ANNEX 34

RESOLUTION MSC.192(79)
(adopted on 6 December 2004)

ADOPTION OF THE REVISED PERFORMANCE STANDARDS FOR RADAR EQUIPMENT

THE MARITIME SAFETY COMMITTEE,

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

RECALLING ALSO resolution A.886(21) by which the Assembly resolved that the functions of adopting performance standards and technical specifications, as well as amendments thereto, shall be performed by the Maritime Safety Committee on behalf of the Organization,

NOTING resolutions A.222(VII), A.278(VIII), A.477(XII), MSC.64(67), annex 4, A.820(19) and A.823(19) containing performance standards applicable to marine radars being produced and installed at different time periods in the past,

NOTING ALSO that marine radars are used in connection/integration with other navigational equipment required to carry on board ships such as, an automatic target tracking aid, ARPA, AIS, ECDIS and others,

RECOGNIZING the need for unification of maritime radar standards in general, and, in particular, for display and presentation of navigation-related information,

HAVING CONSIDERED the recommendation on the revised performance standards for radar equipment made by the Sub-Committee on Safety of Navigation at its fiftieth session,

1. ADOPTS the Revised Recommendation on Performance Standards for radar equipment set out in the Annex to the present resolution;

2. RECOMMENDS Governments to ensure that radar equipment installed on or after 1 July 2008 conform to performance standards not inferior to those set out in the Annex to the present resolution.

ANNEX

REVISED RECOMMENDATION ON PERFORMANCE STANDARDS FOR RADAR EQUIPMENT

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1 SCOPE OF EQUIPMENT

The radar equipment should assist in safe navigation and in avoiding collision by providing an indication, in relation to own ship, of the position of other surface craft, obstructions and hazards, navigation objects and shorelines.

For this purpose, radar should provide the integration and display of radar video, target tracking information, positional data derived from own ship's position (EPFS) and geo referenced data. The integration and display of AIS information should be provided to complement radar. The capability of displaying selected parts of Electronic Navigation Charts and other vector chart information may be provided to aid navigation and for position monitoring.

The radar, combined with other sensor or reported information (e.g. AIS), should improve the safety of navigation by assisting in the efficient navigation of ships and protection of the environment by satisfying the following functional requirements:

- in coastal navigation and harbour approaches, by giving a clear indication of land and other fixed hazards;

- as a means to provide an enhanced traffic image and improved situation awareness;

- in a ship-to-ship mode for aiding collision avoidance of both detected and reported hazards;

- in the detection of small floating and fixed hazards, for collision avoidance and the safety of own ship; and

- in the detection of floating and fixed aids to navigation (see Table 2, note 3).

2 APPLICATION OF THESE STANDARDS

These Performance Standards should apply to all shipborne radar installations, used in any configuration, mandated by the 1974 SOLAS Convention, as amended, independent of the:

- type of ship;

- frequency band in use; and

- type of display,

providing that no special requirements are specified in Table 1 and that additional requirements for specific classes of ships (in accordance with SOLAS chapters V and X) are met.

The radar installation, in addition to meeting the general requirements as set out in resolution A.694(17)*, should comply with the following performance standards.

* IEC Publication 60945.

Close interaction between different navigational equipment and systems, makes it essential to consider these standards in association with other relevant IMO standards.

TABLE 1

Differences in the performance requirements for various sizes/categories of ship/craft to which SOLAS applies

Size of ship/craft	<500 gt	500 gt to <10,000 gt and HSC<10,000 gt	All ships/craft ≥10,000 gt
Minimum operational display area diameter	180 mm	250 mm	320 mm
Minimum display area	195 x 195 mm	270 x 270 mm	340 x 340 mm
Auto acquisition of targets	-	-	Yes
Minimum ***acquired*** radar target capacity	20	30	40
Minimum ***activated*** AIS target capacity	20	30	40
Minimum ***sleeping*** AIS target capacity	100	150	200
Trial Manoeuvre	-	-	Yes

3 REFERENCES

References are in appendix 1.

4 DEFINITIONS

Definitions are in appendix 2.

5 OPERATIONAL REQUIREMENTS FOR THE RADAR SYSTEM

The design and performance of the radar should be based on user requirements and up-to-date navigational technology. It should provide effective target detection within the safety-relevant environment surrounding own ship and should permit fast and easy situation evaluation.*

5.1 Frequency

5.1.1 *Frequency spectrum*

The radar should transmit within the confines of the ITU allocated bands for maritime radar and meet the requirements of the radio regulations and applicable ITU-R recommendations.

* Refer to MSC/Circ.878 - MEPC/Circ.346 on Interim Guidelines for the application of Human Element Analysing Process (HEAP) to the IMO rule-making process.

5.1.2 *Radar Sensor Requirements*

Radar systems of both X and S-Bands are covered in these performance standards:

- X-Band (9.2-9.5 GHz) for high discrimination, good sensitivity and tracking performance; and

- S-Band (2.9-3.1 GHz) to ensure that target detection and tracking capabilities are maintained in varying and adverse conditions of fog, rain and sea clutter.

The frequency band in use should be indicated.

5.1.3 *Interference susceptibility*

The radar should be capable of operating satisfactorily in typical interference conditions.

5.2 Radar Range and Bearing Accuracy

The radar system range and bearing accuracy requirements should be:

Range - within 30 m or 1% of the range scale in use, whichever is greater;
Bearing - within 1°.

5.3 Detection Performance and Anti-clutter Functions

All available means for the detection of targets should be used.

5.3.1 *Detection*

5.3.1.1 *Detection in Clear Conditions*

In the absence of clutter, for long range target and shoreline detection, the requirement for the radar system is based on normal propagation conditions, in the absence of sea clutter, precipitation and evaporation duct, with an antenna height of 15 m above sea level.

Based on:

- an indication of the target in at least 8 out of 10 scans or equivalent; and

- a probability of a radar detection false alarm of 10^{-4},

the requirement contained in Table 2 should be met as specified for X-Band and S-Band equipment.

The detection performance should be achieved using the smallest antenna that is supplied with the radar system.

Recognizing the high relative speeds possible between own ship and target, the equipment should be specified and approved as being suitable for classes of ship having normal (<30 kn) or high (>30 kn) own ship speeds (100 kn and 140 kn relative speeds respectively).

TABLE 2

Minimum detection ranges in clutter-free conditions

Target Description	Target Feature	Detection Range in NM[6]	
Target description[5]	Height above sea level in metres	X-Band NM	S-Band NM
Shorelines	Rising to 60	20	20
Shorelines	Rising to 6	8	8
Shorelines	Rising to 3	6	6
SOLAS ships (>5,000 gross tonnage)	10	11	11
SOLAS ships (>500 gross tonnage)	5.0	8	8
Small vessel with radar reflector meeting IMO Performance Standards[1]	4.0	5.0	3.7
Navigation buoy with corner reflector[2]	3.5	4.9	3.6
Typical Navigation buoy[3]	3.5	4.6	3.0
Small vessel of length 10 m with no radar reflector[4]	2.0	3.4	3.0

5.3.1.2 ***Detection at Close Range***

The short-range detection of the targets under the conditions specified in Table 2 should be compatible with the requirement in paragraph 5.4.

5.3.1.3 ***Detection in Clutter Conditions***

Performance limitations caused by typical precipitation and sea clutter conditions will result in a reduction of target detection capabilities relative to those defined in 5.3.1.1 and Table 2.

5.3.1.3.1 The radar equipment should be designed to provide the optimum and most consistent detection performance, restricted only by the physical limits of propagation.

5.3.1.3.2 The radar system should provide the means to enhance the visibility of targets in adverse clutter conditions at close range.

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1 IMO revised performance standards for radar reflectors (resolution MSC.164(78)) – Radar Cross Section (RCS) 7.5 m^2 for X-Band, 0.5 m^2 for S-Band.

2 The corner reflector (used for measurement), is taken as 10 m^2 for X-Band and 1.0 m^2 for S-Band.

3 The typical navigation buoy is taken as 5.0 m^2 for X-Band and 0.5 m^2 for S-Band; for typical channel markers, with an RCS of 1.0 m^2 (X-band) and 0.1 m^2 (S-band) and height of 1 metre, a detection range of 2.0 and 1.0 NM respectively.

4 RCS for 10 m small vessel taken as 2.5 m^2 for X-Band and 1.4 m^2 for S-Band (taken as a complex target).

5 Reflectors are taken as point targets, vessels as complex targets and shorelines as distributed targets (typical values for a rocky shoreline, but are dependent on profile).

6 Detection ranges experienced in practice will be affected by various factors, including atmospheric conditions (e.g. evaporation duct), target speed and aspect, target material and target structure. These and other factors may either enhance or degrade the detection ranges stated. At ranges between the first detection and own ship, the radar return may be reduced or enhanced by signal multi-path, which depend on factors such as antenna/target centroid height, target structure, sea state and radar frequency band.

5.3.1.3.3 Degradation of detection performance (related to the figures in Table 2) at various ranges and target speeds under the following conditions, should be clearly stated in the user manual:

- light rain (4 mm per hour) and heavy rain (16 mm per hour);
- sea state 2 and sea state 5; and
- and a combination of these.

5.3.1.3.4 The determination of performance in clutter and specifically, range of first detection, as defined in the clutter environment in 5.3.1.3.3, should be tested and assessed against a benchmark target, as specified in the Test Standard.

5.3.1.3.5 Degradation in performance due to a long transmission line, antenna height or any other factors should be clearly stated in the user manual.

5.3.2 *Gain and Anti-Clutter Functions*

5.3.2.1 Means should be provided, as far as is possible, for the adequate reduction of unwanted echoes, including sea clutter, rain and other forms of precipitation, clouds, sandstorms and interference from other radars.

5.3.2.2 A gain control function should be provided to set the system gain or signal threshold level.

5.3.2.3 Effective manual and automatic anti-clutter functions should be provided.

5.3.2.4 A combination of automatic and manual anti-clutter functions is permitted.

5.3.2.5 There should be a clear and permanent indication of the status and level for gain and all anti-clutter control functions.

5.3.3 *Signal Processing*

5.3.3.1 Means should be available to enhance target presentation on the display.

5.3.3.2 The effective picture update period should be adequate, with minimum latency to ensure that the target detection requirements are met.

5.3.3.3 The picture should be updated in a smooth and continuous manner.

5.3.3.4 The equipment manual should explain the basic concept, features and limitations of any signal processing.

5.3.4 *Operation with SARTs and Radar Beacons*

5.3.4.1 The X-Band radar system should be capable of detecting radar beacons in the relevant frequency band.

5.3.4.2 The X-Band radar system should be capable of detecting SARTs and radar target enhancers.

5.3.4.3 It should be possible to switch off those signal processing functions, including polarization modes, which might prevent an X-Band radar beacon or SARTs from being detected and displayed. The status should be indicated.

5.4 Minimum Range

5.4.1 With own ship at zero speed, an antenna height of 15 m above the sea level and in calm conditions, the navigational buoy in Table 2 should be detected at a minimum horizontal range of 40 m from the antenna position and up to a range of 1 NM, without changing the setting of control functions other than the range scale selector.

