Intermaritime Certification Services
ICS Class

This training/examination module is covering the following item:

2D: Load Lines

In compliance with the IMO resolution MSC.349(92) and MEPC.237(65),
RO Code, Appendix 2.

CONTENTS

Module 2D

1. Load Lines

Learning Outcomes

After successful completion of this chapter, you will:

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

1.1 History

2D-001 The founder of the concept of Plimsoll Marks or 'Load Lines' was Samuel Plimsoll. Samuel Plimsoll brought about one of the greatest shipping revolutions ever known by shocking the British nation into making reforms that have since saved the lives of countless seafarers. By the mid-1800s, the overloading of English ships had become a national problem. Plimsoll took up, as a crusade, the plan of James Hall to demand that vessels bear a load line marking indicating the maximum permissible load level, ensuring the safety of crew and cargo. His violent speeches aroused the House of Commons and his book, 'Our Seamen', provoked the general public into clamorous indignation. His book also earned him the hatred of many shipowners, who entered into legal battles against Plimsoll. Through this adversity and personal loss, Plimsoll clung doggedly to his facts. He fought to the point of utter exhaustion until finally, in 1876, parliament was forced to pass the 'Unseaworthy Ships Bill' into law, requiring that vessels bear the load line freeboard

Memorial to Samuel Plimsoll, Victoria Embankment, London.

marking. It was soon known as the 'Plimsoll Mark' and was eventually adopted by all maritime nations of the world.

2D-002 Since Samuel Plimsoll's intervention in 1876, it has been recognized that limitations on the draught to which a ship may be loaded make a significant contribution to her safety. These limits are provided in the form of freeboards that constitute, besides external weathertight and watertight integrity, the main objective of the Convention.

2D-003 While Samuel Plimsoll may be credited for the modern day load line and for forcing the issue through Parliament in the UK, the first official loading regulations are believed to have originated within the kingdom of Crete in 2,500 BC when vessels were required to undergo and pass loading and maintenance inspections. It is believed that Roman sea regulations also contained similar regulations.

2D-004 During the Middle Ages, the Venetian Republic, the city of Genoa and the Hanse9tic League are thought to have required ships to load to a load line. In Venice, this load line was a cross marked on the ship's side and in Genoa it consisted of three horizontal lines.

2D-005 The current load line originated in 1835 when loading recommendations were introduced by Lloyd's Register of British and Foreign Shipping following discussions between ship owners, merchants and underwriters. Lloyd's Register recommended freeboard as a function of the depth of the hold (three inches per foot of depth) and this recommendation was used extensively until 1880, becoming known as 'Lloyd's Rule'.

2D-006 The first International Convention on Load Lines, adopted in 1930, was based on the principle of reserve buoyancy, although it was recognized that the freeboard should also ensure adequate stability and avoid excessive stress on the ship's hull as a result of overloading.

2D-007 In the 1966 Load Lines Convention, adopted by the IMO, provisions were made to determine the freeboard of tankers by subdivision and damage stability calculations.

2D-008 The regulations took into account the potential hazards present in different oceanographic zones and seasons. The technical annex contains several additional safety measures concerning doors, freeing ports, hatchways and other items. The main purpose of these measures is to ensure the watertight integrity of ships' hulls below the freeboard deck.

2D-009 All assigned load lines must be marked amidships on each side of the ship, together with the deck line. Ships intended for the carriage of timber as deck cargo are assigned a smaller freeboard as the deck cargo provides protection against the impact of waves.

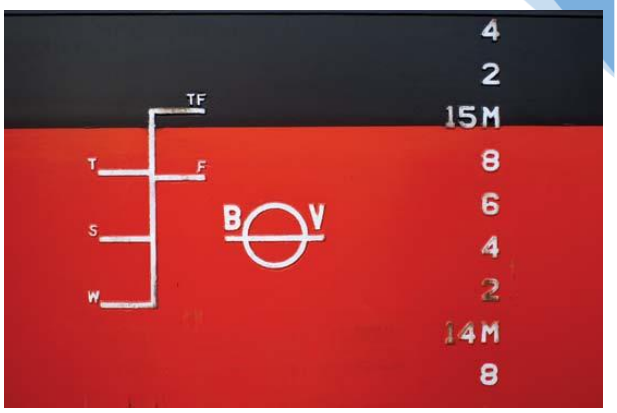


Diagram showing load line and all specialist markings

2D-010 The Plimsoll mark is for the starboard side of a vessel; on the port side, the markings are reversed. This diagram shows all the load line assignments in general use for cargo ships over 100 m (freeboard length). The assignment of the 'Timber Freeboard Grid ' is only necessary if a timber cargo is being carried. There are other specialist markings assigned for passenger ships, which are not shown here. The top of the horizontal line through the disk is placed at the loadline. The lines are 25 mm thick.

2D-011 The Plimsoll mark or Freeboard mark consists of a circle with a diameter of (traditionally) one foot, or 305 mm, which has a horizontal line drawn through its centre. The upper edge of this line indicates the minimum freeboard in salt-water summer conditions. Beside the circle, there are a number of horizontal lines that indicate the minimum freeboard for the various oceanographic and seasonal variations in the salt-water density.

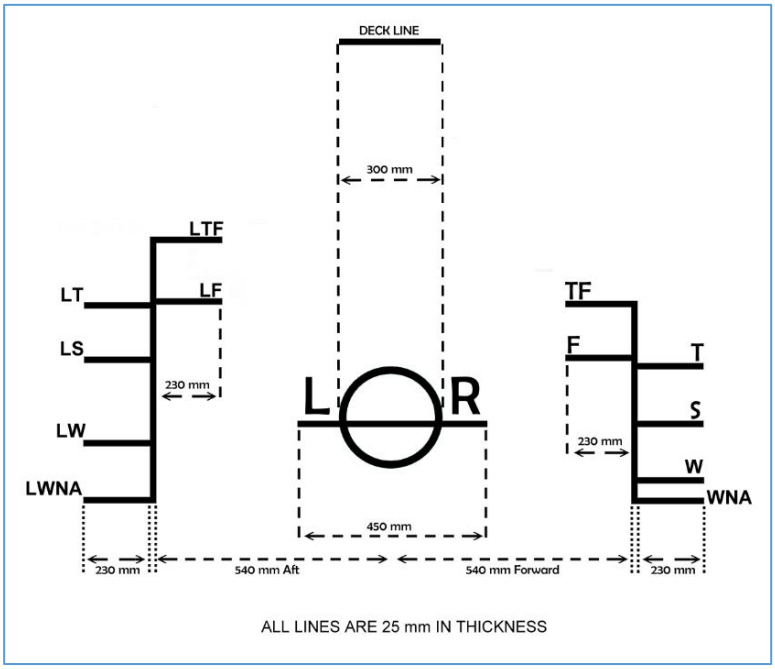


Figure 24

2D-012 The circle and its horizontal line should be placed at the mid length of the ship and there must also be a reference line permanently marked. This line is a reference point for all the others and is called the 'Deck Line' as it is normally positioned at the level of the main deck.

2D-013 The suite of letters used on Figure 24 of last page signifies:

LTF	Lumber, Tropical, Fresh
LF	Lumber, Fresh
LT	Lumber, Tropical
LS	Lumber, Summer
LW	Lumber, Winter
LWNA	Lumber, Winter, North Atlantic
LR	Lloyd's Register of Shipping
TF	Tropical Fresh Water Mark
F	Fresh Water Mark
T	Tropical Load Line
S	Summer Load Line
W	Winter Load Line
WNA	Winter Load Line, North Atlantic

2D-014 The 'LR', as shown on this particular example, may be changed to signify the relevant Classing Society for a particular ship.

2D-015 The 1966 Load Line Convention applies to all ships engaged on international voyages, except as indicated in the Convention.

2D-016 Unless the sides of the ship are of wood or glass reinforced plastic (GRP), the marks may be:

a) Cut in
b) Centre punched
c) Welded
d) A metal profile of the complete disc and grid, welded to the side of the ship.

2D-017 If the ship's sides are of wood, the marks are to be cut into the planking. If the ship's sides are of other materials, such as GRP, and the foregoing methods cannot be applied, the marks are to be permanently affixed to the sides of the ship by bonding or other approved method.

2D-018 The deck line, ring, grid lines and lettering are to be painted in white or yellow on a dark background or in black on a light background.

1.2 Load Lines 1966 - Annexes

2D-019 The Convention includes Annex I, divided into four Chapters:

- Chapter I - General
- Chapter II - Conditions of assignment of freeboard
- Chapter III - Freeboards

- Chapter IV - Special requirements for ships assigned timber freeboards.

Annex II covers zones, areas and seasonal periods.
Annex III contains certificates, including the International Load Line Certificate.

1.3 Amendments 1971, 1975, 1979 and 1983

2D-020 The 1966 Convention provided for amendments to be made by positive acceptance. Amendments would be considered by the Maritime Safety Committee, the IMO Assembly or by a Conference of Governments and would come into force 12 months after being accepted by two thirds of Contracting Parties. In practice, amendments adopted between 1971 and 1983 never received enough acceptances to enter into force. These included:

- The 1971 amendments - to make certain improvements to the text and to the chart of zones and seasonal areas;
- The 1975 amendments to introduce the principle of 'tacit acceptance' into the Convention;
- The 1979 amendments - to make some alterations to zone boundaries off the coast of Australia;
- The 1983 amendments - to extend the summer and tropical zones southward off the coast of Chile.

1.4 The 1988 Protocol

Adoption: 11 November 1988
Entry into force: 03 February 2000

2D-021 The Protocol was primarily adopted to harmonize the Convention's survey and certification requirement with those contained in SOLAS and MAR POL 73/78.

2D-022 All three instruments require the issuing of certificates to show that requirements have been met and this has to be done by means of a survey that can involve the ship being out of service for several days.

2D-023 The harmonized system alleviates the problems caused by survey dates and intervals between surveys that do not coincide. Therefore, a ship should no longer have to go into port or a repair yard for a survey required by one Convention shortly after doing the same thing in connection with another instrument.

2D-024 The 1988 Load Lines Protocol revised certain regulations in the technical Annexes to the Load Lines Convention and introduced the tacit amendment procedure (which was already applicable to the 1974 SOLAS Convention). Amendments to the Convention may be considered either by the Maritime Safety Committee or by a Conference of Parties.

