

PART 5

STABILITY AND SHIPSIDE MARKINGS

5.1 Intact Stability Standard (Regulation 37)

5.1.1 The design and construction of every ship should be such as to ensure that the ship in all probable loading conditions and after due correction has been made for the effect of free surface of liquids in tanks, will meet the stability criteria stated in Schedule 1 of Merchant Shipping Notice MSN 1698 (M). The stability criteria are minimum and are not necessarily sufficient for a ship to withstand damage to the extent outlined in Schedule 3 to Merchant Shipping Notice MSN 1698 (M).

5.1.2 In such cases where the criteria set referred to in paragraph 5.1.1 of these Instructions cannot be met by a particular ship on account of its unique design and operating conditions, consideration may be given to the application of alternative criteria considered to be at least as effective. The surveyor should establish as early as practicable if there is likely to be difficulty in achieving the required stability and if so, submit details to Headquarters for consideration.

5.1.3 Extent of spaces used in the derivation of cross curves

5.1.3.1 Where it is found necessary to include the volumes of side houses or deckhouses in the calculations to derive cross curves of stability, all openings to such space must be provided with weathertight closing arrangements.

5.1.3.2 The effectiveness of enclosed spaces used in the derivation of cross curves of stability can only be maintained if before departure and during a voyage there is adopted a procedure to ensure that weathertight doors and hatches are effectively closed and remain so.

5.1.3.3 In the case of Ro-Ro ships the surveyor should ensure that any door leading into a deckhouse or side house the volume of which is included in the derivation of the cross curves of stability, is listed in the written Instructions provided for the guidance of the master in compliance with the Closing of Openings in Enclosed Superstructures and in Bulkheads above the Bulkhead Deck Regulations (see paragraph 4.3 of these Instructions).

5.1.3.4 The surveyor should ensure that notes for the guidance of the master included in the Stability Information Book include reference to any openings which are to be closed at sea. Suitable reference should be included at item 6 of the required notes at Appendix 7 of these Instructions.

5.1.4 In the development of hydrostatic particulars, vertical centres of gravity of tank or compartment capacities, and maximum allowable vertical centre of gravity curves, a standard base line or datum must be used. In the case of a ship having a designed rake of keel, hydrostatic particulars should be developed for waterlines parallel to the datum line and not parallel to the rake of the keel.

Particular attention must be paid to the marking of draught marks on a ship with a raked keel.

5.1.5 Windows in the side shell in the second tier of superstructures and in deckhouses in the second tier will be acceptable when such spaces are included as buoyant spaces for the purpose of showing compliance with intact stability requirements, provided that windows are fixed and fitted with efficient hinged deadlights.

5.2 Inclining, Lightweight Survey and Stability Information (Regulation 38)

5.2.1 Inclining and lightweight test

5.2.1.1 At or near completion, every ship is to be inclined, and the inclining test is to be prepared and conducted in the manner set out in the Load Line Instructions for the Guidance of Surveyors to determine the elements of the ship's stability in the lightship condition. The test is to be witnessed by a nominated Surveyor and he should be satisfied that it is carried out in such a manner and under such conditions as will give reliable results to verify the lightship particulars upon which the service conditions will be based.

5.2.1.2 The surveyor is to examine the Report of each inclining or lightweight survey which when approved is to be returned for placing on board for the guidance of the master, and to be used in all subsequent stability calculations. If the amended lightship condition particulars are found to deviate significantly from those derived from the previous inclining or lightweight survey, revised stability information is to be placed on board and a copy submitted to the Surveyor for approval. Where an onboard stability computer is used, the agreed lightweight particulars are to be used in the computer irrespective of whether a revised stability book is required. The lightship history page in the trim book is to be endorsed at each subsequent lightweight survey.

5.2.1.3 At the discretion of Headquarters, and after consideration of any relevant information about the ship submitted to him by the surveyor, the interval between lightweight surveys required by the regulations may be extended for a period of not more than one year. See also paragraph 11.3 of these Instructions.

5.2.1.4 If a ship undergoes the addition of an item of equipment or structural change with known weight and centres of gravity then a mathematical adjustment to the lightship details may be acceptable, and the 2% and 1% limits specified in the regulations may be measured from this revised weight and centre.

5.2.2 Stability information

5.2.2.1 Every ship is to be provided with approved reliable information relating to the stability of the ship for the guidance of the master. Such information is to be contained in the form of a book, the "Stability Information Book", and should include the particulars appropriate to the ship required by Appendix 10 of these Instructions, with the sample conditions of loading based on the accepted results of the inclining test. The Stability Information Book shall be kept on board the ship at all times in the custody of the master.

5.2.2.2 It is the owners responsibility to inform the certifying authority of any proposed alterations to the ship's hull, equipment or machinery affecting the seaworthiness of the ship. Where such alterations affect the stability information supplied to the ship, this may need to be amended irrespective of whether it is considered necessary to re-incline the ship.

5.2.2.3 When examining the Stability Information Book the surveyor should ensure that the master is provided with simplified and reliable information which will enable him to calculate any sailing condition to ensure that the ship complies with the prescribed intact and damage stability criteria.

5.2.2.4 A simple process of determining that the ship's stability meets the requirements makes use of tabulated or graphical presentation of required permissible vertical centres of gravity (KG fluid) values or metacentric height (GM fluid) values. Such information is to be developed with the ship on even keel and at trims by the bow and stern covering the operational trim range over the range of displacement or mean draughts which are likely to occur in service.

5.2.2.5 Stability information placed on board for the guidance of the master should contain only calculations and instructions relevant to the determination of the ship's stability. The derivation of the KG (fluid) envelope curves is to take account of required intact and damage stability criteria. There is no need to produce curves of righting levers (GZ) for the loading conditions. However, if an owner so wishes, such curves may be retained but marked "For information only".

5.2.2.6 In the case of Ro-Ro passenger ships, additional information should be provided identifying the method by which the stability calculations are to be undertaken, e.g. on board loading and stability computer, approved shore based loading and stability computer or the method outlined in paragraph 5.5.7 of these Instructions.

5.2.2.7 *Stability book information and approval*

- (i) The Stability Information Book should, in the first place, be examined by the surveyor, who when he is satisfied with the form of presentation and the accuracy of the contents, should arrange for one copy to be placed on board in the custody of the master pending the issue of the final approved copy, and one copy to be placed on the CM

18/01 file. Both copies are to be marked "PROVISIONAL" and endorsed by the surveyor.