5.4.2 Compensation for any range error should be automatically applied for each selected antenna, where multiple antennas are installed.

5.5 Discrimination

Range and bearing discrimination should be measured in calm conditions, on a range scale of 1.5 NM or less and at between 50% and 100% of the range scale selected:

5.5.1 *Range*

The radar system should be capable of displaying two point targets on the same bearing, separated by 40 m in range, as two distinct objects.

5.5.2 *Bearing*

The radar system should be capable of displaying two point targets at the same range, separated by 2.5° in bearing, as two distinct objects.

5.6 Roll and Pitch

The target detection performance of the equipment should not be substantially impaired when own ship is rolling or pitching up to +/-10°.

5.7 Radar Performance Optimization and Tuning

5.7.1 Means should be available to ensure that the radar system is operating at the best performance. Where applicable to the radar technology, manual tuning should be provided and additionally, automatic tuning may be provided.

5.7.2 An indication should be provided, in the absence of targets, to ensure that the system is operating at the optimum performance.

5.7.3 Means should be available (automatically or by manual operation) and while the equipment is operational, to determine a significant drop in system performance relative to a calibrated standard established at the time of installation.

5.8 Radar Availability

The radar equipment should be fully operational (RUN status) within 4 minutes after switch ON from cold. A STANDBY condition should be provided, in which there is no operational radar transmission. The radar should be fully operational within 5 sec from the standby condition.

5.9 Radar Measurements – Consistent Common Reference Point (CCRP)

5.9.1 Measurements from own ship (e.g. range rings, target range and bearing, cursor, tracking data) should be made with respect to the consistent common reference point (e.g. conning position). Facilities should be provided to compensate for the offset between antenna position and the consistent common reference point on installation. Where multiple antennas are installed, there should be provision for applying different position offsets for each antenna in the radar system. The offsets should be applied automatically when any radar sensor is selected.

5.9.2 Own ship's scaled outline should be available on appropriate range scales. The consistent common reference point and the position of the selected radar antenna should be indicated on this graphic.

5.9.3 When the picture is centred, the position of the Consistent Common Reference Point should be at the centre of the bearing scale. The off-centre limits should apply to the position of the selected antenna.

5.9.4 Range measurements should be in nautical miles (NM). In addition, facilities for metric measurements may be provided on lower range scales. All indicated values for range measurement should be unambiguous.

5.9.5 Radar targets should be displayed on a linear range scale and without a range index delay.

5.10 Display Range Scales

5.10.1 Range scales of 0.25, 0.5, 0.75, 1.5, 3, 6, 12 and 24 NM should be provided. Additional range scales are permitted outside the mandatory set. Low metric range scales may be offered in addition to the mandatory set.

5.10.2 The range scale selected should be permanently indicated.

5.11 Fixed Range Rings

5.11.1 An appropriate number of equally spaced range rings should be provided for the range scale selected. When displayed, the range ring scale should be indicated.

5.11.2 The system accuracy of fixed range rings should be within 1% of the maximum range of the range scale in use or 30 m, whichever is the greater distance.

5.12 Variable Range Markers (VRM)

5.12.1 At least two variable range markers (VRMs) should be provided. Each active VRM should have a numerical readout and have a resolution compatible with the range scale in use.

5.12.2 The VRMs should enable the user to measure the range of an object within the operational display area with a maximum system error of 1% of the range scale in use or 30 m, whichever is the greater distance.

5.13 Bearing Scale

5.13.1 A bearing scale around the periphery of the operational display area should be provided. The bearing scale should indicate the bearing as seen from the consistent common reference point.

5.13.2 The bearing scale should be outside of the operational display area. It should be numbered at least every 30° division and have division marks of at least 5°. The 5° and 10° division marks should be clearly distinguishable from each other. 1° division marks may be presented where they are clearly distinguishable from each other.

5.14 Heading Line (HL)

5.14.1 A graphic line from the consistent common reference point to the bearing scale should indicate the heading of the ship.

5.14.2 Electronic means should be provided to align the heading line to within 0.1°. If there is more than one radar antenna (see 5.35) the heading skew (bearing offset) should be retained and automatically applied when each radar antenna is selected.

5.14.3 Provision should be made to temporarily suppress the heading line. This function may be combined with the suppression of other graphics.

5.15 Electronic Bearing Lines (EBLs)

5.15.1 At least two electronic bearing lines (EBLs) should be provided to measure the bearing of any point object within the operational display area, with a maximum system error of 1° at the periphery of the display.

5.15.2 The EBLs should be capable of measurement relative to the ships heading and relative to true north. There should be a clear indication of the bearing reference (i.e. true or relative).

5.15.3 It should be possible to move the EBL origin from the consistent common reference point to any point within the operational display area and to reset the EBL to the consistent common reference point by a fast and simple action.

5.15.4 It should be possible to fix the EBL origin or to move the EBL origin at the velocity of own ship.

5.15.5 Means should be provided to ensure that the user is able to position the EBL smoothly in either direction, with an incremental adjustment adequate to maintain the system measurement accuracy requirements.

5.15.6 Each active EBL should have a numerical readout with a resolution adequate to maintain the system measurement accuracy requirements.

5.16 Parallel Index lines (PI)

5.16.1 A minimum of four independent parallel index lines, with a means to truncate and switch off individual lines, should be provided.

5.16.2 Simple and quick means of setting the bearing and beam range of a parallel index line should be provided. The bearing and beam range of any selected index line should be available on demand.

5.17 Offset Measurement of Range and Bearing

There should be a means to measure the range and bearing of one position on the display relative to any other position within the operational display area.

5.18 User Cursor

5.18.1 A user cursor should be provided to enable a fast and concise means to designate any position on the operational display area.

5.18.2 The cursor position should have a continuous readout to provide the range and bearing, measured from the consistent common reference point, and/or the latitude and longitude of the cursor position presented either alternatively or simultaneously.

5.18.3 The cursor should provide the means to select and de-select targets, graphics or objects within the operational display area. In addition, the cursor may be used to select modes, functions, vary parameters and control menus outside of the operational display area.

5.18.4 Means should be provided to easily locate the cursor position on the display.

5.18.5 The accuracy of the range and bearing measurements provided by the cursor should meet the relevant requirements for VRM and EBL.

5.19 Azimuth Stabilization

5.19.1 The heading information should be provided by a gyrocompass or by an equivalent sensor with a performance not inferior to the relevant standards adopted by the Organization.

5.19.2 Excluding the limitations of the stabilizing sensor and type of transmission system, the accuracy of azimuth alignment of the radar presentation should be within 0.5° with a rate of turn likely to be experienced with the class of ship.

5.19.3 The heading information should be displayed with a numerical resolution to permit accurate alignment with the ship gyro system.

5.19.4 The heading information should be referenced to the consistent common reference point (CCRP).

5.20 Display Mode of the Radar Picture

5.20.1 A True Motion display mode should be provided. The automatic reset of own ship may be initiated by its position on the display, or time related, or both. Where the reset is selected to occur at least on every scan or equivalent, this should be equivalent to True Motion with a fixed origin (in practice equivalent to the previous relative motion mode).

5.20.2 North Up and Course Up orientation modes should be provided. Head Up may be provided when the display mode is equivalent to True Motion with a fixed origin (in practice equivalent to the previous relative motion Head Up mode).

5.20.3 An indication of the motion and orientation mode should be provided.

5.21 Off-Centring

5.21.1 Manual off-centring should be provided to locate the selected antenna position at any point within at least 50% of the radius from the centre of the operational display area.

5.21.2 On selection of off-centred display, the selected antenna position should be capable of being located to any point on the display up to at least 50%, and not more than 75%, of the radius from the centre of the operational display area. A facility for automatically positioning own ship for the maximum view ahead may be provided.

5.21.3 In True Motion, the selected antenna position should automatically reset up to a 50% radius to a location giving the maximum view along own ship's course. Provision for an early reset of selected antenna position should be provided.

5.22 Ground and Sea Stabilization Modes

5.22.1 Ground and Sea stabilization modes should be provided.

5.22.2 The stabilization mode and stabilization source should be clearly indicated.

5.22.3 The source of own ships' speed should be indicated and provided by a sensor approved in accordance with the requirements of the Organization for the relevant stabilization mode.

5.23 Target Trails and Past Positions

5.23.1 Variable length (time) target trails should be provided, with an indication of trail time and mode. It should be possible to select true or relative trails from a reset condition for all true motion display modes.

5.23.2 The trails should be distinguishable from targets.

5.23.3 Either scaled trails or past positions or both, should be maintained and should be available for presentation within 2 scans or equivalent, following:

- the reduction or increase of one range scale;
- the offset and reset of the radar picture position; and
- a change between true and relative trails.

5.24 Presentation of Target Information

5.24.1 Targets should be presented in accordance with the performance standards for the Presentation of Navigation-related Information on Shipborne Navigational Displays adopted by the Organization and with their relevant symbols according to SN/Circ.243.

5.24.2 The target information may be provided by the radar target tracking function and by the reported target information from the Automatic Identification System (AIS).

5.24.3 The operation of the radar tracking function and the processing of reported AIS information is defined in these standards.

5.24.4 The number of targets presented, related to display size, is defined in Table 1. An indication should be given when the target capacity of radar tracking or AIS reported target processing/display capability is about to be exceeded.

5.24.5 As far as practical, the user interface and data format for operating, displaying and indicating AIS and radar tracking information should be consistent.

5.25 Target Tracking (TT) and Acquisition

5.25.1 *General*

Radar targets are provided by the radar sensor (transceiver). The signals may be filtered (reduced) with the aid of the associated clutter controls. Radar targets may be manually or automatically acquired and tracked using an automatic Target Tracking (TT) facility.

5.25.1.1 The automatic target tracking calculations should be based on the measurement of radar target relative position and own ship motion.

5.25.1.2 Any other sources of information, when available, may be used to support the optimum tracking performance.

5.25.1.3 TT facilities should be available on at least the 3, 6, and 12 NM range scales. Tracking range should extend to a minimum of 12 NM.

5.25.1.4 The radar system should be capable of tracking targets having the maximum relative speed relevant to its classification for normal or high own ship speeds (see 5.3).

5.25.2 ***Tracked Target Capacity***

5.25.2.1 In addition to the requirements for processing of targets reported by AIS, it should be possible to track and provide full presentation functionality for a minimum number of tracked radar targets according to Table 1.

5.25.2.2 There should be an indication when the target tracking capacity is about to be exceeded. Target overflow should not degrade the radar system performance.

5.25.3 ***Acquisition***

5.25.3.1 Manual acquisition of radar targets should be provided with provision for acquiring at least the number of targets specified in Table 1.

5.25.3.2 Automatic acquisition should be provided where specified in Table 1. In this case, there should be means for the user to define the boundaries of the auto-acquisition area.

5.25.4 ***Tracking***

5.25.4.1 When a target is acquired, the system should present the trend of the target's motion within one minute and the prediction of the targets' motion within 3 minutes.

5.25.4.2 TT should be capable of tracking and updating the information of all acquired targets automatically.

5.25.4.3 The system should continue to track radar targets that are clearly distinguishable on the display for 5 out of 10 consecutive scans or equivalent.