2D-025 Amendments must be adopted by a two-thirds majority of parties to the Convention present and voting. Amendments enter into force six months after the deemed date of acceptance, which must be at least a year after the date of communication of adoption of amendments unless they are rejected by one-third of parties. Usually, the date from adoption to deemed acceptance is two years.

1.5 The 1995 amendments

Adoption: 23 November 1995
Entry into force: 12 months after being accepted by two third of Contracting Governments.

2D-026 **Status:** 7 acceptances have been received (currently, 95 acceptances are required before the amendments can enter into force).The amendments concern the southern tropical zone off the coast of Australia and are now likely to be incorporated in a general revision of the Convention.

1.6 The 2003 amendments

Adoption: June 2003
Entry into force: 01 January 2005 (under tacit acceptance)

2D-027 The amendments to Annex B to the 1988 Load Lines Protocol (i.e. the International Convention on Load Lines, 1966, as modified by the Protocol of 1988 relating thereto) include a number of important revisions, in particular about regulations concerning strength and intact stability of ships, definitions, superstructure and bulkheads, doors, position of hatchways, doorways and ventilators, hatchway coamings, hatch covers, machinery space openings, miscellaneous openings in freeboard and superstructure decks, cargo ports and other similar openings, spurling pipes and cable lockers, side scuttles, windows and skylights, calculation of freeing ports, protection of the crew and means of safe passage for crew, calculation of freeboard, sheer, minimum bow height and reserve buoyancy and others.

2D-028 The amendments represent a comprehensive revision of the technical regulations of the original Load Lines Convention, do not affect the 1966 Load Line Convention and only apply to those ships flying the flags of states party to the 1988 Load Line Protocol, which represent about two-thirds of the world's fleet.

2D-029 Some National Administrations have their own interpretations of the Convention Regulations or have additional requirements to those contained in the Convention.

2D-030 lACS interpretations of the International Convention on Load Lines, 1966 show that member societies have agreed a number of unified interpretations of the Convention. Where appropriate, these interpretations are included in the member societies' Rules. It is a condition of assignment that the Master is supplied with sufficient information in an approved form with regard to the loading, ballasting and stability of his ship (Reg. 10 of the Convention), normally known as the 'Loading and Stability Manual '.

2D-031 A Load Line Certificate is shown on the following page.

Interim Certificate No. _____

Authorization No. _____

INTERNATIONAL LOAD LINE CERTIFICATE

Issued under the provisions of the INTERNATIONAL CONVENTION ON LOAD LINES, 1966,
as modified by the protocol of 1988 relating thereto
under the Authority of the Government of

_____
(Name of the State)

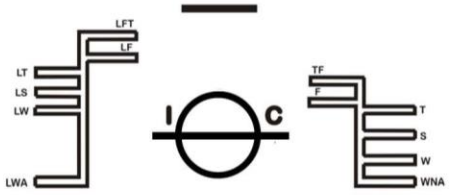
By: Intermaritime Certification Services (ICS)

Particulars of Ship

Name of the Ship:
Distinctive Number or Letters:
Port of Registry:
Length (L) as defined in Article 2(8) (in meters):
IMO Number:
Freeboard assigned as (1): A new ship / An existing ship (*)
Type of ship (2): Type "A" / Type "B" (*)

Freeboard from deck line		Load Line
Tropical	_____ mm (T)	_____ mm above (S)
Summer	_____ mm (S)	Upper edge of line through centre of ring
Winter	_____ mm (W)	_____ mm below (S)
Winter North Atlantic	_____ mm (WNA)	_____ mm below (S)
Timber Tropical	_____ mm (LT)	_____ mm above (LS)
Timber Summer	_____ mm (LS)	_____ mm above (S)
Timber Winter	_____ mm (LW)	_____ mm below (LS)
Timber Winter North Atlantic	_____ mm (LWNA)	_____ mm below (LS)

Note: Freeboards and Load Lines which are not applicable need not be entered on the Certificate. Subdivision load lines may be entered on the certificate on a voluntary basis.
Allowance for fresh water for all freeboards other than timber _____ mm. For timber freeboards _____ mm.
The upper edge of the deck line from which these freeboards are measured is _____ mm. below the top of steel upper deck at side/ continued to side



THIS IS TO CERTIFY:

1. That the ship has been surveyed in accordance with the requirements of article 14 of the Convention.
2. That the survey showed that the freeboards have been assigned and load lines shown above have been marked in accordance with the Convention.

This certificate is valid until the _____ (Day), of _____ (Month) of _____ (Year)

Completion date of the Survey on which this Certificate is based: _____ (Day, Month, Year)

Issued at _____ (Place of issue of Certificate) the _____ (Day), of _____ (Month) of _____ (Year)

_____
Name and Signature of authorized official issuing the Certificate
Intermaritime Certification Services (ICS)

(1) A new ship or An existing ship is to be entered
(2) Type "A" or Type "B" or Type "B" with reduced freeboard or Type "B" with increased freeboard is to be entered

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1.7 Issue of multiple Load Lines Certificates

2D-032 An owner or operator may wish to carry a different cargo from that which a vessel normally carries, or they may wish to trade the vessel into a different country from its normal operations. This may necessitate a change to the Load Line to accommodate the different draught regulations for a given port or the different hull stresses imposed by a different cargo type. In such a case, an additional Load Line Certificate may be issued, provided the National Administration authorizes the issuing of more than one certificate. The Class Society Plan Approval office will compute the freeboards and send the freeboard memoranda to the local Surveyor with a copy of the guidance notes for the Master. The Surveyor verifies all the freeboard marks and issues a Certificate of Restricted Validity for each set of marks. Only the freeboard in use is to be painted in.

Special requirements for specific ship types exist within the Convention and are applicable to:

- Fishing vessels
- dredgers and reclamation craft
- non-ship type vessels, which include:
  - → self-elevating units
  - → column-stabilized units
  - → multi-hull vessels
  - → dynamically supported craft.

2. Assignment of Freeboard - Introduction

2D-033 To improve the profitability, the shipowner will ensure that the greatest possible volume of cargo is carried. However, it is of vital importance to those operating the vessel that sufficient buoyancy remains within the structure to ensure the ship remains seaworthy in adverse weather for the safety of the crew. Consequently, it is important for IACS staff to fully appreciate the importance of freeboard and loadline assignment during the design, construction and survey of ships to maximize capacity while meeting legislative safety requirements.

Figure 25

2D-034 Chapter II, Regulation 10 of the 1966 International Convention on Load Lines says that it is a condition of assignment that the Master is supplied with sufficient information in an approved form with regard to the loading, ballasting and stability of his ship.

2D-035 This is because the Master is ultimately responsible for the seaworthiness of his ship and so he must have the information available onboard in order to determine the safe loading condition for any given voyage.

2D-036 This information is normally provided as a book of loading tables known as the 'Approved Stability Manual'. These tables give the various bending moments for the ship's structure under various load/ballast conditions.

2D-037 The Approved Stability Manual is derived from calculations completed after building the ship and after an 'Inclining Experiment' has been carried out. Manuals are approved by either a Class Society on behalf of a Flag State or by the Flag State itself.

2D-038 Chapter II has further information on the minimum structural requirements that must be complied with for the assignment of freeboard. They are as follows:

Regulation 11	Superstructure end bulkheads
Regulation 12	Doors
Regulation 13	Position of hatches, doorways and ventilators
Regulation 14	Cargo and other hatchways
Regulation 15	Hatchways closed by portable covers and secured watertight by tarpaulins and battening devices
Regulation 16	Hatchways closed by weathertight covers of steel or other equivalent material fitted with gaskets and clamping devices
Regulation 17	Machinery space openings
Regulation 18	Miscellaneous openings in freeboard and superstructure decks
Regulation 19	Ventilators
Regulation 20	Air pipes
Regulation 21	Cargo ports and other similar openings
Regulation 22	Scuppers, inlets and discharges
Regulation 23	Sidescuttles
Regulation 24	Freeing ports
Regulation 25	Protection of the crew
Regulation 26	Special conditions of assignment for type 'A' ships

2D-039 For the purpose of freeboard computation, ships are divided into types '**A**' and '**B**':

'A' type ship - designated to carry only liquid cargoes in bulk and in which cargo tanks have small access openings closed by watertight gasketed covers of steel or equivalent material.

'B' type ship - ships not covered within type 'A'.

2D-040 Full details and tables relating to these assignments can be found in the 1966 International Convention on Load Lines, Chapters II and III.

2D-041 All the above information will be supplied from the build, by the building port Surveyor, as an accompanying document to the Load Line Certificate, which is

known as the Assignment of Load Line. During the lifetime of a ship, any modifications or changes affecting these items must be indicated on the Assignment of Load Line document. Depending on their severity, it may be necessary to re calculate the Load Line and change the Plimsoll markings. No changes should be made to the Load Line related structures without an advanced request to, and approval from, the Certificating Authority.

3. Calculation and Assignment of Freeboard

2D-042 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.
2D-043 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')*.

2D-044 The following ships are **not required** to have load lines assigned (Annex A – Article 5):

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

2D-045 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.

2D-046 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.

3.1 Definitions

2D-047 The following definitions for the purpose of freeboard calculation are detailed in Regulation 3.

3.1.1 Length (L)

2D-048 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.

3.1.2 Perpendiculars (FP, AP)

2D-049 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.

3.1.3 Amidships

2D-050 Amidships is at the middle of the length (L).