(ii) Four copies of the Stability Information Book should be submitted for official approval to Headquarters who will arrange for them to be officially stamped and signed as being approved by the Certifying Authority.

(iii) Two copies should be returned to the owners instructing them to place one copy on board the ship for the use of the master. Acknowledgement of receipt of this information and confirmation that one copy has been placed on board the ship should be obtained from the owners in writing and a copy of their letter retained on the CM 18/01 file for record. One of the retained copies is to be placed on the CM 18/01 file, the other being forwarded to Defence Planning and Emergencies branch of the Department of the Environment, Transport and the Regions (DETR).

(iv) As the provision of approved stability is required for the issue of the Load Line Certificate, the appropriate Classification Society is to be advised of the stability approval, quoting the subdivision draught for which approval has been given. Where a certificate is required to be issued prior to formal approval of the stability information and provisional information has been accepted, the surveyor is to advise the Classification Society that they may issue a FULL TERM Load Line Certificate on condition that the owners are made aware that it will not be endorsed at the annual survey unless approved stability information is on board.

5.2.2.8 *Stabilising tanks*

(i) The free surface effect of stabilising tanks must be taken into account in the conditions shown in the Stability Information Book, and in the damage stability calculations.

(ii) In the event of damage, a stabilising tank will be permitted to be either pressed up or emptied into a lower tank after the final stage of flooding has been reached, in order to improve the stability or further reduce angles of heel, providing that the ship has sufficient residual stability to withstand the effect of either operation.

(iii) Such operations during flooding, to reduce angles of heel may, be permitted providing that it can be shown that they do not have a detrimental effect on the ship. The use of these operations to provide the ship with positive stability during and after flooding, or the fitting of valves in the ship's side for direct flooding of compartments from the sea will not be permitted.

5.2.2.9 *Permanent ballast*

- (i) The nature, amount and distribution of any permanent ballast is to be shown in the lightship condition in the Stability Information Book.
- (ii) If ballast consists of either oil or water, means shall be provided to prevent its accidental use or transfer. This may be achieved by fitting a spectacle blank in the suction line to each tank containing the ballast.
- (iii) Solid ballast should be efficiently stowed, and fixed against movement, and should not be fitted in the double bottom tanks or any other confined space, because of the difficulties in surveying the structure, unless it is necessary to achieve the desired improvement in stability. When it is proposed to fit solid ballast in such spaces, the surveyor should warn the owners that it may be necessary to remove some or all of the ballast in the future, in order that surveyors may examine the internal structure.

5.2.3 Angle of heel due to passenger crowding

For every ship of Classes II and II(A), a calculation shall be made showing the angle of heel which would occur with two thirds of the passengers distributed on one side of the ship and one third on the other side. For the purpose of this calculation the ship should be assumed to be in the worst anticipated service condition. The passengers should each be represented by a weight of 75 kg and should be assumed to be congregated at 4 persons per m² on the uppermost deck or decks to which they have access, and at an assumed centre of gravity of 760 mm above the deck. The resulting angle of heel should not exceed 7 degrees. A statement of the result of this calculation is to be included in stability information book, i.e. the 'Special Notes on Stability' reference Appendix 7 of these Instructions.

5.2.4 Angle of heel due to turning

For every ship of Classes II and II(A), a calculation should be made showing the angle of heel due to turning with the ship assumed to be in the worst anticipated service condition using the following formula. The resulting angle of heel should not exceed 10 degrees.

$$M_R = 0.233 \left(\frac{\Delta}{g} \right) \left(\frac{V_o^2}{L} \right) \left(KG - \frac{d}{2} \right)$$

where M_R	=	heeling moment in metre-tonnes
Δ	=	displacement in tonnes
g	=	acceleration due to gravity 9.81m/sec/sec
V_o	=	service speed in metres/sec
L	=	length of ship in metres
KG	=	height of centre of gravity above keel in metres
d	=	mean draught in metres

A statement of the result of this calculation is to be included in Stability Information Book, i.e. the 'Special Notes on Stability' (reference Appendix 7).

5.3 Subdivision Load Lines (Regulation 39)

5.3.1 C marks

5.3.1.1 Under this regulation, ships of Classes I and II having spaces which are adapted for the accommodation of passengers and the carriage of cargo alternatively may have, if the owners desire, one or more additional load lines assigned and marked, corresponding to the subdivision draughts approved for the alternative conditions. The notation C1 should be used for the deepest subdivision load line, and the notations C2, C3, etc, for the alternative conditions of service.

5.3.1.2 The notation C1 should be used when ships of Classes I and II have only one load line assigned.

5.3.1.3 For ships of Class II(A), the notation C should be used when only one subdivision load line is assigned and marked on the ship. When more than one subdivision load line is assigned to the ship, the notation CA should be used for marking the deepest subdivision load line, and the notations CB, CC, etc for the alternative conditions of service.

5.3.2 Load line marks

5.3.2.1 Ships which are also certificated as cargo ships and are assigned freeboards are required to be marked with load lines under the Merchant Shipping (Load Line) Regulations 1998 are to be marked as follows:-

5.3.2.2 Where the lowest of the Load Line marks is higher on the ship's side than the deepest subdivision load line, the latter shall form part of the same marking, the vertical line of the grid being extended downwards as necessary to reach the lowest subdivision load line. The subdivision load line (C1 or C) or lines (C1, C2 or CA, CB) shall appear on the after side of the vertical line. See figure 5.3.2.2.

