

PART 5

INTACT STABILITY AND STABILITY IN THE DAMAGED CONDITION AFTER FLOODING

5.1 Requirements for Ships Assigned Minimum Statutory Freeboards

5.1.1 All such ships should have sufficient stability for the freeboard assigned. The stability requirements to be complied with are as follows:

Regulation 32, Schedule 2 Part I paragraphs 2(2) and (3) and Schedule 6 in full. Schedule 2 paragraph 1 or Schedule 4 paragraph 5(3), (5) and (6) as appropriate (see Regulation 29).

5.1.2 Where the ship has to satisfy the flooding requirements of Schedule 2 Part 1 or Schedule 4 paragraph 5(3), (5) and (6), details of such calculations will be required (see paragraph 5.7).

5.1.3 Special consideration may be given with regard to the stability information to be provided for ships engaged on voyages of limited extent and where particular conditions of service apply, subject to the approval of Headquarters.

5.1.4 Where a ship is without stability information or the information is inadequate, the MCA will require new stability information to be submitted based on the results of a new inclining test (provided that if the results of an acceptable inclining test are available those may be used).

5.1.5 Consideration may be given by the MCA to the need for providing complete stability information in the case of a ship whose anticipated life is short, i.e. less than the normal term of the current load line certificate, provided the owner states the case in writing to Headquarters. Such cases will be dealt with on their merits.

5.1.6 Particular attention should be paid to the examination of stability information provided for ships engaged in the carriage of grain (see paragraph 8.21).

5.2 Requirements for Ships Issued With load line Exemption Certificates

Ships which are granted exemption under Regulation 5 should comply with the stability requirements stated in paragraph 5.1 above.

5.3 Ships for which less than Statutory Minimum Freeboards are Requested

5.3.1 The MCA is prepared to consider applications for the assignment of freeboards which are less than the statutory minimum to the following types of ships provided they operate within restricted geographical limits and in weather conditions that have been agreed by the Marine Office.

5.3.1.1 Barges and dredgers used for river and harbour maintenance

These craft will be considered for the assignment of a freeboard which may be reduced to 5/8 (Table B) or 150mm whichever is the greater provided:

- (a) they are of the 'hopper' type, i.e. fitted with bottom doors in their shell or have other similar means by which the soil can be speedily dumped;
- (b) they only proceed to sea for the purpose of dumping soil at recognised dumping grounds;
- (c) the strength of the craft is shown to be adequate at the proposed increased draught; and
- (d) the stability at this increased draught fulfils the requirements of paragraph 5.6 and stability information is prepared in accordance with the requirements of paragraph 8.3 of these Instructions.

5.3.1.2 Barges employed in the carriage of cargo on the Humber, Thames, etc.

These barges are in some cases permitted to proceed in winter, i.e. October to April, to the 'summer category D limits'. Barges will be considered for the assignment of a freeboard which may be reduced to 5/8 (Table B) or 150mm whichever is the greater provided that their strength and stability is shown to be adequate. The stability of such craft may be considered acceptable provided that the freeboard to draught and the breadth to draught ratios are at least 0.10 and 2.25 respectively and that the metacentric height when homogeneously loaded is at least 0.04 breadth after taking account of all free surface effects.

5.3.1.3 Hopper dredgers which operate at sea

The terms under which these ships will be considered are given in paragraph 8.3.3.

5.4 Ships Undergoing Sea Trials

It is unlikely that formally approved stability information will be available for ships when first proceeding to sea and in any such case the Surveyor should

ensure that a reliable provisional Stability Information Booklet is available for the use of the master.

5.5 Ships Making Voyages to the Breakers Yard

Surveyors should ensure that such ships are prepared to their satisfaction for the voyage. Suitable instructions are to be issued to the master if considered necessary. Provided the ship is of conventional form and the geometric proportions 'freeboard to draught' and 'beam to draught' ratios are not less than 0.3 and 3.5 respectively the stability characteristics may be considered acceptable

In the case of ships of unusual form or construction details should be submitted to Headquarters for consideration. The foregoing does not apply to fishing boats, ships of war and pleasure yachts which are exempted by virtue of Regulation 4(1).

