



**RULES  
FOR THE CLASSIFICATION AND CONSTRUCTION  
OF SEA-GOING SHIPS**

**PART III  
HULL EQUIPMENT**

January  
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GDAŃSK

## **RULES FOR CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS**

prepared and issued by Polish Register of Shipping, hereinafter referred to as PRS, consist of the following parts:

- Part I – Classification Regulations
- Part II – Hull
- Part III – Hull Equipment
- Part IV – Stability and Subdivision
- Part V – Fire Protection
- Part VI – Ship and Machinery Piping Systems
- Part VII – Main and Auxiliary Machinery and Equipment
- Part VIII – Electrical Installations and Control Systems
- Part IX – Materials and Welding

*Part III – Hull Equipment* – January 2025 was approved by the PRS Board on 13 December 2024 and enters into force on 1 January 2025.

From the entry into force, the requirements of *Part III – Hull Equipment* apply, within the full scope, to new ships.

With respect to existing ships, the requirements of *Part III – Hull Equipment* are applicable within the scope specified in *Part I – Classification Regulations*.

The requirements of *Part III – Hull Equipment* are extended by the below-listed Publications:

- Publication 21/P – Testing of the hull structures,
- Publication 32/P – Requirements concerning stowage and lashing of cargoes on sea-going ships,
- Publication 39/P – Hull survey of bulk carriers,
- Publication 76/P – Stability, subdivision and freeboard of passenger ships engaged on domestic voyages,
- Publication 90/P – Safe return to port and orderly evacuation and abandonment of the ship,
- Publication 100/P – Safety requirements for sea-going passenger ships and high-speed passenger craft engaged in domestic voyages,
- Publication 122/P – Requirements for Baltic Ice Class and Polar Class for ships under PRS supervision,
- Publication 25/I – Explanatory notes to the standards for ship manoeuvrability,
- Publication 27/I – Guidelines for approval/acceptance of alternative means of access.

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## 1 GENERAL

### 1.1 Application

**1.1.1** *Part III – Hull Equipment* applies to sea-going ships specified in 1.1.1, *Part I – Classification Regulations*.

**1.1.2** Hull equipment designed for special or non-typical purposes is subject to special consideration of PRS.

**1.1.3** The present *Part III*, of the *Rules for the Classification and Construction of Sea-going Ships*, (hereinafter referred to as the *Rules*), contains both basic and additional requirements. Compliance with the basic requirements (Chapters 1 to 9), as applicable, is necessary for assignment of the main symbol of class.

Additional marks in the symbol of class determining ship designation will be affixed, provided the additional requirements (Chapters 10 to 21), as applicable, are complied with.

### 1.2 Definitions and Explanations

#### 1.2.1 Definitions

*A.P.* – *after perpendicular* – the perpendicular at the after end of the design length  $L_0$ .

*B* – *moulded breadth* [m] – the greatest moulded breadth of the ship measured between the outer edges of frames.

*B.P.* – *base plane* – horizontal plane which crosses amidships the top of a flat keel or the intersection of the inner surface of the plating with the bar keel.

*D* – *moulded displacement* [t] – mass of water, in tonnes, of the volume equal to the volume of the submerged part of the ship's hull at draught  $T$ . Unless otherwise stated, the salt water density equal to 1.025 t/m<sup>3</sup> shall be taken.

*E* – *elasticity (Young) modulus* [MPa] – for steel may be assumed as equal to  $2.06 \cdot 10^5$  MPa.

*F.P.* – *forward perpendicular* – the perpendicular at the intersection of the summer load waterline with the fore side of the stem. For ships with unconventional stem curvature, the position of the forward perpendicular shall be agreed with PRS.

*H* – *moulded depth* [m] – the vertical distance measured amidships from the base plane to the top of the uppermost continuous deck beam at side. In ships having a rounded gunwale, the moulded depth shall be measured to the point of intersection of the moulded lines of the deck and side.

If the uppermost continuous deck is stepped and the raised part of the deck extends over the point at which the moulded depth shall 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.

*L* – *length* [m] – 96% of the total length of the hull on a waterline at 85% of the moulded depth measured from the base plane, or as the length from the fore side of the stem to the axis of the rudder stock on that waterline, if that be greater. Where the stern contour is concave above the waterline at 85% of the moulded depth, the forward terminal of the length of the ship shall be taken at the vertical projection to that waterline of the aftermost point of the stern contour above that waterline. In ships designed with a rake of keel, the waterline on which this length is measured shall be parallel to the design waterline. In ships with unusual stern and bow arrangement, the length  $L$  shall be agreed with PRS.

- $L_0$  – *design length* [m] – the distance measured on the summer load waterline, from the fore side of the stem to the axis of the rudder stock. However, the assumed value of  $L_0$  shall not be less than 96% and need not be greater than 97% of the extreme length on the summer load waterline  $L_W$ . In ships with unusual stern and bow arrangement, the length  $L_0$  shall be agreed with PRS.
- $L_W$  – *length of summer load waterline* [m] – the distance measured at this waterline from the fore side of the stem to the point of intersection of the waterline with after side of the stern (transom).
- $R_e$  – *material yield stress (yield point)* [MPa] – see 1.2.2, *Part IX – Materials and Welding*.
- $T$  – *moulded draught* [m] – the vertical distance measured amidships from the base plane to the summer load waterline.
- $V$  – *volume of the moulded displacement* [m<sup>3</sup>] – the volume of a body defined by the external edges of frames at draught  $T$ .
- $\delta$  – *moulded block coefficient* – the coefficient calculated in accordance with the formula below:

$$\delta = \frac{V}{L_0 B T}$$

### 1.2.2 Co-ordinate System

**1.2.2.1** In the present Part of the *Rules*, the co-ordinate system, shown in Fig. 1.2.2.1, has been assumed for ships. The following reference planes have been assumed for the system: base plane, centre plane and midship section.

The intersection of the centre plane and the base plane forms the  $x$  axis of the positive sense forward.

The intersection of the base plane and midship section forms the  $y$  axis of the positive sense towards port side.

The intersection of the centre plane and midship section forms the  $z$  axis of the positive sense towards upward.

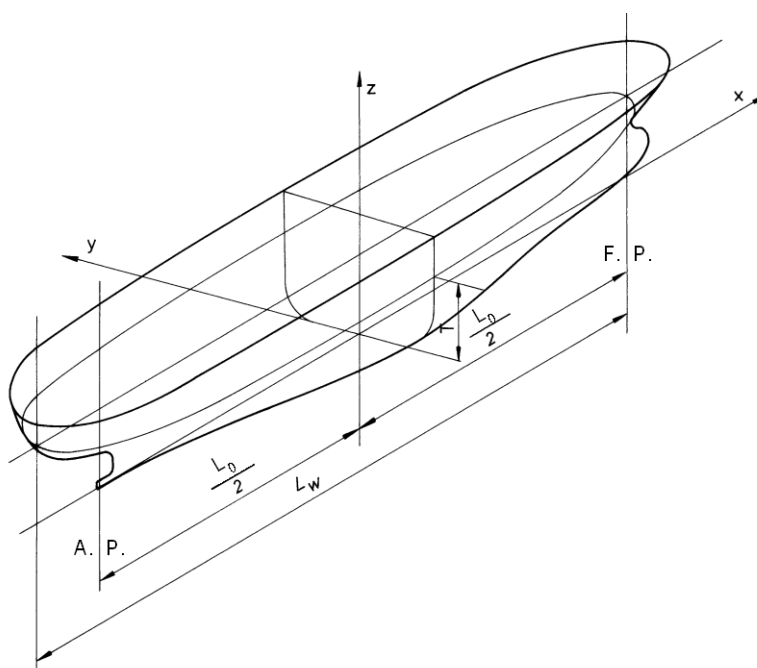


Fig. 1.2.2.1. Ship co-ordinate system



### 1.2.3 Definitions

- .1 **Amidships** – is at the middle of the length (L)
- .2 **Active rudder** – a self-propelled device exerting thrust under any angle to the longitudinal centre plane of the ship (as required by PRS), irrespective of the ship speed and main engine operation.
- .3 **Auxiliary steering gear** – the equipment other than part of the main steering gear necessary to steer the ship in the event of failure of the main steering gear but not including the tiller, quadrant or components serving the same purpose.
- .4 **Balanced rudder** – a rudder whose axis of rotation is located at a specified distance from the leading edge of the rudder blade (usually 25% ÷ 35% of the blade width).
- .5 **Bulkhead deck** – the uppermost deck to which the main watertight bulkheads, subdividing the ship into watertight compartments, are carried.
- .5a) **Bulkhead deck in a passenger ship** (for convention ship) – the uppermost deck to which the main bulkheads and the ship's shell are carried watertight.  
The bulkhead deck may be a stepped deck\*. In a cargo ship, the freeboard deck may be taken as the bulkhead deck.

\* See Explanatory Note on SOLAS Reg. II-1/2.19 in MSC.429(98)/Rev.1.

- .6 **Damage waterlines** – the waterlines of a damaged ship after flooding separate watertight compartments or their combinations as provided in *Part IV – Stability and Subdivision*.
- .7 **Deckhouse** – a decked structure on the freeboard deck or on the superstructure deck with the sides being inboard of one or both ship sides more than 0.04B.
- .8 **Deepest subdivision draught** – the summer load line draught of the ship.
- .9 **Double skin hatch cover** – a hatch cover as single skin cover but with continuous bottom plating such that all the stiffening structure and internals are protected from the environment.
- .10 **Equilibrium waterline** – the waterline in still water when, taking account of flooding due to an assumed damage to a compartment or a group of compartments, the weight and buoyancy forces acting on a ship are in balance, no further flooding takes place or after symmetrical flooding is completed.
- .11 **Freeboard deck\*** – the deck to which the freeboard, calculated according to *ICLL*, is measured.

\* See Explanatory Note on SOLAS Reg. II-1/2.6 in MSC.429(98)/Rev.1.

- .12 **Geometrical rudder axis** – a geometrical axis of rotation of the rudder stock and rudder blade connected to it.
- .13 **Hinged door** – a door having a pivoting motion about one vertical or horizontal edge.
- .14 **ICLL** – *International Convention on Load Line, 1966, with 1988 Protocol*, as amended.
- .15 **Industry standards** – international (ISO etc.) or national standards (PN, DIN, etc.) which are recognized in the country where the ship is built, subject to the approval of PRS or the Administration.
- .16 **Intermediate waterline** – the waterline in still water, which represents the instantaneous floating position of a ship at some intermediate stage between commencement and completion of flooding when, taking account of the assumed instantaneous state of flooding, the weight and buoyancy forces acting on a ship are in balance.