5.25.4.4 The TT design should be such that target vector and data smoothing is effective, while target manoeuvres should be detected as early as possible.

5.25.4.5 The possibility of tracking errors, including target swap, should be minimized by design.

5.25.4.6 Separate facilities for cancelling the tracking of any one and of all target(s) should be provided.

5.25.4.7 Automatic tracking accuracy should be achieved when the tracked target has achieved a steady state, assuming the sensor errors allowed by the relevant performance standards of the Organization.

5.25.4.7.1 For ships capable of up to 30 kn true speed, the tracking facility should present, within 1 min steady state tracking, the relative motion trend and after 3 minutes, the predicted motion of a target, within the following accuracy values (95% probability):

TABLE 3

Tracked Target Accuracy (95% probability figures)

Time of steady state (minutes)	Relative Course (degrees)	Relative Speed (kn)	CPA (NM)	TCPA (minutes)	True Course (degrees)	True Speed (kn)
1 min: Trend	11	1.5 or 10% (whichever is greater)	1.0	-	-	-
3 min: Motion	3	0.8 or 1% (whichever is greater)	0.3	0.5	5	0.5 or 1% (whichever is greater)

Accuracy may be significantly reduced during or shortly after acquisition, own ship manoeuvre, a manoeuvre of the target, or any tracking disturbance and is also dependent on own ship's motion and sensor accuracy.

Measured target range and bearing should be within 50 m (or +/-1% of target range) and 2°.

The testing standard should have detailed target simulation tests as a means to confirm the accuracy of targets with relative speeds of up to 100 kn. Individual accuracy values shown in the table above may be adapted to account for the relative aspects of target motion with respect to that of own ship in the testing scenarios used.

5.25.4.7.2 For ships capable of speeds in excess of 30 kn (typically High-Speed Craft (HSC)) and with speeds of up to 70 kn, there should be additional steady state measurements made to ensure that the motion accuracy, after 3 minutes of steady state tracking, is maintained with target relative speeds of up to 140 kn.

5.25.4.8 A ground referencing function, based on a stationary tracked target, should be provided. Targets used for this function should be marked with the relevant symbol defined in SN/Circ.243.

5.26 Automatic Identification System (AIS) Reported Targets

5.26.1 *General*

Reported targets provided by the AIS may be filtered according to user-defined parameters. Targets may be sleeping, or may be activated. Activated targets are treated in a similar way to radar tracked targets.

5.26.2 *AIS Target Capacity*

In addition to the requirements for radar tracking, it should be possible to display and provide full presentation functionality for a minimum number of sleeping and activated AIS targets according to Table 1. There should be an indication when the capacity of processing/display of AIS targets is about to be exceeded.

5.26.3 ***Filtering of AIS Sleeping Targets***

To reduce display clutter, a means to filter the presentation of sleeping AIS targets should be provided, together with an indication of the filter status. (e.g. by target range, CPA/TCPA or AIS target class A/B, etc.). It should not be possible to remove individual AIS targets from the display.

5.26.4 ***Activation of AIS Targets***

A means to activate a sleeping AIS target and to deactivate an activated AIS target should be provided. If zones for the automatic activation of AIS targets are provided, they should be the same as for automatic radar target acquisition. In addition, sleeping AIS targets may be automatically activated when meeting user defined parameters (e.g. target range, CPA/TCPA or AIS target class A/B).

5.26.5 ***AIS Presentation Status***

TABLE 4

The AIS presentation status should be indicated as follows:

Function	Cases to be Presented		Presentation
AIS ON/OFF	AIS processing switched ON/ graphical presentation switched OFF	AIS processing switched ON/ graphical presentation switched ON	Alphanumeric or graphical
Filtering of sleeping AIS targets	Filter status	Filter status	Alphanumeric or graphical
Activation of Targets		Activation criteria	Graphical
CPA/TCPA Alarm	Function ON/OFF Sleeping targets included	Function ON/OFF Sleeping targets included	Alphanumeric and graphical
Lost Target Alarm	Function ON/OFF Lost target filter criteria	Function ON/OFF Lost target filter criteria	Alphanumeric and graphical
Target Association	Function ON/OFF Association criteria Default target priority	Function ON/OFF Association criteria Default target priority	Alphanumeric

5.27 AIS Graphical Presentation

Targets should be presented with their relevant symbols according to the performance standards for the Presentation of Navigation-related Information on Shipborne Navigational Displays adopted by the Organization and SN/Circ.243.

5.27.1 AIS targets that are displayed should be presented as sleeping targets by default.

5.27.2 The course and speed of a tracked radar target or reported AIS target should be indicated by a predicted motion vector. The vector time should be adjustable and valid for presentation of any target regardless of its source.

5.27.3 A permanent indication of vector mode, time and stabilization should be provided.

5.27.4 The consistent common reference point should be used for the alignment of tracked radar and AIS symbols with other information on the same display.

5.27.5 On large scale/low range displays, a means to present the true scale outline of an activated AIS target should be provided. It should be possible to display the past track of activated targets.

5.28 AIS and Radar Target Data

5.28.1 It should be possible to select any tracked radar or AIS target for the alphanumeric display of its data. A target selected for the display of its alphanumeric information should be identified by the relevant symbol. If more than one target is selected for data display, the relevant symbols and the corresponding data should be clearly identified. There should be a clear indication to show that the target data is derived from radar or from AIS.

5.28.2 For each selected tracked radar target, the following data should be presented in alphanumeric form: source(s) of data, actual range of target, actual bearing of target, predicted target range at the closest point of approach (CPA), predicted time to CPA (TCPA), true course of target, true speed of target.

5.28.3 For each selected AIS target the following data should be presented in alphanumeric form: Source of data, ship's identification, navigational status, position where available and its quality, range, bearing, COG, SOG, CPA and TCPA. Target heading and reported rate of turn should also be made available. Additional target information should be provided on request.

5.28.4 If the received AIS information is incomplete, the absent information should be clearly indicated as 'missing' within the target data field.

5.28.5 The data should be displayed and continually updated, until another target is selected for data display or until the window is closed.

5.28.6 Means should be provided to present own ship AIS data on request.

5.29 Operational Alarms

A clear indication of the cause for all alarm criteria should be given.

5.29.1 If the calculated CPA and TCPA values of a tracked target or activated AIS target are less than the set limits:

- A CPA/TCPA alarm should be given.
- The target should be clearly indicated.

5.29.2 The preset CPA/TCPA limits applied to targets from radar and AIS should be identical. As a default state, the CPA/TCPA alarm functionality should be applied to all activated AIS targets. On user request the CPA/TCPA alarm functionality may also be applied to sleeping targets.

5.29.3 If a user defined acquisition/activation zone facility is provided, a target not previously acquired/activated entering the zone, or is detected within the zone, should be clearly identified with the relevant symbol and an alarm should be given. It should be possible for the user to set ranges and outlines for the zone.

5.29.4 The system should alert the user if a tracked radar target is lost, rather than excluded by a pre-determined range or pre-set parameter. The target's last position should be clearly indicated on the display.

5.29.5 It should be possible to enable or disable the lost target alarm function for AIS targets. A clear indication should be given if the lost target alarm is disabled.

If the following conditions are met for a lost AIS target:

- The AIS lost target alarm function is enabled.
- The target is of interest, according to lost target filter criteria.
- A message is not received for a set time, depending on the nominal reporting rate of the AIS target.

Then:

- The last known position should be clearly indicated as a lost target and an alarm be given.
- The indication of the lost target should disappear if the signal is received again, or after the alarm has been acknowledged.
- A means of recovering limited historical data from previous reports should be provided.

5.30 AIS and Radar Target Association

An automatic target association function based on harmonized criteria avoids the presentation of two target symbols for the same physical target.

5.30.1 If the target data from AIS and radar tracking are both available and if the association criteria (e.g. position, motion) are fulfilled such that the AIS and radar information are considered as one physical target, then as a default condition, the activated AIS target symbol and the alphanumeric AIS target data should be automatically selected and displayed.

5.30.2 The user should have the option to change the default condition to the display of tracked radar targets and should be permitted to select either radar tracking or AIS alphanumeric data.

5.30.3 For an associated target, if the AIS and radar information become sufficiently different, the AIS and radar information should be considered as two distinct targets and one activated AIS target and one tracked radar target should be displayed. No alarm should be raised.

5.31 Trial Manoeuvre

The system should, where required by table 1, be capable of simulating the predicted effects of own ships manoeuvre in a potential threat situation and should include own ship's dynamic characteristics. A trial manoeuvre simulation should be clearly identified. The requirements are:

- The simulation of own ship course and speed should be variable.
- A simulated time to manoeuvre with a countdown should be provided.
- During simulation, target tracking should continue and the actual target data should be indicated.
- Trial manoeuvre should be applied to all tracked targets and at least all activated AIS targets.

5.32 The Display of Maps, Navigation Lines and Routes

5.32.1 It should be possible for the user to manually create and change, save, load and display simple maps/navigation lines/routes referenced to own ship or a geographical position. It should be possible to remove the display of this data by a simple operator action.

5.32.2 The maps/navigation lines/routes may consist of lines, symbols and reference points.

5.32.3 The appearance of lines, colours and symbols are as defined in SN/Circ.243.

5.32.4 The maps/navigation lines/route graphics should not significantly degrade the radar information.

5.32.5 The maps/navigation lines/routes should be retained when the equipment is switched OFF.

5.32.6 The maps/navigation lines/route data should be transferable whenever a relevant equipment module is replaced.

5.33 The Display of Charts

5.33.1 The radar system may provide the means to display ENC and other vector chart information within the operational display area to provide continuous and real-time position monitoring. It should be possible to remove the display of chart data by a single operator action.

5.33.2 The ENC information should be the primary source of information and should comply with IHO relevant standards. Status of other information should be identified with a permanent indication. Source and update information should be made available.

5.33.3 As a minimum, the elements of the ECDIS Standard Display should be made available for individual selection by category or layer, but not as individual objects.

5.33.4 The chart information should use the same reference and co-ordinate criteria as the radar/AIS, including datum, scale, orientation, CCRP and stabilization mode.

5.33.5 The display of radar information should have priority. Chart information should be displayed such that radar information is not substantially masked, obscured or degraded. Chart information should be clearly perceptible as such.

5.33.6 A malfunction of the source of chart data should not affect the operation of the radar/AIS system.

5.33.7 Symbols and colours should comply with the performance standards for the Presentation of Navigation-related Information on Shipborne Navigational Displays adopted by the Organization (SN/Circ.243).

5.34 Alarms and Indications

Alarms and indications should comply with the performance standards for the Presentation of Navigation-related Information on Shipborne Navigational Displays adopted by the Organization.

5.34.1 A means should be provided to alert the user of "picture freeze".

5.34.2 Failure of any signal or sensor in use, including; gyro, log, azimuth, video, sync and heading marker, should be alarmed. System functionality should be limited to a fall back mode or in some cases, the display presentation should be inhibited (see fallback modes, section 9).

