SECTION 26 – CALCULATION AND ASSIGNMENT OF FREEBOARD

INTRODUCTION

All ships (with certain exceptions) are required to be surveyed and marked with permanent load line markings in accordance with the *International Convention on Load Lines, 1966 as modified 1988*. The principle purpose of load line assignment is to ensure that the ship always has sufficient reserve buoyancy and intact stability when proceeding to sea. Reference is made to Part 3 of the IMO publication *'Load Lines – 2002 Edition'* that details the procedure for the calculation and assignment of freeboards. *It will be necessary to refer to this publication as much of the detail of the regulations is not included in this text.*

For UK registered ships reference should be made to the following publications:

The Merchant Shipping (Load Line) Regulations 1998 (S.I. 1998 No. 2241)

The Merchant Shipping (Load Line) (Amendment) Regulations 2000 (S.I. 2000 No. 1335)

MSN 1752 (M)

Load Line – Instructions for the Guidance of Surveyors (MCA)

For the purpose of this section the requirements detailed will be those as stipulated under the 1966 Load Line Convention that has been modified by the 1988 Protocol (as found in **Part 3 – Annex B – Annex I – Chapters I-IV of the IMO publication *'Load Lines – 2002 Edition'*).** Where the MCA requirements differ significantly, applicable to UK registered ships only, then such differences will be emphasised.

The following ships are not required to have load lines assigned:

* warships;
* new ships of less than 24 metres in length;
* existing ships of less than 150 tons gross;
* pleasure yachts not engaged in trade, and;
* fishing vessels.

(Annex A – Article 5)

The principal conditions that must be satisfied before freeboard may be assigned to any ship take account of the following:

* *structural strength of the ship;*

* *preservation of reserve buoyancy;*

* *physical means of preventing entry of water into the hull;*

* *safety of the crew on the weather deck;*
* *potential wetness of the weather deck;*

* *stability in the normal loaded condition (intact stability);*

* *degree of subdivision and stability after suffering prescribed damage.*

The seasonal zones, areas and periods that determine the appropriate load line in a particular sea area at a given time of year are set out in *Annex II* and are shown by way of the chart attached to this annex. The *Tropical, Summer* and *Winter* freeboard zones are based upon the following weather criteria:

Summer Zones – Regions where not more than 10% of wind speeds exceed force 8 Beaufort (34 knots).

Tropical Zones – Regions where not more than 1% of wind speeds exceed force 8 Beaufort (34 knots) and not more than one tropical storm in a ten-year period occurs in an area of 5º latitude/longitude square in any one separate calendar month.

Winter Zones – Are all other regions.

It is a criminal offence for the Master and/or shipowner to allow a vessel to be operated in a zone, when in the upright condition, the relevant amidships zone load line would be below the still load waterline. Such an action would immediately invalidate all Classification Society and Load Line certification and will lead to criminal prosecution.

Learning Objectives

On completion of this section the learner will achieve the following:

1. Understand the appropriate terms and definitions associated with the calculation and assignment of freeboard.
2. Recognise the ship's side markings relating to freeboard assignment.
3. Understand the conditions of assignment applicable to all ships.
4. Understand the additional conditions of assignment for type 'A' ships (tankers).
5. Understand the distinction between type 'A' and type 'B' ships.
6. Understand the conditions necessary for certain type 'B' vessels to be awarded reduced tabular freeboards.
7. Understand the calculation procedure for the assignment of a type 'A' freeboard.
8. Understand the calculation procedure for the assignment of a type 'B' freeboard.
9. Understand the conditions of assignment of timber freeboards.
10. Know the required load line surveys that a ship must undergo and the preparations necessary for such surveys.

26.1 DEFINITIONS

The following definitions for the purpose of freeboard calculation are detailed in *Regulation 3*.

26.1.1 Length (L)

This is taken as 96% of the total length on a waterline at 85% of the least moulded depth, or, as the length from the fore side of the stem to the axis of the rudder stock on that waterline, if greater.

26.1.2 Perpendiculars (FP, AP)

The forward and after perpendiculars are taken as being at the forward and after ends of the length (L). The forward perpendicular shall coincide with the foreside of the stem on the waterline on which the length (L) is measured.

26.1.3 Amidships

Amidships is at the middle of the length (L).

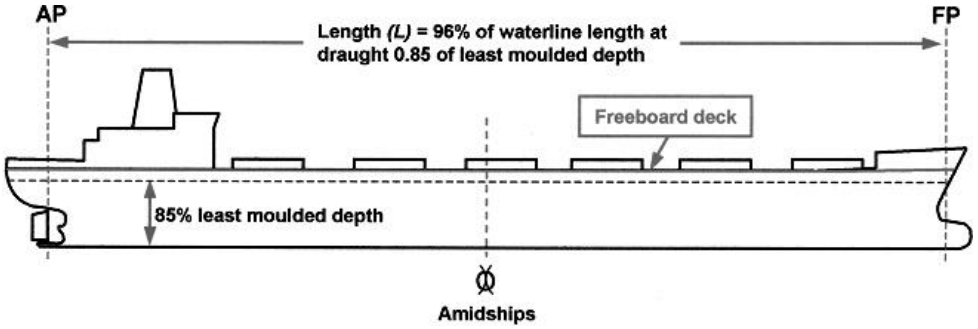


Fig. 26.1

26.1.4 Breadth (B)

Unless expressly provided otherwise, the breadth (B) is the maximum breadth of the ship, measured amidships to the moulded line of the frame in a ship with a metal shell and to the outer surface of the hull in a ship with a shell of any other material.

26.1.5 Moulded depth

This is the vertical distance measured from the top of the keel to the top of the freeboard deck beam at side.

In ships having rounded gunwales, the moulded depth shall be measured at the point of intersection of the moulded lines of the deck and side shell plating, the lines extending as though the gunwale were of angular design.

Where the freeboard deck is stepped and the raised part of the deck extends over the point at which the moulded depth is to be determined, the moulded depth shall be measured to a line of reference extending from the lower part of the deck along a line parallel with the raised part.

26.1.6 Depth for freeboard (D)

This is the moulded depth amidships, plus the thickness of the freeboard deck stringer plate, where fitted, plus $\frac{T(L-S)}{L}$ if the exposed freeboard deck is sheathed, where:

T is the mean thickness of the exposed sheathing clear of deck openings, and
S is the total length of superstructures.

The depth for freeboard (D) in a ship having a rounded gunwale with a radius greater than 4% of the breadth (B) or having topsides of unusual form is the depth for freeboard of a ship having a midship section with vertical topsides and with the same round of beam and area of topside section equal to that provided by the actual midship section.

26.1.7 Block Coefficient (C_b)

Is given by: $$C_b = \frac{\text{Volume of displacement at draught } 0.85D}{\text{Length}^* \times \text{Breadth}^* \times \text{draught (at 85\% of least moulded depth)}}$$

(* as previously defined) (in no case shall the block coefficient (C_b) be taken to be less than 0.68.)

26.1.8 Freeboard

The freeboard assigned is the distance measured vertically downwards amidships from the *upper edge* of the deck line to the *upper edge* of the related load line.

26.1.9 Freeboard Deck

This is normally the uppermost continuous deck exposed to weather and sea, which has permanent means of closing all openings in the weather part thereof, and below which all openings in the sides of the ship are fitted with permanent means of watertight closing (figure 26.1). In a ship having a discontinuous freeboard deck, the lowest line of the exposed deck and the continuation of that line parallel to the upper part of the deck is taken as the freeboard deck (figure 26.2).

The owner may opt to designate a lower deck as the freeboard deck provided that it is a complete and permanent deck in a fore and aft direction at least between the machinery space and peak bulkheads and continuous athwartships (this is typical for a Ro-Ro vessel). In such cases that part of the hull that extends above the freeboard deck may be treated as superstructure for the purposes of calculation of freeboard (figure 26.2).

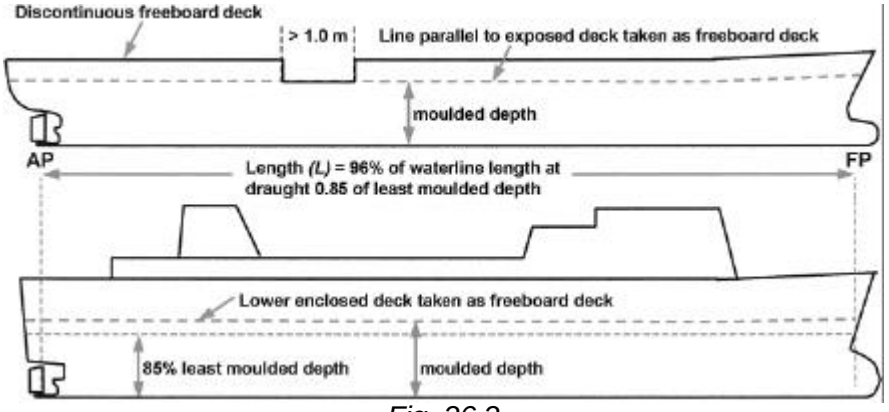


Fig. 26.2

26.1.10 Superstructure

A superstructure is a decked structure on the freeboard deck, extending from side to side of the ship or with the side plating not being inboard of the shell plating more than 4% of the breadth (B). A *raised quarter-deck* is regarded as a superstructure. (*Raised quarter-decks* are often associated with smaller ships. With the machinery space sited aft and being proportionally larger in smaller ships there is a tendency for the ship to be trimmed by the head when fully loaded. To prevent this, the height of the aftermost holds may be increased to increase deadweight aft; this is achieved by means of a raised quarter-deck.)

An *enclosed superstructure* is a superstructure with:

(a) enclosing bulkheads of efficient construction;
(b) access openings, if any, in these bulkheads fitted with doors complying with the requirements of regulation 12 (see 26.3.3).
(c) all other openings in sides or ends of the superstructure fitted with efficient weathertight means of closing.

A bridge or poop shall not be regarded as enclosed unless access is provided for the crew to reach machinery and other working spaces inside these superstructures by alternative means which are available at all times when bulkhead openings are closed. The height of a superstructure is the least vertical height measured at side from the top of the superstructure deck beams to the top of the freeboard deck beams.

The length of a superstructure is the mean length of the part of the superstructure which lies within the length (L).