- .17 Line Design Break Force (LDBF)** – the minimum force that a new, dry, spliced, mooring line will break at. This is for all synthetic cordage materials.
- .18 Lower deck, 'tween deck** – the deck situated below the upper deck. Where there are several lower decks, they are usually named: the second deck, the third deck, etc., counting from the upper deck to bottom.
- .19 Main steering gear** – the machinery, rudder actuators, steering gear, power units, if any, and ancillary equipment and the means of applying torque to the rudder stock (e.g. tiller or quadrant) necessary for effecting movement of the rudder for the purpose of steering the ship under normal service conditions.
- .20 Midship section** – the section of the ship's hull surface at the middle of the length  $L_0$  by a plane normal to both the summer waterplane and the centerline plane of the ship.
- .21 Nominal capacity condition** – the condition defined as the theoretical condition where the maximum possible deck cargoes are included in the ship arrangement in their respective positions. For container ships the nominal capacity condition represents the theoretical condition where the maximum possible number of containers is included in the ship arrangement in their respective positions.
- .22 Normal towing** – means towing operations necessary for manoeuvring in ports and sheltered waters associated with the normal operations of the ship.
- .23 Other towing** – means towing by another ship or a tug, such as to assist the ship in case of emergency.
- .24 Permanent fixed lashing equipment** – components dismountable or permanently attached to the hull structure, such as: guides, seatings, supports, sockets, lashing eyes and plates, etc.
- .25 Pontoon type hatch cover** – a special type of portable cover, secured weathertight by tarpaulins and battening devices. Such covers shall be designed in accordance with *ICLL Regulation 15* and are not covered by requirements of this *Part III*.
- Clarification note:**  
Modern hatch cover designs of lift-away covers (also called lift-on/lift-off or just simply LoLo covers) are in many cases called pontoon covers. This definition does not fit to the definition above. Modern lift-away hatch cover designs should belong to one of the two categories: single skin covers or double skin cover.
- .26 Power actuating system** – the hydraulic equipment provided for supplying power to turn the rudder stock or the steering nozzle, comprising a steering gear power unit or units, together with the associated pipes and fittings, and a rudder actuator. Power actuating systems may share common mechanical components, i.e. tiller, quadrant and rudder stock, or components serving the same purpose.
- .27 Rolling door** – a door having a horizontal or vertical motion parallel to the plane of the door, guided and supported by steel rollers.
- .28 Rudder axle** – a steel shaft, the lower end of which is fastened to the sole piece while the upper one – as a component of vertical coupling – is fastened to the sternframe structure.
- .29 Rudder pintle** – a pin installed in the sternframe structure, the geometrical axis of which is in line with the rudder geometrical axis.
- .30 Rudder stock** – a component of the rudder gear connecting the rudder blade with the tiller and transmitting the torque between these two parts.
- .31 Safe working load (SWL)** - means the safe load limit of shipboard fittings used for mooring operations in harbours or similar sheltered waters.

- .32 Safe towing load (TOW)** - means the safe load limit of shipboard fittings used for normal and other towing.
- .33 Shipboard fittings** – mean bollards and bitts, fairleads, pedestal rollers and chocks used for mooring of the ship and the similar components used for normal or other towing of the ship. Any weld, bolt or other fastening connecting the shipboard fitting to the supporting hull structure is part of the shipboard fitting and subject to any industry standard applicable to such fitting.
- .34 Ship Design Minimum Breaking Load ( $MBL_{SD}$ )** – the minimum breaking load of new, dry mooring lines for which shipboard fittings and supporting hull structures are designed in order to meet mooring restraint requirements.
- .35 Single skin hatch cover** – a hatch cover made of steel or equivalent material that is designed to comply with *ICLL Regulation 16*. The cover has continuous top and side plating, but is open underneath with the stiffening structure exposed. The cover is weathertight and fitted with gaskets and clamping devices unless such fittings are specifically excluded.
- .36 Sliding door** – a door having a horizontal or vertical motion generally parallel to the plane of the door.
- .37 Steering gear control system** – the equipment by which orders are transmitted from the navigation bridge to the steering gear power units. Steering gear control systems comprise transmitters, receivers, hydraulic control pumps and their associated motors, motor controllers, piping and cables.
- .38 Steering gear power unit<sup>1</sup> is:**
- .1 in the case of electric steering gear – an electric motor and its associated electrical equipment;
  - .2 in the case of electrohydraulic steering gear – an electric motor with its associated electrical equipment and a hydraulic pump;
  - .3 in the case of other hydraulic steering gear – a driving engine and a hydraulic pump.
- .39 Summer load waterline** – the waterline corresponding to the Summer Load Line defined in compliance with the regulations of *ICLL*.
- .40 Summer timber load waterline** – the waterline corresponding to the Summer Timber Load Line defined in compliance with the regulations of *ICLL*.
- .41 Superstructure** – a decked structure on the freeboard deck, extending from side to side of the ship or with one side or both sides being inboard of the ship sides not more than  $0.04B$ .
- .42 Superstructure deck** – the deck forming the top of a superstructure. Where the superstructure is subdivided into several tiers, the superstructure decks are named: first tier superstructure deck, second tier superstructure deck, etc., counting one by one eg. from the upper deck.
- .43 Supporting hull structures** – means that part of the ship structure on/in which the shipboard fitting is placed and which is directly submitted to the forces exerted on the shipboard fitting. The hull structure supporting capstans, winches, etc. used for normal or other towing and mooring operations.

<sup>1</sup> Also in the case of alternative steering arrangements. For electric steering gears, electric steering motors shall be considered as part of the power unit and actuator.

- .44 *Trunk*** – a decked structure on the freeboard deck with the side wall being inboard of any ship's side more than  $0.04B$  and having no doors, windows or other similar openings in the outer bulkheads.
- .45 *Type A ship, Type B ship*** – see *ICLL*, regulation 27.
- .46 *Upper deck*** – the uppermost continuous deck extending over the full length of the ship.
- .47 *Watertightness*** – the term pertaining to closing of openings, which means that water will not penetrate through these openings in any direction under a design head. Unless expressly provided otherwise, the design head shall be determined by reference to the bulkhead deck or freeboard deck, as applicable, or to the most unfavourable equilibrium/intermediate waterline, in accordance with the applicable subdivision and damage stability requirements, whichever is the greater. A watertight door is thus one that will maintain the watertight integrity of the subdivision bulkhead in which it is located.
- .48 *Weather deck*** – each deck or part thereof, which may be exposed to the effects of sea and weather.
- .49 *Weathertightness*** – the term pertaining to closing appliances of openings in the above water part of a ship, which means that in any sea condition water will not penetrate through these openings. (Such closing appliances shall withstand a hose test in which the nozzle outlet is at least 16 mm in diameter and the pressure ensures to eject water upwards for at least 10 m in height; the distance from the nozzle to the tested member shall not be more than 3 meters).

### 1.3 Survey and Classification

**1.3.1** The general regulations concerning classification, construction surveys and surveys of ships in service are given in *Part I – Classification Regulations*.

**1.3.2** The following products are subject to PRS' survey during manufacture:

- .1 anchors;
- .2 towing hooks for a pull of 10 kN and over;
- .3 watertight doors and their closing appliances;
- .4 hatch covers and cargo ports;
- .5 side and flush scuttles, windows;
- .6 anchor and mooring stoppers;
- .7 mooring and towing bollards, fairleads, etc.;
- .8 watertight doors in subdivision bulkheads;
- .9 active rudders (only in cases specified in 2.1.4);
- .10 fixed lashing equipment for containers, deck timber cargo and ro-ro cargo.

**1.3.3** During ship construction, the whole hull equipment covered by the requirements of the present Part is subject to PRS' survey, in this:

- .1 rudder and steering gear;
- .2 anchoring equipment;
- .3 mooring equipment;
- .4 towing equipment;
- .5 masts and rigging;
- .6 closures of openings in hull, superstructures and deckhouses and their closing appliances;
- .7 ship spaces equipment;
- .8 grain fittings;
- .9 guard rails, bulwarks and gangways;
- .10 active rudder systems (see 2.1.3);

.11 fixed lashing equipment for containers, deck timber cargo and ro-ro cargo.

**1.3.4** During the manufacture of products and ship construction, the products and equipment specified in 1.3.2 and 1.3.3 is subject to survey for:

- compliance with the approved technical documentation,
- compliance with the requirements of the present *Part III* within the scope not specified in the approved technical documentation,
- compliance with the requirements of *Part IX – Materials and Welding*.

**1.3.5** The scope of survey during manufacture of products and ship construction is specified according to the requirements of Chapter 4, *Supervision Activity Regulations*.

**1.3.6** Hull equipment, upon installing on board, is subject to tests according to the programme agreed with PRS.

## **1.4 Technical Documentation**

### **1.4.1 Classification Documentation of Ship under Construction**

**1.4.1.1** The principles covering the scope of technical documentation and approval procedure are given in Chapter 3 of *Supervision Activity Regulations*.

**1.4.1.2** Prior to beginning the construction of the ship's hull, the documentation, specified in 1.4.2, shall be submitted to PRS Head Office for consideration and approval within the applicable scope, taking into account the ship type, her equipment and outfitting. PRS may extend the scope of classification documentation, specified below, if it is considered necessary upon examination of the ship technical specification and general arrangement plan.

### **1.4.2 Documentation of Hull Equipment**

- .1 List of equipment and basic construction materials, including their main technical characteristics, manufacturers and granted approval.
- .2 Plan of rudder gear, including calculations, as well as drawings of rudder stock, rudder blade, rudder axle, pintles, bearings, glands.
- .3 Plans and calculations of anchor system.
- .4 Towing and mooring arrangements plan and calculations (see 4.2.4.3 and 5.2.4.3).
- .5 Drawings of signal and special structure masts, including calculations of their structure and rigging.
- .6 Arrangement of openings and closures of openings in hull, superstructures, deckhouses and watertight bulkheads, including the openings dimensions, the height of coamings, thresholds, etc., as well as structural details of coamings and closures of openings.
- .7 Arrangement plan of accommodation and service spaces, including exits, doors, corridors, stairways and ladders, plan of railings, bulwarks and gangways on open decks, including structural details, as well as plan of wooden hold panelling.
- .8 Plan of divisions for the carriage of non-cohesive cargoes, drawings and calculations of the divisions.
- .9 Navigation bridge visibility plan (for ships of 55 m in overall length and over).

