



RULES FOR CLASSIFICATION

Ships

Edition July 2022

Part 3 Hull

Chapter 2 General arrangement design

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FOREWORD

DNV rules for classification contain procedural and technical requirements related to obtaining and retaining a class certificate. The rules represent all requirements adopted by the Society as basis for classification.

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CHANGES – CURRENT

This document supersedes the July 2021 edition of DNV-RU-SHIP Pt.3 Ch.2.
The numbering and/or title of items containing changes is highlighted in red.

Changes July 2022, entering into force 1 January 2023

Only editorial corrections have been made.

Editorial corrections

In addition to the above stated changes, editorial corrections may have been made.

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SECTION 1 GENERAL

1 Introduction

1.1 Application

1.1.1 This chapter provides general requirements to the arrangement of hull.

1.1.2 Non-convention vessels shall be designed with consideration to risk and consequences of flooding due to leakages or damage to side and bottom. The Society may require design damage cases to be defined and described in the ship documentation.

1.1.3 Requirements for the arrangement as given in [Sec.2 \[1\]](#) to [Sec.2 \[5\]](#) and [Sec.3 \[2\]](#), assume damage cases as defined by SOLAS and are not mandatory to non-convention vessels.

SECTION 2 SUBDIVISION ARRANGEMENT

Symbols

For symbols not defined in this section, see [Ch.1 Sec.4](#).

1 Watertight bulkhead arrangement

1.1 Number and disposition of watertight bulkheads

1.1.1 All ships shall have at least the following transverse watertight bulkheads:

- one collision bulkhead
- one aft peak bulkhead
- one bulkhead at each end of the engine room.

1.1.2 In the case of ships with an electrical propulsion plant, both the generator room and the engine room shall be enclosed by watertight bulkheads.

1.1.3 In addition to the requirements of [\[1.1.1\]](#) and [\[1.1.2\]](#), the number and disposition of bulkheads shall be arranged to suit the requirements for transverse strength, subdivision, floodability and damage stability, and shall be in accordance with the requirements of national regulations.

1.1.4 For vessels where no damage stability calculations have been carried out the total number of watertight transverse bulkheads shall not be less than given in [Table 1](#).

Table 1 Number of transverse bulkheads

Ship length in [m]	Engine room	
	Aft	Elsewhere
$L \leq 65$	3	4
$65 < L \leq 85$	4	4
$85 < L \leq 105$	4	5
$105 < L \leq 125$	5	6
$125 < L \leq 145$	6	7
$145 < L \leq 165$	7	8
$165 < L \leq 190$	8	9
$190 < L \leq 225$	9	10
$L > 225$	specially considered	

1.1.5 The watertight bulkheads shall extend to the bulkhead deck.

1.1.6 For ships with a continuous deck below the freeboard deck and where the draught is less than the depth to this second deck, all bulkheads except the collision bulkhead may terminate at the second deck. In such cases the engine casing between second and bulkhead deck shall be arranged as a watertight structure, and the second deck shall be watertight outside the casing above the engine room.

1.1.7 In ships with a raised quarter deck, the watertight bulkheads within the quarter deck region shall extend to this deck.

For cargo ships with raised quarter decks where the freeboard deck does not extend to the position of the aft perpendicular, the aft peak bulkhead may be terminated at a watertight deck lower than the freeboard deck. In such case the rudder stock bearings shall be housed in a watertight compartment without open connections to spaces in front of the aft peak bulkhead.

1.2 Openings in watertight bulkheads

1.2.1 The number of openings in watertight bulkheads shall be kept at a minimum. Where penetrations of watertight bulkheads and internal decks are necessary for access, piping, ventilation, electrical cables, arrangements shall be made to maintain the watertight integrity. Requirements to cable penetrations are provided in [Pt.4 Ch.8 Sec.10 \[3.3\]](#) and requirement to pipe penetrations are provided in [Pt.4 Ch.6 Sec.2 \[1.7.6\]](#) and [Pt.4 Ch.6 Sec.3 \[1.4\]](#).

1.2.2 Openings situated below the bulkhead deck and which are intended for use when the ship is at sea, shall have watertight doors, which shall be closable from the bulkhead deck or place above the deck. The operating device shall be well protected and accessible.