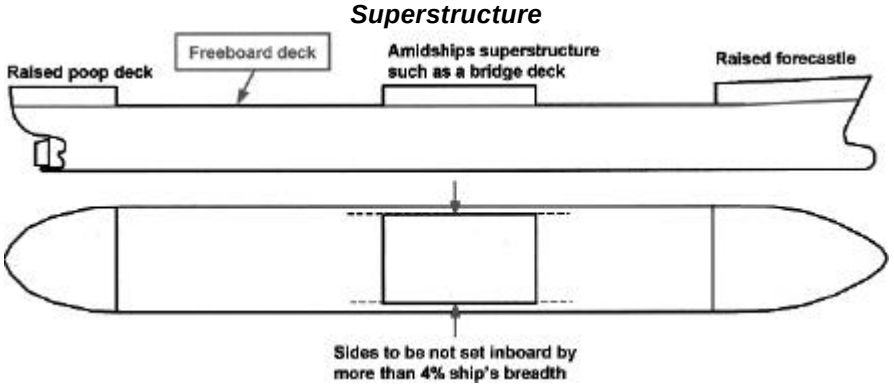


Fig. 26.3

26.1.11 Flush deck ship

Is one that has no superstructure on the freeboard deck.

26.1.12 Weathertight

Means that in any sea conditions water will not penetrate into the ship.

26.2 SHIP'S SIDE MARKINGS

26.2.1 Deck line (Regulation 4)

The deck line is a horizontal line marked amidships on each side of the ship. Its upper edge shall normally pass through the point where the continuation outwards of the upper surface of the freeboard deck intersects the outer surface of the shell plating.

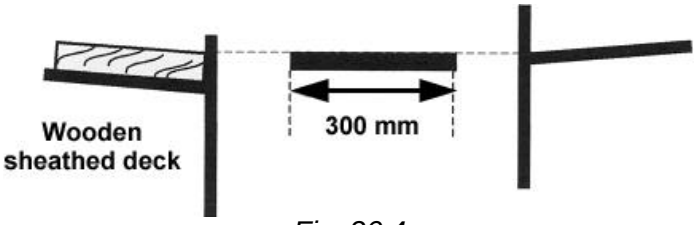


Fig. 26.4

However, the deck line may be placed with reference to another fixed point on the ship on condition that the freeboard is correspondingly corrected and that the reference point location and the identification of the freeboard deck is clearly indicated on the International Load Line Certificate. This is typical in the case of a ship having a radiused sheerstrake (rounded gunwale) (figure 26.5).

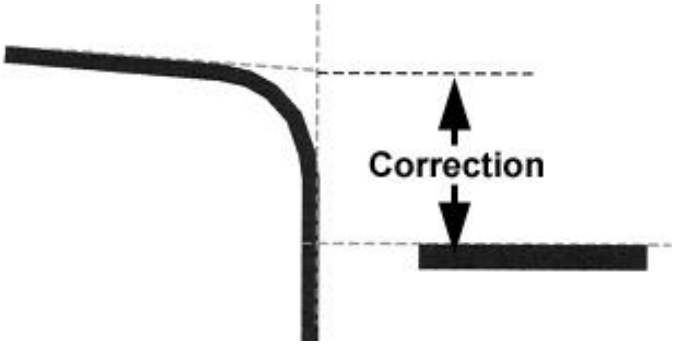


Fig. 26.5

26.2.2 Load line mark and accompanying load lines (Regulations 5 to 8)

The Load Line Mark consists of a ring 300 mm in outside diameter and 25 mm thick which is intersected by a horizontal line 450 mm in length and 25 mm thick, the *upper edge* of which passes through the *centre* of the ring. The centre of the ring is placed amidships and at a distance equal to the assigned summer freeboard measured vertically below the *upper edge* of the deck line. These are indicated in figure 26.6 and were also discussed in Section 4.

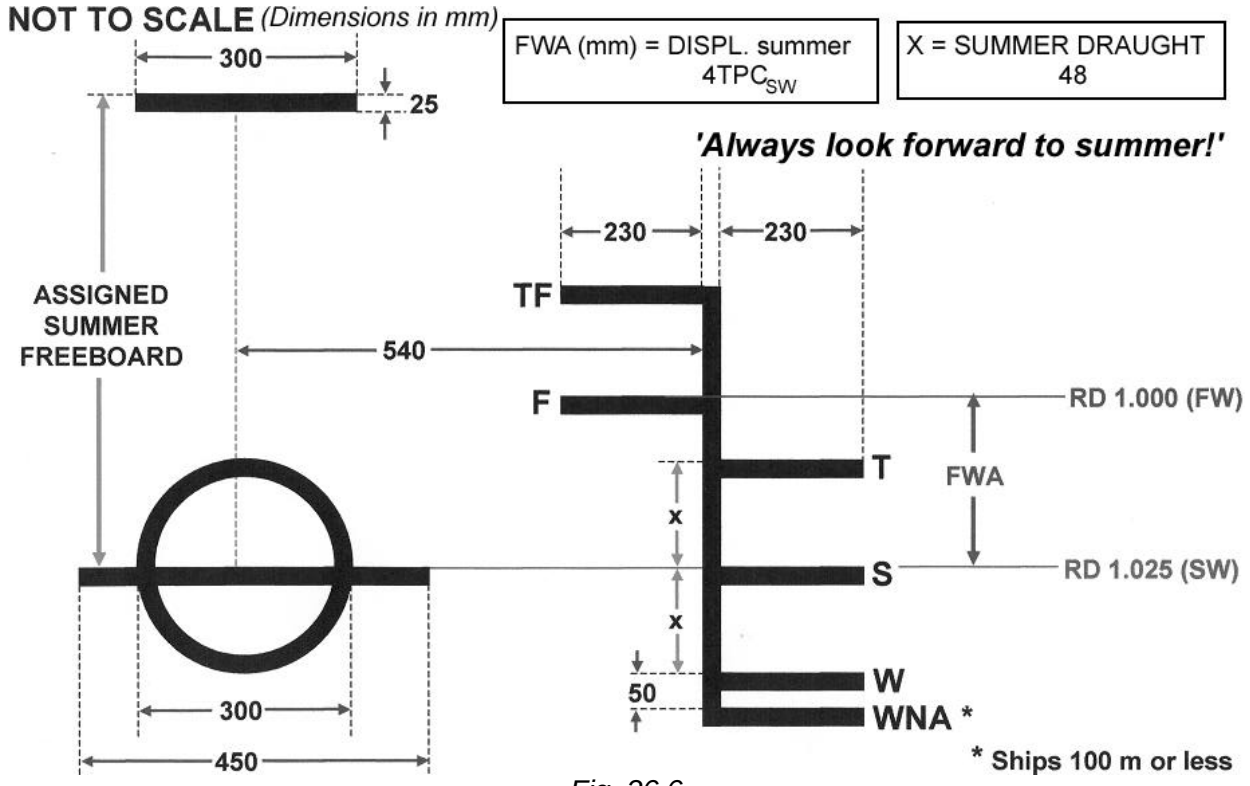


Fig. 26.6

If timber freeboards are assigned the timber load lines are marked in addition to the ordinary load lines as shown in figure 26.7.

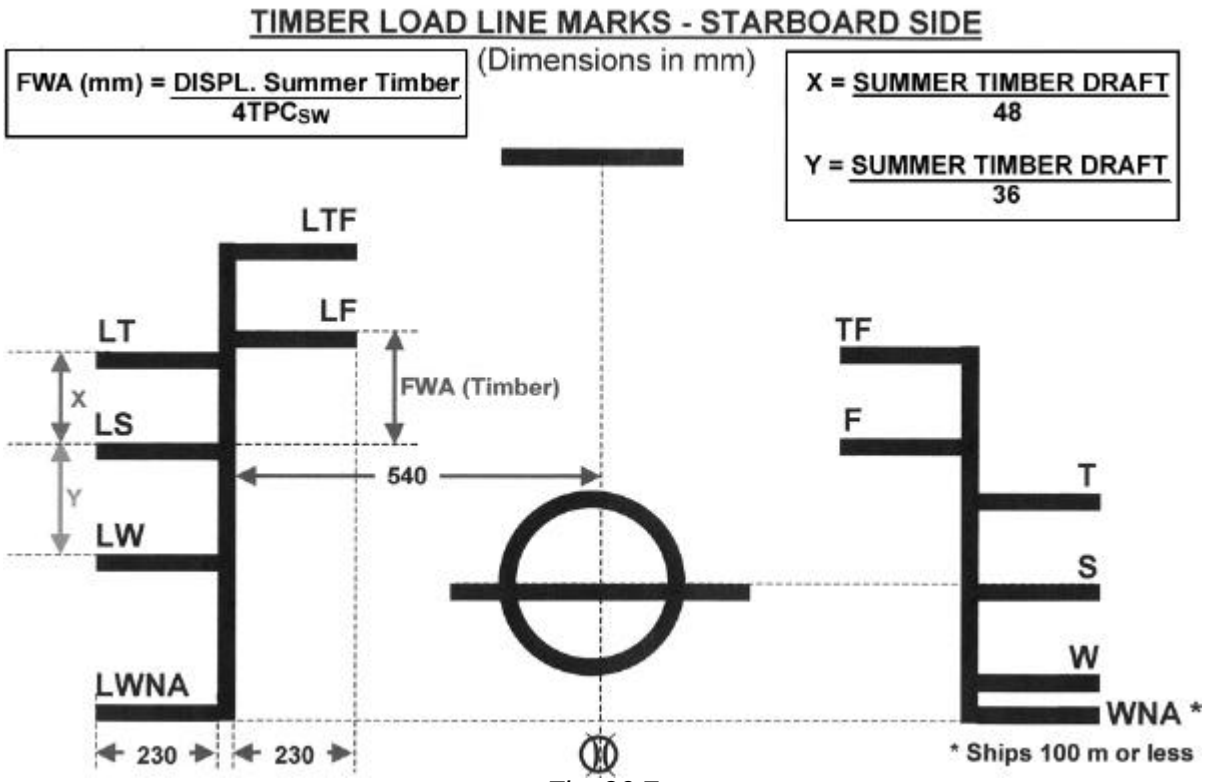


Fig. 26.7

Where a ship is assigned a *greater than minimum* freeboard so that the load line mark is marked at a position corresponding to, or lower than, the lowest seasonal load line assigned at a minimum freeboard in accordance with the calculation procedure, only the *Fresh Water Load Line* need be marked. Such load lines are termed *'All Seasons Load Lines'* and are illustrated in figure 26.8.