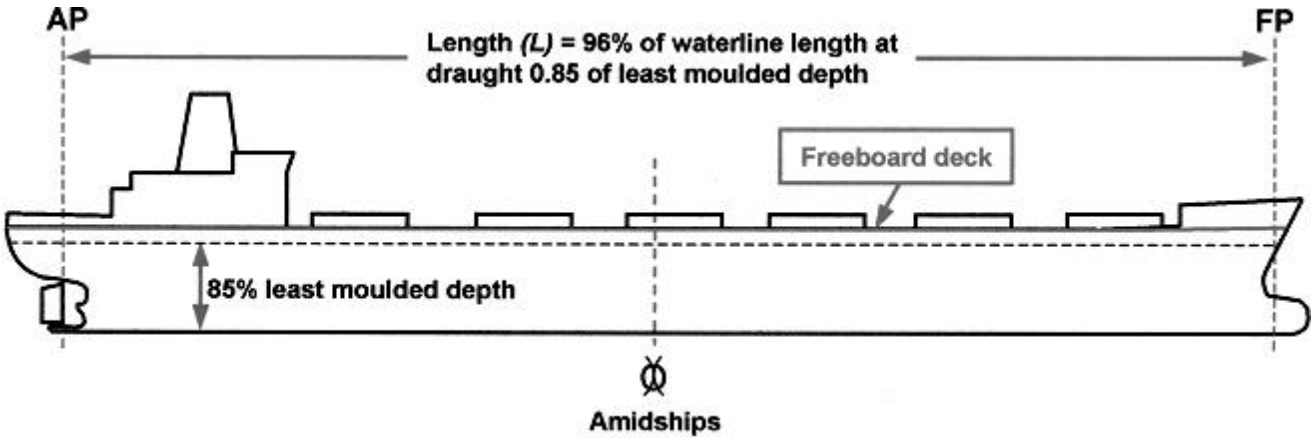


Figure 26.1

3.1.4 Breadth (B)

2D-051 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.

3.1.5 Moulded Depth

2D-052 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.

3.1.6 Depth for freeboard (D)

2D-053 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.

3.1.7 Block Coefficient (C_b)

2D-054 Is given by:

$$C_b = \frac{Volume\ of\ displacement\ at\ draught\ 0.85D}{Lenght* \ x\ Breath* \ x\ draught\ (at\ 85\%\ of\ least\ moulded\ depth)}$$

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

3.1.8 Freeboard Deck

2D-055 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).

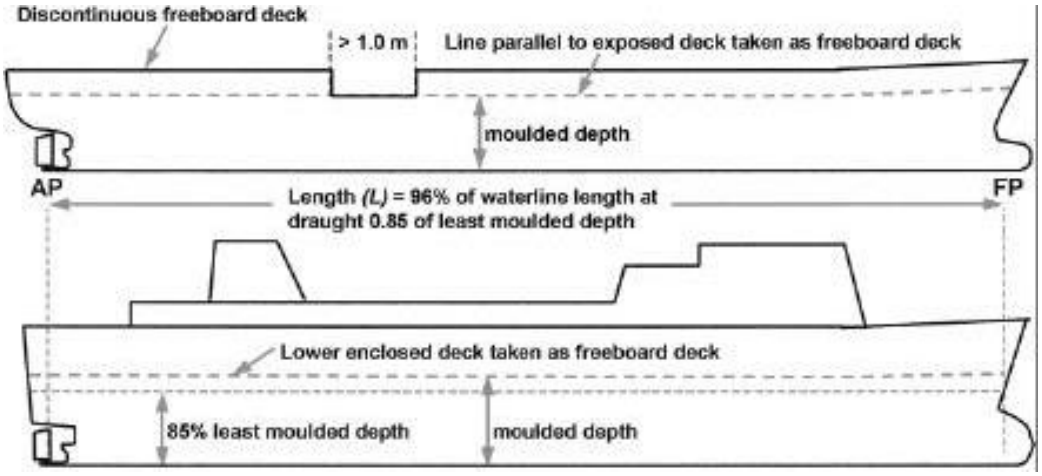


Figure 26.2

2D-056 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).

3.1.9 Superstructure

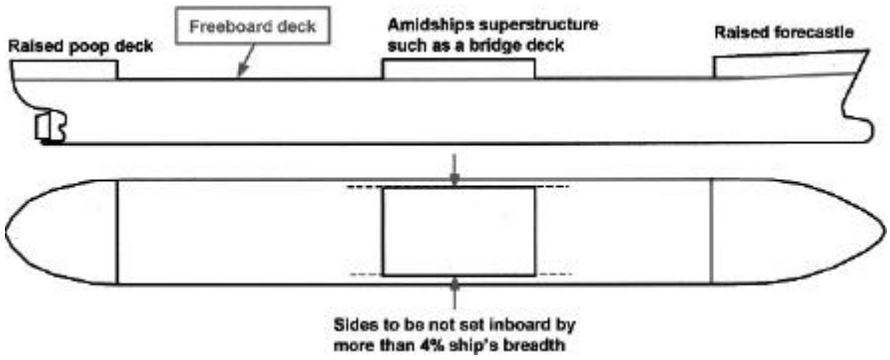
2D-057 A superstructure is a decked structure on the freeboard deck, extending from side to side of the ship or with the side plating not being inboard of the shell plating more than 4% of the breadth (B).

2D-058 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.)

2D-059 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 3.3.3).
c) all other openings in sides or ends of the superstructure fitted with efficient weathertight means of closing.

2D-060 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.



2D-061 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.

2D-062 The length of a superstructure is the mean length of the part of the superstructure which lies within the length (L).

3.1.10 Flush deck ship

2D-063 Is one that has no superstructure on the freeboard deck.

3.1.11 Weathertight

2D-064 Means that in any sea conditions water will not penetrate into the ship.

3.2 Ship's Side Markings

3.2.1 Deck Line (Regulation 4)

2D-065 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.

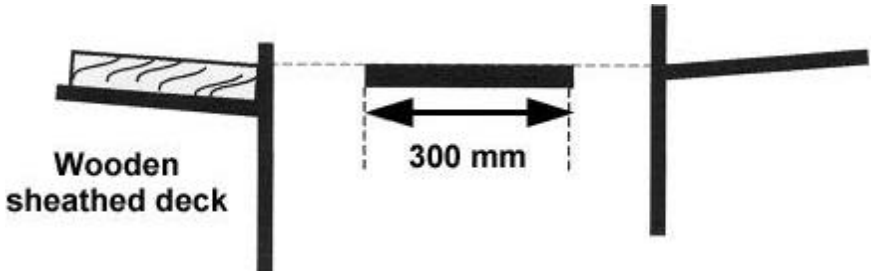


Figure 26.4

2D-066 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).

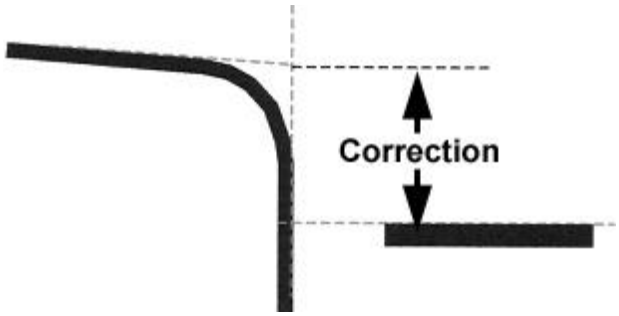


Figure 26.5

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

2D-067 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

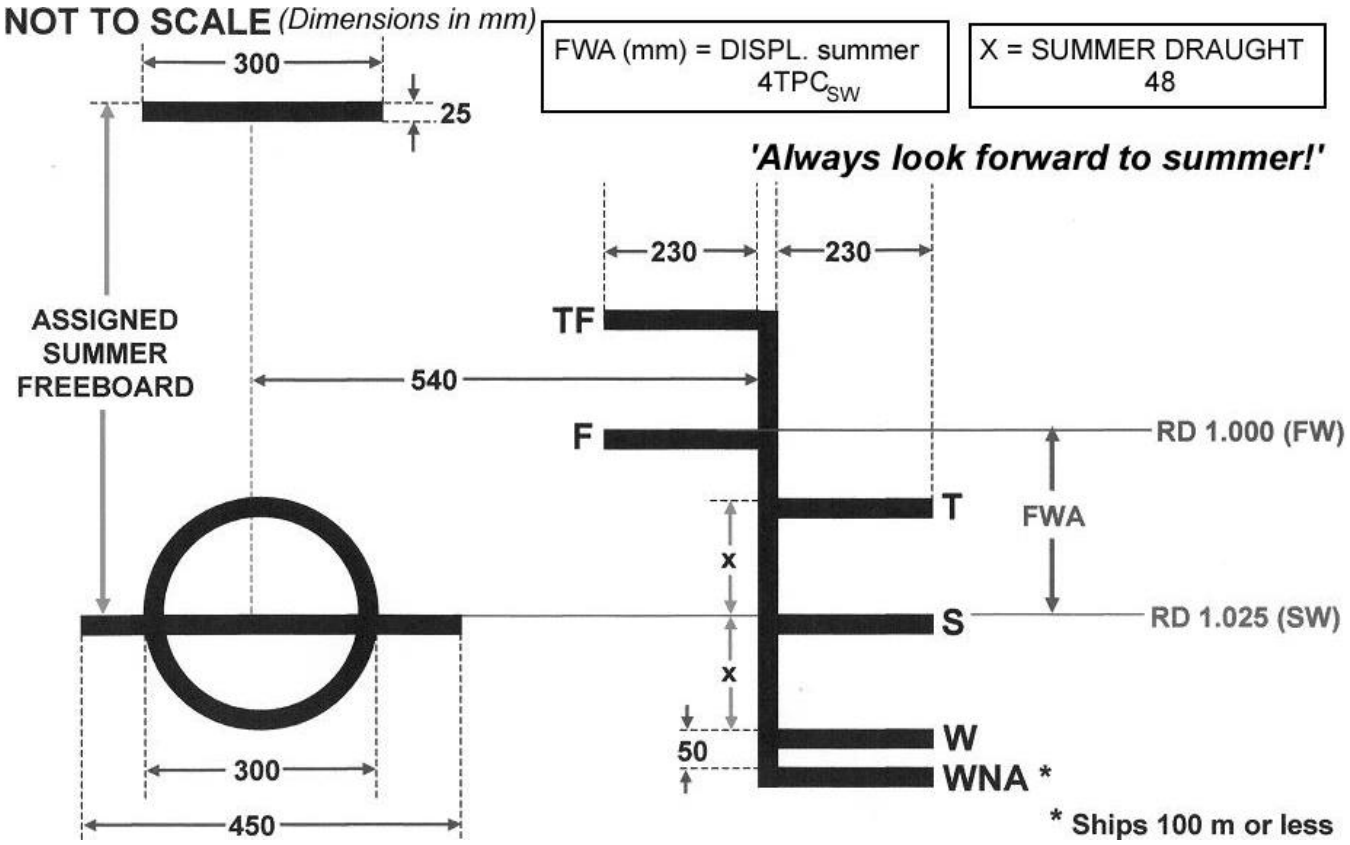


Figure 26.6

2D-068 If timber freeboards are assigned the timber load lines are marked in addition to the ordinary load lines as shown in figure 26.7