5.6 Intact Stability Criteria

5.6.1 All new ships which are assigned freeboards under the Regulations must at least comply with the minimum criteria stated in Schedule 2 Part 1 paragraph 2 (2) for all sea going conditions see Figure 7.

5.6.2 There is also a minimum bow height requirement for each ship. This should always be maintained unless the MCA agrees otherwise. (See Schedule 4 paragraph 16).

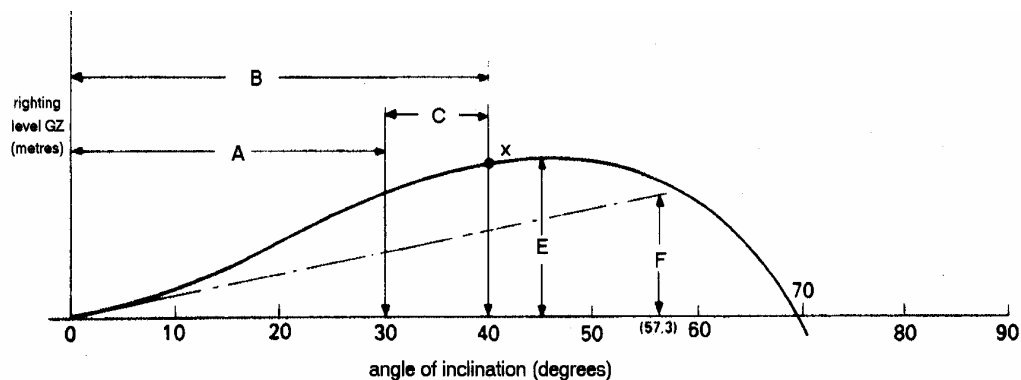


Figure 7

A-area under curve up to 30 degrees to be not less than 0.055 metre-radian.

B-area under curve up to x degrees to be not less than 0.09 metre-radian.

C-area between 30 degrees and x degrees to be not less than 0.03 metre-radian.

x-40 degrees or any lesser angle at which the lower edges of any openings in the hull, superstructure or deckhouses which lead below deck and cannot be closed weathertight, would be immersed.

E-maximum GZ to occur at angle not less than 30 degrees and to be at least 0.20 metre in height.

F-initial GM to be not less than 0.15 metre. In ships with timber deck cargo 0.05 metre will be permitted. The volume of timber deck cargo may be included in the derivation of the cross curves, see paragraph 8.24.

5.6.3 As an alternative to the criterion of Schedule 2 part 1 paragraph 2(2)(c), the angle at which the maximum righting lever occurs may be permitted to be reduced to 25 degrees having regard to the design of a particular ship. If the design of such a ship is likely to result in changes to the longitudinal position of the centre of buoyancy on heeling, the calculation of righting levers should be by use of a computer program which takes into account change in trim on heeling.

5.6.4 Superstructures which are enclosed superstructures, as defined in Schedule 2, may be taken into account in the calculation of righting levers for the intact ship. Where such superstructures are resiliently mounted, the Assigning Authority will be responsible for ensuring that appropriate hydrostatic loadings are taken into account in their design.

5.6.5 For non passenger ships, the IMO Code on Intact Stability (Resolution A.749(18) as amended) (formerly A.167 (ES.IV)) paragraphs 3.1.1 to 3.1.2.4 contain intact stability criteria which may be treated as equivalent to the above provided that for ships having large windage areas, wind heeling criteria are also applied.

5.7 Flooding and Damage Stability Requirements

5.7.1 General

5.7.1.1 All ships which are assigned less than Table B tabular freeboard (as defined in Schedule 4 paragraph 6) should, if over 100 metres in length (or 150 metres where Table A applies), be capable of withstanding the flooding of one or more of their main watertight compartments when loaded to the summer load waterline -see Regulation 29 and Schedule 2 paragraph 1, and Schedule 4 paragraphs 5(3), (5), (6) and (7) or (8) depending on the date of build.

5.7.1.2 It should be noted that any ship which complies with this subdivision standard is not required to comply with the subdivision requirements of the Merchant Shipping (Cargo Ship Construction) Regulations 1997 (SI 1997/1509), Part III. See Regulation 14 (h) of the latter.