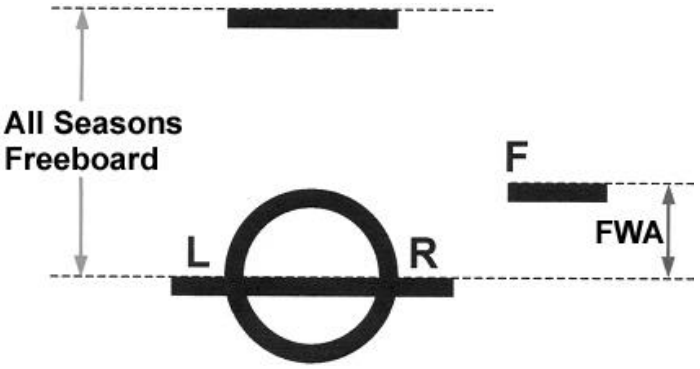


Fig. 26.8

Sailing ships are only required to have the Fresh Water (F) and Winter North Atlantic (WNA) load lines marked.

In addition to the load line markings the initials of the Assigning authority must be marked above the load line mark to identify the Authority's name as shown in figure 26.8 (Lloyds Register). No more than four letters are permitted and each initial must measure approximately 115 mm in height and 75 mm in width.

All markings must be *clearly* and *permanently* marked, being white or yellow on a dark background or in black on a light background. Permanent marking is achieved by the marks being centre-punched onto the ship's side or being welded onto the ship's side. They must also be clearly visible. The marks must be verified as being in place by an approved surveyor before the International Load Line Certificate is issued.

26.3 CONDITIONS OF ASSIGNMENT OF FREEBOARD APPLICABLE TO ALL SHIPS

26.3.1 Structural strength

It is recognised that ships *'built and maintained in conformity with the requirements of a classification society recognised by the Administration'* may be considered to possess the necessary structural strength for freeboards to be assigned (*Regulation 1*).

26.3.2 Information to be supplied to the master

Regulation 10 states:

(1) The master of every new ship shall be supplied with sufficient information, in an approved form, to enable him to arrange for the loading and ballasting of his ship in such a way as to avoid the creation of any unacceptable stresses in the ship's structure, provided that this requirement need not apply to any particular length, design or class of ship where the Administration considers it to be unnecessary.

(2) Every ship which is not required under the International Convention for Safety of Life at Sea in force to undergo an inclining test upon its completion shall:

- *(a) be so inclined and the actual displacement and position of the centre of gravity shall be determined for the light ship condition;*
- *(b) have supplied for the use of its master such reliable information in an approved form as is necessary to enable him by rapid and simple processes to obtain accurate guidance as to the stability of the ship under all conditions likely to be encountered in normal service;*
- *(c) carry on board at all times its approved stability information together with evidence that the information has been approved by the Administration;*
- *(d) if the Administration so approves, have its inclining test on completion 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 ship can be obtained from such basic data.*

Chapter 2 of the *Code on Intact Stability for all Types of Ships Covered by IMO Instruments (IMO)* details more specifically the information that must be provided to the master of all ships in order that stability calculations may be accurately conducted to ensure the ship's safe operation. The current MCA requirements are found in Schedule 6 of MSN 1752(M). Refer to *Section 19 – Inclining Experiment*.

26.3.3 Structural conditions of assignment

The conditions of assignment specified in regulations 11 to 26 should be studied but may be summarised as follows:

Bulkheads at the exposed ends of superstructures shall be of efficient construction (*Regulation 11*).

All access openings in bulkheads at the ends of enclosed superstructures shall be fitted with steel weathertight doors that will provide equivalent bulkhead strength when closed. They must be sealed by gaskets and clamping devices, be capable of being operated from both sides and have sills of at least 380 mm above the level of the deck (*Regulation 12*).

Two positions of hatchways, doorways and ventilators are defined as follows:

<u>Position 1</u> *Upon exposed freeboard and raised quarter-decks, and upon exposed superstructure decks situated forward of a point located a quarter of the ship's length from the forward perpendicular.*

<u>Position 2</u> *Upon exposed superstructure decks situated abaft a quarter of the ship's length from the forward perpendicular. (Regulation 13)*

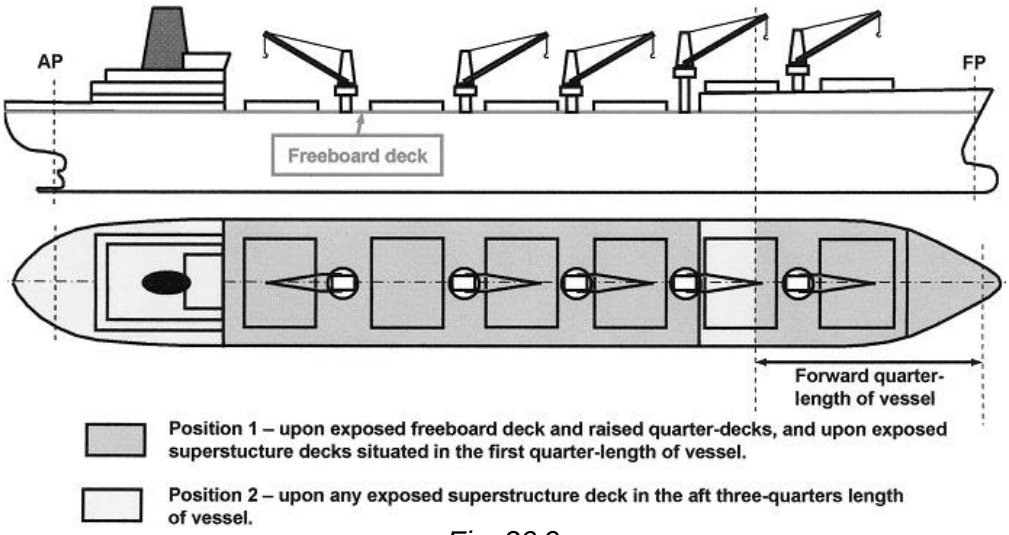


Fig. 26.9

Regulation 15 details the requirements for hatchways closed by portable wooden hatch covers that are secured weathertight by tarpaulins and battening devices. Most modern ships are now fitted with steel hatch covers so regulation 16 is more relevant.

For ships fitted with steel weathertight covers the principal requirements are:

* Hatchway coamings in position 1 are to be at least 600 mm above the deck; in position 2 they are to be at least 450 mm above the deck. (If these are of equivalent superstructure height and strength and have an average width of at least 60% of the ship's breadth at their point of location then they will be regarded as being a trunk and the additional reserve buoyancy that is afforded by them will be taken into account in the calculation of freeboard, which is usually the case.)

* Covers are to be of mild steel and be able to sustain the following loads:
  In position 1 – not less than 1.75 t/m^3;
  In position 2 – not less than 1.30 t/m^3.

* The means for securing of the hatch covers shall be such as to ensure weathertightness in any sea conditions and the hatch covers will be subjected to tests at the initial (and subsequent) surveys to ensure the effectiveness of the arrangements. (*Regulation 16*)

Machinery space openings in positions 1 and 2 shall be properly framed and efficiently enclosed by steel casings, if the casings themselves are not protected by other structures there strength will be specially considered (it is usual on most ships to gain access to the engine room from inside a protecting superstructure). *(Regulation 17)*

Miscellaneous openings in freeboard and superstructure decks such as manholes and flush scuttles in position 1 or 2 or within superstructures other than enclosed superstructures shall be closed by substantial covers capable of being made watertight. Unless secured by closely spaced bolts, the covers shall be permanently attached. Openings in freeboard decks other than hatchways, machinery space openings, manholes and flush scuttles shall be protected by an enclosed superstructure, or by a deckhouse or companionway of equivalent strength and weathertightness. In position 1 the height above the deck of sills to the doorways in companionways shall be at least 600 mm. In position 2 it shall be at least 380 mm. *(Regulation 18)*

Ventilators in position 1 or 2 to spaces below freeboard or superstructure decks shall have steel coamings of at least 900 mm and 760 mm respectively above the deck. Ventilator openings shall be provided with weathertight closing appliances, if the ship is not more than 100 m in length they must be permanently attached. If the coamings extend to more than 4.5 m above the deck in

position 1, and 2.3 m in position 2, they need not be fitted with closing arrangements unless specifically required by the Administration. *(Regulation 19)*

Where air pipes to ballast or other tanks extend above the freeboard or superstructure decks they should be of substantial construction and extend upwards to a height above the deck at least 760 mm on the freeboard deck and 450 mm on the superstructure deck. They shall be fitted with a permanently attached means of closing.*(Regulation 20)*

Cargo ports and other similar openings in the ship's sides below the freeboard deck shall be kept to a minimum number compatible with the design and proper working of the ship. Doors must be designed to ensure structural integrity and watertightness. The lower edge of such openings shall not be below a line drawn parallel to the freeboard deck at side, which has its lowest point level with the upper edge of the uppermost load line.*(Regulation 21)*

Discharges shall be fitted with efficient and accessible means for preventing water from passing inboard. Normally each separate discharge shall have one automatic non-return valve with a positive means of closing it from a position above the freeboard deck. Where, however, the vertical distance from the summer load waterline to the inboard end of the discharge pipe exceeds 0.01L, the discharge may have two automatic non-return valves without positive means of closing, provided that the inboard valve is always accessible for examination under service conditions; where that vertical distance exceeds 0.02L, a single automatic non-return valve may be accepted subject to the approval of the Administration.

Scuppers and discharge pipes originating at any level and penetrating the shell either more than 450 mm below the freeboard deck or less than 600 mm above the summer load waterline shall be provided with a non-return valve at the shell (the valve may be omitted if the piping is of substantial thickness).