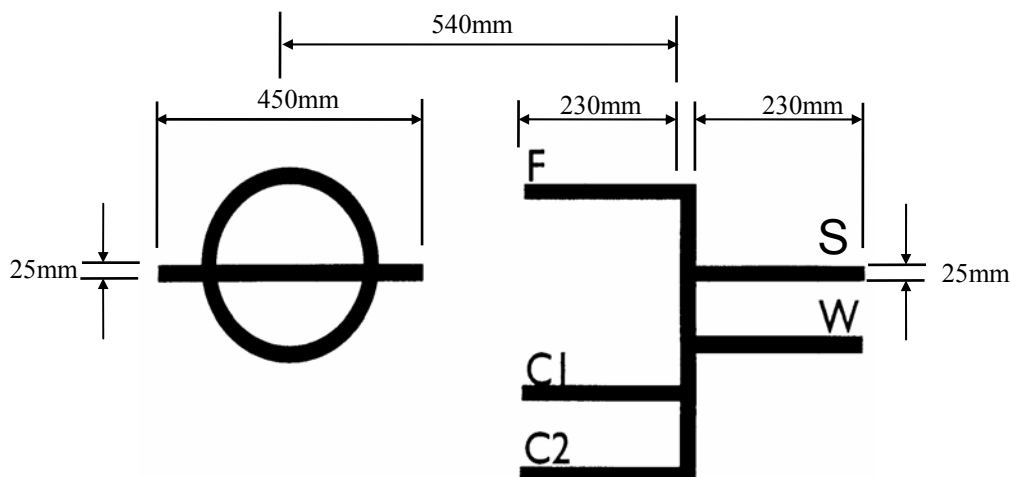


figure 5.3.2.2

5.3.2.3 Where the deepest subdivision load line coincides or nearly coincides with the fresh water line, the subdivision marking C1 or C may be indicated on the forward side of the grid in place of the S mark. See figure 5.3.2.3.

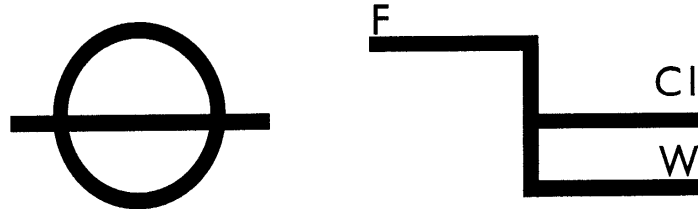


figure 5.3.2.3

5.3.2.4 (i) Where an "all seasons" freeboard is assigned and the deepest subdivision load line coincides with the horizontal line intersecting the load line mark a vertical line shall be marked extending downwards from the fresh water load line to reach the subdivision load line C1 or C on the after side of the vertical line. See figure 5.3.2.4.

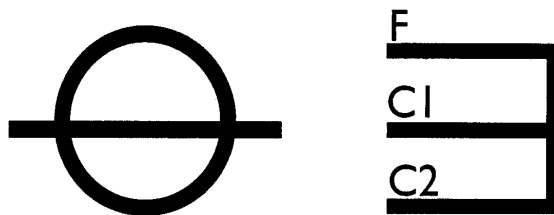


figure 5.3.2.4

(ii) Where the "all seasons" freeboard and the subdivision load line nearly coincides with the Fresh Water line the marking is to be as shown at paragraph 5.3.2.3 of these Instructions.

5.3.2.5 Ships which are certificated only as passenger ships should have an "all seasons" freeboard assigned. The marking should be as shown in figure 5.3.2.3 (excluding the winter mark) or figure 5.3.2.4 as appropriate.

5.3.2.6 Load Line Certificates have been known to have a note added to the effect that the passenger certificate is only relevant when carrying more than twelve passengers. Surveyors should note that unless a ship is also certificated as a cargo ship, the requirements as a passenger ship apply even when carrying less than 12 passengers. Where such notes are found on a Load Line Certificate, the surveyor should inform the issuing authority that the note is to be removed, unless the ship also has certification as a cargo ship.

5.3.3 Position of subdivision load line

5.3.3.1 The freeboard corresponding to each approved subdivision load line should be measured at the same position, and from the same deck line, as the freeboard determined by the Load Line Rules.

5.3.3.2 In no case may any subdivision load line be assigned and marked on the ship's sides above the deepest load line in salt water determined by Load Line Rules.

5.3.3.3 In no case may a ship be so loaded that, when she is in salt water, the subdivision load line mark appropriate to the particular voyage and condition of service is submerged. Whatever may be the position of the subdivision load line marks, the ship must in no case be loaded so as to submerge the load line mark, appropriate to the season and locality, determined by the Load Line Rules.

5.3.4 Inspection and marking

5.3.4.1 The surveyor should inspect the subdivision load line marks on the ship's sides, and satisfy himself that they comply with the requirements of Regulation 39 and the foregoing Instructions, and that the positions of the marks to which the ship may load, when carrying passengers, correspond with the approved subdivision draughts.

5.3.4.2 Where the surveyor finds that the measured moulded depth of the ship is greater than the design moulded depth, the subdivision load line is to be marked corresponding to the approved subdivision draught. Where the measured moulded depth is less than the design moulded depth, the subdivision load line is to be marked corresponding to the approved subdivision draught, less the amount by which the figures differ.

5.3.4.3 Where the moulded depth is different on opposite sides of the ship, the deck line should be lowered on the higher side to correspond with the deck line on the lower side, and then the appropriate action taken in accordance with 5.3.4.1 and 5.3.4.2.

5.3.4.4 In no case should the subdivision load lines be marked in different positions on opposite sides of the ship, or at a higher position than that corresponding to the approved subdivision draught.

5.4 Automatic Draught Gauge System (Regulation 41)

5.4.1 General

Each draught gauge system is to have a procedure incorporated for checking that the operation and display are functioning satisfactorily. This check procedure makes use of known datum points provided in the ship the positions of which should be confirmed by the surveyor at commissioning on board, and recorded for use by the master for his subsequent verifications of the accuracy of the system. Surveyors should undertake the verification of such systems at the ship's annual survey.

5.4.2 Construction and positioning

5.4.2.1 An automatic draught gauge system should comprise at least four measuring units directly connected to digital display units at the loading control positions at each cargo door.

5.4.2.2 The system should be constructed of materials suitable for the environment in which its component parts are to be fitted and should be arranged so as to accommodate fluctuations in the ship's electrical power or other associated services supplying the system as appropriate. The arrangements should ensure, as far as practicable, that its operation will be accurate and reliable.

5.4.2.3 The measuring units should be positioned to provide readings during loading and unloading, on the digital displays, corresponding to the forward and after draught marks and both the midships draughts and the vertical distance between the subdivision load line mark and the waterline on both sides of the ship near amidships.

5.4.2.4 The system should be installed in a manner which reduces the risk of flooding. Where a sea inlet pipe is used in association with a measuring unit an isolating valve with local control must be fitted at or as close to the shell as is practicable. The units shall be fitted in accessible positions within the ship.

5.4.2.5 The measuring units should be designed to give readings over the entire range of draughts and trims likely to be encountered and be sufficient for all service and operational requirements.

5.4.2.6 The measuring units should be placed in positions where the readings obtained will not be significantly affected by turbulence.

5.4.2.7 Arrangements should be provided whereby the accuracy of the measuring units can be confirmed by comparison with established datum marks fitted within the ship.