5.35 Integrating Multiple Radars

5.35.1 The system should safeguard against single point system failure. Fail-safe condition should be applied in the event of an integration failure.

5.35.2 The source and any processing or combination of radar signals should be indicated.

5.35.3 The system status for each display position should be available.

6 ERGONOMIC CRITERIA

6.1 Operational Controls

6.1.1 The design should ensure that the radar system is simple to operate. Operational controls should have a harmonized user interface and be easy to identify and simple to use.

6.1.2 The radar system should be capable of being switched ON or OFF at the main system radar display or at a control position.

6.1.3 The control functions may be dedicated hardware, screen accessed or a combination of these; however the primary control functions should be dedicated hardware controls or soft keys, with an associated status indication in a consistent and intuitive position.

6.1.4 The following are defined as primary radar control functions and should be easily and immediately accessible:

Radar Standby/RUN, Range scale selection, Gain, tuning function (if applicable), Anti-clutter rain, Anti-clutter sea, AIS function on/off, Alarm acknowledge, Cursor, a means to set EBL/VRM, display brightness and acquisition of radar targets.

6.1.5 The primary functions may also be operated from a remote operating position in addition to the main controls.

6.2 Display Presentation

6.2.1 The display presentation should comply with the performance standards for the Presentation of Navigation-related Information on Shipborne Navigational Displays adopted by the Organization.

6.2.2 The colours, symbols and graphics presented should comply with SN/Circ.243.

6.2.3 The display sizes should conform to those defined in Table 1.

6.3 Instructions and Documentation

6.3.1 *Documentation Language*

The operating instructions and manufacturer's documentation should be written in a clear and comprehensible manner and should be available at least in the English language.

6.3.2 *Operating Instructions*

The operating instructions should contain a qualified explanation and/or description of information required by the user to operate the radar system correctly, including:

- appropriate settings for different weather conditions;
- monitoring the radar system's performance;
- operating in a failure or fall-back situation;
- limitations of the display and tracking process and accuracy, including any delays;
- using heading and SOG/COG information for collision avoidance;
- limitations and conditions of target association;
- criteria of selection for automatic activation and cancellation of targets;
- methods applied to display AIS targets and any limitations;
- principles underlying the trial manoeuvre technology, including simulation of own ship's manoeuvring characteristics, if provided;
- alarms and indications;
- installation requirements as listed under section 7.5;
- radar range and bearing accuracies; and
- any special operation (e.g. tuning) for the detection of SARTs; and
- the role of the CCRP for radar measurements and its specific value.

6.3.3 *Manufacturer's Documentation*

6.3.3.1 The manufacturer's documentation should contain a description of the radar system and factors that may affect detection performance, including any latency in signal processing.

6.3.3.2 Documentation should describe the basis of AIS filter criteria and AIS/radar target association criteria.

6.3.3.3 The equipment documentation should include full details of installation information, including additional recommendations on unit location and factors that may degrade performance or reliability.

7 DESIGN AND INSTALLATION

7.1 Design for Servicing

7.1.1 As far as is practical, the radar system should be of a design to facilitate simple fault diagnosis and maximum availability.

7.1.2 The radar system should include a means to record the total operational hours for any components with a limited life.

7.1.3 The documentation should describe any routine servicing requirements and should include details of any restricted life components.

7.2 Display

The display device physical requirements should meet those specified in the performance standards for the Presentation of Navigation-related Information on Shipborne Navigational Displays adopted by the Organization (SN/Circ.243) and those specified in Table 1.

7.3 Transmitter Mute

The equipment should provide a mute facility to inhibit the transmission of radar energy over a preset sector. The mute sector should be set up on installation. An indication of sector mute status should be available.

7.4 Antenna

7.4.1 The antenna should be designed to start operating and to continue to operate in relative wind speeds likely to be encountered on the class of ship on which it is installed.

7.4.2 The combined radar system should be capable of providing an appropriate information update rate for the class of ship on which it is installed.

7.4.3 The antenna side lobes should be consistent with satisfying the system performance as defined in this standard.

7.4.4 There should be a means to prevent antenna rotation and radiation during servicing, or while personnel are in the vicinity of up-mast units.

7.5 Radar System Installation

Requirements and guidelines for the radar system installation should be included in the manufacturers' documentation. The following subjects should be covered:

7.5.1 *The Antenna*

Blind sectors should be kept to a minimum, and should not be placed in an arc of the horizon from the right ahead direction to 22.5^{o} abaft the beam and especially should avoid the right ahead direction (relative bearing 000^{o}). The installation of the antenna should be in such a manner that the performance of the radar system is not substantially degraded. The antenna should be mounted clear of any structure that may cause signal reflections, including other antenna and deck structure or cargo. In addition, the height of the antenna should take account of target detection performance relating to range of first detection and target visibility in sea clutter.

7.5.2 *The Display*

The orientation of the display unit should be such that the user is looking ahead, the lookout view is not obscured and there is minimum ambient light on the display.

7.6 Operation and Training

7.6.1 The design should ensure that the radar system is simple to operate by trained users.

7.6.2 A target simulation facility should be provided for training purposes.

8 INTERFACING

8.1 Input Data

The radar system should be capable of receiving the required input information from:

- a gyro-compass or transmitting heading device (THD);
- a speed and distance measuring equipment (SDME);
- an electronic position fixing system (EPFS);
- an Automatic Identification System (AIS); or
- other sensors or networks providing equivalent information acceptable to the Organization.

The radar should be interfaced to relevant sensors required by these performance standards in accordance with recognized international standards.*

8.2 Input Data Integrity and Latency

8.2.1 The radar system should not use data indicated as invalid. If input data is known to be of poor quality this should be clearly indicated.

8.2.2 As far as is practical, the integrity of data should be checked, prior to its use, by comparison with other connected sensors or by testing to valid and plausible data limits.

8.2.3 The latency of processing input data should be minimized.

8.3 Output Data

8.3.1 Information provided by any radar output interface to other systems should be in accordance with international standards*.

8.3.2 The radar system should provide an output of the display data for the voyage data recorder (VDR).

8.3.3 At least one normally closed contact (isolated) should be provided for indicating failure of the radar.

8.3.4 The radar should have a bi-directional interface to facilitate communication so that alarms from the radar can be transferred to external systems and so that audible alarms from the radar can be muted from external systems, the interface should comply with relevant international standards.

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* Refer to IEC publication 61162.

9 BACKUP AND FALLBACK ARRANGEMENTS

In the event of partial failures and to maintain minimum basic operation, the fallback arrangements listed below should be provided. There should be a permanent indication of the failed input information.

9.1 Failure of Heading Information (Azimuth Stabilization)

9.1.1 The equipment should operate satisfactorily in an unstabilized head-up mode.

9.1.2 The equipment should switch automatically to the unstabilized head up mode within 1 minute after the azimuth stabilization has become ineffective.

9.1.3 If automatic anti-clutter processing could prevent the detection of targets in the absence of appropriate stabilization, the processing should switch off automatically within 1 minute after the azimuth stabilization has become ineffective.

9.1.4 An indication should be given that only relative bearing measurements can be used.

9.2 Failure of Speed through the Water Information

A means of manual speed input should be provided and its use clearly indicated.

9.3 Failure of Course and Speed Over Ground Information

The equipment may be operated with course and speed through the water information.

9.4 Failure of Position Input Information

The overlay of chart data and geographically referenced maps should be disabled if only a single Reference Target is defined and used, or the position is manually entered.

9.5 Failure of Radar Video Input Information

In the absence of radar signals, the equipment should display target information based on AIS data. A frozen radar picture should not be displayed.

9.6 Failure of AIS Input Information

In the absence of AIS signals, the equipment should display the radar video and target database.

9.7 Failure of an Integrated or Networked System

The equipment should be capable of operating equivalent to a stand alone system.

Appendix 1 - References

IMO SOLAS chapters IV, V and X	Carriage rules.
IMO resolution A.278(VII)	Supplement to the recommendation on PS for navigational radar equipment.
IMO resolution A.424(XI)	Performance standards for gyro-compasses.
IMO resolution A.477(XII)	Performance standards for radar equipment.
IMO resolution A.694(17)	General Requirements for ship borne radio equipment forming part of the global maritime distress and safety system and for electronically navigational aids.
IMO resolution A.817(19), as amended	Performance Standards for ECDIS.
IMO resolution A.821(19)	Performance standards for gyro-compasses for high-speed craft.
IMO resolution A.824(19)	Performance standards for devices to indicate speed and distance.
IMO resolution MSC.86(70)	Performance standards for INS.
IMO resolution MSC.64(67)	Recommendations on new and amended performance standards (Annex 2 revised by MSC.114(73)).
IMO resolution MSC.112(73)	Revised performance standards for ship borne global positioning (GPS) receiver equipment.
IMO resolution MSC.114(73)	Revised performance standards for ship borne DGPS and DGLONASS maritime radio beacon receiver equipment.
IMO resolution MSC.116(73)	Performance standards for marine transmitting heading devices (THD).
IMO MSC/Circ.982	Guidelines on ergonomic criteria for bridge equipment and layout.
IHO S-52 appendix 2	Colour and symbol specification for ECDIS.
IEC 62388	Radar Test Standard (replacing 60872 and 60936 series of test standards).
IEC 60945	Maritime navigation and radio communication equipment and systems – General requirements – Methods of testing and required test results.
IEC 61162	Maritime navigation and radio communication equipment and systems – Digital interfaces.
IEC 61174	Maritime navigation and radio communication equipment and systems – Electronic chart display and information system (ECDIS) – Operational and performance requirements, methods of testing and required test results.
IEC 62288	Presentation and display of navigation information.
ISO 9000 (all parts)	Quality management/assurance standards.

Appendix 2 – Definitions

Activated AIS target	A target representing the automatic or manual activation of a sleeping target for the display of additional graphically presented information. The target is displayed by an "activated target" symbol including: ● a vector (COG / SOG); ● the heading; and ● ROT or direction of turn indication (if available) to indicate initiated course changes.
Acquisition of a radar target	Process of acquiring a target and initiating its tracking.
Activation of an AIS target	Activation of a sleeping AIS target for the display of additional graphical and alphanumerical information.
Acquired radar target	Automatic or manual acquisition initiates radar tracking. Vectors and past positions are displayed when data has achieved a steady state condition.
AIS	Automatic Identification System.
AIS target	A target generated from an AIS message**.** See activated target, lost target, selected target and sleeping target.
Associated target	If an acquired radar target and an AIS reported target have similar parameters (e.g. position, course, speed) complying with an association algorithm, they are considered to be the same target and become an associated target.
Acquisition/activation zone	A zone set up by the operator in which the system should automatically acquire radar targets and activate reported AIS targets when entering the zone.
CCRP	Consistent Common Reference Point: A location on own ship, to which all horizontal measurements such as target range, bearing, relative course, relative speed, closest point of approach (CPA) or time to closest point of approach (TCPA) are referenced, typically the conning position of the bridge.
CPA/TCPA	Closest Point of Approach / Time to the Closest Point of Approach: Distance to the closest point of approach (CPA) and time to the closest point of approach (TCPA). Limits are set by the operator related to own ship.
Course Over Ground (COG)	Direction of the ship's movement relative to the earth, measured on board the ship, expressed in angular units from true north.