2 Watertight deck arrangement

Where a ventilation trunk passing through a structure penetrates the bulkhead deck, the trunk shall be capable of withstanding the water pressure that may be present within the trunk, after having taken into account the maximum heel angle allowable during intermediate stages of flooding, in accordance with SOLAS Ch. II-1/7.2.

3 Minimum bow height

3.1 General

3.1.1 Block coefficient

The block coefficient as defined in the International Convention on Load Lines, C_{B-LL} , is as following:

$$C_{B-LL} = \frac{\nabla}{L_{LL} B T_{LL}}$$

where:

- ∇ = volume in m^3 of the moulded displacement, excluding bossings, taken at the moulded draught T_{LL}
- T_{LL} = the draught in m at 85% of the least moulded freeboard depth, D_{LL} , see [Ch.1 Sec.4 Figure 1](#)
- L_{LL} = freeboard length in m as defined in [Ch.1 Sec.4 \[3.1.2\]](#).

3.1.2 Minimum bow height requirements are:

- 1) The bow height F_b , defined as the vertical distance at the forward perpendicular between the waterline corresponding to the assigned summer freeboard and the designed trim and the top of the exposed deck at side shall be not less than:

$$F_b = \left[6075 \left(\frac{L_{LL}}{100} \right) - 1875 \left(\frac{L_{LL}}{100} \right)^2 + 200 \left(\frac{L_{LL}}{100} \right)^3 \right] \cdot \left[2.08 + 0.609 C_{B-LL} - 1.603 C_{wf} - 0.0129 \left(\frac{L_{LL}}{T_{LL}} \right) \right]$$

where:

F_b = the minimum bow height in mm

C_{wf} = water plane area coefficient forward of $L_{LL}/2$

$$= \frac{A_{wf}}{0.5 L_{LL} B}$$

A_{wf} = water plane area forward of $L_{LL}/2$ at draught T_{LL} in m^2 .

For ships to which timber freeboards are assigned, the summer freeboard (and not the timber summer freeboard) shall be assumed when applying item 1).

- 2) Where the bow height required in item 1) is obtained by sheer, the sheer shall extend for at least 15% of the length of the ship measured from the forward perpendicular. Where it is obtained by fitting a superstructure, such superstructure shall extend from the stem to a point at least $0.07 L_{LL}$ abaft the forward perpendicular, and it shall be enclosed.
- 3) Ships which, to suit exceptional operational requirements, cannot meet the requirements of items 1) and 2) may be given special consideration.
- 4) a) The sheer of the forecastle deck may be taken into account, even if the length of the forecastle is less than $0.15 L_{LL}$, but greater than $0.07 L_{LL}$, provided that the forecastle height is not less than one half of standard height of superstructure as defined in the IMO Load Line Regulation 33 between $0.07 L_{LL}$ and the forward perpendicular.
- b) Where the forecastle height is less than one half of the standard height of superstructure, as defined in the IMO Load Line Regulation 33, the credited bow height may be determined as follows:
 - i) Where the freeboard deck has sheer extending from abaft $0.15 L_{LL}$, by a parabolic curve having its origin at $0.15 L_{LL}$ abaft the forward perpendicular at a height equal to the midship depth of the ship, extended through the point of intersection of forecastle bulkhead and deck, and up to a point at the forward perpendicular not higher than the level of the forecastle deck (as illustrated in Figure 1). However, if the value of the height denoted h_t , in m, in Figure 1 is

smaller than the value of the height denoted h_b , in m, then h_t may be replaced by h_b in the available bow height.

- ii) Where the freeboard deck has sheer extending for less than $0.15 L_{LL}$ or has no sheer, by a line from the forecastle deck at side at $0.07 L_{LL}$ extended parallel to the base line to the forward perpendicular (as illustrated in Figure 2).