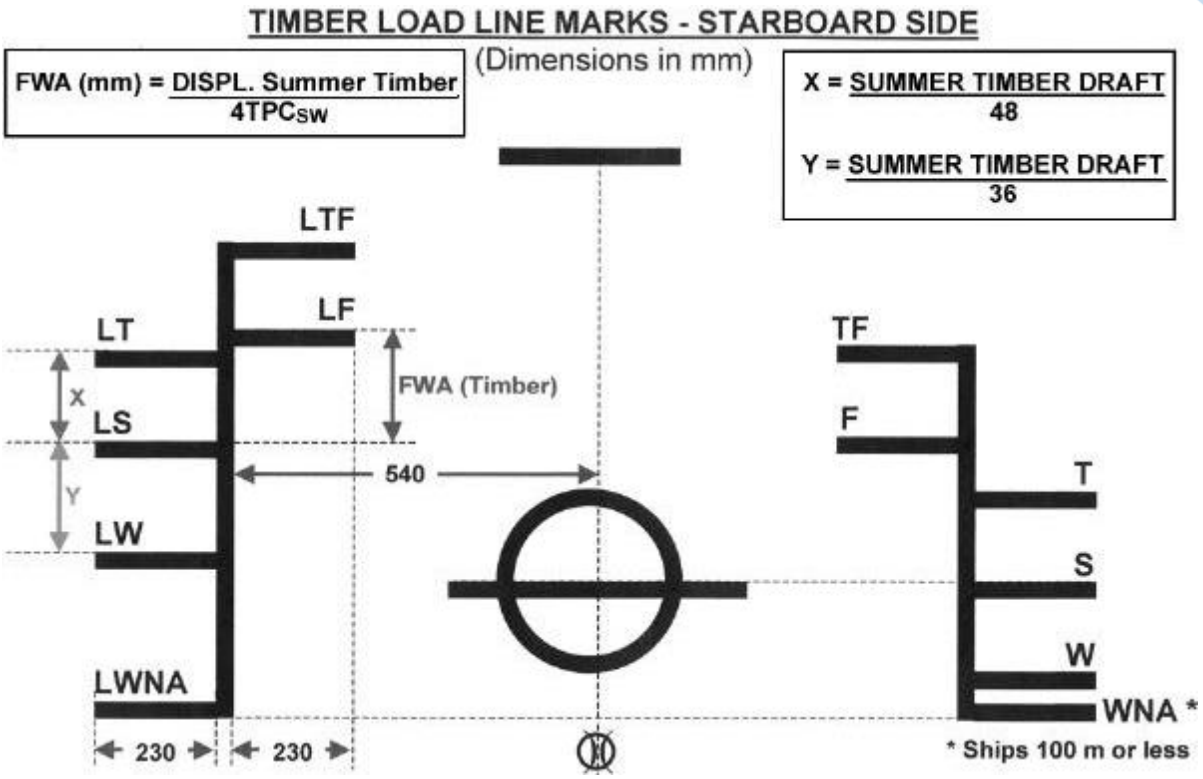


Figure 26.7

2D-069 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.

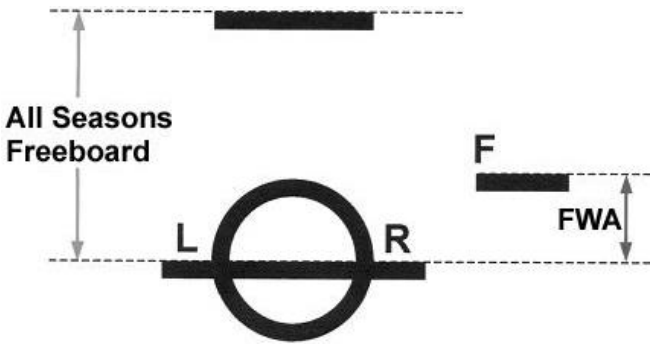


Figure 26.8

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

2D-070 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.

2D-071 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.

3.3 Conditions of Assignment of Freeboard applicable to all ships

3.3.1 Structural Strength

2D-072 It is recognized that ships 'built and maintained in conformity with the requirements of a classification society recognized by the Administration' may be considered to possess the necessary structural strength for freeboards to be assigned (Regulation 1).

3.3.2 Information to be supplied to the master

2D-073 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.

2D-073 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.

3.3.3 Structural Conditions of Assignment

2D-074 The conditions of assignment specified in regulations 11 to 26 should be studied but may be summarized as follows:

2D-075 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).

2D-076 Two positions of hatchways, doorways and ventilators are defined as follows:

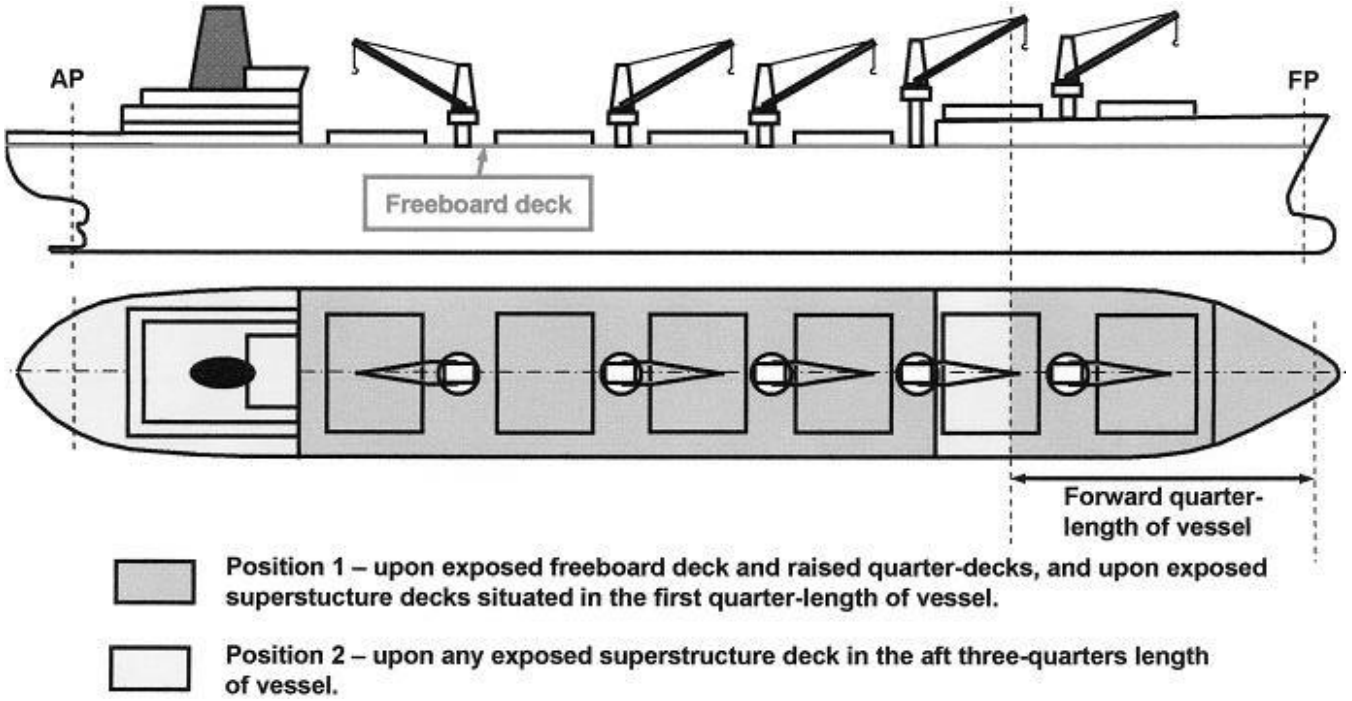


Figure 26.9

2D-077 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.

2D-078 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)

2D-079 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)

2D-080 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)

2D-081 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)

2D-082 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)

2D-083 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)

2D-084 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.

2D-085 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).

2D-086 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)

2D-087 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)

2D-088 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)

2D-089 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)

3.4 Type "A" ships and their additional special conditions of assignment

2D-090 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.

3.4.1 Type "A" ship – definition (Regulation 27)

2D-091 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.

2D-092 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:
2D-093 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.

vi. Alternatively, the actual free surface effects may be used, provided the methods of calculation are acceptable to the Administration.

vii. 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

2D-094 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 subparagraph (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.