In addition, the following shall be submitted:

- .10 For ro-ro ships and ships with movable decks:
  - arrangement plan of deck sockets and appliances for fixing and fastening ro-ro cargoes, as well as their specifications;
  - calculations of hull structure strengthenings under the fixed outfit and equipment;

- drawings of movable ramps for loading vehicles, together with calculations, including data on:
    - the maximum number of vehicles with cargo with the most unfavourable arrangement of vehicles on ramp,
    - the maximum value of hoisting force and forces acting in hinges, indicating the direction of these forces,
    - lifting appliances,
    - securing the ramp in operating and stowage position,
    - the applied sealing means,
    - the programme of strength and operation tests;
  - arrangement plan of movable deck structures;
  - drawings and calculations of movable decks, together with the supporting (suspension) structure, connection with hull structure, including information on reaction forces from hoisting appliances and their characteristics;
  - information on the stowing arrangement of non-used sections of movable decks.
- .11** For ships intended for the carriage of containers:
- arrangement of sockets, securing pads, cellular guides, etc. for fixing and fastening containers (including calculations);
  - structural details of cellular guides and ship structure strengthenings under the fixed lashing equipment;
  - the Cargo Safe Access Plan (CSAP) (see 15.2.2).
- .12** For tankers:
- arrangement of openings and ducts, which may be open, leading to the spaces adjacent to the cargo area.
- .13** For tugs:
- arrangement of towing system;
  - drawings of towing hook (together with calculations);
  - list and characteristics of towing equipment, including information concerning maximum bollard pull (pull diagram) and towrope breaking force;
  - drawings of seating and supporting the towing equipment, including fastening the hook and towing winch.
- .14** For supply vessels:
- drawings of supports and racks for deck cargo;
  - drawings of separated cargo tanks with foundations.
- .15** For vessels intended to be moored at sea:
- information on means alternating hull impacts.
- .16** For timber carriers:
- arrangement and structural details of fixing and fastening equipment for deck load of timber (racks, catches, etc.).
- .17** For vessels adapted for survey of underwater part of hull without dry-docking:
- plan of adaptation, including hull openings closure appliances and identification of tanks in the underwater part.
- .18** For chemical recovery vessels:
- general arrangement drawing showing the position and applications of the equipment used during service in a hazardous atmosphere;
  - details of openings and accesses which are in use during service in a hazardous atmosphere and cannot be closed gastight;
  - details of openings and accesses which during service in a hazardous atmosphere must be closed gastight;



- details of the supporting structures and securing arrangements of the cargo tanks if independent tanks are intended to be provided;
- drawings showing the design and arrangement of windows, together with information about materials used (instead of windows plan, where the windows have not been manufactured to any of approved standards).

.19 For fishing vessels:

- navigation bridge visibility plan (regardless their length).

#### 1.4.3 Workshop Documentation

Upon approval of classification documentation by PRS Head Office, the following workshop documentation shall be submitted to the relevant PRS Branch Office Survey Station for consideration and agreement:

- program of mooring and sea trials,
- drawings of local strengthenings under gear and machinery not shown in classification documentation.

#### 1.4.4 Classification Documentation of Ship under Alteration or Reconstruction

Prior to the commencement of ship alteration or reconstruction, the documentation of ship's equipment, in the ship part to be changed, shall be submitted to PRS Head Office for consideration.

When new machinery or arrangements, covered by the requirements of the *Rules*, are installed on existing ship, or the machinery installed differ substantially from those initially fitted, supplementary documentation of new systems related to these machinery or arrangements, within the scope required for ship under construction, shall be submitted to PRS Head Office.

#### 1.4.5 Documentation of Products

Prior to the commencement of manufacture of products, mentioned in 1.3.2, the following documentation shall be submitted to PRS:

- assembly drawing;
- calculations;
- drawings of assemblies and parts if they are not manufactured in accordance with standards and specifications previously agreed with PRS.

### 1.5 Materials

**1.5.1** Materials intended for structures and equipment covered by the requirements of the present *Part III* shall fulfil the requirements of *Part IX – Materials and Welding*.

**1.5.2** Components, products and structures, as well as the material which shall be used for their manufacture are specified in Table 1.5.2.

**Table 1.5.2**

Item	Specification	Material
1	Rudder stocks and steering nozzles with their flanges	steel forgings, steel castings
2	Parts of rudder blades and steering nozzles	steel forgings, steel castings, rolled steel
3	Removable rudder axles with their flanges	steel forgings, steel castings

Item	Specification	Material
4	Rudder and steering nozzle pintles	steel forgings, steel castings
5	Connecting items: bolts and nuts of flange or conical couplings of rudder or nozzle stocks; bolts and nuts connecting rudder axle to sternframe	steel forgings
6	Towing hooks for pull of 10 kN and over and elements connecting them to the ship's hull	steel forgings
7	Hatch covers, cargo port doors 25TP <sup>1)</sup> P25TP,P25TP <sup>2)</sup>	rolled steel, wrought aluminum alloys
8	Watertight sliding doors 25TP <sup>1)</sup> P25TP,P25TP <sup>2)</sup>	steel forgings, steel castings, rolled steel
9	Anchors	steel forgings, steel castings
10	Anchor chains	rolled steel, steel forgings, steel castings

<sup>1)</sup> The grade of rolled steel plates and profiles shall be selected in accordance with Table 2.2.1.3-2, *Part II – Hull* for structural members group I; for ships with ice strengthening L1 and L1A (except closures of cargo hatches located outside positions 1 and 2, see 7.1.4) – not below category B.

<sup>2)</sup> Welded structures and welding procedure shall also fulfil the relevant requirements of Chapters 3 and 4, *Part II – Hull*.

**1.5.3** The materials intended for other items of machinery and equipment shall fulfil the requirements given in technical documentation approved by PRS.

## 1.6 Working and Permissible Stresses

**1.6.1** Wherever working (actual) stresses are mentioned in the text of the present *Part III*, they mean equivalent stresses calculated from the formula:

$$\sigma_{zr} = \sqrt{\sigma^2 + 3\tau^2} \text{ [MPa]} \quad (1.6.1)$$

$\sigma$  – normal stress in the considered cross-section, [MPa];

$\tau$  – shear stress in the considered cross-section, [MPa].

The strength shall be checked for equivalent stress  $\sigma_{zr}$ .

The equivalent stresses may also be calculated by other method subject to PRS consent in each particular case.

**1.6.2** Permissible stresses, to which equivalent stresses are compared at strength checking, are expressed in the present *Part III* as a percentage (expressed as a fraction) of the material yield stress of the material used in the product.

Unless stated otherwise, the yield stress shall not be taken greater than 0.7 times the tensile strength of this material.

## 1.7 Equipment Number

**1.7.1** Equipment number is a value according to which the dimensions of anchors, chains or anchor ropes, mooring lines and towropes are selected from Tables, taking into account the requirements of Chapters 3, 4 and 5.



**1.7.2** The equipment number shall be determined from the following formulae:

**.1** for monohull ships:

$$N_c = D^{2/3} + 2.0(hB + S_{fun}) + 0.1A \quad (1.7.2.1-1)$$

$D$  – moulded displacement of ship at draught to the summer load waterline, [t];

$B$  – ship's moulded breadth, [m];

$h$  – effective height measured from the summer load waterline to the top of the uppermost house, [m], and:

$$h = a + \sum_{i=1}^{i=n} h_i \quad (1.7.2.1-2)$$

$a$  – vertical distance at hull side from the summer load waterline amidships to the upper deck, [m];

$h_i$  – height on the centerline of each tier of houses having a breadth greater than  $B/4$ ; for the lowest tier  $h_1$  is to be measured at centerline from the upper deck or from a notional deck line where there is local discontinuity in the upper deck, see figure 1.7.2 for an example, [m];

$S_{fun}$  – effective front projected area of the funnel, in [m<sup>2</sup>], defined as:

$$S_{fun} = A_{FS} - S_{shield}$$

$A_{FS}$  – front projected area of the funnel, in [m<sup>2</sup>], calculated between the upper deck at centerline, or notional deck line where there is local discontinuity in the upper deck, and the effective height  $h_F$ .  $A_{FS}$  is taken equal to zero if the funnel breadth is less than or equal  $B/4$  at all elevations along the funnel height.

$h_F$  – effective height of the funnel, in [m] measured from the upper deck at centreline, or notional deck line where there is local discontinuity in the upper deck, and the top of the funnel. The top of the funnel may be taken at the level where the funnel breadth reaches  $B/4$ .

$S_{shield}$  – the section of front projected area  $A_{FS}$ , in [m<sup>2</sup>], which is shielded by all deck houses having breadth greater than  $B/4$ . If there are more than one shielded section, the individual shielded sections i.e.  $S_{shield1}$ ,  $S_{shield2}$  etc as shown in Fig. 1.7.4 to be added together. To determine  $S_{shield}$ , the deckhouse breadth is assumed  $B$  for all deck houses having breadth greater than  $B/4$  as shown for  $S_{shield1}$ ,  $S_{shield2}$  in Fig. 1.7.4.

$A$  – side projected area, in [m<sup>2</sup>], of the hull, superstructures, houses and funnels above the summer load waterline which are within the length  $L_0$  and also have a breadth greater than  $B/4$ . The side projected area of the funnel is considered in  $A$  when  $A_{FS}$  is greater than zero. In this case, the side projected area of funnel should be calculated between the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the effective height  $h_F$ .

$n$  – number of tiers described in the above definition of  $h_i$ .

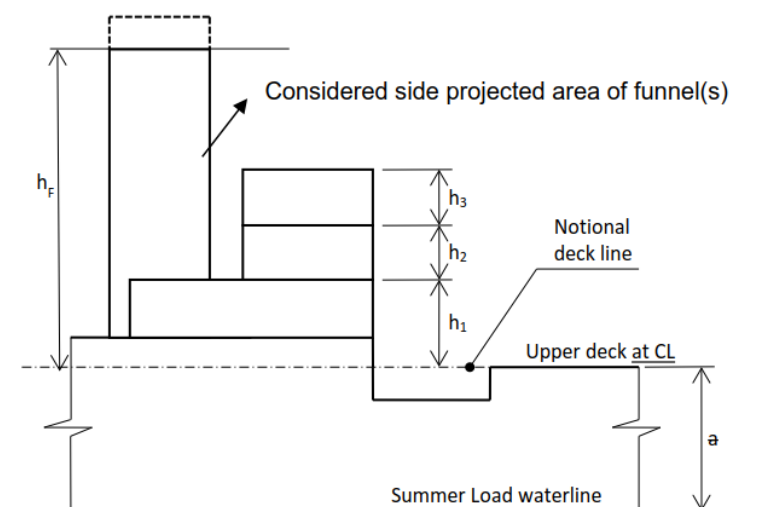


Fig. 1.7.2

.2 for catamarans:

$$N_c = D^{\frac{2}{3}} + 2 \left( 2a_p b_p + B h_p + \sum_{i=1}^{i=n} b_i h_i \right) + 0.1A \quad (1.7.2.2)$$

$D, B, A, h_i, n$  – as for 1.7.2.1;

$a_p$  – vertical distance from the summer load waterline to the lower edge of the cross-deck structure measured at the centre plane, [m];

$b_p$  – breadth of any of individual hulls measured in the middle of  $a_p$ , [m];

$h_p$  – height of the cross-deck structure (vertical distance from the lower edge of the structure to the upper deck) measured at the centre plane, [m];

$b_i$  – breadth of a given tier of superstructure (or deckhouse) with height  $h_i$ , [m].