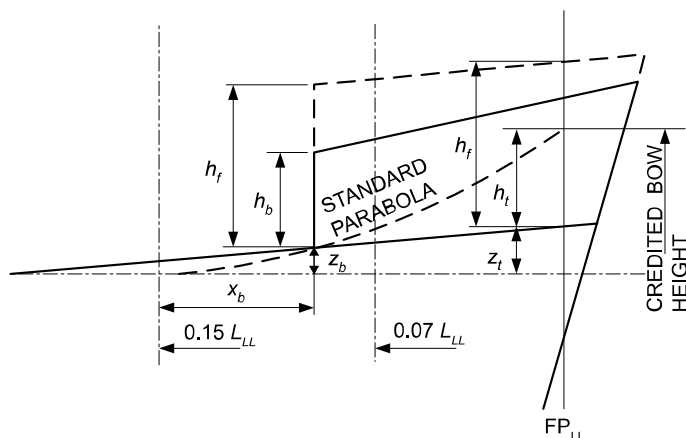


Figure 1 Forecastle, procedure 1

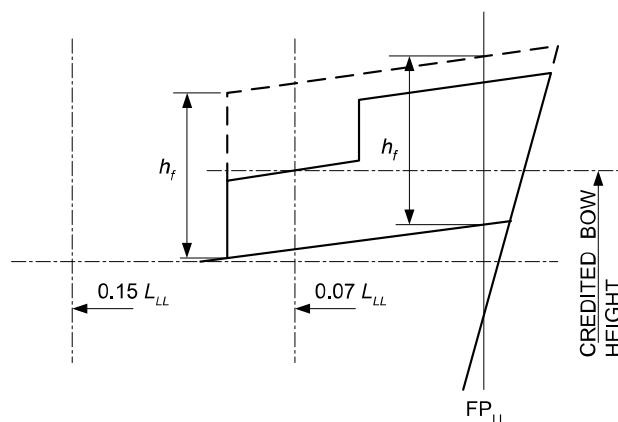


Figure 2 Forecastle, procedure 2

h_f = half standard height of superstructure, in m, as defined in International Convention on Load Lines Reg 33

$$= z_b \left(\frac{0.15L}{x_b} \right)^2 - z_t$$

- 5) All ships assigned a type 'B' freeboard, other than oil tankers, chemical tankers and gas carriers, shall have additional reserve buoyancy in the fore end as given in the International Convention on Load Lines Reg 39.

4 Collision bulkhead

4.1 Extent and position of collision bulkhead

4.1.1 A collision bulkhead shall be fitted on all ships and shall extend to the bulkhead deck. The distance x_c in m, from the perpendicular FP_{LL} to the collision bulkhead shall be taken between the following limits:

$$\begin{aligned} x_{c-min} &= 0.05L_{LL} - x_f \text{ for } L_{LL} < 200 \text{ m} \\ &= 10 - x_f \text{ for } L_{LL} \geq 200 \text{ m} \\ x_{c-max} &= 0.05L_{LL} + 3.0 - x_f \text{ for } L_{LL} < 100 \text{ m} \\ &= 0.08L_{LL} - x_f \text{ for } L_{LL} \geq 100 \text{ m} \end{aligned}$$

where:

x_f = adjustment of reference point due to bulbous bow in m, as given in [4.1.2].

A greater value of x_{c-max} may be permitted by the flag administration, see [4.1.3].

4.1.2 For ships without bulbous bows the reference point shall be taken where the forward end of L_{LL} coincides with the forward side of stem, on the waterline which L_{LL} is measured:

$$x_f = 0$$

For ships with bulbous bow the adjustment of the reference point x , in m, shall be taken as:

$$x_f = \min(0.5x_{be}; 0.015L_{LL}; 3.0)$$

where:

x_{be} = the distance in m from FP_{LL} to the extreme forward end of the bulb extension, see Figure 3.

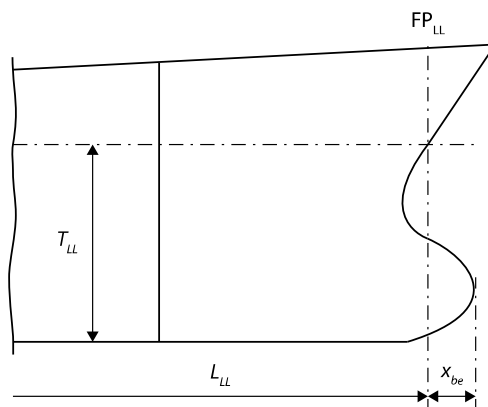


Figure 3 Bulbous bow shape

4.1.3 An increase of the maximum distance given by [4.1.1] may be acceptable upon consideration in each case, provided a floatability and stability calculation shows that, with the ship fully loaded to summer draught on even keel, flooding of the space forward of the collision bulkhead will not result in any other compartments being flooded, nor in an unacceptable loss of stability.