2D-095 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

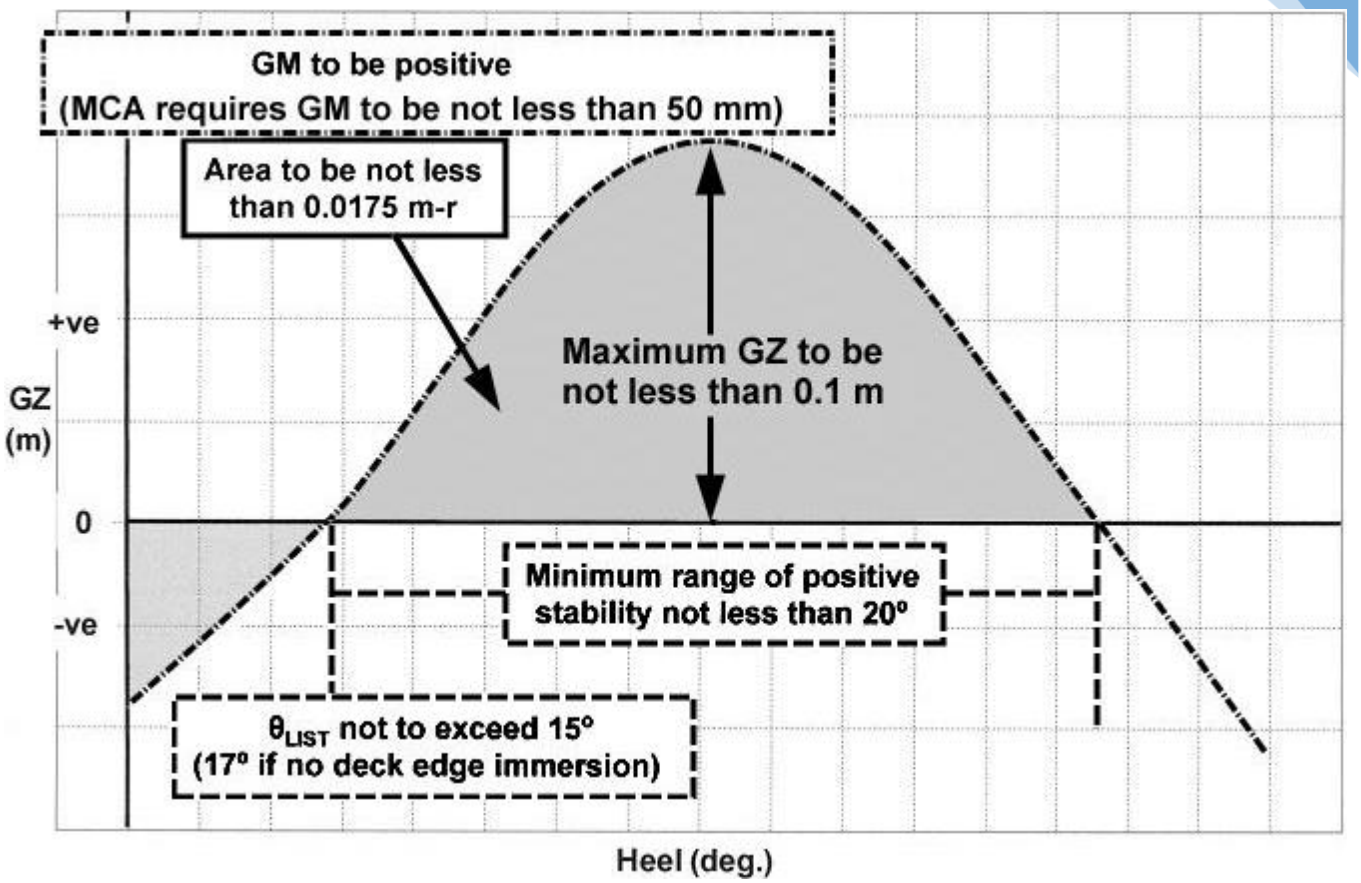
b. If pipes, ducts or tunnels are situated within the assumed extent of damage penetration as defined in paragraph (12)(b) (being the transverse extent of damage), arrangements shall be made so that progressive flooding cannot thereby extend to compartments other than those assumed to be floodable in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

e. 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.



Minimum damaged stability requirements for types "A" ships.

Figure 26.10

3.4.2 Special structural conditions of assignment for type "A" ships (Regulations 26)

1) 2D-096 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) 2D-097 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

3) 2D-098 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.

4) 2D-099 Safe and satisfactory access from the gangway level shall be available between separate crew accommodations and also between crew accommodations and the machinery space.

5) 2D-100 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.

6) 2D-101 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.

7) 2D-102 Where superstructures are connected by trunks, open rails shall be fitted for the whole length of the exposed parts of the freeboard deck.

3.5 The distinction between Type "A" ships and Type "B" ships explained

2D-103 A type 'B' ship is any ship other than a type 'A' ship.

2D-104 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.

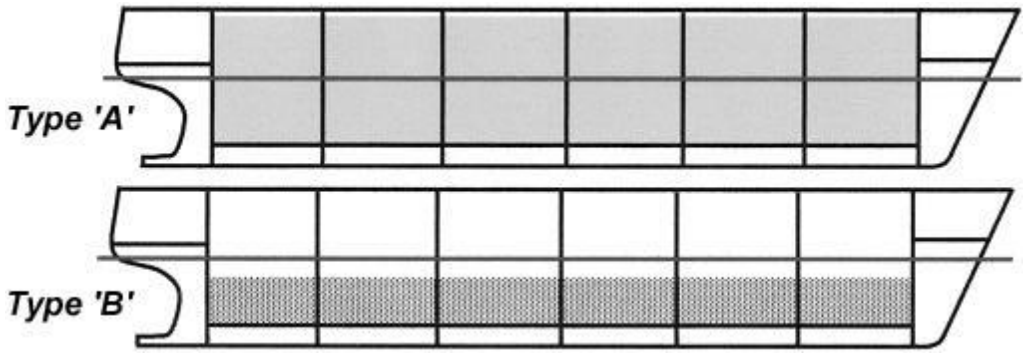


Figure 26.11

2D-105 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').

2D-106 Consider what will happen if a loaded amidships compartment becomes bilged in each ship.

2D-107 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.

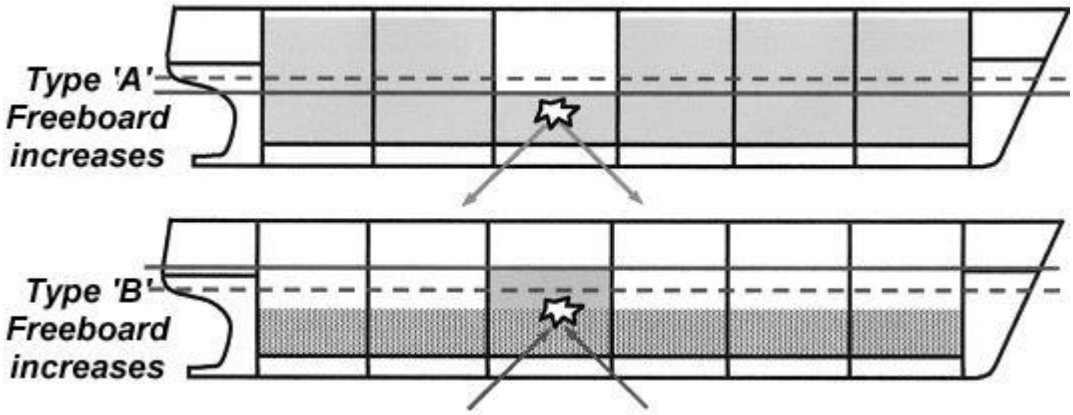


Figure 26.12

2D-108 The general advantages of a Type 'A' ship can be summarized 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.

2D-109 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).

3.6 B-60 and B-100 Tabular Freeboards

3.6.1 B-60 and B-100 Tabular freeboards explained

2D-110 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 (meters)	Freeboard (millimeters)	Length of ship (meters)	Freeboard (millimeters)
140	1803	140	2109
141	1820	141	2130
142	1837	142	2131
143	1853	143	2171

2D-111 For a given length of ship the tabular freeboard is less for a Type 'A' ship than a Type 'B' ship.

2D-112 If the ship to which freeboard is to be assigned were 140 m in length the tabular freeboards would be:

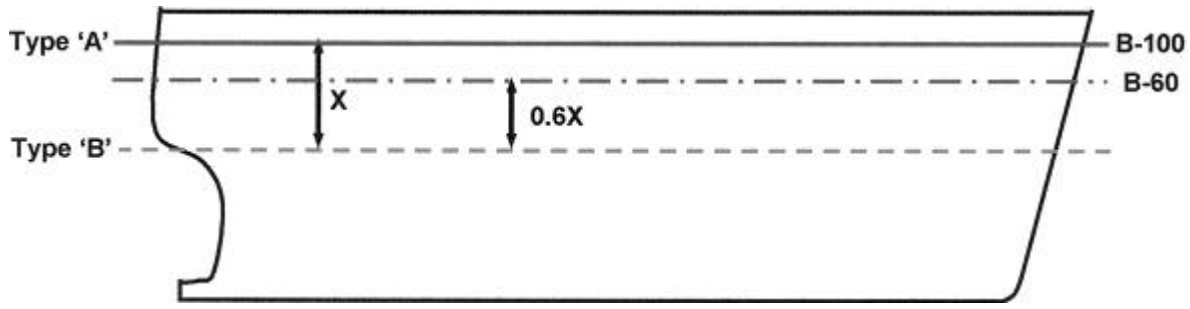


Figure 26.13

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

=**X** in figure 26.13

2D-113 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 x 306)= 1925 mm.

2D-114 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 x 306)= 1803 mm.
(It can be seen that type 'A' and type 'B-100' tabular freeboards are the same!)

3.6.2 Additional conditions of assignment for type "B-60" freeboard (Regulation 27)

2D-115 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.

2D-116 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 3.4.1)

3.6.3 Additional conditions of assignment for type "B-100" freeboard (Regulation 27)

2D-117 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.)

3.7 Calculation procedure for the assignment of a Type "A" Freeboard

2D-118 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.

2D-119 It must be emphasized that the calculation procedure is only summarized 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.

2D-120 The expressions in this schedule are those as defined in the definitions given in section 26.1.

2D-121 Freeboard is determined as follows:

3.7.1 Obtain the tabular freeboard (Regulation 28)

2D-122 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 recognized 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).

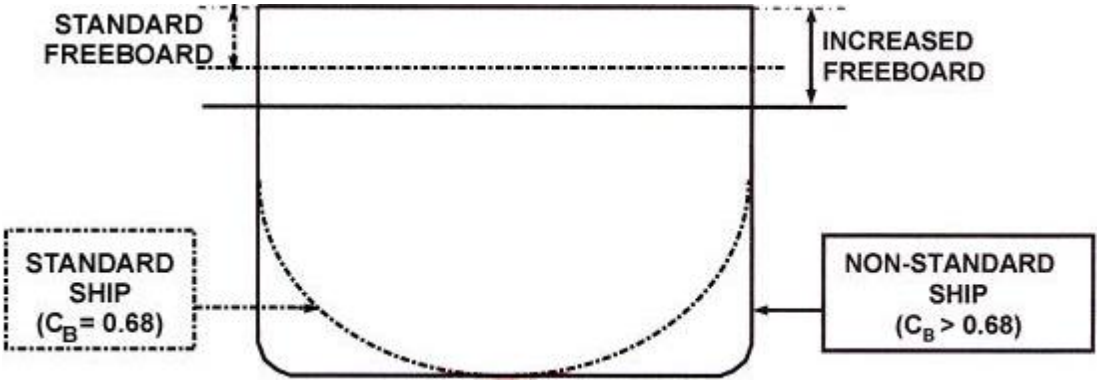
2D-123 It is how each of the above characteristics for the ship in question differs from the standard ship that will determine whether the corrections to the tabular freeboard are added or subtracted.

3.7.2 Correction for block coefficient (Regulation 30)

2D-124 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: $\text{Tabular Freeboard x } \frac{(C_b \; x \; 0.68)}{1.36}$

Reasoning for this is as follows:

2D-125 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 if increased when C_b is greater than 0.68 (standard ship) to ensure that the same percentage of reserve of buoyancy is maintained.