Course Through Water (CTW)	Direction of the ship's movement through the water, defined by the angle between the meridian through its position and the direction of the ship's movement through the water, expressed in angular units from true north.
Dangerous target	A target whose predicted CPA and TCPA are violating the values as preset by the operator. The respective target is marked by a "dangerous target" symbol.
Display modes	**Relative motion:** means a display on which the position of own ship remains fixed, and all targets move relative to own ship. **True motion:** a display across which own ship moves with its own true motion.
Display orientation	**North up display:** an azimuth stabilized presentation which uses the gyro input (or equivalent) and north is uppermost on the presentation. **Course up display:** an azimuth stabilized presentation which uses the gyro input or equivalent and the ship's course is uppermost on the presentation at the time of selection. **Head up display:** an unstabilized presentation in which own ship's heading is uppermost on the presentation.
ECDIS	Electronic Chart Display and Information System.
ECDIS Display Base	The level of information which cannot be removed from the ECDIS display, consisting of information which is required at all times in all geographic areas and all circumstances. It is not intended to be sufficient for safe navigation.
ECDIS Standard Display	The level of information that should be shown when a chart is first displayed on ECDIS. The level of the information it provides for route planning or route monitoring may be modified by the mariner according to the mariner's needs.
ENC	Electronic Navigational Chart. The database standardized as to content, structure and format according to relevant IHO standards and issued by, or on the authority of, a Government.
EPFS	Electronic Position Fixing System.
ERBL	Electronic bearing line carrying a marker, which is combined with the range marker, used to measure range and bearing from own ship or between two objects.

Evaporation duct	A low lying duct (a change in air density) that traps the radar energy so that it propagates close to the sea surface. Ducting may enhance or reduce radar target detection ranges.
Heading	Direction in which the bow of a ship is pointing expressed as an angular displacement from north.
HSC	High-speed craft (HSC) are vessels which comply with the definition in SOLAS for high speed craft.
Latency	The delay between actual and presented data.
Lost AIS target	A target representing the last valid position of an AIS target before the reception of its data was lost. The target is displayed by a "lost AIS target" symbol.
Lost tracked target	Target information is no longer available due to poor, lost or obscured signals. The target is displayed by a "lost tracked radar target" symbol.
Maps/Nav lines	Operator defined or created lines to indicate channels, Traffic Separation Schemes or borders of any area important for navigation.
Operational display area	Area of the display used to graphically present chart and radar information, excluding the user dialogue area. On the chart display this is the area of the chart presentation. On the radar display this is the area encompassing the radar image.
Past positions	Equally time-spaced past position marks of a tracked or reported target and own ship. The past positions' track may be either relative or true.
Radar	(**Ra**dio **d**irection **a**nd **r**anging). A radio system that allows the determination of distance and direction of reflecting objects and of transmitting devices.
Radar beacon	A navigation aid which responds to the radar transmission by generating a radar signal to identify its position and identity.
Radar detection false alarm	The probability of a radar false alarm represents the probability that noise will cross the detection threshold and be called a target when only noise is present.
Radar target	Any object fixed or moving whose position and motion is determined by successive radar measurements of range and bearing.

Radar target enhancer	An electronic radar reflector, the output of which is an amplified version of the received radar pulse without any form of processing except limiting.
Reference target	Symbol indicating that the associated tracked stationary target (e.g. a navigational mark) is used as a speed reference for the ground stabilization.
Relative bearing	Direction of a target's position from own ship's reference location expressed as an angular displacement from own ship's heading.
Relative course	Direction of motion of a target relative to own ship's direction. (Bearing).
Relative motion	Combination of relative course and relative speed.
Relative speed	Speed of a target relative to own ship's speed data.
Rate of turn	Change of heading per time unit.
SART	Search And Rescue Transponder.
SDME	Speed and Distance Measuring Equipment.
Selected target	A manually selected target for the display of detailed alphanumeric information in a separate data display area. The target is displayed by a "selected target" symbol.
Sleeping AIS target	A target indicating the presence and orientation of a vessel equipped with AIS in a certain location. The target is displayed by a "sleeping target" symbol. No additional information is presented until activated.
Stabilization modes	**Ground stabilization:** Display mode in which speed and course information are referred to the ground, using ground track input data, or EPFS as reference. **Sea stabilization:** Display mode in which speed and course information are referred to the sea, using gyro or equivalent and water speed log input as reference.
Standard display	The level of information that should be shown when a chart is first displayed on ECDIS. The level of the information it provides for route planning or route monitoring may be modified by the mariner according to the mariner's needs.
Standard radar reflector	Reference reflector mounted 3.5 m above sea level with 10 m^2 effective reflecting area at X-Band.

Steady state tracking	Tracking a target, proceeding at steady motion: - after completion of the acquisition process, or - without a manoeuvre of target or own ship, or - without target swap or any disturbance.
Speed Over Ground (SOG)	Speed of the ship relative to the earth, measured on board of the ship.
Speed Through Water	Speed of the ship relative to the water surface.
SOLAS	International Convention for the Safety of Life at Sea.
Suppressed area	An area set up by the operator within which targets are not acquired.
Target swap	Situation in which the incoming radar data for a tracked target becomes incorrectly associated with another tracked target or a non-tracked radar echo.
Target's predicted motion	Prediction of a target's future course and speed based on linear extrapolation from its present motion as determined by past measurements of its range and bearing on the radar.
Target Tracking (TT)	Computer process of observing the sequential changes in the position of a radar target in order to establish its motion. Such a target is a Tracked Target.
Trails	Tracks displayed by the radar echoes of targets in the form of an afterglow. Trails may be true or relative.
Trial manoeuvre	Graphical simulation facility used to assist the operator to perform a proposed manoeuvre for navigation and collision avoidance purposes, by displaying the predicted future status of at least all acquired or activated targets as a result of own ship's simulated manoeuvres.
True bearing	Direction of a target from own ship's reference location or from another target's position expressed as an angular displacement from true north.
True course	Direction of motion relative to ground or to sea, of a target expressed as an angular displacement from north.
True motion	Combination of true course and true speed.
True speed	Speed of a target relative to ground, or to sea.

Vector modes	**True vector:** Vector representing the predicted true motion of a target, showing course and speed with reference to the ground. **Relative vector:** Predicted movement of a target relative to own ship's motion.
User configured presentation	A display presentation configured by the user for a specific task at hand. The presentation may include radar and/or chart information, in combination with other navigation or ship related data.
User dialogue area	Is an area of the display consisting of data fields and/or menus that is allocated to the interactive presentation and entry or selection of operational parameters, data and commands mainly in alphanumeric form.

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ANNEX 35

DRAFT AMENDMENTS TO SOLAS REGULATION V/19

CHAPTER V

SAFETY OF NAVIGATION

Regulation 19 – Carriage requirements for shipborne navigational systems and equipment

1 The following new subparagraph .8 is added to paragraph 2.4:

".8 The information provided through the AIS shall be presented to the OOW."

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ANNEX 36

DRAFT AMENDMENTS TO SOLAS REGULATION V/22

CHAPTER V

SAFETY OF NAVIGATION

Regulation 22 – Navigation bridge visibility

1 The following new paragraph 4 is added after existing paragraph 3:

"4 Notwithstanding the requirements of paragraphs 1.1, 1.3, 1.4 and 1.5, ballast water exchange may be undertaken provided that:

.1 the master has determined that it is safe to do so and takes into consideration any increased blind sectors or reduced horizontal fields of vision resulting from the operation to ensure that a proper lookout is maintained at all times;

.2 the operation is conducted in accordance with the ship's ballast water management plan, taking into account the recommendations on ballast water exchange adopted by the Organization; and

.3 the commencement and termination of the operation are recorded in the ship's record of navigational activities pursuant to regulation 28."

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ANNEX 37

DRAFT REVISED SOLAS CHAPTER II-1 PARTS A, B AND B-1

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

"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 [*date to be inserted*].

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 *all ships* means ships constructed before, on or after [*date to be inserted*];

.3 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;

.4 the expression *alterations and modifications of a major character* means, in the context of cargo ship subdivision and stability, any modification to the construction which affects the level of subdivision of that ship. Where a cargo ship is subject to such modification, it shall be demonstrated that the A/R ratio calculated for the ship after such modifications is not less than the A/R ratio calculated for the ship before the modification. However, in those cases where the ship's A/R ratio before modification is equal to or greater than unity, it is only necessary that the ship after modification has an 'A' value which is not less than 'R', calculated for the modified ship.

2 Unless expressly provided otherwise, for ships constructed before [*date to be inserted*], the Administration shall 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) and MSC.134(76) 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.

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.

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.

2 *Mid-length* is the mid-point of the subdivision length of the ship.

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.

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 mid-length to the waterline in question.

10 *Deepest subdivision draught (d_s)* is the waterline which corresponds to 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 onboard.

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 terminals respectively, disregarding any rake of keel.

14 *Permeability (μ)* 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 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.

The bulkhead deck may be a stepped deck. In a cargo ship the freeboard deck may be taken as the bulkhead deck.

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 1 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 cargo spaces or special category spaces as defined in regulation II-2/3.

24 *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 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.

25 *Amidship* is at the middle of the length (L).

Regulation 3
Definitions relating to parts C, D and E

1 *Steering gear control system* is the equipment by which orders are transmitted from the navigating bridge to the steering gear power units. Steering gear control systems comprise transmitters, receivers, hydraulic control pumps and their associated motors, motor controllers, piping and cables.

2 *Main steering gear* is the machinery, rudder actuators, steering gear, power units, if any, and ancillary equipment and the means of applying torque to the rudder stock (e.g. tiller or quadrant) necessary for effecting movement of the rudder for the purpose of steering the ship under normal service conditions.

3 *Steering gear power unit* is:

.1 in the case of electric steering gear, an electric motor and its associated electrical equipment;

.2 in the case of electrohydraulic steering gear, an electric motor and its associated electrical equipment and connected pump;

.3 in the case of other hydraulic steering gear, a driving engine and connected pump.

4 *Auxiliary steering gear* is the equipment other than any part of the main steering gear necessary to steer the ship in the event of failure of the main steering gear but not including the tiller, quadrant or components serving the same purpose.

5 *Normal operational and habitable condition* is a condition under which the ship as a whole, the machinery, services, means and aids ensuring propulsion, ability to steer, safe navigation, fire and flooding safety, internal and external communications and signals, means of escape, and emergency boat winches, as well as the designed comfortable conditions of habitability are in working order and functioning normally.

6 *Emergency condition* is a condition under which any services needed for normal operational and habitable conditions are not in working order due to failure of the main source of electrical power.

7 *Main source of electrical power* is a source intended to supply electrical power to the main switchboard for distribution to all services necessary for maintaining the ship in normal operational and habitable conditions.

8 *Dead ship condition* is the condition under which the main propulsion plant, boilers and auxiliaries are not in operation due to the absence of power.

9 *Main generating station* is the space in which the main source of electrical power is situated.