5.4.2.8 The system should include an arrangement whereby a visual warning signal is given if it becomes inoperative.

5.4.2.9 A continual read out of the draughts and the vertical distances to the subdivision load line marks calculated from the measuring units must be provided in metres graduated in centimetres at the display units located at the loading control positions at each cargo door.

5.4.3 Performance

5.4.3.1 The automatic draught gauge system should be capable of functioning efficiently for a period of not less than 2 years without the need to place the ship in dry dock.

5.4.3.2 The system should be capable of providing steady readings continuously throughout the loading and unloading of the ship to an accuracy of one centimetre.

5.4.3.3 The system and the manner in which it is fitted must be to the approval of the Certifying Authority.

5.5 **Calculation of Loading Condition and Stability Prior to Departure (Regulation 43)**

5.5.1 Calculation of loading condition

5.5.1.1 The primary aim is to ensure that passenger ships always depart with sufficient stability to enable them to operate safely in adverse weather conditions or withstand the possible effects of any collision damage for which they have been designed. In deciding the most effective means of making the required stability calculation the ship's loading pattern, its margin of stability and the time which will be available to make the calculations needs to be considered. When loading has been completed, the master should be satisfied that the ship is not overloaded and has an adequate standard of stability before it departs on its voyage.

5.5.1.2 The calculations and recording of information required are still to be carried out even when the ship is, for the time being, engaged on voyages for which a Class III, V, VI or VI(A) Passenger Certificate is appropriate.

5.5.2 Information needed to make the calculation

5.5.2.1 The following information will be needed to calculate the ship's loaded condition:-

- (i) up-to-date approved information for the lightweight and the vertical and longitudinal centres of gravity;

(ii) the contents of all tanks in the ship. The master must ensure that tanks are regularly sounded and that large void compartments and tanks which are assumed to be empty are in fact empty by frequently checking such spaces;

(iii) the weight and vertical centre of gravity of the goods vehicles and units of cargo to be carried. It should be noted that the recommended practice of applying a 7 per cent uplift to declared weights of commercial vehicles should be continued and used in the moment calculations for stability unless weighing procedures complying with the Merchant Shipping (Weighing of Goods Vehicles and other Cargo) Regulations 1988 are in operation in respect of the commercial vehicles and other cargo carried;

(iv) the weights of motor cars, to be taken as 1.25 tonnes in all cases;

(v) the weights of coaches, excluding the weight of passengers, to be taken as:-

(a) for 2 axle coaches 14 tonnes

(b) for 3 axle coaches 19 tonnes

(vi) the number of passengers and their assumed weight and position;

(vii) the weight and assumed position of the crew and their baggage; and

(viii) the weight and assumed position of the stores on board.

5.5.3 Procedures for calculating the loading condition

5.5.3.1 The master or, where appropriate, the designated person responsible for the shore based computer system, should arrange for the information specified in paragraphs 5.5.2.1 (i) to (viii) of these Instructions to be entered in the loading and stability computer or in the adopted method of calculating the ship's loading condition. When considering the vertical centres of gravity of vehicles or cargo in vehicle spaces, one of the four options described in Appendix 2 is to be used.

5.5.3.2 The vertical centre of gravity of passengers is to be taken as 760 mm above the deck.

5.5.3.3 Unless the displacement and hydrostatic particulars of the ship in the level trim condition can be used without affecting significantly the accuracy of the subsequent calculations it will be necessary to derive such particulars from trimmed data.

5.5.3.4 The free surface effects of liquids in the ship's tanks should be calculated from the information entered in the computer or as otherwise provided, and taken either:-

- (i) at the appropriate liquid level in the tanks; or alternatively
- (ii) as the maximum value which can occur, in which case the maximum value shall be assumed both during the filling of the tank and whenever the tank is not completely filled.

5.5.3.5 Where a computer is fitted it should provide, on demand, a visual display or record of the progress of loading.

5.5.3.6 The computer or the adopted method of making the calculation of the loading condition should also provide for the rapid determination of the appropriate limiting value of the ship's vertical centre of gravity or transverse metacentric height, as may be appropriate to the ship. The limiting value is to be adjusted for the draught or displacement of the ship and its current trim by using the information provided in the Stability Information Book.

5.5.3.7 The calculation procedure should permit the master to predict the effect of loading any item(s) of cargo, the effects of proposed transfer of liquids within the ship, or the taking on or discharging of liquids.

5.5.3.8 The computer or the adopted method of making the calculation of the loading condition should be arranged to permit entry of the readings of the draughts and the vertical distances from the waterline to the subdivision load line mark on each side of the ship. Using this information, the draught at the forward and after perpendiculars, the mean draught, the trim and the displacement at the floating condition should be determined. If the master has reason to believe that the automatic draught gauge system is not functioning correctly, visual readings or a practical alternative means of determining the draughts may be substituted if, in the conditions prevailing, the draughts can be measured with an accuracy of plus or minus two centimetres.

5.5.3.9 The computer or the adopted method of making the calculation of the loading condition should provide an identifiable record of the calculations performed for each condition.

5.5.3.10 The comparison between the displacement obtained from the calculated loading condition and that derived from the actual draughts should be made. A record should be made of any discrepancy between the Displacement obtained by calculation and that using the actual draught readings. The method of dealing with such a discrepancy is given in paragraph 5.5.4 of these Instructions.

5.5.3.11 To cater for late arrivals of cargo, the calculation sequence should be capable of being completed rapidly.

5.5.4 Action to be taken if there is a significant difference between the calculated displacement and that obtained from the actual draughts

5.5.4.1 *Comparison of displacements as calculated and actual*

If the displacement of the ship determined from the observed draughts differs significantly from that obtained by summation of known weight of the ship, its cargo and other items of deadweight, the loading master should accept the displacement determined from the observed draughts as paramount.

5.5.4.2 *Actual displacement greater than calculated*

Where the displacement obtained from the observed draughts is greater than the calculated displacement the discrepancy should be treated as an additional increment of cargo weight, and assumed to be acting at the mean vertical centre of gravity position for the total cargo weight being carried or ship as a whole, whichever is the greater.

5.5.4.3 *Actual displacement less than calculated*

Where the displacement obtained from the observed draughts is less than the calculated displacement the KG of the ship should be that obtained from the calculations of the loading condition but the displacement should be taken as that obtained from the observed draughts.