Figure 26.14

3.7.3 Correction for depth (Regulation 31)

2D-126 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.

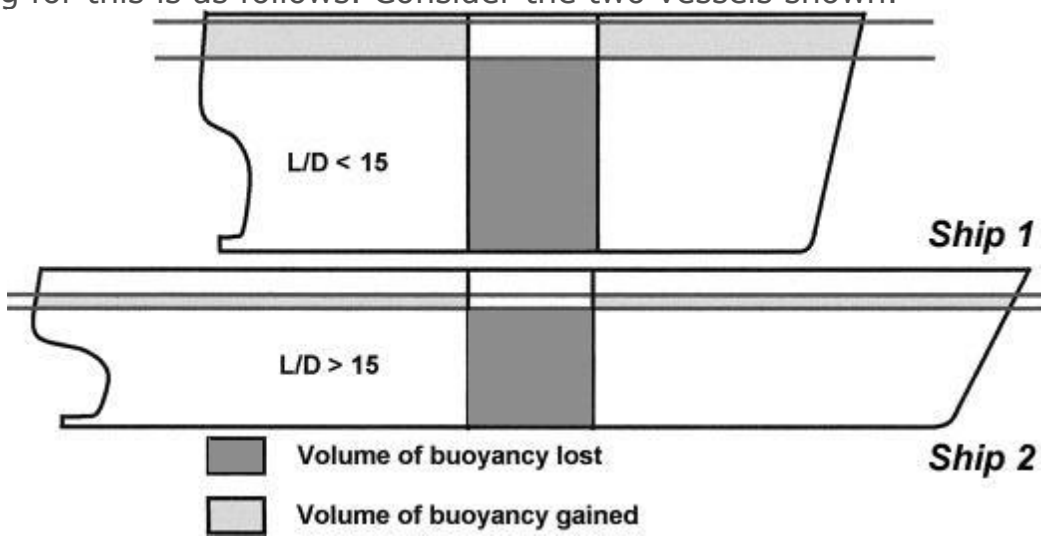


Figure 26.15

2D-127 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.

3.7.4 Correction for position of deck line (Regulation 32)

2D-128 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.

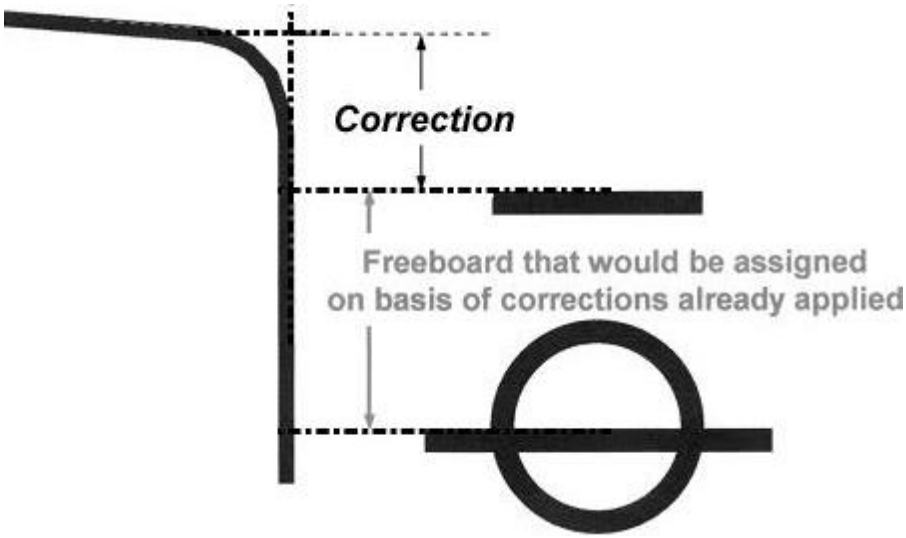


Figure 26.16

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

2D-129 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.

2D-130 Regulation 33 defines the standard height of superstructure as given in the following table:

	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

2D-131 Standard heights for intermediate lengths are obtained by interpolation.

2D-132 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.

2D-133 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.

3.7.6 Correction for Sheer Profile (Regulation 38)

2D-134 Sheer is defined as being the curvature of the freeboard deck in a fore and aft direction.
2D-135 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.

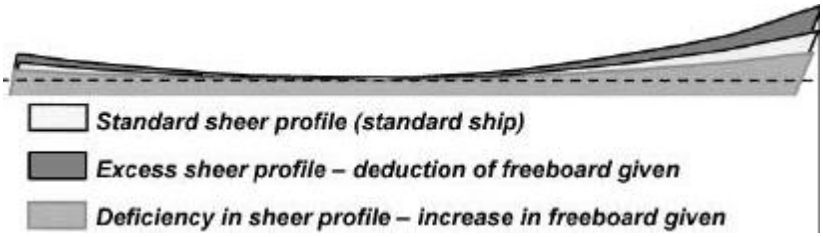


Figure 26.17

2D-136 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.

2D-137 Any deficiency in sheer will result in an increase in freeboard.

2D-138 Excess sheer will result in a deduction in freeboard.

2D-139 The amount of the deduction or increase in freeboard is determined by formulae in regulation 38.

3.7.7 Correction for bow height (Regulation 39)

2D-140 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:

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

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

(Cb shall not be less than 0.68)

2D-141 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.

2D-142 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.

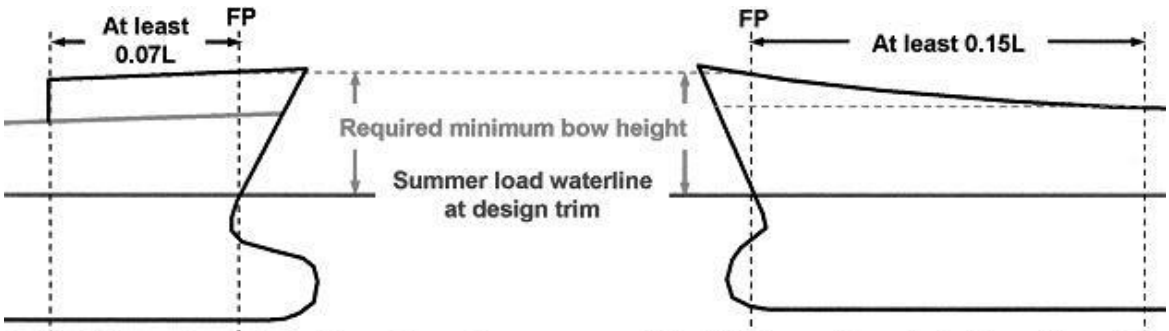


Figure 26.18

2D-143 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).

2D-144 The Tropical (T), Winter (W), Winter North Atlantic (WNA) and Fresh water (F) freeboards are then calculated as illustrated in figure 26.6 (section 3.2.2).

3.8 Calculation procedure for the assignment of a Type "B" Freeboard

3.8.1 Obtain the tabular freeboard (Regulation 28)

2D-145 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.

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

2D-146 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 dependent on the length of ship (Regulation 27(6)).

3.8.3 Correction to tabular freeboard for type "B" ships under 100 meters in length (Regulation 29)

2D-147 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:

$$7.5(100 - L)\left(0.35 - \frac{E}{L}\right) mm$$

2D-148 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 minimizing the amount of water shipped. Longer ships (over 100 m) tend to pass through the waveform and thus will pitch less.

2D-149 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.

3.9 Timber Freeboards (Chapter IV)

2D-150 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.

2D-151 The term 'timber deck cargo' means a cargo of timber carried on an uncovered part of a freeboard or superstructure deck.

2D-152 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.

2D-153 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.

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

These are summarized below:

2D-154 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.

2D-155 Double bottom tanks: Double bottom tanks within the midship half-length of the ship are to have satisfactory watertight longitudinal subdivision in order to minimize the loss of stability due to the free surface effects of slack tanks.

2D-156 Bulwarks: The ship is to be fitted with permanent bulwarks at least one meter 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 meter in height of especially strong construction.

3.9.2 Stowage requirements (Regulation 44)

2D-157 The general requirements are as follows:

2D-158 Openings in the weather deck over which the timber cargo is stowed should be securely closed and battened down.

2D-159 Ventilators and air pipes should be efficiently protected against damage resulting from a shift of the cargo.

2D-160 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.

2D-161 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.

2D-162 The timber should be stowed as solidly as possible to at least the standard height of a superstructure other than any raised quarter deck.

2D-163 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.

2D-164 The deck cargo should not interfere with the ship's safe operation and navigation, including access to ship's steering arrangements.

2D-165 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.

2D-166 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.

2D-167 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.

2D-168 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.

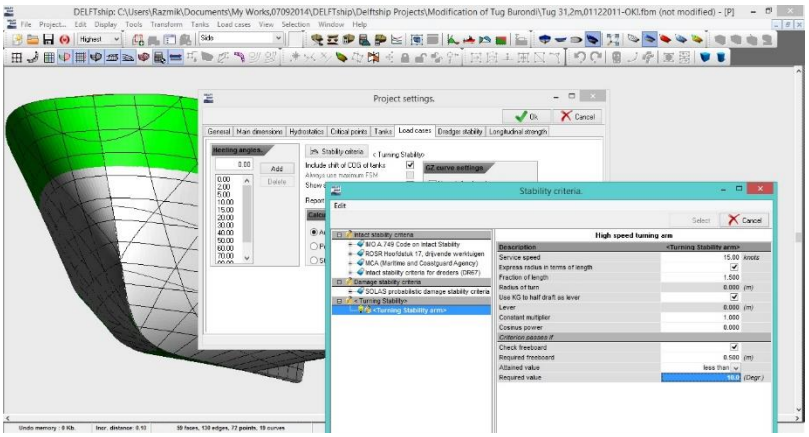
2D-169 The crew should have safe access across the deck stow by means of a walkway fitted over the timber deck cargo. Guard rails or lifelines not more than 330 mm apart vertically should be provided on each side of the cargo deck to a height of at least 1 meter above the cargo.

3.9.3 Calculation of the Summer timber freeboard (Regulation 45)

2D-170 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.

2D-171 Corrections to the Summer Timber freeboard to give the other seasonal freeboards are as shown in figure 26.7 in section 3.2.2.