10 *Main switchboard* is a switchboard which is directly supplied by the main source of electrical power and is intended to distribute electrical energy to the ship's services.

11 *Emergency switchboard* is a switchboard which in the event of failure of the main electrical power supply system is directly supplied by the emergency source of electrical power or the transitional source of emergency power and is intended to distribute electrical energy to the emergency services.

12 *Emergency source of electrical power* is a source of electrical power, intended to supply the emergency switchboard in the event of a failure of the supply from the main source of electrical power.

13 *Power actuating system* is the hydraulic equipment provided for supplying power to turn the rudder stock, comprising a steering gear power unit or units, together with the associated pipes and fittings, and a rudder actuator. The power actuating systems may share common mechanical components, i.e., tiller, quadrant and rudder stock, or components serving the same purpose.

14 *Maximum ahead service speed* is the greatest speed which the ship is designed to maintain in service at sea at the deepest sea-going draught.

15 *Maximum astern speed* is the speed which it is estimated the ship can attain at the designed maximum astern power at the deepest sea-going draught.

16 *Machinery spaces* are all machinery spaces of category A and all other spaces containing propelling machinery, boilers, oil fuel units, steam and internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air conditioning machinery, and similar spaces, and trunks to such spaces.

17 *Machinery spaces of category A* are those spaces and trunks to such spaces which contain:

.1 internal combustion machinery used for main propulsion; or

.2 internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW; or

.3 any oil-fired boiler or oil fuel unit.

18 *Control stations* are those spaces in which the ship's radio or main navigating equipment or the emergency source of power is located or where the fire recording or fire control equipment is centralized.

19 *Chemical tanker* is a cargo ship constructed or adapted and used for the carriage in bulk of any liquid product listed in either:

.1 chapter 17 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk adopted by the Maritime Safety Committee by resolution MSC.4(48), hereinafter referred to as "the International Bulk Chemical Code", as may be amended by the Organization; or

.2 chapter VI of the Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk adopted by the Assembly of the Organization by resolution A.212(VII), hereinafter referred to as "the Bulk Chemical Code", as has been or may be amended by the Organization,

whichever is applicable.

20 *Gas carrier* is a cargo ship constructed or adapted and used for the carriage in bulk of any liquefied gas or other products listed in either:

.1 chapter 19 of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk adopted by the Maritime Safety Committee by resolution MSC.5(48), hereinafter referred to as "the International Gas Carrier Code", as may be amended by the Organization; or

.2 chapter XIX of the Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk adopted by the Organization by resolution A.328(IX), hereinafter referred to as "the Gas Carrier Code", as has been or may be amended by the Organization;

whichever is applicable.

Part A-1
Structure of ships

Regulation 3-1
Structural, mechanical and electrical requirements for ships
(This regulation applies to ships constructed on or after 1 July 1986)

In addition to the requirements contained elsewhere in the present regulations, ships shall be designed, constructed and maintained in compliance with the structural, mechanical and electrical requirements of a classification society which is recognized by the Administration in accordance with the provisions of regulation XI/1, or with applicable national standards of the Administration which provide an equivalent level of safety.

Regulation 3-2
Corrosion prevention of seawater ballast tanks in oil tankers and bulk carriers
(This regulation applies to oil tankers and bulk carriers constructed on or after 1 July 1998)

All dedicated seawater ballast tanks shall have an efficient corrosion prevention system, such as hard protective coatings or equivalent. The coatings should preferably be of a light colour. The scheme for the selection, application and maintenance of the system shall be approved by the Administration, based on the guidelines adopted by the Organization.* Where appropriate, sacrificial anodes shall also be used.

Regulation 3-3
Safe access to tanker bows

1 For the purpose of this regulation and regulation 3-4, tankers include oil tankers as defined in regulation 2, chemical tankers as defined in regulation VII/8.2 and gas carriers as defined in regulation VII/11.2.

2 Every tanker shall be provided with the means to enable the crew to gain safe access to the bow even in severe weather conditions. Such means of access shall be approved by the Administration based on the guidelines developed by the Organization.**

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* Refer to the Guidelines for the selection, application and maintenance of corrosion prevention systems of dedicated seawater ballast tanks, adopted by the Organization by resolution A.798(19).

** Refer to the Guidelines for safe access to tanker bows, adopted by the Maritime Safety Committee by resolution MSC.62(67).

Regulation 3-4

Emergency towing arrangements on tankers

1 Emergency towing arrangements shall be fitted at both ends on board every tanker of not less than 20,000 tonnes deadweight.

2 For tankers constructed on or after 1 July 2002:

.1 the arrangements shall, at all times, be capable of rapid deployment in the absence of main power on the ship to be towed and easy connection to the towing ship. At least one of the emergency towing arrangements shall be pre-rigged ready for rapid deployment; and

.2 emergency towing arrangements at both ends shall be of adequate strength taking into account the size and deadweight of the ship, and the expected forces during bad weather conditions. The design and construction and prototype testing of the emergency towing arrangements shall be approved by the Administration, based on the Guidelines developed by the Organization.

3 For tankers constructed before 1 July 2002, the design and construction of emergency towing arrangements shall be approved by the Administration, based on the Guidelines developed by the Organization.*

Regulation 3-5

New installation of materials containing asbestos

1 This regulation shall apply to materials used for the structure, machinery, electrical installations and equipment covered by the present Convention.

2 For all ships, new installation of materials which contain asbestos shall be prohibited except for:

.1 vanes used in rotary vane compressors and rotary vane vacuum pumps;

.2 watertight joints and linings used for the circulation of fluids when, at high temperature (in excess of 350ºC) or pressure (in excess of 7×10^6 Pa), there is a risk of fire, corrosion or toxicity; and

.3 supple and flexible thermal insulation assemblies used for temperatures above 1000ºC.

* Refer to the Guidelines on emergency towing arrangements for tankers, adopted by the Maritime Safety Committee by resolution MSC.35(63), as may be amended.

Regulation 3-6*

Access to and within spaces in the cargo area of oil tankers and bulk carriers

1 Application

1.1 Except as provided for in paragraph 1.2, this regulation applies to oil tankers of 500 gross tonnage and over and bulk carriers, as defined in regulation IX/1, of 20,000 gross tonnage and over, constructed on or after 1 January 2005.

1.2 Oil tankers of 500 gross tonnage and over constructed on or after 1 October 1994 but before 1 January 2005 shall comply with the provisions of regulation II-1/12-2 adopted by resolution MSC.27(61).

2 Means of access to cargo and other spaces

2.1 Each space within the cargo area shall be provided with a permanent means of access to enable, throughout the life of a ship, overall and close-up inspections and thickness measurements of the ship's structures to be carried out by the Administration, the company, as defined in regulation IX/1, and the ship's personnel and others as necessary. Such means of access shall comply with the requirements of paragraph 5 and with the Technical provisions for means of access for inspections, adopted by the Maritime Safety Committee by resolution MSC.133(76), 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.

2.2 Where a permanent means of access may be susceptible to damage during normal cargo loading and unloading operations or where it is impracticable to fit permanent means of access, the Administration may allow, in lieu thereof, the provision of movable or portable means of access, as specified in the Technical provisions, provided that the means of attaching, rigging, suspending or supporting the portable means of access forms a permanent part of the ship's structure. All portable equipment shall be capable of being readily erected or deployed by ship's personnel.

2.3 The construction and materials of all means of access and their attachment to the ship's structure shall be to the satisfaction of the Administration. The means of access shall be subject to survey prior to, or in conjunction with, its use in carrying out surveys in accordance with regulation I/10.

3 Safe access to cargo holds, cargo tanks, ballast tanks and other spaces

3.1 Safe access** to cargo holds, cofferdams, ballast tanks, cargo tanks and other spaces in the cargo area shall be direct from the open deck and such as to ensure their complete inspection. Safe access** to double bottom spaces may be from a pump-room, deep cofferdam, pipe tunnel, cargo hold, double hull space or similar compartment not intended for the carriage of oil or hazardous cargoes.

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* Text needs to be revisited upon entry into force of amendments to regulation 3-6 on 1 January 2006.

** Refer to the Recommendations for entering enclosed spaces aboard ships, adopted by the Organization by resolution A.864(20).

3.2 Tanks, and subdivisions of tanks, having a length of 35 m or more, shall be fitted with at least two access hatchways and ladders, as far apart as practicable. Tanks less than 35 m in length shall be served by at least one access hatchway and ladder. When a tank is subdivided by one or more swash bulkheads or similar obstructions which do not allow ready means of access to the other parts of the tank, at least two hatchways and ladders shall be fitted.

3.3 Each cargo hold shall be provided with at least two means of access as far apart as practicable. In general, these accesses should be arranged diagonally, for example one access near the forward bulkhead on the port side, the other one near the aft bulkhead on the starboard side.

4 Ship structure access manual

4.1 A ship's means of access to carry out overall and close-up inspections and thickness measurements shall be described in a Ship structure access manual approved by the Administration, an updated copy of which shall be kept on board. The Ship structure access manual shall include the following for each space in the cargo area:

.1 plans showing the means of access to the space, with appropriate technical specifications and dimensions;

.2 plans showing the means of access within each space to enable an overall inspection to be carried out, with appropriate technical specifications and dimensions. The plans shall indicate from where each area in the space can be inspected;

.3 plans showing the means of access within the space to enable close-up inspections to be carried out, with appropriate technical specifications and dimensions. The plans shall indicate the positions of critical structural areas, whether the means of access is permanent or portable and from where each area can be inspected;

.4 instructions for inspecting and maintaining the structural strength of all means of access and means of attachment, taking into account any corrosive atmosphere that may be within the space;

.5 instructions for safety guidance when rafting is used for close-up inspections and thickness measurements;

.6 instructions for the rigging and use of any portable means of access in a safe manner;

.7 an inventory of all portable means of access; and

.8 records of periodical inspections and maintenance of the ship's means of access.

4.2 For the purpose of this regulation "critical structural areas" are locations which have been identified from calculations to require monitoring or from the service history of similar or sister ships to be sensitive to cracking, buckling, deformation or corrosion which would impair the structural integrity of the ship.

5 General technical specifications

5.1 For access through horizontal openings, hatches or manholes, the dimensions shall be sufficient to allow a person wearing a self-contained air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also provide a clear opening to facilitate the hoisting of an injured person from the bottom of the space. The minimum clear opening shall not be less than 600 mm x 600 mm. When access to a cargo hold is arranged through the cargo hatch, the top of the ladder shall be placed as close as possible to the hatch coaming. Access hatch coamings having a height greater than 900 mm shall also have steps on the outside in conjunction with the ladder.

5.2 For access through vertical openings, or manholes, in swash bulkheads, floors, girders and web frames providing passage through the length and breadth of the space, the minimum opening shall be not less than 600 mm x 800 mm at a height of not more than 600 mm from the bottom shell plating unless gratings or other foot holds are provided.

5.3 For oil tankers of less than 5,000 tonnes deadweight, the Administration may approve, in special circumstances, smaller dimensions for the openings referred to in paragraphs 5.1 and 5.2, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of the Administration.