.3 for trimarans:

$$N_c = D^{\frac{2}{3}} + 2 \left( \sum_{j=1}^{j=3} a_p b_{pj} + B h_p + \sum_{i=1}^{i=n} b_i h_i \right) + 0.1A \quad (1.7.2.3)$$

$D, B, A, h_i, n$  – as for 1.7.2.1;

$a_p, b_p, h_p, b_i$  – as for 1.7.2.2;

$b_{pj}$  – breadth of a given hull measured in the middle of distance  $a_p$ , [m].

When calculating  $h$ , sheer and trim may be neglected.

**1.7.3** When determining  $A$  and  $h$ , the masts, guard rails, bulwarks and similar structures of 1.5 m in height and over shall be included in calculations and treated as erections, while hatch coamings and deck cargo, such as containers, may be disregarded.

Where the height of the bulwark exceeds 1.5 m, the area  $A_2$ , indicated in Fig. 1.7.3, shall be included in  $A$ .

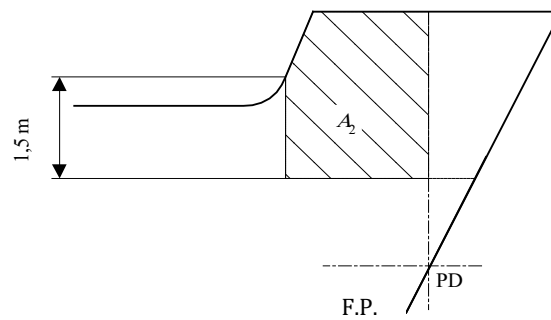


Fig. 1.7.3

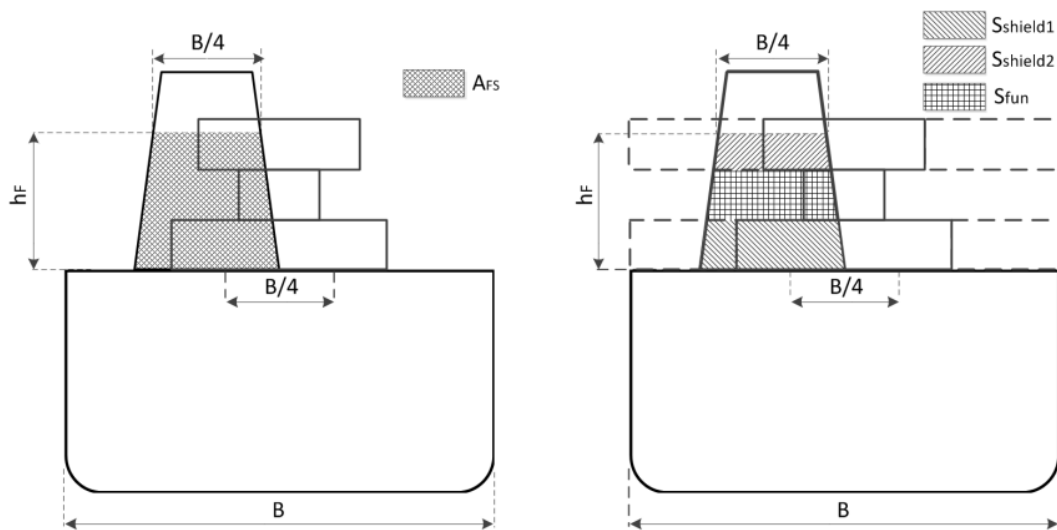


Fig. 1.7.4

**1.7.4** When calculating  $h$ , sheer and trim are to be ignored, i.e.  $h$  is the sum of freeboard amidship plus the height (at centerline) of each tier of houses having a breadth greater than  $B/4$ .

**1.7.5** If a house having a breadth greater than  $B/4$  is above a house with a breadth of  $B/4$  or less, then the wide house is to be included but the narrow house ignored.

**1.7.6** When several funnels are fitted on the ship, the above parameters are taken as follows:

$h_F$  – effective height of the funnel, in [m], measured from the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the top of the highest funnel. The top of the highest funnel may be taken at the level where the sum of each funnel breadth reaches  $B/4$ .

$A_{FS}$  – sum of front projected area of each funnel, in [m<sup>2</sup>], calculated between the upper deck, or notional deck line where there is local discontinuity in the upper deck, and the effective height  $h_{FR}$ .  $AR_{FSR}$  is to be taken equal zero if the sum of each funnel breadth is less than or equal to  $B/4$  at all elevations along the funnels height.

$A$  – Side projected area, in [m<sup>2</sup>], of the hull, superstructures, houses and funnels above the summer load waterline which are within the length  $LR_{\theta R}$ . The total side projected area of the funnels is to be considered in the side projected area of the ship,  $A$ , when  $AR_{FSR}$  is greater than zero. The shielding effect of funnels in transverse direction may be considered in the total side projected area, i.e., when the side projected areas of two or more funnels fully or partially overlap, the overlapped area needs only to be counted once.

## 1.8 Ergonomic Considerations

**1.8.1** Manned spaces as well as spaces and areas entered for the purpose of inspection, survey and maintenance, including means of access<sup>1</sup>, shall be designed and located so that the proper health-related conditions and safety of personnel onboard are ensured, as well as the comfort and effectiveness of their work, taking into account the following factors:

- possible exposure to vibration and noise (see also 1.8.3),
- lighting,
- ventilation,
- access,
- operation and inspection of equipment.

**1.8.2** More detailed recommendations in this domain and applicable standards are given in IACS Recommendation No. 132 – Human Element Recommendations for structural design of lighting, ventilation, vibration, noise, access and egress arrangements.

**1.8.3** Ships of gross tonnage 1,600 and above shall be constructed to reduce onboard noise and to protect personnel from the noise in accordance with *the Code on Noise Levels on Board Ships* (MSC.337(91)), together with interpretation contained in IACS UI SC296 and [MSC.1/Circ.1509 rev.1](#). This requirements does not apply to the ships mentioned in paragraph 1.3.4 of the *Code*.

For existing ships of gross tonnage 1,600 and above, the specific requirements relating to potentially hazardous noise levels, mitigation and personal protective gear contained in the *Code* may be applied, as far as practical, to the satisfaction of the Administration.

For new ships of less than gross tonnage 1,600, the *Code* may be applied as far as reasonable and practical, to the satisfaction of the Administration.

**1.8.3.1** Consideration shall be given to the acoustic insulation between accommodation spaces in order to make rest and recreation possible even if activities are going on in adjacent spaces, e.g. music, talking, cargo handling, etc. The airborne sound insulation properties for specific types of divisions are contained in paragraph 6.1.2 of the *Code*.

**1.8.3.2** It is recommended to apply the methods of attenuating noise (including the isolation of sources of noise and the use of sound reducing enclosures for machinery operators) given in Annex 3 to the *Code*.

**1.8.3.3** The *Code* is intended to provide the basis for the design of ships, for which – after the satisfactory conclusion of relevant sea trials – a Noise Survey Report will be issued (another source of information to be taken into account in this context is [MSC.1/Circ. 1509 rev.1](#)).

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<sup>1</sup> Designs facilitating egress from holds, tanks, voids etc. in emergency shall be also taken into account.

## 2 STEERING GEAR

### 2.1 General

**2.1.1** Every ship shall be provided with an appropriate arrangement ensuring her manoeuvrability and course-keeping ability.

**2.1.2** The requirements of the present Chapter apply primarily to arrangements with ordinary profile rudders, some enhanced profile rudders with special arrangements for increasing the rudder force and streamlined steering nozzles with fixed stabilizers.

Other special arrangements such as steering nozzles with movable stabilizers, Voith-Schneider propellers, etc., are subject to special consideration of PRS.

This Chapter applies to rudders made of steel for ships with  $L \geq 24\text{m}$ .

**2.1.3** Active rudder systems are complementary to the arrangements specified in 2.1.1 and are subject to PRS' consideration only with respect to the effect of their construction, installation, etc. on the ship general safety.

**2.1.4** In special cases – taking into account the purpose, characteristics and assumed operating conditions of the ship – PRS may agree to that the required steering qualities of the ship at small propeller rotations be acquired by means of arrangements mentioned in 2.1.1 in conjunction with the active rudder system. In these cases, the active rudder system will be specially considered by PRS.

**2.1.5** Rudder stocks, pintles, keys and coupling bolts shall be made of forged or rolled steel, while cast components – of carbon-manganese steel according to the requirements specified in 3, 12 and 13 of *Part IX – Materials and Welding*.

The specified minimum yield stress of materials used for the above-mentioned items shall not be less than 200 MPa.

The requirements of the present *Part III* are based on a material's specified minimum yield stress of 235 MPa. If the material used has a specified minimum yield stress different than 235 MPa, the material factor  $k$  shall be determined from the formula<sup>1</sup>:

$$k = \left(\frac{235}{R_e}\right)^e \quad (2.1.5)$$

$e = 0.75$  for  $R_e > 235$  Mpa,

$e = 1.0$  for  $R_e \leq 235$  MPa;

$R_e$  – specified minimum yield stress of the material used, [MPa] and shall not be taken greater than  $0.7R_m$  or 450 MPa, whichever is less;

$R_m$  – tensile strength of the material used, [MPa].

**2.1.6** Welded components of rudders shall be made of approved rolled hull materials.

**2.1.7** Material factor,  $k$ , for normal and high tensile steel plating may be taken into account when specified in each individual rule requirement. The material factor  $k$  shall be taken as defined in UR S4, unless otherwise specified.

**2.1.8** Steel grade of plating materials for rudders and rudder horns shall be in accordance with UR S6.

<sup>1</sup> Please note that this formula differs from that for material factors in *Part II – Hull*.