5.5.4.4 *Significant difference*

A significant difference in displacement is where the displacements differ by an amount equal to or greater than twice the tonnes per centimetre immersion.

5.5.4.5 *Consideration of KG (GM) and compliance*

(i) The vertical centre of gravity of the ship KG (or metacentric height GM) as calculated, and after being corrected for the free surface effect of slack tanks, is to be compared with the maximum permissible KG (or minimum permissible GM) relevant to the appropriate draught and trim.

(ii) The ship will be considered as meeting all intact stability and damage stability criteria only if the calculated vertical centre of gravity KG (fluid) is less than or equal to the maximum permissible vertical centre of gravity (or if the calculated metacentric height GM (fluid) is equal to or greater than the minimum permissible GM).

(iii) Where the calculated vertical centre of gravity is found to be higher than the maximum permissible vertical centre of gravity, (or the calculated metacentric height found to be lower than the minimum permissible GM), the ship should not be permitted to leave until

adjustments to the pattern of loading result in the lowering of the actual vertical centre of gravity sufficiently to ensure compliance with the curves of maximum permissible KG, or minimum permissible GM, as appropriate.

5.5.5 Exemptions and approved loading conditions

5.5.5.1 Where a ro-ro ship makes regular voyages to and from the same place in conditions of loading which correspond closely to conditions of loading recorded in the Stability Information Book, an owner may apply to have these conditions accepted without the need to undertake the required calculations before departure. In examining the conditions of loading, the surveyor should satisfy himself that the calculated vertical centres of gravity shown are sufficiently lower than the maximum permissible vertical centres of gravity to allow for small variations which might occur between a specified condition of loading and an actual condition of loading.

5.5.5.2 Where the maximum deadweight which a ship is capable of carrying does not exceed 650 tonnes, it may be exempted from the requirements of calculating stability prior to departure on condition that the ship complies with approved loading conditions.

5.5.5.3 Before the ship proceeds on a voyage confirmation will be required that the actual condition of loading corresponds closely to one of the approved conditions specified in the Stability Information Book. The specified approved condition of loading is to be recorded in the book retained on board for that purpose. The Stability Information Book is to provide information to the master to this effect.

5.5.5.4 A copy of this information should be forwarded, as soon as practicable, to a person nominated by the owner as being responsible and retained in his custody for a period of at least one calendar month.

5.5.5.5 When examining the Stability Information Book to ensure that it contains sufficient sample conditions of loading to cover the expected range of actual loading conditions, the surveyor should be satisfied that the sample conditions are practical based on the ship's pattern of loading, refuelling, taking of fresh water and ballasting, and not merely a combination of the components of deadweight taken over a range of small increments of draught up to the maximum subdivision draught.

5.5.6 Stability computer

Where the required calculation is made by computer, details of the standards to be met by computers is described in Appendix 1. The surveyor should confirm at its commissioning that the simple check procedure incorporated in the computer system is operating satisfactorily.

5.5.7 “Step by step” guide

A “step by step” guide for calculating the stability before departure (one for KG’s and one for GM’s) is shown in Appendix 6. A copy of the relevant guide is to be included in the Stability Information Book together with an example on its use.

5.5.8 Condition of loading prior to departure to be satisfactory

Before a ship proceeds on a voyage the master shall ensure that the condition of loading of the ship is within the permissible standard of stability and satisfies all the relevant requirements prescribed in the Stability Information Book.

5.5.9 Permissible standard of stability to be recorded

Before a ship proceeds on a voyage the master shall cause the maximum permissible KG, or the minimum permissible GM, whichever is appropriate to the ship, to be determined and recorded in the official log book.

5.5.10 Stability and freeboard during loading and unloading

5.5.10.1 The owner of every ship shall ensure that the master is provided with information relating to its stability during the process of loading and unloading. This information shall be included in the ship's Stability Information Book. Where any alterations are made or changes occur to the ship so as to affect materially the information supplied to the master, amended information shall be provided.

5.5.10.2 The master shall use the information provided and, when necessary, make calculations or cause calculations to be made in order to ensure that during loading and unloading the ship has adequate stability and the freeboard at any door giving access to the hull or to an enclosed superstructure is sufficient to prevent the entry of water.

5.5.10.3 (i) The recording of particulars in the log book and elsewhere, may cause problems in certain cases, where a large number of entries may be required each day. Completion of an additional “Freeboard and Stability Sheet” (AFS/RO/89 or AFR/72) and appended to the official log book, with an appropriate entry in the narrative section, has been used satisfactorily.

(ii) Where a stability computer is used to perform the required calculations, the printout will be accepted in lieu of the “Freeboard and Stability Sheet” (AFS/RO/89 or AFR/72) provided that it contains the information required to be recorded and it is appended to the official log book and an appropriate entry made in the narrative section.

5.6 Stability in Damaged Condition - Ships Constructed Before 29 April 1990 (Regulation 44)

5.6.1 General

5.6.1.1 In addition to satisfying the requirements relating to intact stability (Regulation 37 and paragraph 5.1 of these Instructions) and subdivision (Regulations 8 and paragraph 2.5 of these Instructions) all ships are to satisfy the prescribed requirements of damage stability. The sufficiency of stability in the damaged condition required by Section 2 of Schedule 3 of Merchant Shipping Notice MSN 1698 (M) is that commonly referred to as STAB 80. All existing Ships are to comply with this standard as a minimum.

5.6.1.2 Ro-Ro passenger ships that do not operate to and from the UK on a "regular scheduled service" are subject to a higher standard, known as SOLAS 90, by a date given in Regulation 44(2)(a) dependent on their A/Amax value. For requirements regarding calculation of the A/Amax value see Part 15 of these Instructions.

5.6.1.3 Ro-Ro passenger ships that operate to and from the UK on a "regular scheduled service" are subject to the Merchant Shipping (Ro-Ro Passenger Ship Survivability) Regulations 1997 which requires an even higher standard of survivability to be complied with by a date dependent on their A/Amax. These ships are considered in Part 14 of these Instructions.

5.6.1.4 For ships of Class II(A), the longitudinal extent of damage to be considered may include 10%L in addition to those stated in section 1(3)(a) of Schedule 3 of Merchant Shipping Notice MSN 1698(M).