3.9.4 Minimum IMO stability Criteria for ships Carrying timber deck cargo



2D-172 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 meters in length and over engaged in the carriage of timber deck cargoes.

2D-173 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 metreradians 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) 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.

2D-174 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.

2D-175 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.

2D-176 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.

2D-177 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.

2D-178 In the arrival condition it should be assumed that the weight of the timber deck cargo has increased by 10% due to water absorption.

2D-179 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).

4. Load Lines Certification and Surveys

2D-180 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'.

4.1 Surveys

2D-181 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.

2D-182 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.

4.2 Load Line survey preparation

2D-183 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'.

2D-184 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.

5) Locking bars and side wedges must be in place and be in good order.

6) Inspect all machinery space openings on exposed decks.

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

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

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

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

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

12) 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.

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

14) Check bulwarks and guardrails are in good condition.

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

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

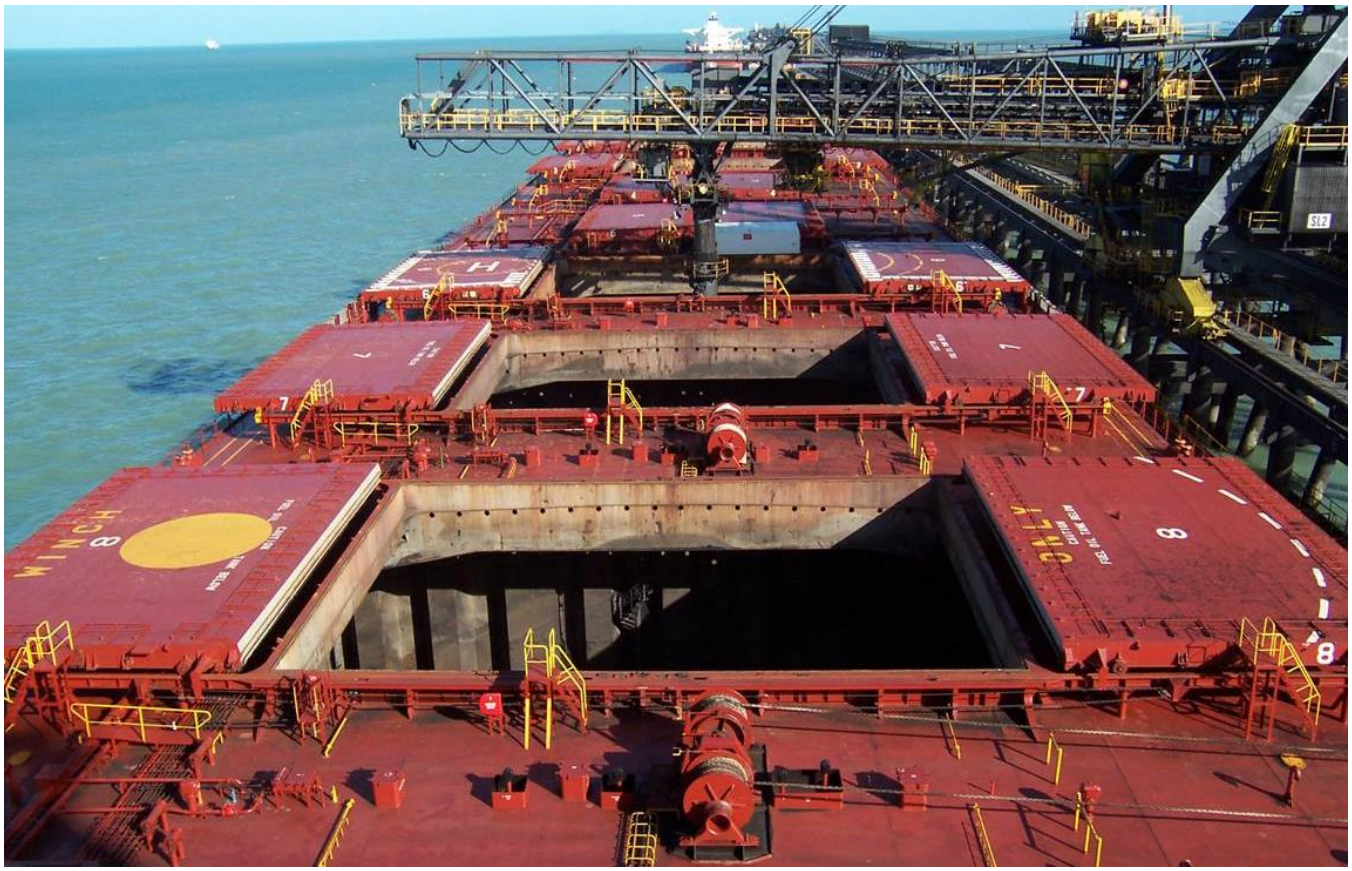
2D-185 On the day of the survey ensure that the International Load Line certificate and associated documentation are available for inspection. Sufficient manpower should be made available for the operation of hatch covers and the rigging of staging and ladders to allow the surveyor to view the load line and draught marks. The ship's stability data book should also be on hand for inspection.

5. Load Lines Surveys examples

Cargo Hatches (Reg.13,14,15 & 16)	Coaming
Position 1	600 mm
Position 2	450 mm

- The flush hatches are not allowed in position 1 if they are exposed. They are acceptable in position 2 if they have double joint and the space between is drained to the outside
- Once completed must be hose tested

Side Rolling Hatch Covers



Defects from the strength point of view

HATCHES

- General corrosion of flat panels (holes, patches) (visual aspect and TM)
- Corrosion in panels of transverse joints (scale, holes) corrosion of stiffening structure (edge thinned, holes, cracks etc.) (visual aspect and TM)

COAMINGS

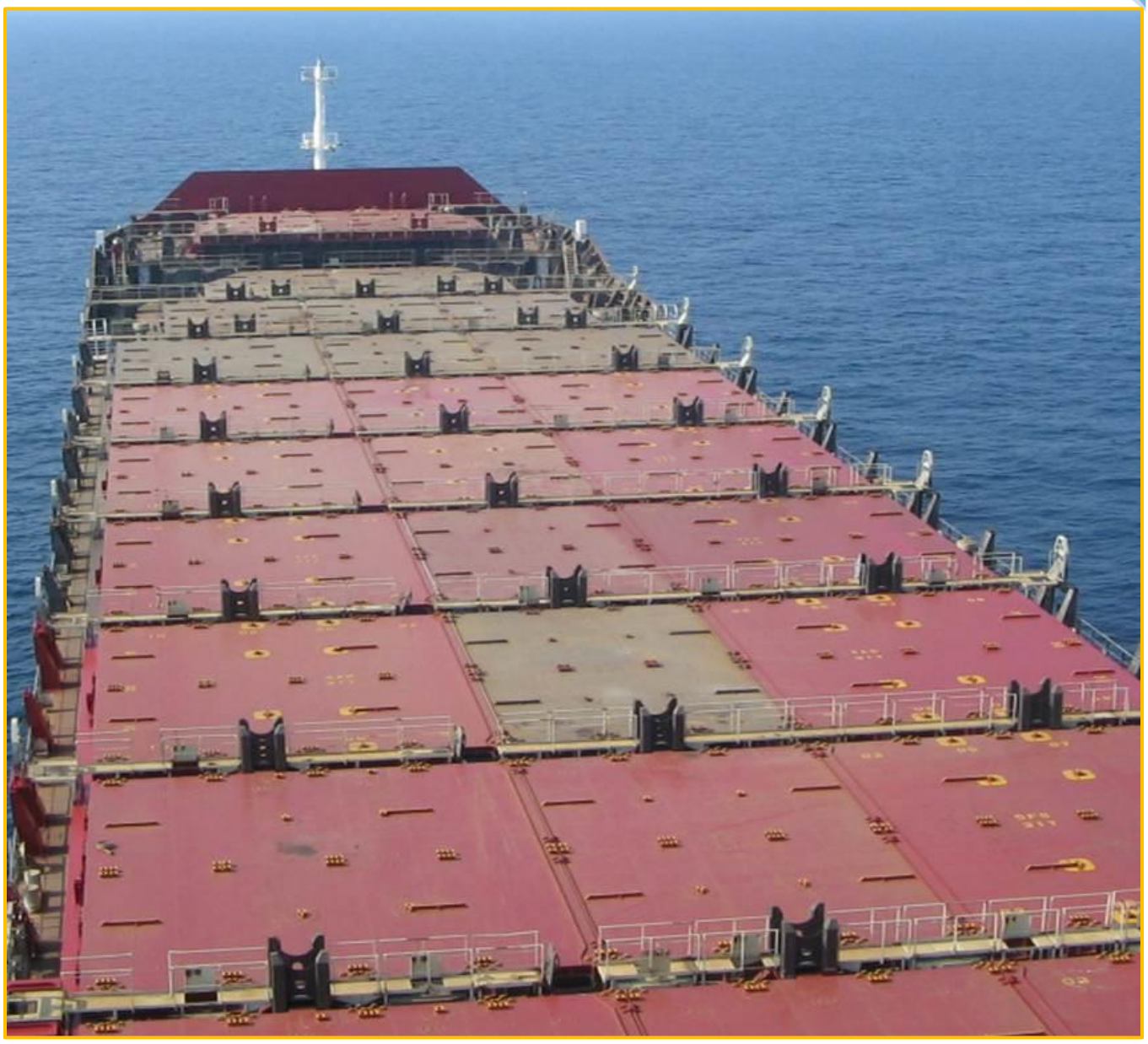
- Corrosion, holes
- Cracks at the end of long. coaming end brackets

Folding Covers and Hinge/Ram

End Rolling Hatch Covers

Condition (corrosion, loss of thickness, deformations) of upper part, side area and stiffeners. (If it is necessary or where required thickness measurement). (The sides in way of transverse joints are especially vulnerable to corrosion due to the difficulties in cleaning and painting. It is recommended to shot blast and paint during special surveys if required)