## 2.1.9 Welding and design details

**2.1.9.1** Slot-welding shall be limited as far as possible. Slot welding shall not be used in areas with large in-plane stresses transversely to the slots or in way of cut-out areas of semi-spade rudders. When slot welding is applied, the length of slots shall be minimum 75 mm with breadth of  $2t$ , where  $t$  is the rudder plate thickness, in mm. The distance between ends of slots shall not be more than 125 mm. The slots shall be fillet welded around the edges and filled with a suitable compound, e.g. epoxy putty. Slots shall not be filled with weld.

**2.1.9.2** Continuous slot welds shall be used instead of slot welds. When continuous slot welding is applied, the root gap shall be between 6-10 mm. The bevel angle shall be at least  $15^\circ$ .

**2.1.9.3** In way of the rudder horn recess of semi-spade rudders the radii in the rudder plating except in way of solid part in cast steel shall not be less than 5 times the plate thickness, but in no case less than 100 mm. Welding in side plate shall be avoided in or at the end of the radii. Edges of side plate and weld adjacent to radii shall be ground smooth.

**2.1.9.4** Welds in the rudder side plating subjected to significant stresses from rudder bending and welds between plates and heavy pieces (solid parts in forged or cast steel or very thick plating) shall be made as full penetration welds. In way of highly stressed areas e.g. cut-out of semi-spade rudder and upper part of spade rudder, cast or welding on ribs shall be arranged. Two sided full penetration welding is normally to be arranged. Where back welding is impossible, welding shall be performed against ceramic backing bars or equivalent. Steel backing bars may be used and shall be fitted with continuous weld on one side to the bevelled edge, see Figure 2.1.9.4. The bevel angle is to be at least  $15^\circ$  for one sided welding.

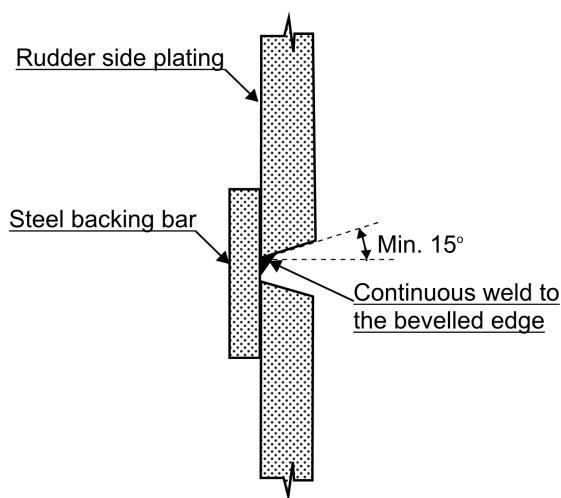


Fig. 2.1.9.4

Use of steel backing bar in way of full penetration welding of rudder side plating

## 2.1.10 Rudder strength calculations

**2.1.10.1** The rudder force and resulting rudder torque as given in subchapters 2.2.2 and 2.2.3 cause bending moments and shear forces in the rudder body, bending moments and torques in the rudder stock, supporting forces in pintle bearings and rudder stock bearings and bending moments, shear forces and torques in rudder horns and heel pieces. The rudder body shall be stiffened by horizontal and vertical webs enabling it to act as a bending girder.

**2.1.10.2** The bending moments, shear forces and torques as well as the reaction forces shall be determined by a direct calculation or by an approximate simplified method considered appropriate by PRS. For rudders supported by sole pieces or rudder horns these structures shall be included in the calculation model in order to account for the elastic support of the rudder body. Guidelines for calculation of bending moment and shear force distribution are given in 2.2.4. Requirements of IACS UR S10 are to be also fulfilled and recommendations for the simplified methods application given there may be applied.

### 2.1.11 Alternative designs

**2.1.11.1** PRS may accept alternatives to requirements given in this chapter, provided they are deemed to be equivalent.

**2.1.11.2** Direct analyses adopted to justify an alternative design shall take into account all relevant modes of failure, on a case by case basis. These failure modes may include, among others: yielding, fatigue, buckling and fracture. Possible damages caused by cavitation shall also be considered.

**2.1.11.3** If deemed necessary by PRS, lab tests, or full scale tests may be requested to validate the alternative design approach.

## 2.2 Steering Gear Loads

### 2.2.1 Scope of Application

The parameters calculated in this sub-chapter are applicable only to determining the scantlings of the ordinary rudders structural components and cannot be used for determining the steering gear power system characteristics.

### 2.2.2 Force Acting on the Rudder Blade

**2.2.2.1** The rudder blade force, upon which the rudder scantlings shall be based, shall not be taken less than that determined from the formula:

$$F = 132K_1 K_2 K_3 A v^2 \quad [\text{N}] \quad (2.2.2.1-1)$$

$A$  – rudder blade area, [m<sup>2</sup>];

$v$  – maximum service speed at the ship's draught to the summer load waterline, [knots].

When the ship's speed is less than 10 knots,  $v$  shall be determined from the formula:

$$v_{\min} = \frac{v+20}{3} \quad (2.2.2.1-2)$$

For the astern condition the maximum astern speed as defined in SOLAS Regulation II-1/3.15 is to be used. However, in no case is this speed to be less than  $v_{\text{astern}} = 0.5v$ .

$K_1$  – factor depending on the rudder blade dimensions,

$$K_1 = \frac{a_1+2}{3} \quad (2.2.2.1-3)$$

$$a_1 = \frac{b^2}{A_1}, \text{ but shall not be taken greater than } 2.0; \quad (2.2.2.1-4)$$

$b$  – mean height of the rudder blade, [m];

$c$  – mean breadth of the rudder blade, [m].

The mean height and mean breadth of rudder blade shall be calculated according to the coordinate system given in Fig. 2.2.2.1.

- $A_1$  – sum of rudder blade area  $A$  and the area of rudder post or rudder horn, if any, within the height  $b$ , [m<sup>2</sup>];  
 $K_2$  – factor depending on the kind of rudder blade profile according to Table 2.2.2.1;  
 $K_3 = 0.8$  for rudders outside the propeller jet,  
 = 1.15 for rudders behind a fixed propeller nozzle,  
 = 1.0 otherwise;

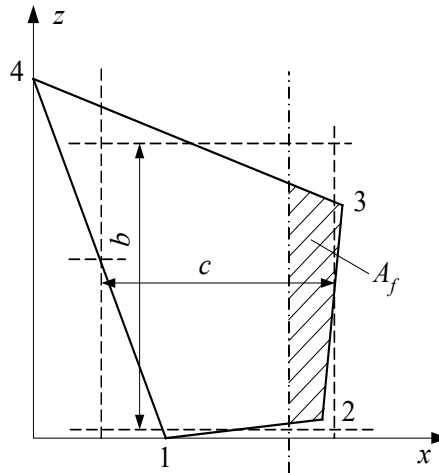








Fig. 2.2.2.1

$$\text{Mean breadth of rudder blade: } c = \frac{x_2 + x_3 - x_1}{2} \quad (2.2.2.1-5)$$

$$\text{Mean height of rudder blade: } b = \frac{z_3 + z_4 - z_2}{2}. \quad (2.2.2.1-6)$$

Table 2.2.2.1

Profile Type	$K_2$	
	Ahead condition	Astern condition
NACA-00 series Göttingen 	1.10	0.80
Flat side 	1.10	0.90
Hollow 	1.35	0.90
High lift rudders 	1.70	1.30
Fish tail 	1.40	0.80
Single plate 	1.00	1.00
Mixed profiles (e.g. HSVA)	1.21	0.90



## 2.2.3 Rudder Torque

**2.2.3.1** The rudder torque applied to steering gear for supported and spade rudders shall be determined for both ahead and astern condition from the following formula:

$$M_s = Fr \text{ [Nm]} \quad (2.2.3.1-1)$$

$$r = c (\alpha - k_1) \text{ [m]} \quad (2.2.3.1-2)$$

$F$  – rudder blade force according to 2.2.2.1, [N];

$c$  – mean breadth of rudder blade according to Fig. 2.2.2.1, [m];

$\alpha = 0.33$  for ahead condition,

$\alpha = 0.66$  for astern condition;

$k_1$  – factor determined from the formula:

$$k_1 = \frac{A_f}{A} \quad (2.2.3.1-3)$$

$A_f$  – portion of the rudder blade area situated ahead of the rudder stock centreline;

$r_{\min} = 0.1c$ , [m], for ahead condition.

**2.2.3.2** For semi-spade rudders (rudder blades with cut-outs), the total value of rudder torque applied to the steering gear shall be determined for ahead and astern condition from the following formula:

$$M_s = M_{s1} + M_{s2} \text{ [Nm]} \quad (2.2.3.2-1)$$

$M_{s1}, M_{s2}$  – rudder torque components calculated according to the formulae:

$$M_{s1} = F_1 r_1 \text{ [Nm]} \quad (2.2.3.2-2)$$

$$M_{s2} = F_2 r_2 \text{ [Nm]} \quad (2.2.3.2-3)$$

$F_1, F_2$  – component forces acting on areas  $A_1$  and  $A_2$  of the rudder blade, determined from the formulae:

$$F_1 = F \frac{A_1}{A} \text{ [N]} \quad (2.2.3.2-4)$$

$$F_2 = F \frac{A_2}{A} \text{ [N]} \quad (2.2.3.2-5)$$

$F$  – total rudder force acting upon the rudder blade, determined according to 2.2.2.1;

$A_1, A_2$  – partial areas of the total rudder blade area (may be considered as trapezoidal parts), [m<sup>2</sup>];

$A_1 + A_2 = A$  according to Fig. 2.2.3.2, [m<sup>2</sup>];

$r_1, r_2$  – levers of component torques to be determined as follows:

$$r_1 = c_1 (\alpha - k_1) \text{ [m]} \quad (2.2.3.2-6)$$

$$r_2 = c_2 (\alpha - k_2) \text{ [m]} \quad (2.2.3.2-7)$$

$c_1, c_2$  – mean breadths of partial areas  $A_1$  and  $A_2$  determined according to Fig. 2.2.3.2;

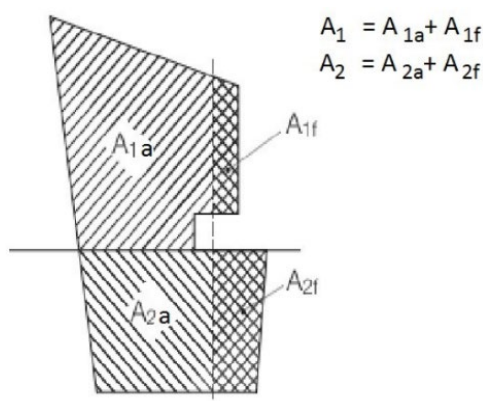


Fig. 2.2.3.2

$k_1, k_2$  – factors determined from the formulae:

$$k_1 = \frac{A_{1f}}{A_1} \quad (2.2.3.2-8)$$

$$k_2 = \frac{A_{2f}}{A_2} \quad (2.2.3.2-9)$$

$A_{1a}$  – portion of  $A_1$  situated aft of the centreline of the rudder stock,

$A_{1f}$  – portion of  $A_1$  situated ahead of the centreline of the rudder stock,

$A_{2a}$  – portion of  $A_2$  situated aft of the centreline of the rudder stock,

$A_{2f}$  – portion of  $A_2$  situated ahead of the centreline of the rudder stock,

$\alpha = 0.33$  for ahead condition,

$\alpha = 0.66$  for astern condition;

for rudder blade parts behind a fixed structure, such as rudder horn:

$\alpha = 0.25$  for ahead condition,

$\alpha = 0.55$  for astern condition.