Part B
Subdivision and stability

Regulation 4
General

1 The damage stability requirements in Parts B-1 through B-4 shall apply to cargo ships of 80 m in length (L) and upwards and to all passenger ships regardless of length but shall exclude those cargo ships which are shown to comply with subdivision and damage stability regulations in other instruments* developed by the Organization.

2 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.

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* Cargo ships shown to comply with the following regulations may be excluded from the application of part B-1:

.1 Annex I to MARPOL 73/78, except OBO ships with type B freeboards are not excluded;
.2 International Bulk Chemical Code;
.3 International Gas Carrier Code;
.4 Guidelines for the design and construction of offshore supply vessels (resolution A.469(XII));
.5 Code of Safety for Special Purpose Ships (resolution A.534(13), as amended);
.6 Damage stability requirements of regulation 27 of the 1966 Load Line 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).

3 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.

4 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.

Part B-1
Stability

Regulation 5
Intact stability information[*]

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 and the elements of its stability determined.

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 weight 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_s is found.

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.

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_s is found or anticipated.

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* Refer to the Code on Intact Stability for All Types of Ships covered by IMO Instruments, adopted by the Organization by resolution A.749(18).

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 satisfactory to 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) versus draught which assures compliance with the relevant intact and damage stability requirements, alternatively corresponding curves or tables of the maximum allowable vertical centre of gravity (KG) versus draught, or with the equivalents of either of these curves;

.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 and stability after damage.

3 The stability information shall show the influence of various trims in cases where the operational trim range exceeds +/- 0.5% of L_s.

4 For ships which have to fulfil the stability requirements of part B-1, information referred to in paragraph 2 are determined from considerations related to the subdivision index, in the following manner: Minimum required GM (or maximum permissible vertical position of centre of gravity KG) for the three draughts d_s, d_p and d_l are equal to the GM (or KG values) of corresponding loading cases used for the calculation of survival factor "s". For intermediate draughts, values to be used shall be obtained by linear interpolation applied to the GM value only between the deepest subdivision draught and the partial subdivision draught and between the partial load line and the light service draught respectively.[*] Intact stability criteria will also be taken into account by retaining for each draft the maximum among minimum required GM values or the minimum of maximum permissible KG values for both criteria. If the subdivision index is calculated for different trims, several required GM curves will be established in the same way.

5 When curves or tables of minimum operational metacentric height (GM) versus draught are not appropriate, the Master should ensure that the operating condition does not deviate from a studied loading condition, or verify by calculation that the stability criteria are satisfied for this loading condition.

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* Refer also to: MSC/Circ.456, Guidelines for the preparation of intact stability information; MSC/Circ.706, Guidance on intact stability of existing tankers during transfer operations; and MSC/Circ.707, Guidance to the master for avoiding dangerous situations in following and quartering seas.

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 0.5 R for cargo ships.

2 For all ships to which the damage stability requirements of this chapter 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 100m in length (L_s):

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

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

$$R = 1 - [1/(1 + \frac{L_s}{100} \times \frac{R_0}{1 - R_0})]$$

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

.3 In the case of passenger ships:

$$R = 1 - \frac{5000}{L_s + 2.5N + 15225}$$

where:

$N = N_1 + 2N_2$
N_1 = number of persons for whom lifeboats are provided
N_2 = number of persons (including officers and crew) the ship is permitted to carry in excess of N_1.

.4 Where the conditions of service are such that compliance with paragraph 2.3 of this regulation on the basis of $N = N_1 + 2N_2$ is impracticable and where the Administration considers that a suitably reduced degree of hazard exists, a lesser value of N may be taken but in no case less than $N = N_1 + N_2$.

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* [The Maritime Safety Committee, in adopting the regulations contained in parts B to B-4, invited Administrations to note that the regulations should be applied in conjunction with the explanatory notes developed by the Organization in order to ensure their uniform application.]

Regulation 7
Attained subdivision index A

1 The Attained Subdivision Index A is obtained by the summation of the partial indices A_s, A_p and A_l, (weighted as shown) 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:

$$A = \Sigma p_i s_i$$

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.

2 In the calculation of A, the level trim shall be used for the deepest subdivision draught and the partial subdivision draught. The actual service trim shall be used for the light service draught. If in any service condition, the trim variation in comparison with the calculated trim is greater than 0.5% of L_s, one or more additional calculations of A are to be submitted for the same draughts but different trims so that, for all service conditions, the difference in trim in comparison with the reference trim used for one calculation will be less than 0.5% of L_s.

3 When determining the positive righting lever (GZ) of the residual stability curve, the displacement used should be that of the intact condition. That is, the constant displacement method of calculation should be used.

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 angle to the centreline at the level of the deepest subdivision draught.

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.

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 7-1
Calculation of the factor p_i

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 = is 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;

x1 = the distance from the aft terminal of L_s to the aft end of the zone in question;

x2 = 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 loadline 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 loadline the vertical plane used for determination of b is assumed to extend upwards to the deepest subdivision waterline.

If the damage involves a single zone only:

$$p_i = p(x1_j,x2_j) \cdot [r(x1_j,x2_j,b_k) - r(x1_j,x2_j,b_{k-1})]$$

If the damage involved two adjacent zones:

$$p_i = p(x1_j,x2_{j+1}) \cdot [r(x1_j,x2_{j+1},b_k) - r(x1_j,x2_{j+1},b_{k-1})] - p(x1_j,x2_j) \cdot [r(x1_j,x2_j,b_k) - r(x1_j,x2_j,b_{k-1})] - p(x1_{j+1},x2_{j+1}) \cdot [r(x1_{j+1},x2_{j+1},b_k) - r(x1_{j+1},x2_{j+1},b_{k-1})]$$

If the damage involves three or more adjacent zones:

$$p_i = p(x1_j,x2_{j+n-1}) \cdot [r(x1_j,x2_{j+n-1},b_k) - r(x1_j,x2_{j+n-1},b_{k-1})] - p(x1_j,x2_{j+n-2}) \cdot [r(x1_j,x2_{j+n-2},b_k) - r(x1_j,x2_{j+n-2},b_{k-1})] - p(x1_{j+1},x2_{j+n-1}) \cdot [r(x1_{j+1},x2_{j+n-1},b_k) - r(x1_{j+1},x2_{j+n-1},b_{k-1})] + p(x1_{j+1},x2_{j+n-2}) \cdot [r(x1_{j+1},x2_{j+n-2},b_k) - r(x1_{j+1},x2_{j+n-2},b_{k-1})]$$

and where r(x1, x2, b0) = 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

Probability density at y = 0:

$$b_{12} = 2\left(\frac{p_k}{J_{kn}} - \frac{1-p_k}{J_{\max} - J_{kn}}\right)$$

Maximum normalized damage length:

$$J_m = \min\left\{J_{\max}, \frac{l_{\max}}{L_s}\right\}, \text{ but not less than } \frac{2}{b_{12}}$$

$$J_k = \frac{J_m}{2} + \frac{1 - \sqrt{1 + (1-2p_k)b_{12}J_m + \frac{1}{4}{b_{12}}^2{J_m}^2}}{b_{12}}$$

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

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

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

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

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

$J \le J_k$:

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

$J > J_k$:

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

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:

$J \le J_k$:

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

$J > J_k$:

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

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:

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

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

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

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

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

$$G = G_2 = -\frac{1}{3} b_{11} {J_0}^3 + \frac{1}{2}\left(b_{11} J - b_{12}\right) {J_0}^2 + b_{12} J J_0 \quad \text{, where}$$
$$J_0 = \min\left(J, J_b\right)$$

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:

$$G = \frac{1}{2} \cdot \left(G_2 + G_1 \cdot J\right)$$

Regulation 7-2
Calculation of the factor s_i

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.

"θ_e" is the equilibrium heel angle in any stage of flooding, in degrees;

"θ_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 θ_v;

"Range" is the range of positive righting levers, in degrees, measured from the angle θ_e. The positive range is to be taken up to the angle θ_v;

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

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

$$s_i = \text{minimum } \{ s_{intermediate,i} \text{ or } s_{final,i} \cdot s_{mom,i} \}$$

where:

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

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

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

2 The factor "$s_{intermediate,i}$" is applicable only to passenger ships (for cargo ships $s_{intermediate,i}$ should be taken as unity) and shall be taken as the least of the s-factors obtained from all flooding stages including the stage before equalisation, 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 degrees. $s_{intermediate} = 0$ if the intermediate heel angle exceeds 15º. Where cross-flooding fittings are required the time for equalization shall not exceed 10 minutes.

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

$$s_{final,i} = K \cdot \left[\frac{GZ_{max}}{0.12} \cdot \frac{Range}{16} \right]^{\frac{1}{4}}$$

where:

GZ_{max} is not to be taken as more than 0.12 m;

Range is not to be taken as more than 16 degrees;

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

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

$K = \sqrt{\frac{\theta_{max} - \theta_e}{\theta_{max} - \theta_{min}}}$ otherwise;

where:

"θ_{min}" is 7 degrees for passenger ships and 25 degrees for cargo ships, and

"θ_{max}" is 15 degrees for passenger ships and 30 degrees for cargo ships.

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 subdivision draught;

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

$s_{mom,i} \leq 1.0$

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

M_{heel} = maximum { $M_{passenger}$; M_{wind} ; $M_{SurvivalCraft}$ }

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

$M_{passenger} = (0.075 \cdot N) \cdot (0.45 \cdot B)$ (ton-m)

where:

"N" 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 beam of the ship.

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 force acting in a damage situation:

$M_{wind} = (P \cdot A \cdot Z) / 9806$ (ton-m)

where:

P = 120 N/m^2
A = projected lateral area above water line

Z = distance from centre of lateral projected area above water line to T/2
T = ship's draught, d_i

4.1.3 $M_{SurvivalCraft}$ 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 equalisation devices are provided they shall be operable from above the bulkhead deck. These fittings together with their controls shall be acceptable to the Administration.* Suitable information concerning the use of equalisation devices shall be supplied to the master of the ship.

5.1 Tanks and compartments taking part in such equalisation 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 In all cases "s_i" is to be taken as zero in those cases where the final waterline, taking into account sinkage, heel and trim, immerses:

.1 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. Such openings shall include air-pipes, ventilators and openings which are closed by means of weathertight doors or hatch covers; and

.2 any part of the bulkhead deck in passenger ships considered a horizontal evacuation route for compliance with chapter II-2.

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* Reference is made to the Recommendation on a standard method for establishing compliance with the requirements for cross-flooding arrangements in passengers ships, adopted by the Organization by resolution A.266(VIII), as may be amended.

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 intended for compliance with chapter II-2;

.2 any controls intended for the operation of watertight doors, equalisation devices, valves on piping or on ventilation ducts intended to maintain the integrity of watertight bulkheads from above the bulkhead deck become inaccessible or inoperable;

.3 immersion of any part of piping or ventilation ducts carried through a watertight boundary that is located within any compartment included in damage cases contributing to the attained index A, if not fitted with watertight means of closure at each boundary.

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

5.5 Except as provided in 5.3.1 openings closed by means of watertight manhole covers and flush scuttles, small watertight hatch covers, remotely operated sliding watertight doors, side scuttles of the non-opening type as well as watertight access doors and hatch covers required to be kept closed at sea may 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.