4.1.4 In ships having a visor or doors in the bow and a sloping loading ramp forming part of the collision bulkhead above the freeboard deck, that part of the closed ramp which is more than 2.30 m above the freeboard deck may extend forward of the limits specified in [4.1.1], see Figure 4.

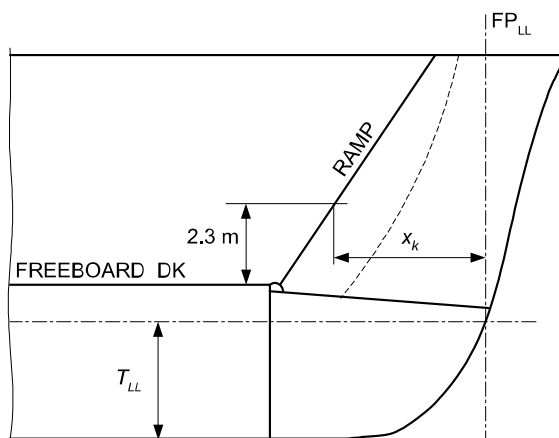


Figure 4 Bow visor or door

The ramp shall be arranged for weathertight closing over its complete length.

The distance x_k in Figure 4 shall not be less than the minimum value as given in [4.1.1].

4.2 Arrangement of collision bulkhead

4.2.1 In general, the collision bulkhead shall be in one plane; however, the bulkhead may have steps or recesses provided that they are within the limits prescribed in [4.1.1] and [4.1.2].

4.2.2 Doors, manholes, permanent access openings, ventilation ducts or any other openings shall not be cut in the collision bulkhead below the freeboard deck. Where the collision bulkhead is extended above the freeboard deck, the number of openings in the extension shall be kept to a minimum compatible with the design and proper working of the ship.

4.2.3 The collision bulkhead may be pierced below the bulkhead deck by not more than one pipe for dealing with fluid in the forepeak tank. Requirements for arrangements of such piping are provided in [Pt.4 Ch.6 Sec.3](#).

4.2.4 For ships having complete or long forward superstructures, length equal to or greater than 0.25 L, the collision bulkhead shall extend weathertight to the next deck above the bulkhead deck. The extension need not be fitted directly over the bulkhead below, provided the requirements for distances from FP_{LL} are complied with, and the part of the bulkhead deck forming the step is made weathertight.

5 Aft peak bulkhead

5.1 General

5.1.1 An aft peak bulkhead, enclosing the stern tube and rudder trunk in a watertight compartment, shall be provided. Where the shafting arrangements make enclosure of the stern tube in a watertight compartment impractical, alternative arrangements will be specially considered.

5.1.2 The aft peak bulkhead may be stepped below the bulkhead deck, provided that the degree of safety of the ship as regards subdivision is not thereby diminished.

5.1.3 The aft peak bulkhead location on ships powered and/or controlled by equipment that do not require the fitting of a stern tube and/or rudder trunk are also subject to special consideration.

5.1.4 The aft peak bulkhead may terminate at the first deck above the deepest draught at the aft perpendicular, provided that this deck is made watertight to the stern or to the transom.

5.1.5 Aft peak/machinery space bulkheads may terminate as given in [\[5.1.4\]](#) when the aft space is not utilised for cargo or passengers.

SECTION 3 COMPARTMENT ARRANGEMENT

Symbols

For symbols not defined in this section, see [Ch.1 Sec.4](#).

1 Cofferdams

1.1 Definition

A cofferdam means an empty space arranged so that compartments on each side have no common boundary; a cofferdam may be located vertically or horizontally. As a rule, a cofferdam shall be kept gas-tight and shall be properly ventilated and of sufficient size to allow proper inspection, maintenance and safe evacuation.