5.7.2 Type A ships built before 8 June 2000

5.7.2.1 Ships over 150 metres but not exceeding 225 metres in length. Such ships must be capable of withstanding the flooding of anyone compartment, other than the machinery space, designed to be empty* in the summer load condition. The permeability of the empty* compartment is to be taken as 95%.

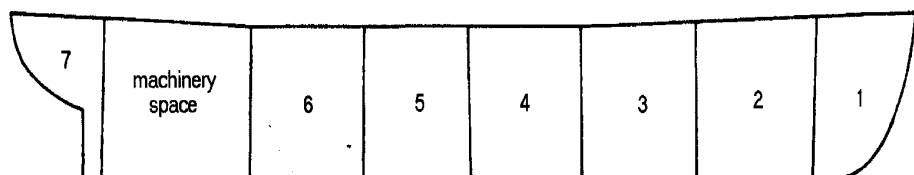


Figure 8

* or as shown to be in the Stability Information Booklet

5.7.2.2 Ships over 225 metres in length

Such ships must be capable of withstanding the flooding of any one compartment, designed to be empty*, in the summer load condition or the machinery space. The permeabilities of the machinery space and other compartments are to be taken as 85% and 95% respectively.

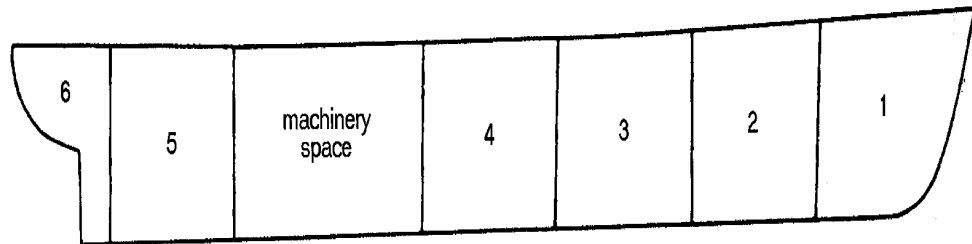


Figure 9

5.7.2A Type A ships built on or after 8 June 2000

5.7.2A.1 Ships over 150 metres in length

Such ships must be capable of withstanding the flooding of anyone compartment with an assumed permeability of 0.95. In such a ship the machinery space shall be treated as a floodable compartment but with a permeability of 0.85.

5.7.3 Type B ships built before 8 June 2000

5.7.3.1 Tabular freeboard less than B but not less than B-60

(a) Ships over 100 metres but not exceeding 225 metres in length

Such ships must be capable of withstanding the flooding of any 8 one compartment, other than the machinery space when loaded to the summer load waterline. The permeability of the compartment is taken as 95%.

(b) Ships over 225 metres in length

Such ships must be capable of withstanding the flooding of any one compartment (including the machinery space) when loaded to the summer load waterline. The permeabilities of the machinery space, and other compartments are to be taken as 85% and 95% respectively.

5.7.3.2 Tabular Freeboard less than B-60 but not less than B-100

(a) Ships over 100 metres but not exceeding 225 metres in length

Such ships must be capable of withstanding the flooding of any I two adjacent fore and aft compartments, neither of which is the machinery space, when loaded to the summer load waterline. The permeability of each compartment is to be taken as 95%.

(b) Ships over 225 metres in length

Such ships must be capable of withstanding the flooding of the machinery space alone or any two other adjacent fore and aft compartments. The permeabilities of the machinery space and other compartments are to be taken as 85% and 95% respectively.

5.7.3A Type B ships built on or after 8 June 2000

5.7.3A.1 Tabular freeboard less than B but not less than B-60

(a) Ships over 100 metres but not exceeding 150 metres in length

As for paragraph 5.7.3.1 (a) above

(b) Ships over 150 metres in length

As for paragraph 5.7.3.1 (b) above

5.7.3A.2 Tabular freeboard less than B-60 but not less than B-100

(a) Ships of over 100 metres but not exceeding 150 metres in length

Such ships must be capable of surviving damage to anyone transverse bulkhead throughout the length of the ship such that two adjacent fore and aft compartments are flooded simultaneously, neither of which is the machinery space.