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 $x_{1(j)}...x_{2(j+n-1)}$ of the m^{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 $x_{1(j)}...x_{2(j+n-1)}$ of the $(m-1)^{th}$ 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.

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:

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

$$v(H,d) = 0.8 + 0.2\left[\frac{(H-d)-7.8}{4.7}\right]$$ 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 vessel within the range $(x1_{(j)}...x2_{(j+n-1)})$, 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:

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

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[1]

[1] Whichever results 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 cargo spaces	0.90	0.90	0.95
Cargo liquids	0.70	0.80	0.95

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

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 the 3 loading conditions on which is based the calculation of the subdivision index and for a damage involving all the compartments within 0.08L measured from the forward perpendicular.

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 3 loading conditions on which is based the calculation of the subdivision index.

3 The damage extent to be assumed when demonstrating compliance with paragraph 2, is to be dependent on both N as defined in regulation 6, and L_s as defined in regulation 2, 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', in which case this reduced extent is to be used.

.2 where 400 or more persons are to be carried, a damage length of $0.03L_s$ 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 angle 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 shell side 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 0.015Ls 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.

.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 N=36 and N=400 as specified in present sub-paragraphs 3.4 and 3.2.

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.

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 2000 mm.

3 Small wells constructed in the double bottom in connection with drainage arrangements of holds, etc., shall not extend downward more than necessary. A well extending to the outer bottom is, however, permitted at the after end of the shaft tunnel. 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. In no case shall the vertical distance from the bottom of such a well to a plane coinciding with the keel line be less than 500 mm.

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 passenger ship or a cargo ship that is not fitted with a double bottom in accordance with paragraphs 1, 4 or 5 of this regulation shall be capable of withstanding bottom damages as specified in paragraph 8 in that part of the ship.

7 In the case of unusual bottom arrangements in a passenger ship or a cargo ship it shall be demonstrated that the ship is capable of withstanding bottom damages as specified in paragraph 8.

8 Compliance with paragraphs 6 or 7 is to be achieved by demonstrating that s_i, when calculated in accordance with regulation 7-2, is not less than 1.0 for all service conditions when subject to a bottom damage assumed at any position along the ship's bottom and with an extent specified in .2 below for 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 or 2 m, whichever is less	B/20 or 2 m, whichever is less

.3 If any damage of a lesser extent than the maximum damage specified in .2 would result in a more severe condition, such damage should be considered.

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 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.

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

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.

2 The forepeak, double bottoms (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. 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 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.

3 The bulkhead may have steps or recesses provided they are within the limits prescribed in paragraph 1 or 2.

4 No doors, manholes, access openings, ventilation ducts or any other openings shall be fitted in the collision bulkhead below the bulkhead deck.

5.1 Except as provided in paragraph 5.2, the collision bulkhead may be pierced below the bulkhead deck 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, the valve chest being secured inside the forepeak to 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. All valves shall be of steel, bronze or other approved ductile material. Valves of ordinary cast iron or similar material are not acceptable.

5.2 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 by two pipes, each of which is fitted as required by paragraph 5.1, 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.

6 Where a long forward superstructure is fitted the collision bulkhead shall be extended weathertight to the deck next above the bulkhead deck. The extension need not be fitted directly above the bulkhead below provided it is located within the limits prescribed in paragraph 1 or 2 with the exception permitted by paragraph 7 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 causing damage to it in the case of damage to, or detachment of, a bow door.

7 Where bow doors are fitted and a sloping loading ramp forms part of the extension of the collision bulkhead above the bulkhead deck 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 bulkhead deck may extend forward of the limit specified in paragraph 1 or 2. Ramps not meeting the above requirements shall be disregarded as an extension of the collision bulkhead.

8 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.

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

10 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 stem 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 13

Openings in watertight bulkheads below the bulkhead deck in passenger ships

1 The number of openings in watertight bulkheads 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.

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

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

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

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 9.1 and in regulation 14.

4 Subject to paragraph 10, 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.

5.1 Watertight doors, except as provided in paragraph 9.1 or regulation 14, shall be power-operated sliding doors complying with the requirements of paragraph 7 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^{o} 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.

7.1 Each power-operated sliding watertight door:

.1 shall have a vertical or horizontal motion;

.2 shall, subject to paragraph 10, 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:

.2.1 special consideration shall be given to the strength of the door and its closing appliances in order to prevent leakages;

.2.2 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;

.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 at the navigation bridge;

.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.

7.2 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.

7.3 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 at the navigation bridge; 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^{o}. 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 on the navigation bridge. 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^{o}.

For the systems specified in 7.3.1, 7.3.2 and 7.3.3, 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.

7.4 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.

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

7.7 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.

7.8 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 7.3. Loss of any such power supply should activate an audible and visual alarm at the central operating console at the navigation bridge.

8.1 The central operating console 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. 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.

8.2 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.

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

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* Refer to the following IEC publication 529, 1976:

.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.

9.1 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. 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.

9.2 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.

10 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 7.1.2 to be substituted for these portable plates, 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 7.1.4 regarding complete closure by hand-operated gear in 90 s.

11.1 Where trunkways or tunnels for access from crew accommodation to the stokehold, 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.

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

11.3 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.

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.

* Refer to MSC/Circ.651, Interpretations of regulations of part B-1 of SOLAS chapter II-1.

Regulation 15

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

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.

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.

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 steerage 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.

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.

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 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 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 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.

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 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.

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

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.

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 doors, sidescuttles, etc.

1 In all ships:

.1 the design, materials and construction of all watertight doors, sidescuttles, gangway and cargo ports, valves, pipes, ash-chutes and rubbish-chutes referred to in these regulations shall be to the satisfaction of the Administration;

.2 such valves, doors and mechanisms shall be suitably marked to ensure that they may be properly used to provide maximum safety; and

.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.

2 In passenger ships and cargo ships watertight doors shall be tested by water pressure to a head of water they might sustain in a final or intermediate stage of flooding. Where testing of individual doors is not carried out because of possible damage to insulation or outfitting items, testing of individual doors may be replaced by a prototype pressure test of each type and size of door with a test pressure corresponding at least to the head required for the intended location. The prototype test shall be carried out before the door is fitted. The installation method and procedure for fitting the door on board shall correspond to that of the prototype test. When fitted on board, each door shall be checked for proper seating between the bulkhead, the frame and the door.

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 Where a ventilation trunk passing through a structure penetrates 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 allowable during intermediate stages of flooding, in accordance with regulation 7-2.

3 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

1 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.*

2 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.

3 The open end of air pipes terminating within a superstructure shall be at least 1 m above the waterline when the ship heels to an angle of 15º, or the maximum angle of heel during intermediate stages of flooding, as determined by direct calculation, whichever is the greater. Alternatively, air pipes from tanks other than oil tanks may discharge through the side of the superstructure. The provisions of this paragraph are without prejudice to the provisions of the International Convention on Load Lines in force.

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* Refer to MSC/Circ.541 (as may be amended): 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.

4 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.*

5 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.

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 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.

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.

1.3 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, subject to such accesses being made watertight, alarmed and indicated on the navigation bridge.

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 cargo 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 cargo spaces.

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

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.

3 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.

4 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.

5 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.**

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 in compliance with stability criteria in relevant regulations. The determination of the ship's stability shall always be made by calculation. 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.

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* Refer to MSC/Circ.919, Guidelines for damage control plans.

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

Regulation 21

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

1 Drills for the operating of watertight doors, sidescuttles, valves and closing mechanisms of scuppers, ash-shoots and rubbish-shoots shall take place weekly. In ships in which the voyage exceeds one week in duration a complete drill shall be held before leaving port, 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 and inspections required by this regulation shall be entered in the log book with an explicit record of any defects which may be disclosed.

Regulation 22

Prevention and control of water ingress, etc.

1 All watertight doors shall be kept closed during navigation except that they may be opened during navigation as specified in paragraphs 3 and 4. Watertight doors of a width of more than 1.2 m in machinery spaces as permitted by paragraph 10 of regulation 13 may only be opened in the circumstances detailed in that paragraph. 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 having a maximum clear opening width of more than 1.2 m shall be kept closed when the ship is at sea, 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.

4 Certain watertight doors may be permitted to remain open during navigation only if considered absolutely necessary; that is, being open is determined essential to the safe and effective operation of the ship's machinery or to permit passengers normally unrestricted access throughout the passenger area. Such determination shall be made by the Administration only after careful consideration of the impact on ship operations and survivability. A watertight door permitted to remain thus open shall be clearly indicated in the ship's stability information and shall always be ready to be immediately closed.

5 Portable plates on bulkheads shall always be in place before the ship leaves port, 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 and shall remain closed during navigation except in case of urgent necessity at the discretion of the master.

6 Watertight doors fitted in watertight bulkheads dividing cargo between deck spaces in accordance with regulation 13.9.1 shall be closed before the voyage commences and shall be kept closed during navigation; the time of opening such doors in port and of closing them before the ship leaves port shall be entered in the log book.

7 Gangway, cargo and fuelling ports fitted below the bulkhead deck shall be effectively closed and secured watertight before the ship leaves port, and shall be kept closed during navigation.

8 The following doors, located above the bulkhead deck, shall be closed and locked before the ship proceeds on any voyage 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 8.1;

.3 cargo loading doors in the collision bulkhead; and

.4 ramps forming an alternative closure to those defined in paragraphs 8.1 to 8.3 inclusive.

9 Provided that 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.

10 Notwithstanding the requirements of paragraphs 8.1 and 8.4, 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.

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 8 is implemented.

12 The master shall ensure, before the ship proceeds on any voyage, that an entry in the log book is made of the time of the last closing of the doors specified in paragraph 13 and the time of any opening of particular doors in accordance with paragraph 14.

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 ship leaves port. The time of closing and the time of opening (if permissible under these regulations) shall be recorded in such log book as may be prescribed by the Administration.

14 Where in a between-decks, 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 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, all the sidescuttles in that between-decks shall be closed watertight and locked before the ship leaves port, 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 of opening such sidescuttles in port and of closing and locking them before the ship leaves port shall be entered 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 15 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, and having its lowest point 1.4 m plus 25% 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 port without previously closing and locking them and to open them at sea on the responsibility of the master during the voyage to the next port. In tropical zones as defined in the International Convention on Load Lines in force, this limiting draught may be increased by 0.3 m.

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

16 If cargo is carried in such spaces, the sidescuttles and their deadlights shall be closed watertight and locked before the cargo is shipped and such closing and locking shall be recorded in such log book as may be prescribed by the Administration.

17 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 23

Special requirements for ro-ro passenger ships

1 Special category spaces and ro-ro cargo 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 underway.

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 cargo 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 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.

5 The master shall ensure, before the ship leaves the berth on any voyage, that an entry in the log book, as required by regulation 22.13, 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.

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 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.

Regulation 24

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.

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 internally subdivide large cargo spaces shall be closed before the voyage commences and shall be kept closed during navigation; the time of opening such doors in port and of closing them before the ship leaves port shall be entered in the log book.

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.”

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