1.2 Arrangement of cofferdams

1.2.1 Cofferdams shall be provided between compartments intended for liquid hydrocarbons (fuel oil, lubricating oil) and those intended for fresh water (drinking water, water for propelling machinery and boilers) as well as tanks intended for the carriage of liquid foam for fire extinguishing.

1.2.2 Furthermore, a cofferdam shall be arranged separating tanks carrying fresh water for human consumption from other tanks containing substances hazardous to human health.

Guidance note:

Normally, tanks for fresh water and water ballast are considered non-hazardous.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.2.3 Where a corner to corner situation occurs, tanks are not considered to be adjacent.

2 Double bottom

2.1 General

2.1.1 A double bottom need not to be fitted in way of watertight compartments used exclusively for the carriage of liquids, provided the safety of the ship in the event of a bottom damage is not thereby impaired. For oil tankers, see [Pt.5 Ch.5 Sec.3](#), for chemical carriers, see [Pt.5 Ch.6 Sec.3](#), and for liquefied gas carriers, see [Pt.5 Ch.7 Sec.3](#).

2.1.2 Subject to agreement with the Society, the requirements in [\[2.1.3\]](#) and [\[2.2\]](#) to [\[2.4\]](#) may be specially considered for vessels not required to comply with SOLAS II-1/9 or $L_{LL} < 80$ m.

2.1.3 Any part of the ship that is not fitted with a double bottom in accordance with [\[2.2\]](#) to [\[2.4\]](#) shall be capable of withstanding bottom damages.

Guidance note:

Bottom arrangements regulated under the SOLAS Convention that are not in compliance with Reg.II-1/9 are subject to acceptance by the flag administration.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.2 Extent of double bottom

For passenger vessels and cargo ships other than tankers, a double bottom shall be fitted, extending from the collision bulkhead to the aft peak bulkhead, as far as this is practicable and compatible with the design and proper working of the ship.

2.3 Height of double bottom

Where a double bottom is required to be fitted the inner bottom shall be continued out to the ship side in such a manner as to protect the bottom to the turn of bilge. Such protection will be deemed satisfactory if the inner bottom is not lower at any part than a plane parallel with the keel line and which is located not less than a vertical distance h_{DB} measured from the keel line, in mm, as calculated by the formula:

$$h_{DB} = 1000 \cdot B/20, \text{ minimum } 760 \text{ mm}$$

The height, h_{DB} , need not be taken more than 2000 mm.

The height, h_{DB} , shall be sufficient to give good access to all parts of the double bottom. For ships with large rise of floor, the minimum height may have to be increased after special consideration.

2.4 Small wells in double bottom tank

Small wells constructed in the double bottom, in connection with the drainage arrangements of holds, shall not extend in depth more than necessary. For ships with length L_{LL} 80 m or above the vertical distance from the bottom of such a well to a plane coinciding with the keel line shall not be less than 500 mm or half the required double bottom height. Other wells, e.g. for lubricating oil under main engines, may be permitted if the arrangement gives protection equivalent to that afforded by a double bottom complying with this regulation.

3 Fore end compartments

3.1 General

The fore peak and other compartments located forward of the collision bulkhead shall not be arranged for the carriage of fuel oil or other flammable products.

4 Aft end compartments

4.1 Sterntube

Stern tubes shall be enclosed in a watertight space (or spaces) of moderate volume. In case the stern tube terminates at an aft peak bulkhead also being a machinery space bulkhead, a pressurized stern tube sealing system may be accepted as an alternative to the watertight enclosure. Other measures to minimise the danger of water penetrating into the ship in case of damage to stern tube arrangement may be taken at the discretion of the Society.

4.2 Propulsion thruster compartment

The propulsion thruster compartment shall comply with the requirements given in [Pt.4 Ch.5 Sec.3 \[2.3.5\]](#) and [Pt.4 Ch.5 Sec.3 \[2.3\]](#).

5 Fuel oil tanks

5.1 Arrangement of fuel oil tanks

Fuel oil tanks shall be arranged in accordance with the requirements in SOLAS Ch II-2, Reg 4.2 and MARPOL, Annex I, Ch 3, Reg 12A.