(b) Ships over 150 metres in length

Such ships must be capable of withstanding the flooding of the machinery space alone or the damage specified in paragraph (a) above.

5.7.4 Assumptions to be made when undertaking flooding calculations for ships built before 8 June 2000

When undertaking flooding and damage stability calculations, account should be taken of the following assumptions and conditions which are additional to those contained in the Regulations.

5.7.4.1 While the flooding envisaged in Type B ships is clearly stated to have been caused by damage this fact is not evident in the case of Type

A ships. Nevertheless for these calculations the cause of flooding in Type A ships should be assumed to have been produced by damage; the extent of damage being that laid down in Schedule 4 paragraph 5(7) for Type B ships.

5.7.4.2 The ship should be assumed to have no trim when in the intact condition prior to flooding.

5.7.4.3 Although the vertical extent of damage is in all cases only to be taken to the freeboard deck at side, the buoyancy of any superstructure or deckhouse in way of the damage shall be disregarded.

5.7.4.4 If in any transverse bulkhead there are steps or recesses of not more than 3.05 metres in length located within the extent of transverse penetration of damage as defined in Schedule 4 paragraph (7)(b) such transverse bulkheads may be considered intact and the adjacent compartments may be floodable singly. If, however, within the extent of penetration of damage there is a step or recess of more than 3.05 metres in length in a transverse bulkhead the two compartments adjacent to this bulkhead should be considered flooded.

5.7.4.5 If a double bottom, side or top tank is divided by a transverse bulkhead located more than 3.05 metres from a main transverse bulkhead, the adjacent double bottom side, or topside tank should be considered as flooded. If the topside tank has openings into the holds, such holds should also be considered as flooded. This provision is applicable even when such openings are fitted with watertight closing appliances.

5.7.4.6 Only main transverse watertight bulkheads which are spaced at least 3.05 metres + 0.03L. or 10.65 metres apart whichever is the lesser will be considered effective as watertight boundaries. Where transverse bulkheads are spaced at a lesser distance one or more of these bulkheads should be assumed as non-existent in order to establish the minimum space between bulkheads.

5.7.4.7 In considering the position of equilibrium after flooding for both Type A and Type B ships, in addition to the conditions laid down in Schedule 2 paragraph 1 for Type A ships and Schedule 4 paragraph 5(6) for Type B ships, it should be noted that the 'final waterline' is that reached taking into account sinkage, heel and trim. It is assumed that progressive flooding does not take place through openings which have watertight means of closing, e.g. openings closed by:

(a) manhole covers and flush scuttles complying with Schedule 2 paragraph 8(1);

(b) hatch covers complying with schedule 2 paragraph 19 (i.e. small watertight type hatches);

(c) watertight doors which are securely closed while at sea and so recorded in the ship's log;

(d) remotely operating sliding watertight doors; and

(e) non-opening side scuttles complying with the appropriate requirements of BS MA 24:1974.

In regard to items (c) and (d) openings in main transverse watertight bulkheads closed with watertight doors are permissible provided that:

(i) approval is sought from the MCA for their fitting;

(ii) the number of such openings is the minimum compatible with the design and proper working of the ship;

(iii) the size of any such opening is kept to the minimum consistent with its intended purpose; and

(iv) such openings are as near as practicable to the centre line and in no such case outboard of the B/5 lines. Any piping, wiring etc. associated with the operation of watertight doors should also be kept at a minimum distance of B/5 from the ship's side.

5.7.4.8 If pipes, ducts or tunnels are situated within the assumed extent of penetration of damage as defined in Schedule 4 paragraph 5(7)(b) arrangements should be made so that flooding cannot thereby extend beyond the limits assumed for the calculations of the damaged conditions.

5.7.4.9 (a) In calculating the height of the centre of gravity in accordance with Schedule 4 paragraph 5 (7)(d) account should be taken of corrections for free surfaces of liquids. In calculating the free surface correction it should be assumed that, for each type of liquid, at least one single centre line tank or each of a transverse pair of tanks has a free surface. Any tank taken into account should be that where the effect of free surface is greatest. Remaining tanks should be assumed either completely empty or completely full, and the distribution of consumable liquids between these tanks should be arranged so as to obtain the greatest possible height above the keel for the centre of gravity.