All shell fittings and valves required by regulation 12 shall be of steel, bronze or other approved ductile material. All pipes are to be of steel or other approved equivalent material. *(Regulation 22)*

Side scuttles to spaces below the freeboard deck or to spaces within enclosed superstructures shall be fitted with efficient hinged inside deadlights arranged so that they can be effectively closed and secured watertight. *(Regulation 23)*

Freeing ports shall be provided in bulwarks to allow for rapid freeing of water from decks. Required freeing port area is specified in terms of a number formulae detailed in regulation 24. *(Regulation 24)*

Protection of crew is to be ensured by the provision of efficient guard rails or bulwarks which are to be fitted to all exposed freeboard and superstructure decks. These should be at least 1 metre in height from the deck. In the case of guard rails, the opening below the lowest course of the guard rails shall not exceed 230 mm. The other rails shall not be more than 380 mm apart. Special provision, including lifelines, shall be made as necessary for allowing the crew safe access to all parts of the ship during the normal operation of the ship, this will include access in way of deck cargoes also. *(Regulation 25)*

26.4 TYPE 'A' SHIPS AND THEIR ADDITIONAL SPECIAL CONDITIONS OF ASSIGNMENT

A type 'A' ship is any ship designed to carry liquid cargoes in bulk such as tankers, chemical carriers, LPG and LNG carriers. However, the regulations give a much more precise definition.

26.4.1 Type 'A' ship – definition (Regulation 27)

For the purpose of assigning freeboards a type 'A' ship is one which:

(a) is designed to carry only liquid cargoes in bulk;

(b) has a high integrity of the exposed deck with only small access openings to cargo compartments, closed by watertight gasketed covers of steel or equivalent material, and;

(c) has a low permeability of loaded cargo compartments.

A type 'A' ship if over 150 m in length to which a freeboard less than type 'B' has been assigned, when loaded in accordance with the assumed initial condition of loading, shall be able to withstand the flooding of any compartment or compartments, with an assumed permeability of 0.95, consequent upon the damage assumptions specified, and shall remain afloat in a satisfactory condition of equilibrium. In such a ship the machinery space shall be treated as a floodable compartment, but with a permeability of 0.85.

In the above paragraph:
The *initial condition of loading* before flooding shall be determined as follows:

(a) The ship is loaded to its summer load waterline on an imaginary even keel.

(b) When calculating the vertical centre of gravity, the following principles apply:

(i) Homogeneous cargo is carried.

(ii) All cargo compartments, except those referred to under (iii), but including compartments intended to be partially filled, shall be considered fully loaded except that in the case of fluid cargoes each compartment shall be treated as 98% full.

(iii) If the ship is intended to operate at its summer load waterline with empty compartments, such compartments shall be considered empty provided the height of the centre of gravity so calculated is not less than as calculated under (ii).

(iv) 50% of the individual total capacity of all tanks and spaces fitted to contain consumable liquids and stores is allowed for. It shall be assumed that for each type of liquid, at least one transverse pair or a single centreline tank has maximum free surface, and the tank or combination of tanks to be taken into account shall be those where the effect of free surfaces is the greatest; in each tank the centre of gravity of the contents shall be taken at the centre of volume of the tank. The remaining tanks shall be assumed either completely empty or completely filled, and the distribution of consumable liquids between these tanks shall be effected so as to obtain the greatest possible height above the keel for the centre of gravity.

(v) At an angle of heel of not more than 5º in each compartment containing liquids, as prescribed in (ii) except that in the case of compartments containing consumable fluids, as prescribed in (iv), the maximum free surface effect shall be taken into account.
Alternatively, the actual free surface effects may be used, provided the methods of calculation are acceptable to the Administration.

(vi) Weights shall be calculated on the basis of the following values for specific gravities:

salt water	1.025
fresh water	1.000
oil fuel	0.950
diesel oil	0.900
lubricating oil	0.900

The *damage assumptions* are as follows:

(a) The vertical extent of damage in all cases is assumed to be from the base line upwards without limit.

(b) The transverse extent of damage is equal to B/5 or 11.5 m, whichever is the lesser, measured inboard from the side of the ship perpendicularly to the centreline at the level of the summer load waterline.

(c) If damage of a lesser extent than specified in sub-paragraphs (a) and (b) results in a more severe condition, such lesser extent shall be assumed.

(d) Except where otherwise required by paragraph (10)(a) ***(which relates to B-100 vessels***) the flooding shall be confined to a single compartment between adjacent transverse bulkheads provided the inner longitudinal boundary of the compartment is not in a position within the transverse extent of assumed damage. Transverse boundary bulkheads of wing tanks which do not extend over the full breadth of the ship shall be assumed not to be damaged, provided they extend beyond the transverse extent of assumed damage prescribed in sub-paragraph (b).

If in a transverse bulkhead there are steps or recesses of not more than 3 m in length located within the transverse extent of assumed damage as defined in subparagraph (b), such transverse bulkhead may be considered intact and the adjacent compartment may be floodable singly. If, however, within the transverse extent of assumed damage there is a step or recess of more than 3 m in length in a transverse bulkhead, the two compartments adjacent to this bulkhead shall be considered as flooded. The step formed by the afterpeak bulkhead and the afterpeak tank top shall not be regarded as a step for the purpose of this regulation.

(e) Where a main transverse bulkhead is located within the transverse extent of assumed damage and is stepped in way of a double bottom or side tank by more than 3 m, the double bottom or side tanks adjacent to the stepped portion of the main transverse bulkhead shall be considered as flooded simultaneously. If this side tank has openings, into one or several holds, such as grain feeding holes, such hold or holds shall be considered as flooded simultaneously. Similarly in a ship designed for the carriage of fluid cargoes, if a side tank has openings into adjacent compartments, such adjacent compartments shall be considered as empty and as being flooded simultaneously. This provision is applicable even where such openings are fitted with closing appliances, except in the case of sluice valves fitted in bulkheads between tanks and where the valves are controlled from the deck. Manhole covers with closely spaced bolts are considered equivalent to the unpierced bulkhead except in the case of openings in topside tanks making the topside tanks common to the holds.

(f) Where the flooding of any two adjacent fore and aft compartments is envisaged, main transverse watertight bulkheads shall be spaced at least ? $L^{2/3}$ or 14.5 m, whichever is the lesser, in order to be considered effective. Where transverse bulkheads are spaced at a lesser distance, one or more of these bulkheads shall be assumed as non-existent in order to achieve the minimum spacing between bulkheads.

The *condition of equilibrium* after flooding shall be considered as satisfactory provided that:

(a) The final waterline after flooding, taking into account sinkage, heel and trim, is below the lower edge of any opening through which progressive downflooding may take place. Such openings shall include air pipes, ventilators and openings which are closed by means of weathertight doors or hatch covers, and may exclude those openings closed by means of manhole covers and flush scuttles (which comply with regulation 18), cargo hatch covers of the type described in regulation 27(2) ***(referring to the small, watertight and gasketed***

covers of steel as required for type 'A' ships), remotely operated sliding watertight doors, and side scuttles of the non-opening type (which comply with regulation 23). However, in the case of doors separating a main machinery space from a steering gear compartment, watertight doors may be of a hinged, quick-acting type kept closed at sea, whilst not in use, provided also that the lower sill of such doors is above the summer load waterline

(b) If pipes, ducts or tunnels are situated within the assumed extent of damage penetration as defined in paragraph (12)(b) *(being the transverse extent of damage)*, arrangements shall be made so that progressive flooding cannot thereby extend to compartments other than those assumed to be floodable in the calculation for each case of damage.

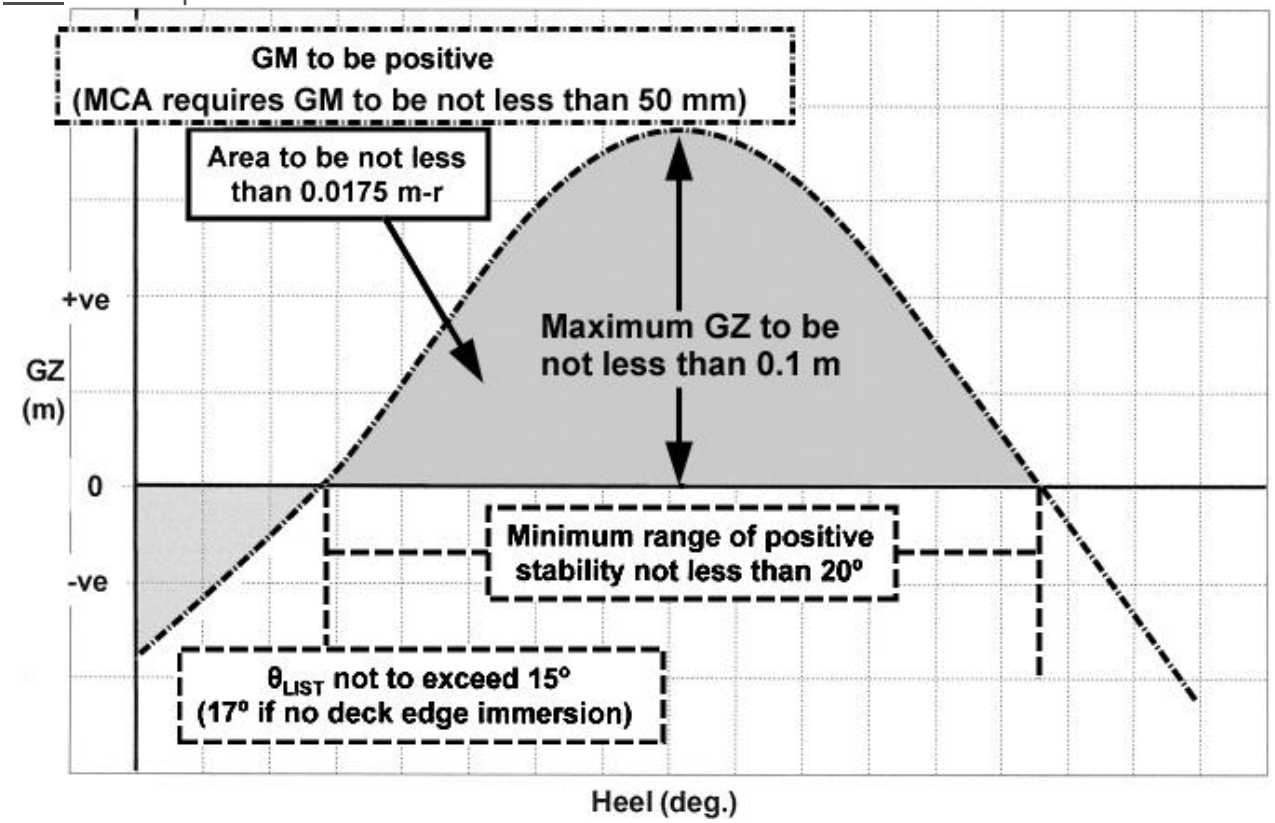
(c) The angle of heel due to unsymmetrical flooding does not exceed 15º. If no part of the deck is immersed, an angle of heel of up to 17º may be accepted.