6 Shaft tunnels

6.1 General

6.1.1 In ships with engine room situated amidships, a watertight shaft tunnel shall be arranged. Openings in the forward end of shaft tunnels shall be fitted with watertight sliding doors capable of being operated from a position above the load waterline.

6.1.2 The shaft tunnel may be omitted in ships with service restriction notation **R2**, **R3**, **R4** and **RE** provided the shafting is otherwise effectively protected. Bearings and stuffing boxes shall be accessible.

7 Steering gear compartment

7.1 General

The steering gear compartment shall be readily accessible and separated from machinery spaces. See also [Ch.14 Sec.1 \[1.3\]](#) for additional requirements for the steering gear compartment.

SECTION 4 ACCESS ARRANGEMENT

1 Access to tanks and compartments

1.1 Access to tanks

1.1.1 All vessels shall be provided with means of access giving safe and practical access to the internal structure during operational phase.

1.1.2 Ship structure access manual

Ship structures on oil tankers, bulk carriers, ore carriers and combination carriers subject to overall and close-up inspection and thickness measurements shall be provided with means of access which shall be described in a ship structure access manual. Reference is made to SOLAS Ch II-1 Reg 3.6 (as amended).

1.1.3 All tanks shall be accessible for easy inspection and close-up survey as defined in [Pt.7 Ch.1 Sec.3 \[2\]](#) and [Pt.7 Ch.1 Sec.4 \[2\]](#).

1.2 Access to double bottom compartments

1.2.1 Manholes shall be cut in the inner bottom, floors and longitudinal girders to provide access to all parts of the double bottom. The edges of manholes shall be smooth. Manholes in the inner bottom plating shall have reinforcement rings.

Manhole covers in the inner bottom plating in cargo holds shall be effectively protected.

2 Closed spaces

2.1 General

In general, all closed spaces shall be accessible for easy inspection. Special measures for inspection and maintenance shall be put in place for small closed spaces for which the design causes impracticality for the access.

Closing of spaces of limited size, that are not possible to enter for inspection and maintenance, may be accepted after special consideration.

CHANGES – HISTORIC

July 2021 edition

Changes July 2021, entering into force 1 January 2022

Topic	Reference	Description
Cable penetrations	Sec.2 [1.2]	Included a reference to requirement to cable penetrations in Pt.4.
Rebranding to DNV	All	This document has been revised due to the rebranding of DNV GL to DNV. The following have been updated: the company name, material and certificate designations, and references to other documents in the DNV portfolio. Some of the documents referred to may not yet have been rebranded. If so, please see the relevant DNV GL document.

July 2020 edition

Changes July 2020, entering into force 1 January 2021

Only editorial corrections have been made.

July 2019 edition

Changes July 2019, entering into force 1 January 2020

Topic	Reference	Description
Clarification of rules	Sec.1 [1.1]	A paragraph is added to clarify application of chapter.
SOLAS update	Sec.3 [2]	Wells shall not be located closer to keel line than the maximum of 500 mm or half the required double bottom height for ships with $L_{LL} \geq 80m$.
Openings in primary supporting members	Sec.4 [1.2.1]	Details of openings and manholes have been removed from this paragraph, as they are not applicable for all ship types.

January 2018 edition

Changes January 2018, entering into force as from date of publication

Topic	Reference	Description
Improvement of rules for vessels below 90m	Sec.1 [1.1.3]	The text is modified to clarify application for non-convention vessels.

<i>Topic</i>	<i>Reference</i>	<i>Description</i>
Requirement to openings within superstructures	Sec.2 [4.2]	Paragraph removed.

October 2015 edition

Amendments January 2017

- Sec. 2 Subdivision arrangement
 - Sec.2 [4.1.1]: Symbol corrected and maximum distance for ships less than 100 m added.

Amendments July 2016

- Sec. 2 Subdivision arrangement
 - Sec.2 [1.1.6]: Editorial corrections have been made.
 - Sec.2 [2]: Editorial corrections have been made.
- Sec. 3 Compartment arrangement
 - Sec.3 [6.1.2]: Editorial corrections have been made.

Amendments January 2016

- General
 - Only editorial corrections have been made.

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