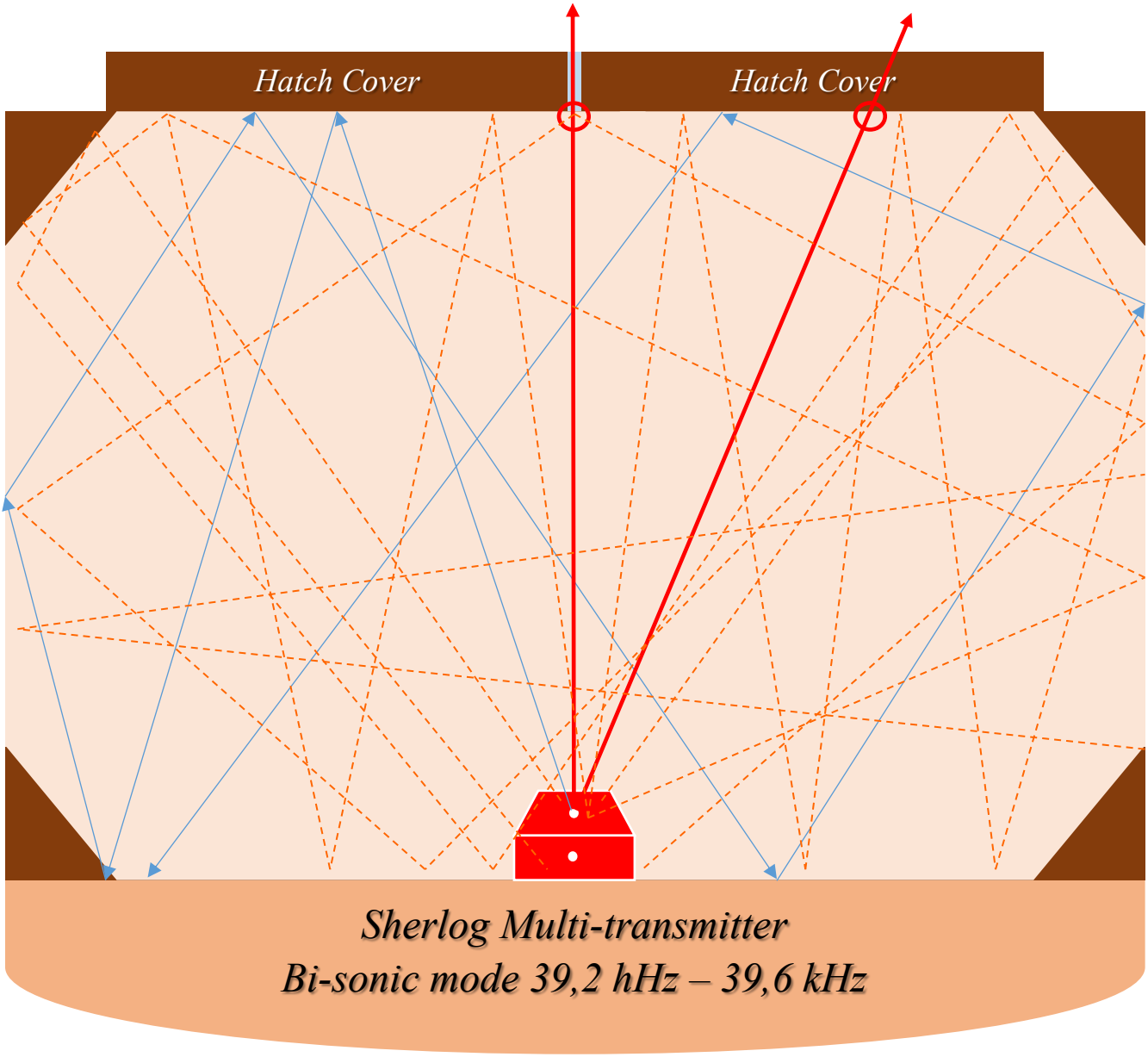
Steel Pontoon Covers



Hatch cover Examination – Structure Condition

Hatch cover examination – Weathertighness

Ultrasonic Waves Generation



Record of Conditions of Assignment (C11-IMO) Reg.12, 17 & 18

Small hatches (machinery space openings and miscellaneous openings in freeboard and superstructure decks) (Regs. 17 & 18)					
Position	Reference number on sketch plan	Dimensions Height of coaming	Cover Material	How is cover attached	Number and spacing of toggles

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Machinery space openings and miscellaneous openings (Reg. 17 and 18)

Location	Sills
Position 1	600 mm
Position 2	380 mm

- The maximum size for access hatch is 1,5m^2
- Whenever possible the covers should open forward

Access Hatches

Defects

- General corrosion in the rubber housing
- Rubber in bad condition
- Hinges
- Bent toggles or missing
- Compression bar thinned (edge knife)

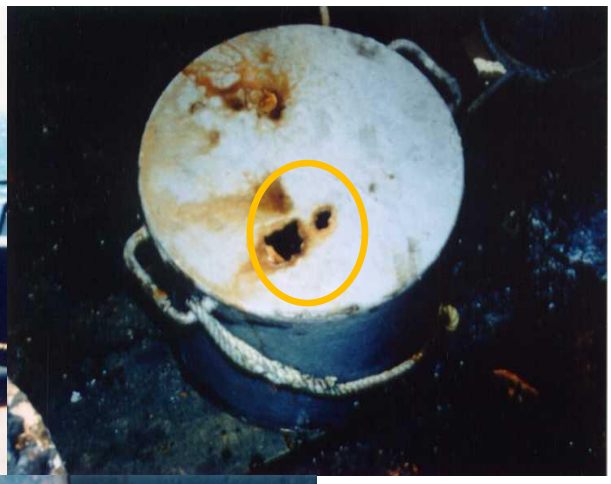
or

Record of Conditions of Assignment (C11-IMO) Reg.19

Location	Coamings
Position 1	600 mm
Position 2	380 mm

- If the coaming of ventilators in position 1 extend to more than 4,5 m above deck, and in position 2 to more than 2,3 m above the deck, closing arrangements are not normally required
- Where the coaming of ventilator exceeds 900 mm in height, it is to be specially supported by brackets
- Main Types:
  - ✓ Gooseneck
  - ✓ Mushroom
  - ✓ Bulkhead opening

Ventilators – Common types

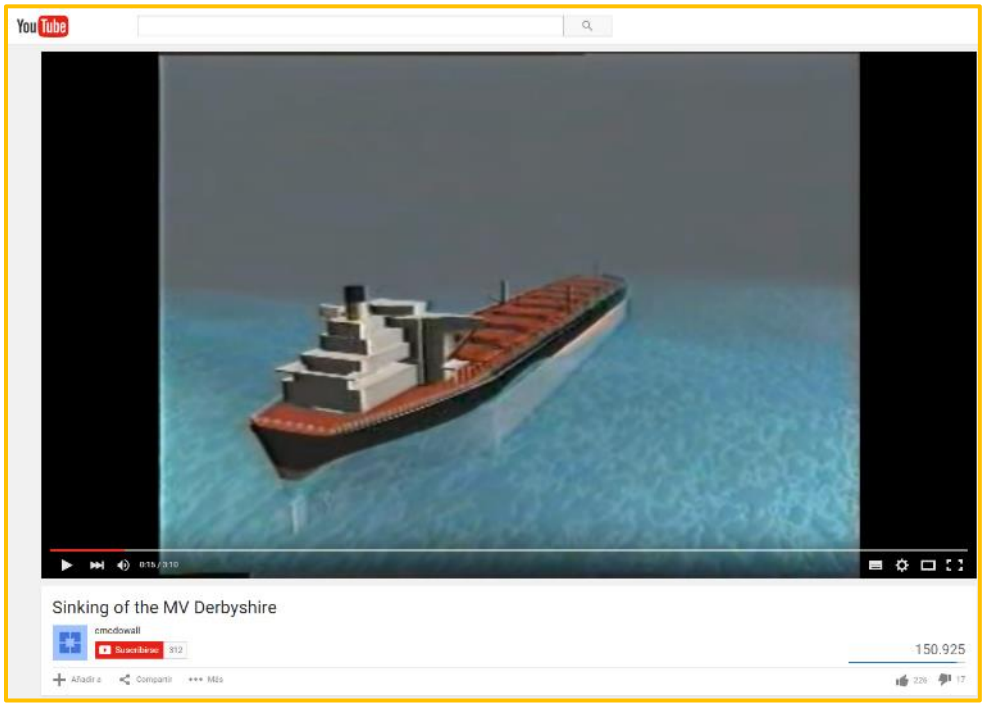


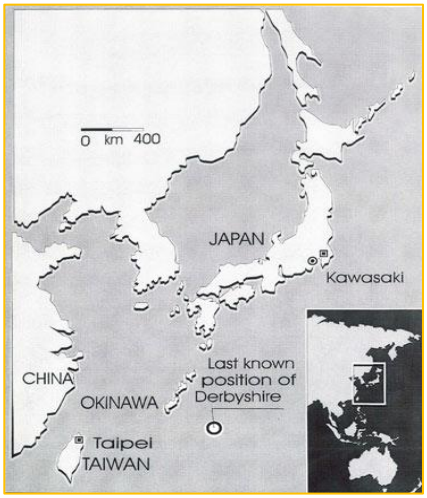
- Corrosion in tubes or heads
- Failures in weathertightness elements:
  - Cover
  - Rubber
  - Shaft and operating handle
- Failure in signaling: opening or closed

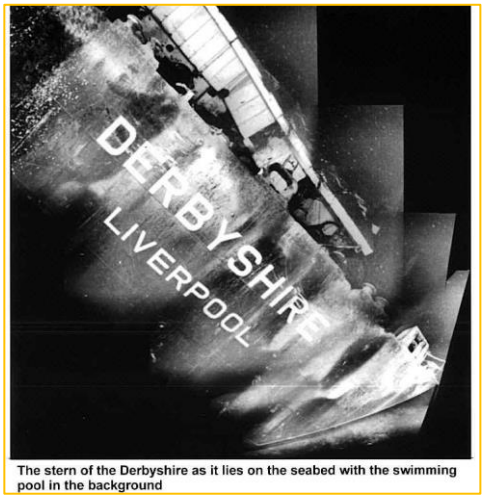
Ventilators – Common types

6. Case of Study

Visit the YouTube website and find the video title: "Sinking of the MV Derbyshire" or click on the below link: https://www.youtube.com/watch?v=9tN4xROtMjI







The stern of the Derbyshire as it lies on the seabed with the swimming pool in the background

She was lost in September 1980 in the South China Seas during typhoon Orchid, en route from Canada to Japan. All 44 people onboard died, including 42 crew members and 2 of their wives.