(d) The metacentric height in the flooded condition is positive.

(a) When any part of the deck outside the compartment assumed flooded in a particular case of damage is immersed, or in any case where the margin of stability in the flooded condition may be considered doubtful, the residual stability is to be investigated. It may be regarded as sufficient if the righting lever curve has a minimum range of 20º beyond the position of equilibrium with a maximum righting lever of at least 0.1 m within this range. The area under the righting lever curve within this range shall be not less than 0.0175 metre-radians. The Administration shall give consideration to the potential hazard presented by protected or unprotected openings which may become temporarily immersed within the range of residual stability.

(f) The Administration is satisfied that the stability is sufficient during intermediate stages of flooding.

Note MCA requires that the GM must be at least 50 mm.



Minimum damaged stability requirements for type 'A' ships.
Fig. 26.10

26.4.2 Special structural conditions of assignment for type 'A' ships (Regulation 26)

(1) Machinery casings on type 'A' ships, as defined in regulation 27, shall be protected by an enclosed poop or bridge of at least standard height, or by a deckhouse of equal height and equivalent strength, provided that machinery casings may be exposed if there are no openings giving direct access from the freeboard deck to the machinery space. A door complying with the requirements of regulation 12 may, however, be permitted in the machinery casing, provided that it leads to a space or passageway which is as strongly constructed as the casing and is separated from the stairway to the engine-room by a second weathertight door of steel or other equivalent material.

(2) An efficiently constructed fore and aft permanent gangway of sufficient strength shall be fitted on type 'A' ships at the level of the superstructure deck between the poop and the midship bridge or deckhouse where fitted or equivalent means of access shall be provided to carry out the purpose of the gangway, such as passages below deck. Elsewhere, and on type 'A' ships without a midship bridge, arrangements to the satisfaction of the Administration shall be provided to safeguard the crew in reaching all parts used in the necessary work of the ship.

(3) Safe and satisfactory access from the gangway level shall be available between separate crew accommodations and also between crew accommodations and the machinery space.

(4) Exposed hatchways on the freeboard and forecastle decks or on the tops of expansion trunks on type 'A' ships shall be provided with efficient watertight covers of steel or other equivalent material.

(5) Type 'A' ships with bulwarks shall have open rails fitted for at least half the length of the exposed parts of the weather deck or other effective freeing arrangements. The upper edge of the sheer strake shall be kept as low as practicable.

(6) Where superstructures are connected by trunks, open rails shall be fitted for the whole length of the exposed parts of the freeboard deck.

26.5 THE DISTINCTION BETWEEN TYPE 'A' SHIPS AND TYPE 'B' SHIPS EXPLAINED

A type 'B' ship is any ship other than a type 'A' ship.

When assigning freeboards to ships the first part of the calculation procedure is to firstly ascertain the *tabular freeboard* from the appropriate table in regulation 28. Type 'A' tabular freeboards are smaller than type 'B' tabular freeboards for ships of equivalent length because of the structural layout and types of cargo carried.

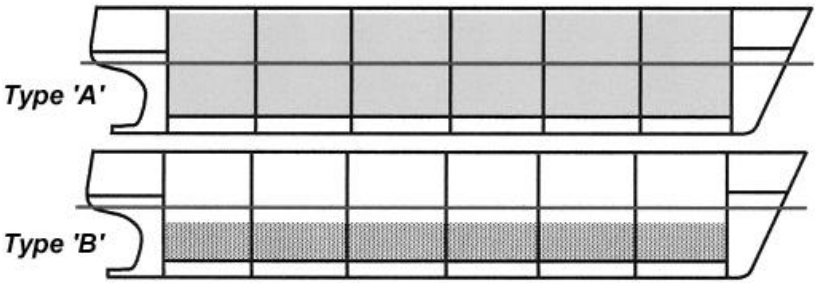


Fig. 26.11

Consider two ship hulls, one designed to carry oil cargoes (type 'A') and another designed to carry a bulk cargo of iron ore say (type 'B').

Consider what will happen if a loaded amidships compartment becomes bilged in each ship.

In the case of the type 'A' ship the cargo oil will run out of the damaged compartment, resulting in a reduction in displacement and an increase in the freeboard.

In the case of the type 'B' ship the seawater will run into the damaged compartment, resulting in an increase in displacement and a reduction in the freeboard.

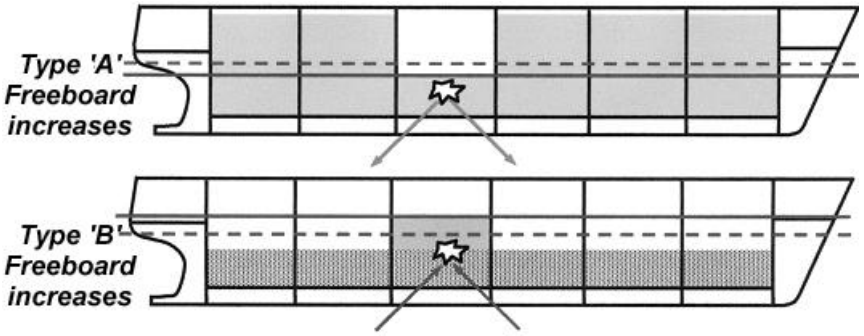


Fig. 26.12

The general *advantages* of a Type 'A' ship can be summarised as follows:

* *High watertight integrity of the exposed freeboard deck as cargo tanks have small access openings closed by watertight and gasketed covers of steel.*
* *Loaded cargo tanks have a low permeability.*
* *Because of the large free surface effects possible with liquid cargoes, type 'A' ships must have a high degree of subdivision, both longitudinally and transversely. This subdivision limits the volume of lost buoyancy when a compartment becomes bilged, unlike the relatively large hold of a cargo vessel (type 'B' ship).*
* *The greater degree of subdivision improves the stability characteristics in the damaged condition when damage is in way of a transverse bulkhead causing the flooding of two adjacent loaded compartments.*
* *Greater subdivision also reduces the effect of trim when near end compartments become bilged.*
* *Cargo pumps provide efficient means of maintaining a level of flood water in a damaged cargo compartment, especially if the damaged compartment was empty.*

In contrast type 'B' ships have comparatively large hatchways which can only be made *weathertight*. Depending on the nature of the cargo, permeability of loaded holds can be high (as with dense cargoes). If a type 'B' ship exceeds 100 metres in length, is fitted with steel hatch covers and has sufficient subdivision to meet certain damage stability criteria they may be allowed a reduction in freeboard (B-60 and B-100 vessels).

26.6 B-60 AND B-100 TABULAR FREEBOARDS

26.6.1 B-60 and B-100 tabular freeboards explained

If a type 'B' ship can satisfy certain additional conditions of assignment with respect to structure and damaged stability it will qualify for a reduction in its tabular freeboard. This reduction may be 60% the difference between the tabular A and tabular B freeboard, and in some cases be 100% the difference; hence the terms 'B-60' and 'B-100'.

Consider the extracts from the freeboard tables in regulation 28 below:

TABLE A		**TABLE B**	
Length of ship (metres)	**Freeboard (millimetres)**	**Length of ship (metres)**	**Freeboard (millimetres)**
140	**1803**	**140**	**2109**
141	**1820**	**141**	**2130**
142	**1837**	**142**	**2131**
143	**1853**	**143**	**2171**

For a given length of ship the tabular freeboard is less for a Type 'A' ship than a Type 'B' ship.

If the ship to which freeboard is to be assigned were 140 m in length the tabular freeboards would be:

Type 'B' 2109 mm
Type 'A' 1803 mm
Difference 306 mm

= **X** in *figure 26.13.*

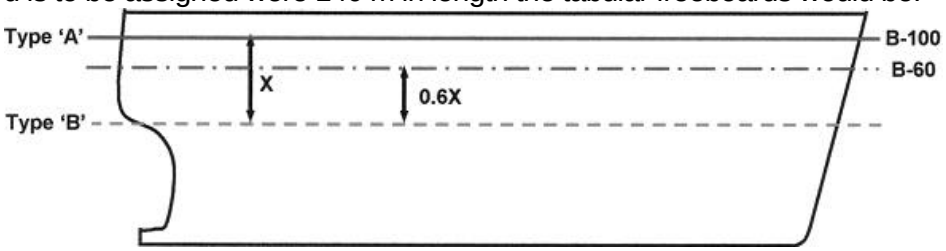


Fig. 26.13

If a type 'B' ship has a certain improved standard of subdivision and steel hatch covers it may qualify for a reduction in the tabular freeboard of 60% the difference between the type 'A' and type 'B' freeboards, hence, the term 'B-60'.
Tabular Freeboard assigned = 2109 - (0.6 $\times$ 306) = 1925 mm.

Further improvement in design might qualify the type 'B' ship a reduction of the full amount of the difference - 'B-100'.
Tabular Freeboard assigned = 2109 - (1 $\times$ 306) = 1803 mm.
(It can be seen that type 'A' and type 'B-100' tabular freeboards are the same!)

26.6.2 Additional conditions of assignment for type 'B-60' freeboard (Regulation 27)

The following additional conditions must be satisfied:

(1) Ship must be over 100 m in length.

(2) measures must be provided for the protection of the crew on exposed decks must be adequate (such as the fitting of a raised catwalk or underdeck walkways along each side of the hull).

(3) arrangements for freeing water off the deck must be adequate (railings instead of bulwarks may have to be fitted).

(4) hatch covers in positions 1 and 2 must be of steel and have adequate strength, special care being given to their sealing and securing arrangements.