5.6.2 Damage stability calculations

5.6.2.1 Damage stability calculations should be submitted which cover the intended operational range of draught and trim. In order for a full independent check to be undertaken prior to acceptance, the following information is required in addition to any included in Part 1:

- (i) Lines plan.
- (ii) General arrangement or subdivision plan identifying and showing all the compartments.
- (iii) Hydrostatics and cross curves covering the operational draught.
- (iv) Volumes and centres of gravity of all compartments, and the assumed permeabilities.

- (v) Details of any passive down or cross flooding arrangements together with calculations substantiating the flooding times.
- (vi) The subdivision draught required and the compartmentation standard to be considered.
- (vii) Calculation details of the factor of subdivision.
- (viii) A summary of the damage stability results which is to include the required KG (or GM) to satisfy each of the stipulated criteria for the full range of operational draughts and trims. The results are to include the consideration of bottom damage.
- (ix) The limiting KG (or GM) envelope curve that shows the required values in order to satisfy both the intact and damage criteria for the full range of operational draughts and trims.
- (x) Details of any permanent solid or liquid ballast assumed in the calculation of (viii) and (ix) above.
- (xi) Details and location of all potential progressive flooding openings, including sill heights and any proposed closure fitted to such openings.

5.6.2.2 The damage stability calculations should be carried out for the final stage of flooding plus five equally spaced intermediate stages assuming the ship free to trim at each of the stages.

5.6.2.3 Where, in accordance with Regulation 11, no double bottom is fitted, the requirements of the International Bulk Carrier (IBC) Code are to be used assuming bottom damage to occur anywhere in the length. An extract of the appropriate requirements from the IBC Code is reproduced below for convenience:

	For 0.3L from the forward perpendicular of the ship	Any other part of the ship
Longitudinal extent: whichever is less	$1/3L^{2/3}$ or 14.5m, whichever is less	$1/3L^{2/3}$ or 5m,
Transverse extent: whichever is less	B/6 or 10m, whichever is less	B/6 Or 5m,

5.6.2.4 Compliance with the following limitations will satisfy the requirements of Section 2 of Schedule 3 of Merchant Shipping Notice MSN 1698(M), i.e. STAB 80:-

(i) In each of the intermediate stages of flooding or equalisation the residual stability should be represented by a positive GZ curve having a maximum GZ of at least 30 mm and a range of not less than 5 degrees.

(ii) At the final stage of flooding and also after equalisation measures if any have been taken the residual stability should be represented by a positive GZ curve having a maximum GZ value of at least 50 mm and a range of not less than 7 degrees.

5.6.3 Margin line immersion

5.6.3.1 At no stage should the margin line be submerged unless the provision of partial subdivision above the bulkhead deck, limits sufficiently the spread of water along the bulkhead deck and results in an acceptable angle of heel, see paragraph 2.10 of these Instructions. Margin line immersion outside the line of damage may be allowed, provided there is no danger of downflooding, but each case will be considered separately.

5.6.3.2 The maximum angle of heel during any stage of flooding shall not be such as will endanger the safety of the ship.

5.6.4 Cross flooding and downflooding

5.6.4.1 Where a calculation results in an unacceptable state of stability, and recourse is made to depositing floodwater to a lower level by means of automatic down-flooding ducts or similar devices, full details of the process will need to be submitted.

5.6.4.2 Full details of cross-flooding fittings and calculations, showing that they will expeditiously reduce the list of the ship should be submitted.

5.6.4.3 Fittings should be self-acting, except that when it can be shown that this is not practicable, it may be permitted for them to be controlled from accessible positions above the bulkhead deck.

5.6.4.4 The surveyor's attention is drawn to the need for air pipes to be of adequate area in relation to the area of cross-flooding fittings. Cross-flooding pipes should normally be not less than 150 mm diameter and bends should be kept to a minimum. Care should be taken that the ends of cross flooding pipes are fully submerged during all stages of flooding. This should be checked with the ship at its lightest service draught.

5.6.4.5 Information about cross-flooding fittings, and other information about stability in the damaged condition referred to in Regulations 44 and 45

should be incorporated in the damage control booklets available on board the ship for the use of the master.

5.6.4.6 In cases of asymmetrical flooding the angle of heel and the condition of the ship should be calculated initially on the assumption that no cross-flooding has taken place. A recommended method of calculation is as follows:-

Time required for complete cross - flooding (seconds)

$$T_0 = \frac{2W}{SF} \cdot \frac{\left(1 - \sqrt{\frac{h_f}{H_0}}\right)}{\sqrt{2g \cdot H_0}} \cdot \frac{1}{\left(1 - \frac{h_f}{H_0}\right)} \dots\dots(I)$$

Time required to bring vessel from an angle θ (or the angle of margin line immersion) to the upright

$$T_\theta = \frac{2W}{SF} \cdot \frac{\left(1 - \sqrt{\frac{h_f}{H_\theta}}\right)}{\sqrt{2g \cdot H_\theta}} \cdot \frac{1}{\left(1 - \frac{h_f}{H_\theta}\right)} \dots\dots(II)$$

Hence:

Time required from commencement of cross - flooding to θ heel (or the angle of the margin line immersion)

$$T_\theta = T_0 - T_\theta \dots\dots(III)$$

The parameters used in the formulae are as follows:-

W = volume of water entering the equalising compartments during the considered period.

S = cross-section area through the cross-flooding duct.

H₀ = head of water before commencement of cross-flooding

H_θ = head of water at the time of cross-flooding where the vessel is heeled θ degrees (or at the angle of margin line immersion).

h_f = final head of water after cross-flooding (h_f = 0 when the level inside the equalising compartment is equal to the free level of the sea.

$$F = \frac{1}{\sqrt{1 + \sum k}}$$

= dimensionless factor of reduction of speed through the duct, being a function of bends, valves, etc. in the cross-flooding system.