(b) The free surface effect in compartments containing fluid cargoes which may exist in the normal full load condition should be taken into account.

(c) Weights should be calculated using the following specific gravities:

Salt Water	1.025
Fresh Water	1.000
Oil Fuel	0.950
Diesel Oil	0.900
Lubricating Oil	0.900

(d) Tanks situated in the machinery compartments and designed to contain consumable liquids such as fuel oil, diesel oil, lubricating oil and fresh water, should be assumed not floodable, unless the heeling moment due to unsymmetrical flooding of these tanks is appreciable (i.e. producing an angle of heel in excess of that stated in paragraph 5.7.5.2.

5.7.4A Assumptions to be made when undertaking flooding calculations for ships built on or after 8 June 2000

These are fully detailed in Schedule 2, paragraph 1 and Schedule 4, paragraph

5.7.5 Requirements in the flooded condition

After flooding the ship must be capable of remaining afloat in the following condition of equilibrium:

5.7.5.1 The final waterline after flooding should be below the top of any ventilator coaming, the lower edge of any air pipe opening, the upper edge of the sill of any access opening fitted with a weathertight door and the lower edge of any other opening through which progressive flooding could take place.

5.7.5.2 The angle of heel due to unsymmetrical flooding should not normally exceed 15 degrees but if no part of the deck is immersed an angle of 17 degrees may be accepted.

5.7.5.3 In the case of symmetrical flooding the metacentric height (GM) calculated using the constant displacement method should have a positive value of at least 50mm in the upright condition after flooding.

5.7.5.4 The residual stability should not be less than that indicated by the statical stability curve shown in Figure 10.

5.7.5A Requirements in the flooded condition for ships built on or after 8 June 2000

These are fully detailed in Schedule 2, paragraph 1.

5.7.6 Information to be presented from flooding calculations

In cases where flooding calculations are required as a condition of assignment of freeboard, i.e. under Schedule 2 paragraph (1) or Schedule 4 paragraph 5(3),

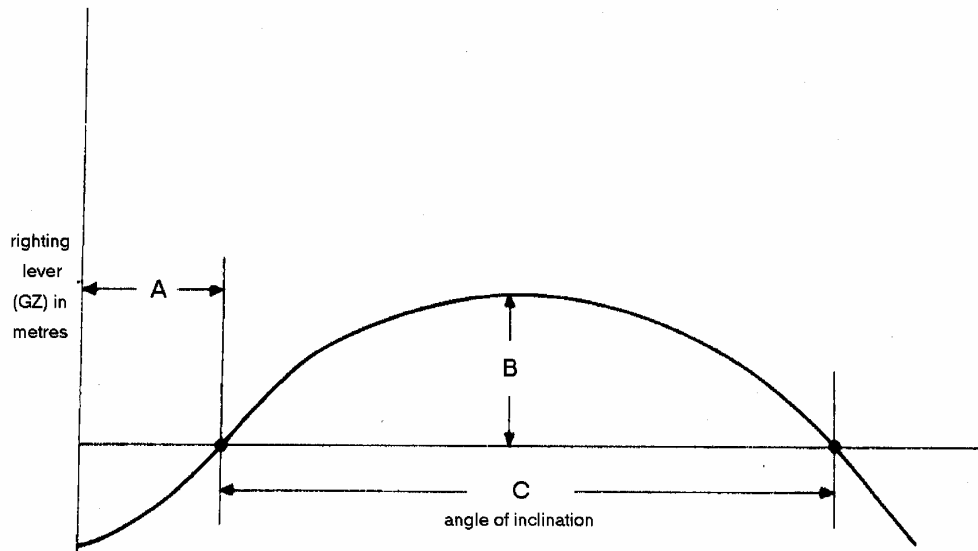


Figure 10

A-the final angle of heel should not exceed 15 degrees (or 17 degrees if paragraph 5.7.5.2 applies).

B-the maximum height of righting lever (gz) should not be less than 0.1 metre.