(5) the ship, when loaded in accordance with the *initial condition of loading*, shall be able to withstand the flooding of any compartment or compartments, with an assumed permeability of 0.95, consequent upon the *damage assumptions* specified and shall remain afloat in a satisfactory *condition of equilibrium*.

If the ship is over 150 m in length, the machinery space may be treated as a floodable compartment with a permeability of 0.85.

(The *initial condition of loading*, *damage assumptions* and *condition of equilibrium* are the same as those applicable in the definition of a type 'A' ship – *section 26.4.1.*)

26.6.3 Additional conditions of assignment for type 'B-100' freeboard (Regulation 27)

The following additional conditions must be satisfied:

(1) All the special conditions of assignment applicable to type 'A' ships (as per *section 26.4.2*);

(2) All the additional conditions applicable to the assignment of 'B-60' freeboards in the previous *sub-section - 26.6.2*.

(3) the ship, when loaded in accordance with the *initial condition of loading*, shall be able to withstand the simultaneous flooding of any *two adjacent* fore and aft compartments (not including the machinery space) with an assumed permeability of 0.95, consequent upon the *damage assumptions* specified and shall remain afloat in a satisfactory *condition of equilibrium*.

If the ship is over 150 m in length, the machinery space may be treated as one of the floodable compartments with a permeability of 0.85.

(The *initial condition of loading*, *damage assumptions* and *condition of equilibrium* are the same as those applicable in the definition of a type 'A' ship – *section 26.4.1.*)

26.7 CALCULATION PROCEDURE FOR THE ASSIGNMENT OF A TYPE 'A' FREEBOARD

This section details the calculation procedure for the assignment of summer freeboard for a type 'A' ship to which corrections will be applied to determine the seasonal zone load lines.

It must be emphasised that the calculation procedure is only summarised in this section as it is the reasoning behind each of the corrections that will be questioned on in examinations and not the full detail of an actual freeboard assignment calculation. Chapter III – Freeboards (Regulations 27 to 40) should be consulted for more detail if required.
The expressions in this schedule are those as defined in the definitions given in section 26.1.
Freeboard is determined as follows:

26.7.1 Obtain the tabular freeboard (Regulation 28)

From *Table A* ascertain the ship's tabular freeboard for the ship's length (L).
The *tabular freeboard* is the freeboard that would be assigned to a *standard ship* built to the highest recognised standard and having five specific characteristics as follows:

* a block coefficient of 0.68;
* a length to depth ratio of 15 i.e. L/D = 15;
* no superstructure;
* a parabolic sheer of the freeboard deck attaining a particular height at the forward and after perpendiculars as prescribed by formulae (depending on the length of the ship);
* a minimum bow height above the load waterline as prescribed by formulae (depending on C_b and length of ship).

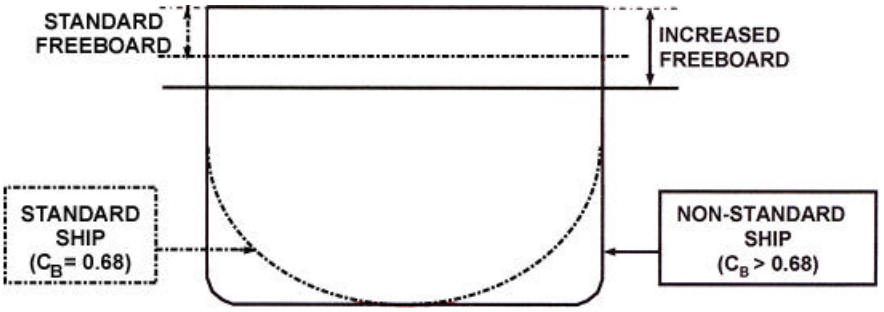
It is how each of the above characteristics for the ship in question differs from the standard ship that will determine whether the corrections to the tabular freeboard are *added* or *subtracted*.

26.7.2 Correction for block coefficient (Regulation 30)

The *standard ship* has a block coefficient of 0.68. If C_b is *greater* than this the freeboard must be *increased*. This is achieved by: Tabular Freeboard $\times \frac{C_b + 0.68}{1.36}$

Reasoning for this is as follows:

A larger C_b causes an increase in the underwater volume, so freeboard must be increased in order that the reserve buoyancy amounts to the same percentage of the greater displaced volume as it would have been had C_b been 0.68. This is illustrated in figure 26.14.



Freeboard is increased when C_b is greater than 0.68 (standard ship) to ensure that the same percentage of reserve buoyancy is maintained.

Fig. 26.14

The tabular freeboard having been corrected for block coefficient is termed *Basic Freeboard* under the *M.S. (Load Line) Regulations 1998 (MSN 1752(M)*.

26.7.3 Correction for depth (Regulation 31)

The *standard ship* has a L/D ratio of 15. If the L/D ratio is *less than 15*, which is usually the case, the *freeboard is increased.*

If the L/D ratio is *greater than 15* then the *freeboard may be decreased* provided that the ship has an enclosed superstructure covering at least 0.6L amidships, a complete trunk or a combination of detached enclosed superstructures and trunks which extend all fore and aft.

Reasoning for this is as follows. Consider the two vessels shown.

If the ships in *figure 26.15* are considered where an amidships compartment extending the full depth of the hull were flooded due to damage, *Ship 1* would experience greater sinkage and loss of freeboard than *Ship 2*, since in each case, the volume of buoyancy that has been lost must be regained by the remaining intact parts of the hull.

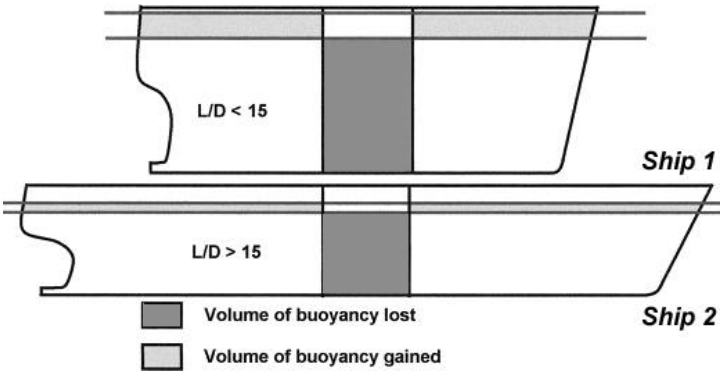


Fig. 26.15

26.7.4 Correction for position of deck line (Regulation 32)

If the actual depth to the upper edge of the deck line is greater or less than the depth for freeboard (D), the difference if greater, shall be added to, or if less shall be deducted from, the freeboard.

Figure 26.16 illustrates the example of a rounded sheer strake.

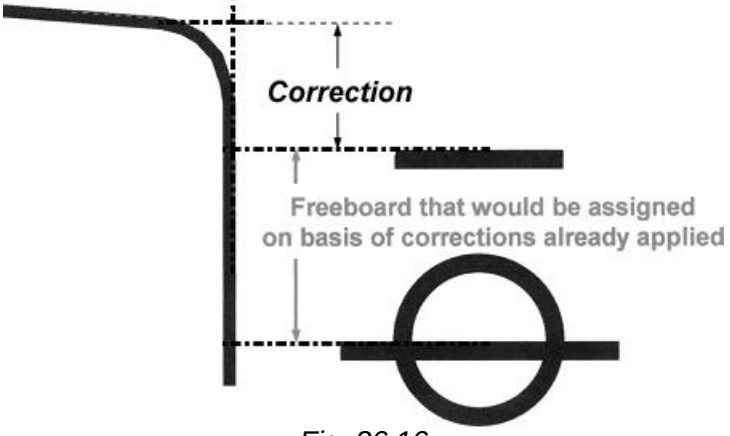


Fig. 26.16

26.7.5 Correction for superstructure and trunks (Regulations 33 to 37)

The *standard ship* has no superstructure. Enclosed superstructures of a significant height are important in providing reserve buoyancy above the freeboard deck. Freeboard *deductions* are allowed for effective enclosed superstructure length as a proportion of the ship's freeboard length. The deduction in freeboard allowed is determined by a number of formulae and tables.

Regulation 33 defines the standard height of superstructure as given in the following table:

Standard heights for intermediate lengths are obtained by interpolation.

	Standard height (m)	
L (m)	***Raised quarter-deck***	***All other superstructures***
30 or less	0.90	1.80
75	1.20	1.80
125 or more	1.80	2.30

Regulation 36 allows the reserve buoyancy of trunks to be taken into consideration also. Although not precisely defined in the regulations a trunk may be regarded as *a structure having equivalent bulkhead strength as that of a superstructure that opens directly into the space below the freeboard deck and having an average width of at least 60% of the ship at the position in which they are situated.* Hatch coamings that have heights equivalent to that of the standard height of the superstructure as determined by the above table may be considered as trunks that provide additional reserve buoyancy for the ship.

Regulation 37 details the deduction of freeboard that will be permitted for effective length of superstructures and trunks. It is always a *deduction* in freeboard since the standard ship has no superstructure.

26.7.6 Correction for sheer profile (Regulation 38)

Sheer is defined as being the curvature of the freeboard deck in a fore and aft direction.

Benefits of sheer include:

* Greater reserve buoyancy at the ends of the ship, particularly forward, ensuring good lift in a head/following sea;
* Reduces water shipped on deck;
* Reduces risk of foredeck being submerged after collision thus improving survivability in the damaged condition and helps to maintain an acceptable angle of heel at which progressive downflooding takes place.

The tabular freeboards are based upon a standard sheer profile (standard ship), measured at seven equally spaced stations along the hull. A process based on Simpson's 1331 Rule of area estimation is applied separately to the sheer measurements from the aft perpendicular to amidships and the forward perpendicular to amidships to produce measures of effective sheer aft and forward respectively.

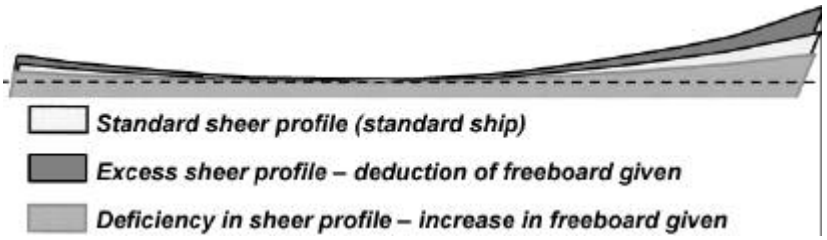


Fig. 26.17

Any deficiency in sheer will result in an *increase* in freeboard.