For guidance some typical values for k are given in figure 5.6.4.6 a).
FRICITION COEFFICIENTS IN CROSS-FLOODING ARRANGEMENT

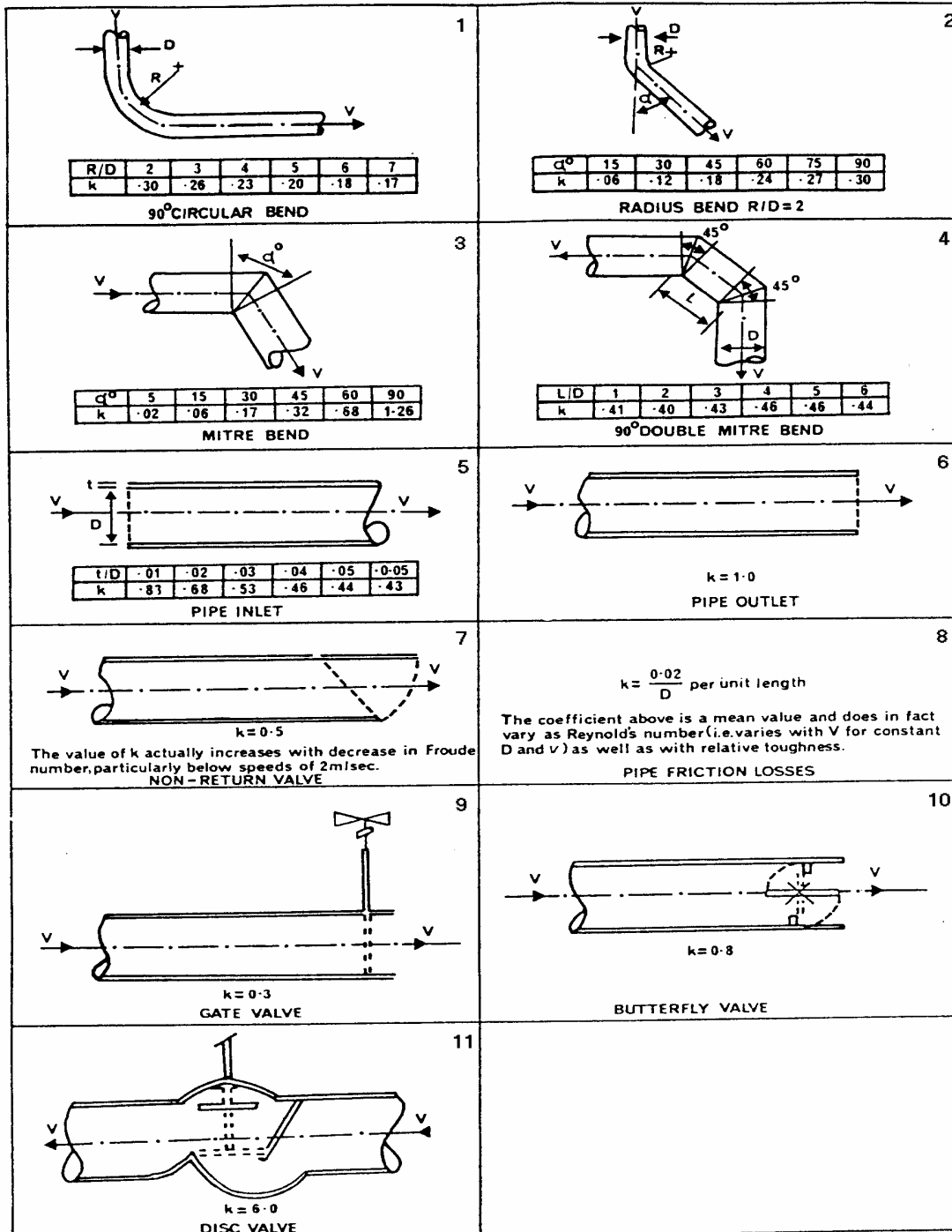


figure 5.6.4.6 a)

EXAMPLE

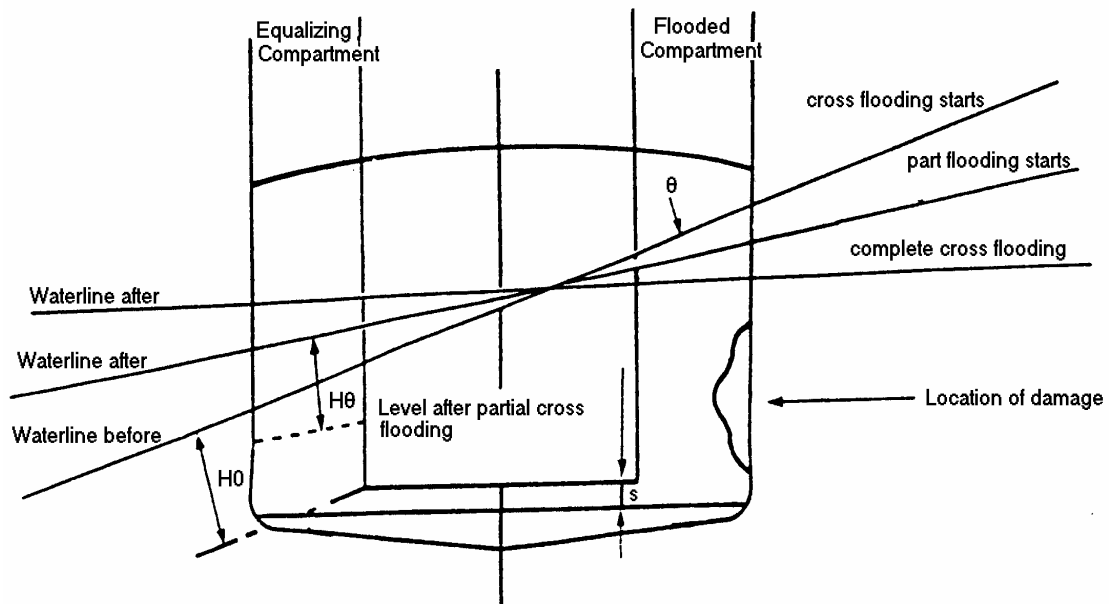


figure 5.6.4.6 b)

Cross-flooding pipe, diameter (D) 0.39m, length (l) 21.0m, cross section area (S) 0.12m².