The total rudder torque for ahead condition shall not be less than that determined from the formula:

$$M_{smin} = 0.1 F \frac{A_1 c_1 + A_2 c_2}{A} \text{ [Nm]} \quad (2.2.3.2-10)$$

## 2.2.4 Bending Moment

**2.2.4.1** In the case of rudders supported by a rudder horn or a sole piece, moments bending the rudder stock, rudder blade and rudder horn, shear forces and reaction forces shall be calculated assuming that the rudder stock with rudder blade form a continuous beam of stiffness varying in concord with their structure, resting on three supports of specific rigidities.

Supports in the hull can be recognized as unmovable in the direction perpendicular to the length of the beam if the rudder bearings are firmly in-built in the system of hull stiffeners.

The lower support shall be recognized as flexibly installed and its rigidity shall be determined by the calculation of its deflection in the direction perpendicular to ship's centre line due to unit shear force acting on the lower bearing. It is recommended to determine that rigidity by means of direct calculations – it can be done according to 2.2.4.2.1 for supported rudder and according to 2.2.4.4.1 for semi-spade rudder. If the supports are very rigid, the bending moments can be determined according to 2.2.4.2.2 and 2.2.4.4.2.

## 2.2.4.2 Bending Moments at Supported Rudders

2.2.4.2.1 Precise calculations for supported rudder shall be made with the use of the following data (see Fig.2.2.4.2.1):

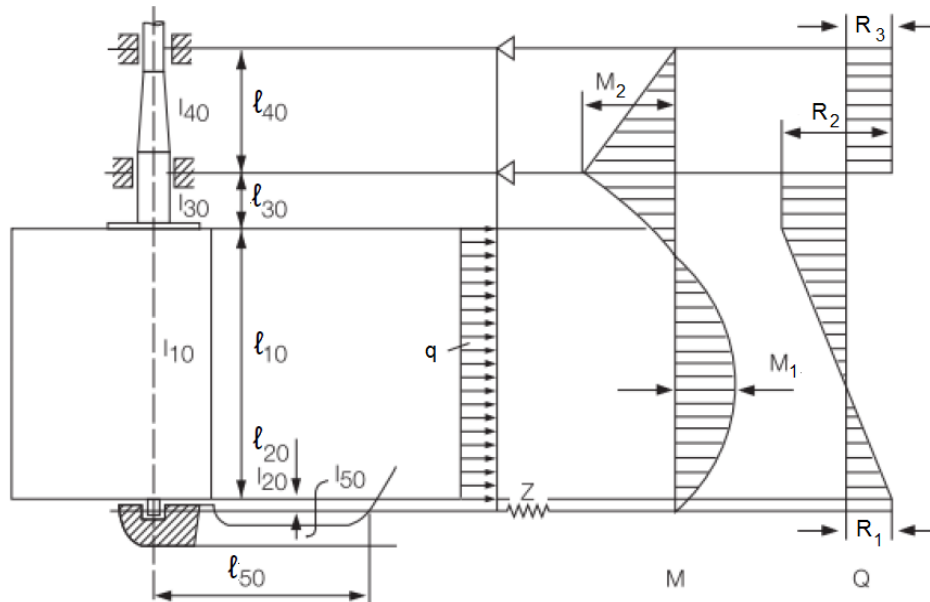


Fig. 2.2.4.2.1. Supported rudder by sole piece

$q$  – continuous load acting on rudder blade:

$$q = \frac{F}{10^3 \cdot l_{10}} \quad [\text{kN/m}] \quad (2.2.4.2.1-1)$$

$F$  – total rudder force acting upon the rudder blade, determined according to 2.2.2.1, [kN];

$Z$  – spring constant of lower support (in the sole piece):

$$Z = \frac{6.18 I_{50}}{l_{50}^3} \quad [\text{kN/m}] \quad (2.2.4.2.1-2)$$

$I_{50}$  – moment of inertia of sole piece around the z-axis, [cm<sup>4</sup>];

$l_{50}$  – effective length of sole piece (from the axis of lower bearing to the point of sole piece fixing in hull), [m];

$l_{10} \div l_{50}$  – lengths of the individual girders of the system, [m];

$I_{10} \div I_{50}$  – moments of inertia of the individual girders of the system, [cm<sup>4</sup>].

2.2.4.2.2 If bending moments for supported rudders (shown in Fig. 2.2.4.2.1) have not been determined by direct calculations, they may be determined – with PRS' consent – from formulae 2.2.4.2.2-1 and 2.2.4.2.2-2.

The maximum value of the rudder blade bending moment shall be determined from the formula:

$$M_1 = 0.125 F b \quad [\text{Nm}] \quad (2.2.4.2.2-1)$$

$F$  – rudder blade force according to formula.2.2.2.1-1, [N];

$b$  – mean height of the rudder blade according to formula 2.2.2.1-6, [m].

The rudder stock bending moment in way of the lower bearing shall be determined from the formula:

$$M_2 = \frac{F b}{7} \quad [\text{Nm}] \quad (2.2.4.2.2-2)$$

### 2.2.4.3 Bending Moments and Forces acting at Spade Rudders

**2.2.4.3.1** For spade rudders without a trunk, shown in Fig. 2.2.4.3.1, the bending moments shall be determined from formulae 2.2.4.3.1-1 and 2.2.4.3.1-2.

The value of the rudder blade bending moment shall be determined from the formula:

$$M_1 = \frac{FA_b h_1}{A} \text{ [Nm]} \quad (2.2.4.3.1-1)$$

$F$  – see 2.2.2.1-1;

$A_b$  – rudder blade area below the section considered, [m<sup>2</sup>];

$h_1$  – vertical distance from the centre of partial rudder blade area  $A_b$  to the section considered, [m];

$A$  – rudder blade area, [m<sup>2</sup>].

The rudder stock bending moment in way of the lower bearing shall be determined from the formula:

$$M_2 = F \left( \ell_{20} + \frac{\ell_{10}(2c_1+c_2)}{3(c_1+c_2)} \right) \text{ [Nm]} \quad (2.2.4.3.1-2)$$

$F$  – see 2.2.2-1;

$\ell_{10}, \ell_{20}, \ell_{30}$  – lengths of the individual girders of the system (i.e. equivalent beam, Fig. 2.2.4.3.1), [m].

Load of rudder body:

$$q = \frac{F}{\ell_{10}10^3} \text{ [kN/m]} \quad (2.2.4.3.1-3)$$

The reactions in way of the lower and upper bearings shall be determined from the formulae:

$$R_2 = F + R_3 \text{ [N]} \quad (2.2.4.3.1-4)$$

$$R_3 = \frac{M_2}{\ell_{30}} \text{ [N]} \quad (2.2.4.3.1-5)$$

The maximum moment,  $M_c$ , in top of the cone coupling as shown in Figure 2.2.4.3.1 is applicable for the connection between the rudder and the rudder stock.

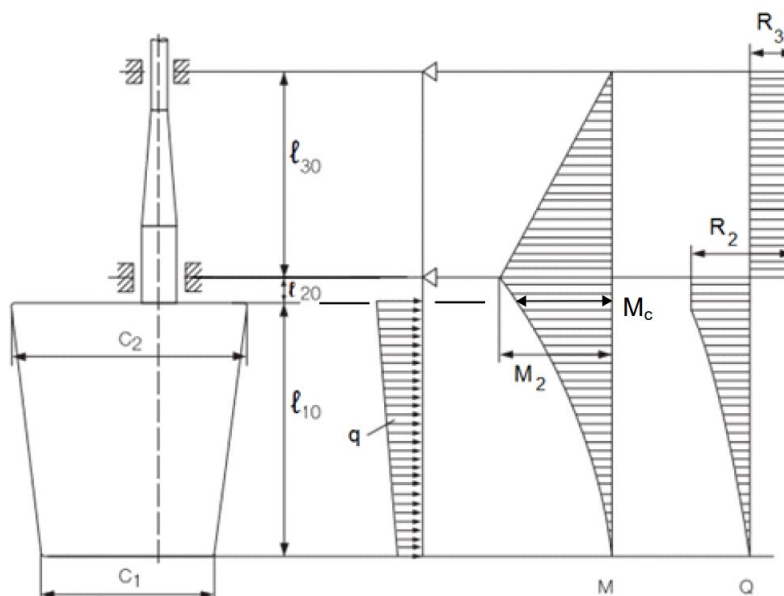


Fig. 2.2.4.3.1 Spade rudder without trunk

**2.2.4.3.2** For a spade rudder with trunk extending inside the rudder, the strength shall be checked against the following two cases:

- a) pressure applied on the entire rudder area
- b) pressure applied only on rudder area below the middle of neck bearing.

The moments and forces for the two cases defined above may be determined according to Figure 2.2.4.3.2-1 and 2.2.4.3.2-2, respectively.

The moments and forces shall be determined by the following formulae:

$$M_{F1} = F_1(CG_{1Z} - \ell_{10}) \text{ [Nm]} \quad (2.2.4.3.2-1)$$

$$M_{F2} = F_2(\ell_{10} - CG_{2Z}) \text{ [Nm]} \quad (2.2.4.3.2-2)$$

$F_1$  – ruder force over the rudder blade area  $A_1$  (see 2.2.3.2) [N];

$F_2$  – ruder force over the rudder blade area  $A_2$  (see 2.2.3.2) [N].