C-the range of positive stability should be not less than 20 degrees.

(5) and (6), the MCA will require the following information to be included in the Stability Information Booklet:

5.7.6.1 a statement indicating the condition of the ship prior to flooding. This should include the displacement and the centre of gravity of the ship in the light condition. These values must be examined carefully to see that they relate to the results obtained from either the inclining test or detailed weight calculation;

5.7.6.2 a small scale plan showing the compartments assumed to have been flooded (see Figure 11);

5.7.6.3 a statement indicating the method of calculation that has been employed to obtain the final results;

5.7.6.4 A statement and small scale sketches giving the condition of the ship after flooding indicating:

(a) the draughts of the final trim (see Figure 12);

(b) the final angle of heel, if any, or if the ship remains upright after flooding the value of the metacentric height (GM) (see Figure 13); and

(c) The proximity of the final trim line to the nearest opening through which progressive flooding could take place (see Figure 13);

5.7.6.5 a curve of residual stability for the final condition of flooding (similar to Figure 10); and

5.7.6.6 a cautionary note on any condition of loading that could be rearranged without affecting the freeboard where such a rearrangement, e.g. filling of central compartments instead of wing compartments, would place the ship in a more onerous condition should collision damage be sustained.

Typical sketches and data to comply with paragraph 5.7.6.

Details of damaged compartment

Location of compartment	Weight of flood water	V.C.G	Vertical moment	L.C.G	Longitudinal moment	T.C.G	Transverse Moment

Plan view



Figure 11

Centerline (to a sufficient number of compartments as are appropriate)

Profile showing final trim condition

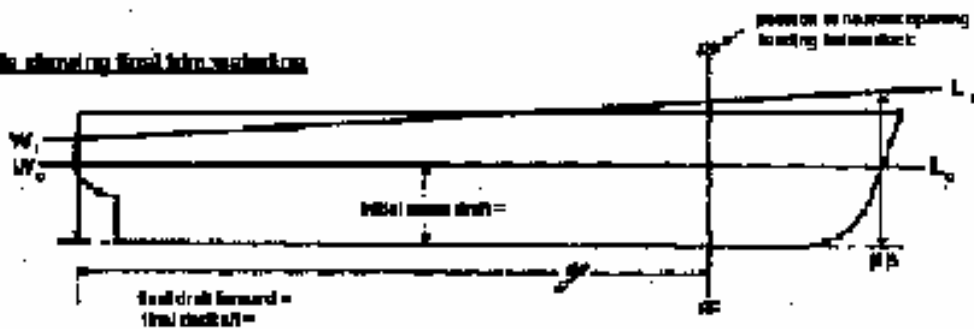


Figure 12

Position of the damaged compartment to be shown in the profile

Section to show position of final waterline for rearranged compartment loading below deck

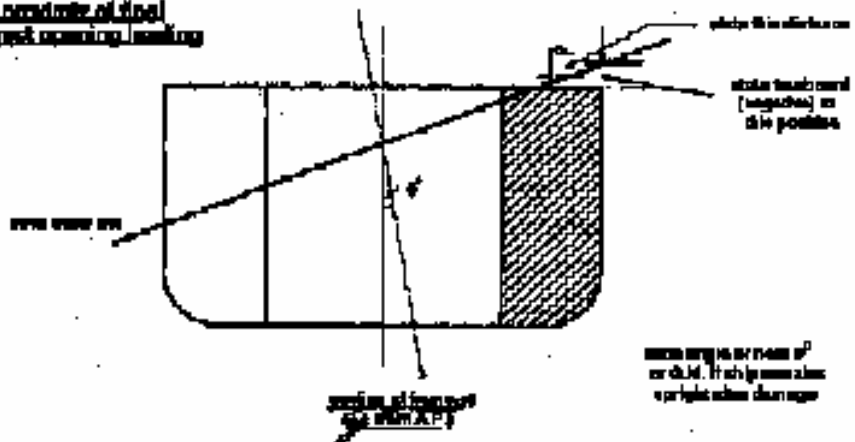


Figure 13

The 'Curve of Residual Stability' should be given on the original draft

5.7.7 Information for the guidance of fire fighting personnel

Surveyors should impress upon ship owners the value of providing additional information for the guidance of ship's officers, fire brigade officers, and other personnel who may be engaged in fighting a fire on board ship. It is recommended that such information should indicate the effect on the ship's stability of the large volumes of water that might be pumped into the ship during fire fighting operations.