Excess sheer will result in a *deduction* in freeboard.

The amount of the deduction or increase in freeboard is determined by formulae in regulation 38.

26.7.7 Correction for bow height (Regulation 39)

A minimum allowable bow height must be maintained when the vessel is floating to the summer load line at its design trim. The assigned Summer Freeboard for a vessel must be *increased*, if necessary, to ensure that the minimum bow height requirements are met.

The minimum bow height (H_B) in millimetres measured at the forward perpendicular at the summer waterline is given by the following formulae:

$$H_B = 56L\left(1 - \frac{L}{500}\right) \times \frac{1.36}{C_B + 0.68} \quad \text{if freeboard length (L) < 250 m or}$$

$$H_B = 7000 \times \frac{1.36}{C_B + 0.68} \quad \text{if freeboard length (L) } \geq \text{ 250 m}$$

(C_b shall not be less than 0.68)

If the freeboard as calculated from considering the previous corrections is less than the bow height minimum, then the bow height formula minimum will be assigned as the Summer Freeboard.

The required bow height may be achieved by:

* including sheer provided sheer extends over at least 0.15L from the forward perpendicular; or

* fitting a raised forecastle provided that such a forecastle extends over at least 0.07L from the forward perpendicular.

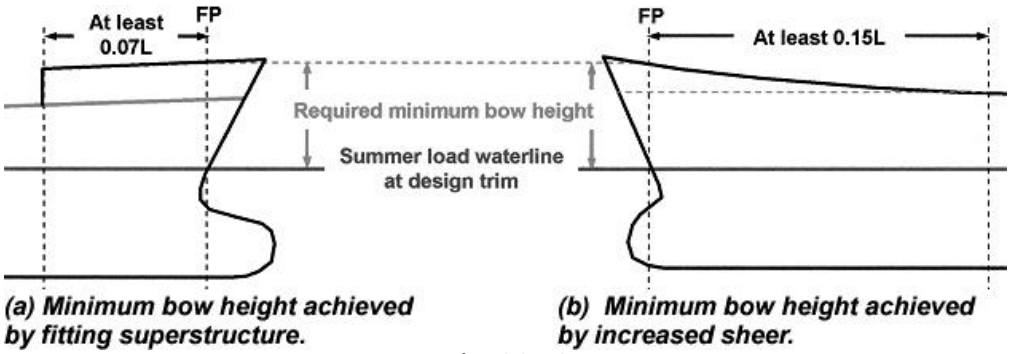


Fig. 26.18

The freeboard as calculated applies to the ship when in salt water and is assigned to the ship as its *Summer* freeboard. The summer freeboard shall not be less than 50 mm; if the ship has hatches in position 1 that are not made of steel then the summer freeboard shall not be less than 150 mm (ignoring the correction for the position of the deck line).

The Tropical (T), Winter (W), Winter North Atlantic (WNA) and Fresh water (F) freeboards are then calculated as illustrated in figure 26.6 (section 26.2.2).

26.8 CALCULATION PROCEDURE FOR THE ASSIGNMENT OF A TYPE 'B' FREEBOARD

Freeboard is determined as follows:

26.8.1 Obtain the tabular freeboard (Regulation 28)

From *Table B* ascertain the ship's tabular freeboard for the ship's length (L).

If the ship qualifies for the reduction in tabular freeboard, either 60% or 100% (B-60 or B-100) then this is applied as previously discussed in section 26.6.

26.8.2 Correction to tabular freeboard for type 'B' ships having wooden hatch covers (Regulation 27)

If the ship has hatchways in Position 1, the covers of which are not made of steel but are made of wood with tarpaulin covers then the tabular freeboard obtained from Table B will be *increased* by an amount dependant on the length of ship (Regulation 27(6)).

26.8.3 Correction to tabular freeboard for type 'B' ships under 100 metres in length (Regulation 29)

If any Type 'B' ship is not more than 100 m in length and has enclosed superstructures the total effective length (E) of which does not exceed 35% of the ship's length (L) the freeboard will be *increased* by the following amount: $7.5(100 - L)(0.35 - \frac{E}{L})$ mm.

A shorter vessel is likely to pitch more as it makes way through the water and as such the presence of superstructure forward and aft becomes more important in minimising the amount of water shipped. Longer ships (over 100 m) tend to pass through the waveform and thus will pitch less.

The tabular freeboard thus so far corrected (type 'B' Basic Freeboard) now has the same corrections as described in section 26.7 previously for the type 'A' ship applied to obtain the assigned summer freeboard.

26.9 TIMBER FREEBOARDS (Chapter IV)

Ships regularly carrying timber can be assigned reduced 'timber freeboards' that allow for an increase in the maximum draught when the vessel is carrying a deck cargo of timber. The regulations consider a deck cargo of wood to be additional reserve buoyancy, provided that it is well secured and covers the entire length of the ship's cargo deck up to at least standard superstructure height. The timber deck cargo will also offer a greater degree of protection for the hatches against the sea.

The term *'timber deck cargo'* means a cargo of timber carried on an uncovered part of a freeboard or superstructure deck.

The timber (lumber) load lines and the special timber minimum stability criteria only apply to the vessel when it is loaded with timber on deck that meets the timber conditions of assignment. The normal load line marks limit the drafts for any other loaded condition of the ship.

It is the responsibility of the shipowner to decide whether or not to have the ship built that meets all the special timber conditions of assignment and many will choose not to, in which case, the ship's draft will be restricted by the normal load lines, even when it is loaded with timber on deck.

26.9.1 Special construction requirements applicable to ships assigned timber freeboards (Regulation 43)

These are summarised below:

Superstructures: The ship must have a forecastle of at least standard height not less in length than 0.07L. Additionally, if the ship is less than 100 m in length it shall be fitted aft with either:

* a poop of not less than standard height ;or
* a raised quarterdeck having either a deckhouse or a strong steel hood, so that the total height is not less than the standard height of an enclosed superstructure.

Double bottom tanks: Double bottom tanks within the midship half-length of the ship are to have satisfactory watertight longitudinal subdivision in order to minimise the loss of stability due to the free surface effects of slack tanks.

Bulwarks: The ship is to be fitted with permanent bulwarks at least one metre in height, specially stiffened on the upper edge and supported by strong bulwark stays attached to the deck and provided with necessary freeing ports, or, efficient guardrails and stanchions of at least one metre in height of especially strong construction.

26.9.2 Stowage requirements (Regulation 44)

In addition to the requirements stated below the *Code of Safe Practice for Ships Carrying Timber Deck Cargoes (IMO)* should also be consulted. For UK registered ships this code is enforced by *SI 1999 No. 336 Merchant Shipping (Carriage of Cargoes) Regulations*.

The general requirements are as follows:

Openings in the weather deck over which the timber cargo is stowed should be securely closed and battened down.

Ventilators and air pipes should be efficiently protected against damage resulting from a shift of the cargo.

The timber stow should extend over the entire available length of the weather deck in the well or wells between superstructures. Where there is no limiting superstructure at the after end, the timber should extend at least to the after end of the aftermost hatchway. This ensures that the reserve buoyancy afforded by the stow and superstructures is evenly distributed along the ship's

length and there is no trimming effect due to the immersion of a partial stow, either near the bow or stern, occurring at the furthest extent of a roll.

The timber deck cargo should extend athwartships as close as possible to the ship's side, allowance being given for obstructions such as guard rails, bulwark stays, uprights etc. provided that any gap thus created at the side of the ship does not exceed 4% of the ship's breadth.

The timber should be stowed as solidly as possible to at least the standard height of a superstructure other than any raised quarter deck.

When within a Winter seasonal zone during the period specified as being a Winter season the timber will be stowed so that at no point throughout its length does the height of the deck cargo above the level of the weather deck at side exceed one third of the extreme breadth of the ship.

The deck cargo should not interfere with the ship's safe operation and navigation, including access to ship's steering arrangements.

Uprights, when required by the nature of the timber, should be of adequate strength considering the breadth of the ship; the strength of the uprights should not exceed the strength of the bulwark and the spacing should be suitable for the length and character of timber carried, but should not exceed 3 metres. Strong angles or metal sockets or equally efficient means should be provided for securing the uprights.

The timber deck cargo should be efficiently secured throughout its length by independent overall lashings. The spacing of the lashings should be determined by the maximum height of the cargo above the weather deck in the vicinity of the lashing:

* for a height of 4 m and below the spacing should be not more than 3 m;
* for a height of 6 m and above the spacing should be not more than 1.5 m;
* at intermediate heights the spacing is obtained by linear interpolation of the above figures.

When timber is in lengths of less than 3.6 m, the spacing of the lashings should be reduced or other suitable provisions made to suit the length of timber. The lashings should be capable of withstanding an ultimate tensile load of not less than 13600 Kg. They should be fitted with sliphooks and turnbuckles which should be accessible to allow adjustment of the lashings during the passage. Wire rope lashings should have a short length of long link chain to permit the length of the lashings to be regulated. Shackles, stretching devices and all other ancillary lashing components incorporated into a chain or wire rope lashing and its securings should have a minimum ultimate load of 14100 Kg. Each component should be proof loaded to 5600 Kg.

The timber deck cargo is to be distributed so as to:

* avoid excessive loading with respect to the strength of the deck and supporting structure;
* to ensure that the ship will retain adequate stability with respect to:
  - vertical distribution;
  - effects of wind heeling;
  - losses of weight low down in the ship due to fuel/stores consumption;
  - increases of timber weight caused by water absorption and icing.

The crew should have safe access across the deck stow by means of a walkway fitted over the timber deck cargo. Guard rails or lifelines not more than 330 mm apart vertically should be provided on each side of the cargo deck to a height of at least 1 metre above the cargo.

26.9.3 Calculation of the Summer timber freeboard (Regulation 45)

The Summer Timber freeboard is calculated as for the ordinary Assigned Summer freeboard but an alternative percentage of 'Superstructure Deduction' is applied in the freeboard calculation. The table in regulation 37 is modified by substituting the percentages for those given in the table in regulation 45. It is this alternative correction that causes the difference between the Assigned

Summer freeboard and the Summer Timber freeboard whereby benefit is given for the timber deck cargo being additional effective superstructure.