$\ell_{10}, \ell_{20}, \ell_{30}$  – lengths of the individual girders of the system (i.e. equivalent beam, Fig. 2.2.4.3.2) [m]

$CG_{1Z}, CG_{2Z}$  – vertical positions of the centres of gravity of the rudder blade area  $A_1$  and  $A_2$  respectively, from base, [m].

$$q = \frac{F}{(\ell_{10} + \ell_{20})10^3} \text{ [kNm]} \quad (2.2.4.3.2-3)$$

$$R_3 = (M_{F2} - M_{F1}) / (\ell_{20} + \ell_{30}) \text{ [N]} \quad (2.2.4.3.2-4)$$

$$R_2 = F + R_3 \text{ [N]} \quad (2.2.4.3.2-5)$$

$$F = F_1 + F_2 \text{ [N]} \quad (2.2.4.3.2-6)$$

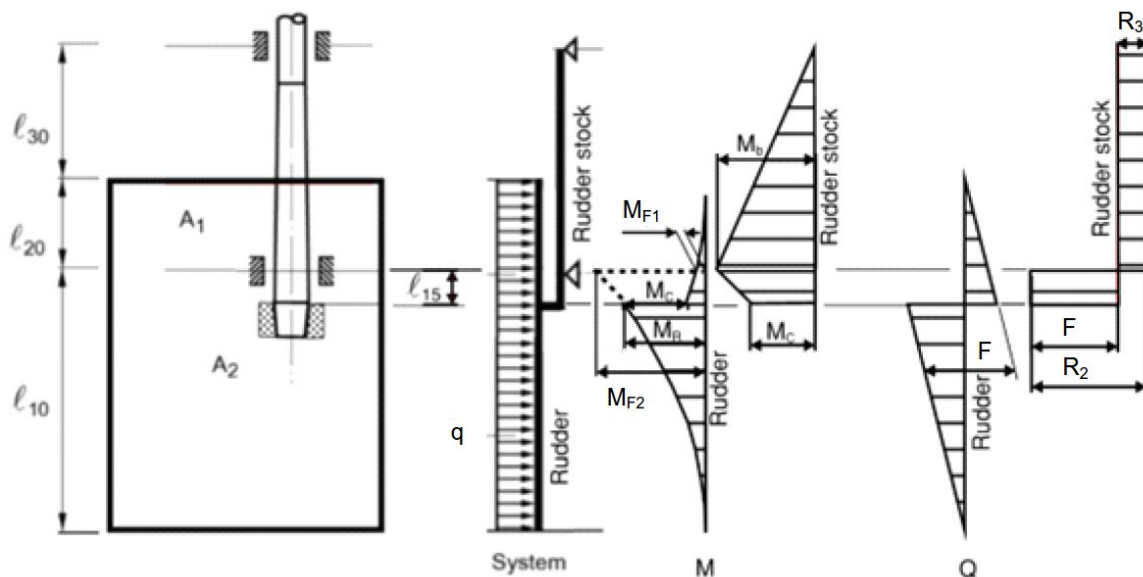


Fig. 2.2.4.3.2-1 Full rudder force  $F = F_1 + F_2$  and total rudder torque  $M_s = M_{s1} + M_{s2}$  with rudders stock bending moment  $M_b = M_{F1} + M_{F2}$ .

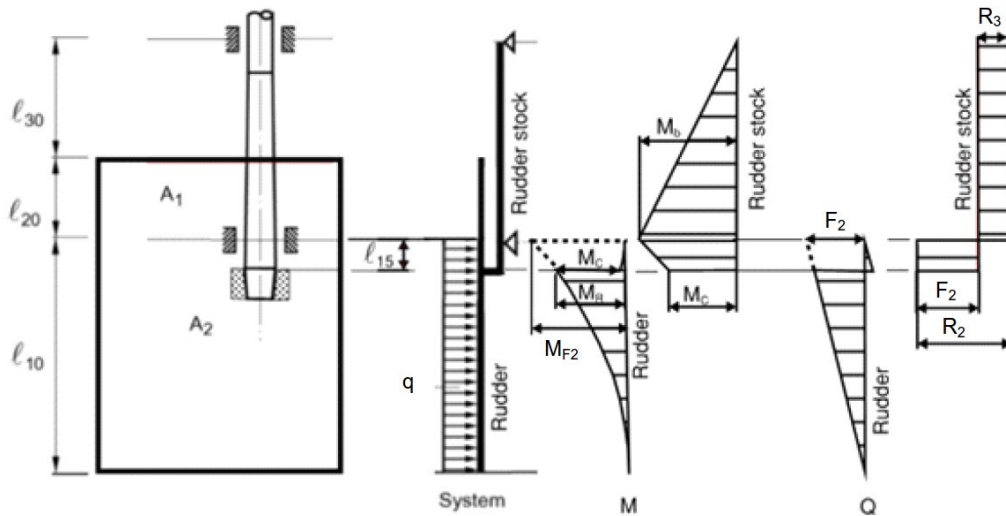


Fig. 2.2.4.3.2-2 Rudder force  $F_2$  corresponding to rudder torque  $M_{S2}$  acting at rudder blade area  $A_2$  with rudders stock bending moment  $M_b = M_{F2}$ .

### 2.2.4.4 Bending Moments at Semi-Spade Rudders

2.2.4.4.1 Precise calculations for semi-spade rudder shall be made with the use of the following data and beam models (see Fig. 2.2.4.4.1-1 and 2.2.4.4.1-2):

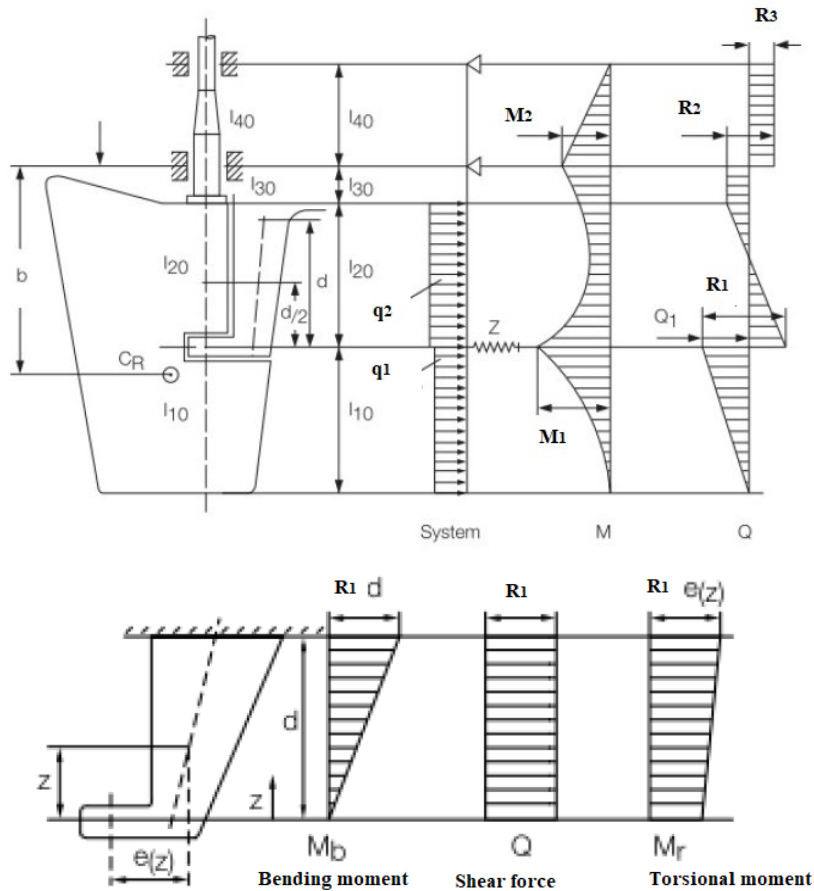


Fig. 2.2.4.4.1-1. Semi-spade rudder with one elastic support

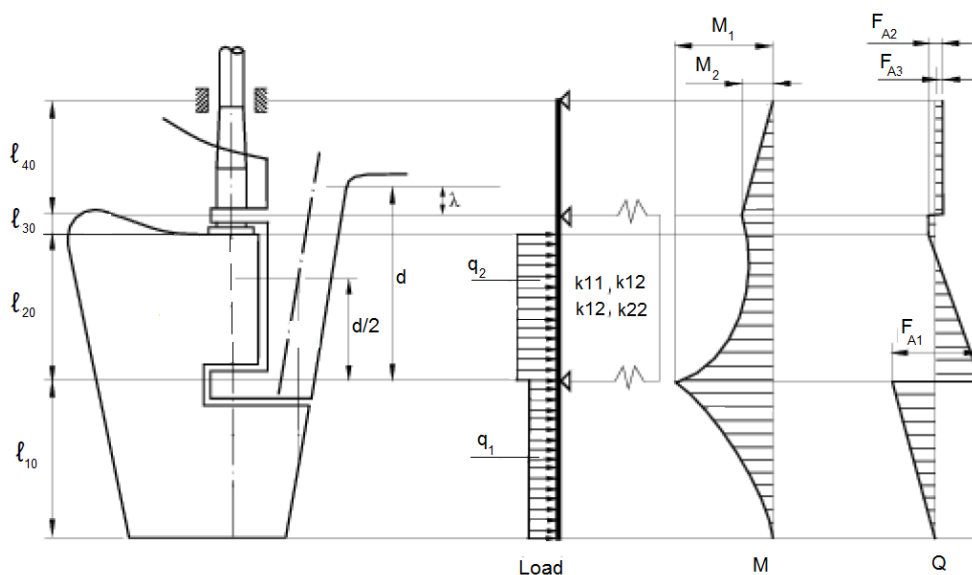


Fig. 2.2.4.4.1-2. Semi-spade rudder with two-conjugate elastic supports

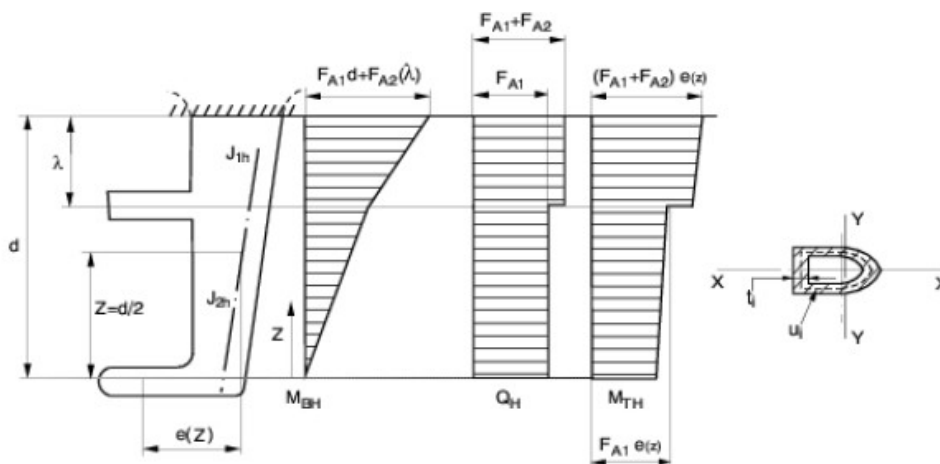


Fig. 2.2.4.4.1-3

$q_1, q_2$  – continuous loads:

$$q_1 = \frac{F_2}{10^3 \ell_{10}} \quad [\text{kN/m}] \quad (2.2.4.4.1-1)$$

$$q_2 = \frac{F_1}{10^3 \ell_{20}} \quad [\text{kN/m}] \quad (2.2.4.4.1-2)$$

$F_1, F_2$  – see 2.2.4.3.2.