5.8 Examination and Approval Procedure

The administrative procedures to be followed by surveyors dealing with stability approval are contained in documented MCA procedures which should be used in conjunction with this section.

5.8.1 New ships

The procedure for the examination and approval of stability data to ensure that it meets the requirements detailed in paragraph 5.1.1 should be as follows:

5.8.1.1 Checking of hydrostatic particulars, cross curves of stability (Schedule 6, paragraph 9) and the capacity and centre of gravity of all spaces should be progressed by the Surveyor during the ship's construction. The Stability Declaration (form FRE 14) should be completed concurrently with the foregoing. Whenever this basic information has been obtained by using a computer program both the input and output data should be examined and agreed by the Surveyor.

5.8.1.2 As the ship nears completion an inclining test, conducted to the satisfaction of the Surveyor should be held to determine the displacement and the position of the centre of gravity of the ship in the light condition. See Part 6 "Notes for Guidance for Carrying Out an Inclining Test".

5.8.1.3 When examining the Stability Information Booklet the Surveyor should ensure that:

(a) The free surface effects of liquids have always been taken into account. All service tanks, i.e. those containing fuel or lubricating oil and feed or fresh water, which are required for immediate use should be assumed to be slack and a free surface correction made. When tanks are stated to be approximately 98% full they should be assumed to be slack and a free surface correction applied. Where the shipbuilders or their consultants indicate to the Surveyor that the application of a full free surface correction would be an unrealistic a lesser correction may be applied subject to agreement by Headquarters. A correction should also be applied for the liquid in a stabiliser tank wherever such a tank is fitted.

(b) The stability characteristics for a ship designed to operate with a large trim has been evaluated in the actual trimmed condition.

(c) It does not contain conditions of loading that have been evaluated using a mixture of imperial and metric units.

(d) In the case of small ships there is included a table or graph giving the maximum dead-weight moment and/or minimum metacentric height (GM) values for given draughts, as recommended in paragraph 5.8.4.

5.8.1.4 When the Surveyor has completed the examination of the stability information (and flooding calculations where appropriate, see paragraph 5.7.5, and is satisfied that it meets the MCA requirements, arrangements should be made for at least three copies of the information to be given formal approval and complete form FRE 14.

5.8.1.5 (a) Once the stability information for a particular ship has been formally approved the appropriate Assigning Authority should be informed by letter. This letter should also indicate the assigned freeboard and the corresponding summer load draught.

(b) Additionally, if the ship has been assigned a freeboard which entails flooding calculations or is required to comply with Regulation 33, a further copy of the Stability Information Booklet should be obtained and forwarded to the Assigning Authority.

5.8.1.6 The Surveyor should arrange for one copy of the approved stability information to be returned to the shipowner together with instructions for it to be placed and retained on the ship for the guidance of the master. The shipowner should be requested to acknowledge receipt of the information.

5.8.2 Existing ships

The procedure for the examination and approval of stability data should be as indicated in paragraphs 5.8.1.1 to 5.8.1.6 inclusive. In all cases where substantial structural alterations have taken place since the last documented inclining test was carried out, a new inclining test should be carried out.

5.8.3 General information

In order to standardise the form of presentation and to expedite the examination and approval of stability data, it is recommended that the Model Stability Information Booklet format should be used (see Annex 1).

5.8.4 Simplified stability information for small ships

5.8.4.1 As a result of the capsizing of a small ship when the improperly loaded cargo shifted it is recommended that Owners should endeavour to have their ships comply with the statutory intact stability criteria even when not required to do so by law.

5.8.4.2 It is also recommended that the presentation of stability data should be simplified, particularly on small ships. An acceptable method of presentation is shown in the Model Stability Information Booklet at Annex 1. The provision of maximum permissible vertical dead-weight moments tabulated or plotted against draught is particularly useful for ships carrying deck cargoes.