'k' values for the cross-flooding system:

Inlet		0.45
Pipe friction	$\frac{0.02}{D} \cdot l$	1.08
2 Radius bends ($\alpha = 45^\circ$)		0.36
Non-return valve		0.50
Outlet		
	$\Sigma k =$	$\frac{1.00}{3.39}$

$$\therefore F = \frac{1}{\sqrt{1 + \Sigma k}} = \frac{1}{\sqrt{1 + 3.39}} = 0.48$$

Initial angle of heel	= θ_0	= 11.9°
head before cross-flooding commences	= H_0	= 5.3m
Head after complete cross-flooding	= h_f	= 1.5m

Time to complete cross - flooding :

$$T_0 = \frac{2W}{SF} \cdot \frac{\left(1 - \sqrt{\frac{h_f}{H_0}}\right)}{\sqrt{2g \cdot H_0}} \cdot \frac{1}{\left(1 - \frac{h_f}{H_0}\right)}$$

In this case W = final volume of water entering the equalisation compartment
= 365 m³

$$\therefore T_0 = \frac{2 \cdot 365}{0.12 \cdot 0.48} \cdot \frac{\left(1 - \sqrt{\frac{1.5}{5.3}}\right)}{\sqrt{2g \cdot 5.3}} \cdot \frac{1}{\left(1 - \frac{1.5}{5.3}\right)}$$

= 815 seconds (13.6 minutes)

The vessel is balanced at 7 degrees using the stability curve and H_θ measured to the equilibrium waterplane. W is now the volume added to reduce the heel angle from 7 degrees (or θ) to zero.

$$\text{Time from } 7^\circ \text{ heel to upright} = T_\theta = \frac{2W}{SF} \cdot \frac{\left(1 - \sqrt{\frac{h_f}{H_\theta}}\right)}{\sqrt{2g \cdot H_\theta}} \cdot \frac{1}{\left(1 - \frac{h_f}{H_\theta}\right)}$$

Head after partial cross-flooding to 7° heel = H_θ = 3.7m, and W = 160m³

$$\therefore T_\theta = \frac{2 \cdot 160}{0.12 \cdot 0.48} \cdot \frac{\left(1 - \sqrt{\frac{1.5}{3.7}}\right)}{\sqrt{2g \cdot 3.7}} \cdot \frac{1}{\left(1 - \frac{1.5}{3.7}\right)} = 400 \text{ seconds (6.7 minutes)}$$

Therefore from start of cross-flooding to 7° heel = T₀ - T_θ
= 415 seconds (6.9 minutes)

5.6.5 Verification of damage stability calculations

5.6.5.1 When the cases of damage referred to in paragraph 5.6.2.1 (viii) of these Instructions are submitted, the surveyor is to be satisfied that:-

- (i) the cases are as required, i.e. that the correct spaces have been assumed damaged, and the correct permeabilities have been used;
- (ii) the measurements which make up the data correspond to the ship as building, or built, and adequately define the volumes, levers, etc used in the calculations; and

(iii) the results comply with the requirements of Schedule 3 to Merchant Shipping Notice MSN 1698 (M). When the results do not comply with the Regulations, the builder/consultant is to be advised and requested to submit proposals to ensure compliance.

5.6.5.2 It should be impressed on builders that it is in their interest to be satisfied with the methodology of calculation and the accuracy of measurements which make up the data, because of delay which may arise from cases having to be re-submitted. Where modifications are made after the initial submission, supporting modified calculations and or statements are to be submitted substantiating that the changes comply with all the requirements of the regulations and not only damage stability. See also paragraph 1.1.3 of these Instructions.

5.6.6 In general, no allowance will be made for superstructures involved in side damage, except the portion or portions of the erection which can be shown to remain intact, and provide positive buoyancy after the submersion of the margin line. In the case of multi-hulled ships, side damage calculations should assume only one hull involved in the damage but additional calculations may be required for damage to each hull at the same time, so that the effect of collisions involving end compartments or of grounding may be considered.

5.6.7 Flagging in to UK register

On flagging in, details as required by paragraphs 5.6.2 to 5.6.4 of these Instructions will be required to substantiate the standard of survivability. In the case of Ro-Ro, ships details will also be required to substantiate the ships A/Amax value in order that the date by which compliance with the standard outlined in paragraphs 5.6.1.2 or 5.6.1.3 of these Instructions can be confirmed. Details will also be required to show compliance with subdivision requirements (see also paragraph 2.3 of these Instructions).

5.6.8 Increase in draught or structural alterations

When an increase in draught is requested, the owner should submit, after revision, all information outlined in paragraph 1.1.2 of these Instructions which is affected by such an increase. The intact and damage stability and subdivision arrangements are to be reconsidered and the results submitted for acceptance to the certifying authority. This may also apply when structural alterations are to be undertaken and details of such alterations should be submitted for consideration.

5.7 Stability in the Damage Condition - Ships Constructed on or After 29 April 1990 (Regulation 45)

5.7.1 General

Generally, the requirements of paragraph 5.6 of these Instructions are also applicable to this part, except that the standard of survivability referred to in paragraph 5.6.1.1 of these Instructions is replaced by SOLAS 90, i.e. Section 3 of Schedule 3 of Merchant Shipping Notice MSN 1698 (M).

5.7.2 Heeling moments due to crowding of passengers

5.7.2.1 In calculating the moment required by paragraph 3(1)(c) of Schedule 3 of Merchant Shipping Notice MSN 1698 (M), it should be noted that due to differing arrangements and sizes of ships, the moment can vary with passenger numbers. The calculations should therefore reflect that various passenger numbers have been considered in arriving at the maximum moment.

5.7.2.2 The calculation can be made using the displacement at draughts covering the operational range. If, to simplify the calculation, only one displacement is used, then it must be the displacement at the lightest seagoing draught.

5.8 Requirements for Ro-Ro Passenger Ships Which Carry 400 Persons or More (Regulation 46)

This regulation requires that all ro-ro passenger ships, including those constructed before 29 April 1992, carrying 400 persons or more comply with two compartment standard of survivability by given phase in dates.

5.9 Damage Control Plans and Booklets (Regulation 47)

5.9.1 Damage control plan

The plan should be simple and free from unnecessary detail and lettering, show an elevation of the ship, plan views of the double bottom, decks and flats below, and include the bulkhead deck and any other deck from which fittings affecting the integrity of the subdivision arrangements may be operated. The watertight subdivision bulkheads and decks should be clearly indicated. The position of any opening or fitting which may affect the integrity of the subdivision arrangements, and the position from which they may be closed is also to be shown. Wherever possible clear symbols (to the surveyor's satisfaction) should be used. Details of openings or fittings, the means of closing and position of operating them should be given in tabular form at the ends of the plan. In the case of ships of Class II(A), the plan may be dispensed with if the required information is minimal.

5.9.2 Damage control booklet

The booklet should contain similar information to the damage control plan and, in addition, the extent of damage assumed in the damage stability calculations, a copy of the curves of maximum KG (or minimum GM) permitted over the range of operating draughts and trims, and instructions to the master on any action to be taken in the event of the ship sustaining damage. It is not considered necessary to supply any other details of the damage stability calculations. The booklet may be dispensed with if the information is minimal, and can be readily incorporated in the Stability Information Booklet.