Corrections to the Summer Timber freeboard to give the other seasonal freeboards are as shown in figure 26.7 in section 26.2.2.

26.9.4 Minimum IMO stability criteria for ships carrying timber deck cargoes

Chapter 4 Regulation 4.1 of the *Code on Intact Stability for all Types of Ships Covered by IMO Instruments (IMO)*, hereafter referred to as the Code, details the minimum intact stability requirements for cargo ships 24 metres in length and over engaged in the carriage of timber deck cargoes.

Ships that are provided with and make use of their timber load line should also comply with the following requirements:

* *The area under the righting lever curve (GZ curve) should not be less than 0.08 metre-radians up to 40º heel or the angle of downflooding if this angle is less than 40º.*

* *The maximum value of the righting lever (GZ) should be at least 0.25 m.*

* *At all times during the voyage, the metacentric height (GM) should not be less than 0.10 m after correction for the free surface effects of liquid in tanks and, where appropriate, the absorption of water by the deck cargo and /or ice accretion on the exposed surfaces. (Details regarding ice accretion are given in Chapter 5 of the Code)*

* *When determining the ability of the ship to withstand the combined effects of beam wind and rolling (Regulation 3.2 of the Code; section 24.1.2.2 of this text) the 16º limiting angle of heel under the action of steady wind should be complied with, but the additional criterion of 80% of the angle of deck edge immersion may be ignored.*

The Code requires that comprehensive stability information be provided which takes into account the timber deck cargo to include guidance as to the stability of the ship under varying conditions of service. This assumes permeability of the cargo of 25% (by volume), if permeability is likely to be significantly different from this value then additional information as appropriate must be provided.

The stability of the ship must be positive at all times and should be calculated having regard to:

* the increased weight of the timber deck cargo due to:
  (1) absorption of water, and;
  (2) ice accretion if applicable;

* variations in consumables (such as fuel consumption from tanks low down in the ship);

* the free surface effects of liquids in tanks, and;

* weight of water trapped in broken spaces within the timber deck cargo and especially logs.

Ships carrying timber deck cargoes should operate, as far as possible, with a margin of safety with respect to metacentric height (GM), however the metacentric height should preferably *not* exceed 3% of the breadth of the ship in order to prevent excessive accelerations in rolling that would cause large racking stresses and high stresses on cargo lashings which might result in cargo loss or shift.

The Administration may allow the buoyancy of the timber deck cargo to be taken in to account in the derivation of the KN curves, assuming a permeability of 25% of the volume of the timber (this is allowed under the MCA criteria and is explained fully in section 26.9.5.

In the arrival condition it should be assumed that the weight of the timber deck cargo has increased by 10% due to water absorption.

Finally, the stowage of the timber deck cargo must be in accordance with the requirements of Chapter 3 of the *Code of Safe Practice for Ships Carrying Timber Deck Cargoes 1991 (IMO).*

26.9.5 Minimum MCA (UK ships) stability criteria for ships carrying timber deck cargoes

The MCA requirements (as detailed in the *M. S. (Load Line) Regulations 1998* and *MSN 1752(M)*) differ to the IMO requirements.

* *The area under the curve of righting levers (GZ curve) shall not be less than:*
- *(i) 0.055 metre-radians up to an angle of 30º;*
- *(ii) 0.09 metre-radians up to an angle of 40º or the angle at which the lower edge of any openings in the hull, superstructures or deckhouses which cannot be closed weathertight, are immersed if that angle is less; and*
- *(iii) 0.03 metre-radians between the angles of heel of 30º and 40º or such lesser angle as referred to in subparagraph (ii) above.*

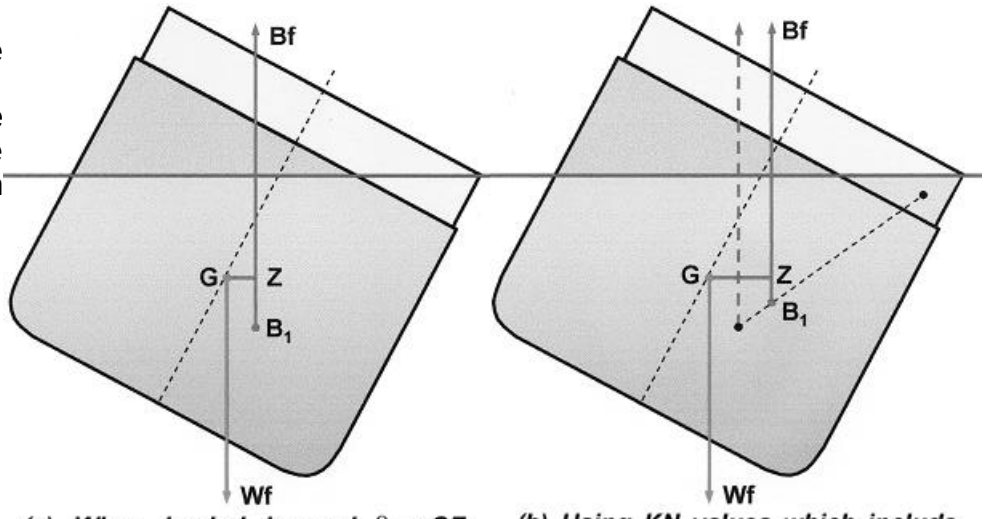
* *The righting lever (GZ) shall be at least 0.20 m at an angle of heel equal to or greater than 30º.*

* *The maximum righting lever shall occur at an angle of heel not less than 30º.*

* *The initial transverse metacentric height shall not be less than 0.15 m. In the case of a ship carrying a timber deck cargo that complies with the area requirements above by taking into account the volume of timber deck cargo, the initial transverse metacentric height shall not be less than 0.05 m.*

Schedule 6 – 5(2) of MSN 1752(M) states that the calculation of effective KG must allow for 15% increase in the weight of the deck timber due to water absorption during the voyage. Consideration must also be given to the effects of wind heeling and ice accretion as appropriate (MCA requirements) and consumptions of fuel and stores during the voyage as previously described.
Stability data must include alternative KN curves/tables to account for the specified heights of timber deck cargo stows. In the derivation of the additional KN values to be supplied ***only 75% of the timber volume must be considered as reserve buoyancy as 25% of the volume must be allowed for water absorption.***

The principle of the inclusion of the timber as reserve buoyancy in the derivation of the alternative KN data is illustrated in figure 26.19.



(a) When heeled beyond θ_{DEI} GZ values are small when the reserve buoyancy of the timber is not included (GZ values derived from ship's ordinary KN values).

(b) Using KN values which include 75% of the volume of the immersed timber as reserve buoyancy causes an outward movement of B which increases the GZ values.

Fig. 26.19

26.10 LOAD LINE CERTIFICATION AND SURVEYS

All ships must be issued with a load line certificate. The form of the certificate will depend upon the Assigning Authority as follows:

* If the certificate is an *International Load Line Certificate* it shall be in the form prescribed by the 1966 Convention which is detailed in the IMO publication *'Load Lines – 2002 Edition'*.
* If the certificate is a *United Kingdom Load Line Certificate* (applicable to UK registered ships that must comply with the *M. S. (Load Line) Regulations 1998*) it shall be in the form prescribed in Schedule 8 of MSN 1752(M).

26.10.1 Surveys

A ship will be subject to the following surveys:

* *Initial survey* before the ship is put into service;
* *Renewal survey* at intervals not exceeding five years;
* *Annual survey* within 3 months either way of the anniversary date of the load line certificate. The surveyor will endorse the load line certificate on satisfactory completion of the annual survey.

The period of validity of the load line certificate may be extended for a period not exceeding 3 months for the purpose of allowing the ship to complete its voyage to the port in which it is to be surveyed.

26.10.2 Load line survey preparation

The preparation for a load line survey will involve ensuring that the hull is watertight below the freeboard deck and weathertight above it (cargo tank lids on tankers must be watertight).

Reference should be made to the *Form of record of conditions of assignment of load lines* as specified in Part 6 of *'Load Lines – 2002* Edition' (*Record of particulars* as detailed in MSN 1752(M) for UK ships).

The following checks should be conducted prior to survey:

(1) Check that all access openings at the ends of enclosed superstructures are in good condition. All dogs, clamps and hinges should be free and greased. Gaskets and other sealing arrangements should not show signs of perishing (cracked rubbers). Ensure that doors can be opened from both sides. Ensure that door labels such as '*To be kept closed at sea'* are in place.

(2) Check all cargo hatches and accesses to holds for weathertightness. Securing devices such as clamps, cleats and wedges are to be all in place, well greased and adjusted to provide optimum sealing between the hatch cover and compression bar on the coaming. Replace perished rubber seals as necessary. Hose test hatches to verify weathertightness.

(3) Check the efficiency and securing of portable beams.

(4) For wooden hatches, ensure that the hatch boards are in good condition and that the steel binding bands are well secured. A minimum of at least two tarpaulins should be provided at each hatch which must be in good condition, waterproof and of a strong approved material. Locking bars and side wedges must be in place and be in good order.

(5) Inspect all machinery space openings on exposed decks.

(6) Check that manhole covers on the freeboard deck are capable of being made watertight.

(7) Check that all ventilator openings are provided with efficient weathertight closing appliances.

(8) All air pipes must be provided with permanently attached means of closing.

(9) Inspect cargo ports below the freeboard deck and ensure that they are watertight.

(10) Ensure that all non-return valves on overboard discharges are effective.

(11) Side scuttles below the freeboard deck or to spaces within enclosed superstructures must have efficient internal watertight deadlights. Inspect deadlight rubber seals and securing arrangements.

(12) Check all freeing ports, ensure shutters are not jammed, hinges are free and that pins are of non-corroding type (gun metal).

(13) Check bulwarks and guardrails are in good condition.

(14) Rig life lines (if required) and ensure they are in good order.

(15) De-rust and repaint deck line, load line mark, load lines and draught marks.

On the day of the survey ensure that the International Load Line certificate and associated documentation are available for inspection. Sufficient manpower should be made available for the operation of hatch covers and the rigging of staging and ladders to allow the surveyor to view the load line and draught marks. The ship's stability data book should also be on hand for inspection.