$Z$  – spring constant of support:

$$Z = \frac{1}{f_b + f_t} \quad [\text{kN/m}] \quad (2.2.4.4.1-3)$$

$f_b$  – unit displacement of rudder horn due to a unit force of 1 kN acting in the centre of support, [m]

$$f_b = 1.3d^3 / (6.18I_n) \quad [\text{m/kN}] \quad (2.2.4.4.1-4)$$

$I_n$  – moment of inertia of rudder horn around the x-axis, [cm<sup>4</sup>];

$f_t$  – unit displacement due to torsion:

$$f_t = de^2 \sum \frac{u_i}{t_i} / (3.14F_T^2 10^8) \quad [\text{m/kN}] \quad (2.2.4.4.1-5)$$

- $F_T$  – sectional area of rudder horn, [m<sup>2</sup>];  
 $u_i$  – breadth of the individual plates forming the mean horn sectional area, [mm];  
 $t_i$  – thickness within the individual breadth  $u_i$ , [mm];  
 $d$  – height of the rudder horn defined in Fig. 2.2.4.4.1-1, [m]. This value is measured downwards from the upper rudder horn end, at the point of curvature transition, to the mid-line of the lower rudder horn pintle;  
 $e_{(z)}$  – distance as defined in Fig. 2.2.4.4.1-1, [m].

Semi spade rudder with 2-conjugate elastic support:

The way coefficients  $k_{11}$ ,  $k_{12}$  and  $k_{22}$  may be computed and the way they are used to compute deflection of the beam (see Fig. 2.2.4.4.1-2) are explained below:

$k_{11}$ ,  $k_{12}$ ,  $k_{22}$  – rudder horn compliance constants calculated for rudder horn with 2-conjugate elastic supports (Fig. 2.2.4.4.1-2). The 2-conjugate elastic supports are defined in terms of horizontal displacements,  $y_i$  by the following equations:

- at the lower rudder horn bearing:

$$y_1 = -k_{12}F_{A2} - k_{22}F_{A1} \quad (2.2.4.4.1-6)$$

- at the upper rudder horn bearing:

$$y_2 = -k_{11}F_{A2} - k_{12}F_{A1} \quad (2.2.4.4.1-7)$$

where:

- $y_1, y_2$  – horizontal displacements at the lower and upper rudder horn bearings, respectively, [m];  
 $F_{A1}, F_{A2}$  – horizontal support forces at the lower and upper rudder horn bearings, respectively, [kN];  
 $k_{11}, k_{12}, k_{22}$  – obtained from the following formulae, [m/kN]:

$$k_{11} = 1.3 \frac{\lambda^3}{3EJ_{1h}} + \frac{e^2\lambda}{GJ_{th}} \quad (2.2.4.4.1-8)$$

$$k_{12} = 1.3 \left[ \frac{\lambda^3}{3EJ_{1h}} + \frac{\lambda^2(d-\lambda)}{2EJ_{1h}} \right] + \frac{e^2\lambda}{GJ_{th}} \quad (2.2.4.4.1-9)$$

$$k_{22} = 1.3 \left[ \frac{\lambda^3}{3EJ_{1h}} + \frac{\lambda^2(d-\lambda)}{EJ_{1h}} + \frac{\lambda(d-\lambda)^2}{EJ_{1h}} + \frac{(d-\lambda)^3}{3EJ_{2h}} \right] + \frac{e^2\lambda}{GJ_{th}} \quad (2.2.4.4.1-10)$$

- $d$  – height of the rudder horn defined in Fig. 2.2.4.4.1-2, [m]. This value is measured downwards from the upper rudder horn end, at the point of curvature transition, till the mid-line of the lower rudder horn pintle;  
 $\lambda$  – length, as defined in Fig. 2.2.4.4.1-2, [m]. This length is measured downwards from the upper rudder horn end, at the point of curvature transition, till the mid-line of the upper rudder horn bearing. For  $\lambda = 0$ , the above formulae converge to those of spring constant  $Z$  for a rudder horn with 1-elastic support, and assuming a hollow cross section for this part;  
 $e$  – rudder-horn torsion lever, as defined in Fig. 2.2.4.4.1-2 (value taken at  $z = d/2$ ), [m];  
 $J_{1h}$  – moment of inertia of rudder horn about the  $x$  axis for the region above the upper rudder horn bearing, [m<sup>4</sup>]. Note that  $J_{1h}$  is an average value over the length  $\lambda$  (see Fig. 2.2.4.4.1-3);  
 $J_{2h}$  – moment of inertia of rudder horn about the  $x$  axis for the region between the upper and lower rudder horn bearings, [m<sup>4</sup>]. Note that  $J_{2h}$  is an average value over the length  $d - \lambda$  (see Fig. 2.2.4.4.1-3);  
 $J_{th}$  – torsional stiffness factor of the rudder horn, [m<sup>4</sup>]:



For any thin wall closed section

$$J_{th} = \frac{4F_T^2}{\sum t_i^3} \quad (2.2.4.4.1-11)$$

$F_T$  – mean of areas enclosed by outer and inner boundaries of the thin walled section of rudder horn, [m<sup>2</sup>];

$u_i$  – length of the individual plates forming the mean horn sectional area, [mm];

$t_i$  – thickness of the individual plates mentioned above, [mm].

Note that the  $J_{th}$  value is taken as an average value, valid over the rudder horn height.

**2.2.4.4.2** If bending moments for semi-spade rudders, shown in Fig. 2.2.4.4.1-1 have not been determined by direct calculations, they may be determined – with PRS' consent – from formulae 2.2.4.4.2-1 and 2.2.4.4.2-2.

The value of the maximum rudder blade bending moment shall be determined from the formula:

$$M_1 = \frac{FA_b h_2}{A} \quad [\text{Nm}] \quad (2.2.4.4.2-1)$$

$F$  – see 2.2.2.1-1;

$A, A_b, h_2$  – see 2.2.4.3.

The rudder stock bending moment in way of the lower bearing shall be determined from the formula:

$$M_2 = \frac{Fb}{17} \quad [\text{Nm}] \quad (2.2.4.4.2-2)$$

## 2.2.5 Reaction Forces in Bearings

**2.2.5.1** If reaction forces  $R$  at the respective bearings have not been determined by direct calculations of rudder stock and rudder blade bending, they may be calculated – with PRS' consent – from the formulae given in 2.2.5.2, 2.2.5.3, 2.2.5.4.

**2.2.5.2** For balanced rudders with sole piece support, the reaction forces are as follows:

$$R_1 = 0.6F \quad [\text{N}] \quad \text{– at sole piece pintle bearing,} \quad (2.2.5.2-1)$$

$$R_2 = 0.7F \quad [\text{N}] \quad \text{– at stern pintle or the lower bearing,} \quad (2.2.5.2-2)$$

$$R_3 = 0.1F \quad [\text{N}] \quad \text{– at the upper bearing;} \quad (2.2.5.2-3)$$

$F$  – design value of the rudder blade force, according to 2.2.2.1.

**2.2.5.3** For semi-spade rudders, it is assumed that the horn pintle bearing is located not more than  $0.1b$  m below or above the centre of gravity of the rudder blade, ( $b$  – mean height of rudder blade, see 2.2.2.1-6), and the reaction forces are as follows:

$$R_1 = 1.1F \quad [\text{N}] \quad \text{– at horn pintle bearing,} \quad (2.2.5.3-1)$$

$$R_2 = 0.4F \quad [\text{N}] \quad \text{– at stern pintle or } 0.3F \text{ at the lower bearing of rudder stock,} \quad (2.2.5.3-2)$$

$$R_3 = 0.1F \quad [\text{N}] \quad \text{– at the upper bearing of rudder stock.} \quad (2.2.5.3-3)$$

The above-listed reaction forces at stern pintle bearing or the lower bearing are the minimum values.

**2.2.5.4** For spade rudders, the reaction forces are as follows:

For spade rudders without trunks (see Fig.2.2.4.3.1):

$$R_2 = F + R_3 \quad [\text{N}] \quad \text{– at the lower bearing of rudder stock (or rudder trunk),} \quad (2.2.5.4-1)$$

$$R_3 = \frac{M_2}{\ell_{30}} \quad [\text{N}] \quad \text{– at the upper bearing of rudder stock;} \quad (2.2.5.4-2)$$

For spade rudders with trunks (see Fig. 2.2.4.3.2):

$$R_2 = F_1 + F_2 + R_3 \text{ [N]} \text{ – at the lower bearing of rudder trunk} \quad (2.2.5.4-3)$$

$$R_3 = \frac{M_2 - M_{F1}}{\ell_{20} + \ell_{30}} \text{ [N]} \text{ – at the upper bearing of rudder stock;} \quad (2.2.5.4-4)$$

$F$  – design value of the rudder blade force, according to 2.2.2.1;

$F_1, F_2, M_2, M_{F1}, \ell_{20}, \ell_{30}$  – see 2.2.4.3.1 or 2.2.4.3.2 respectively.

## 2.3 Loads Acting on Steering Nozzles

### 2.3.1 Scope of Application

**2.3.1.1** The initial design data specified in the present sub-chapter are applicable only to determining the scantlings of steering nozzles with fixed stabilizers and cannot be used for calculation of steering nozzle gear characteristics.

**2.3.1.2** Wherever steel with yield stress other than  $R_e = 235$  MPa is used, the material coefficient, determined in 2.1.6, shall be applied.

**2.3.1.3** When checking the steering nozzle pintles, as well as the nozzle stock bearings, pressures shall not exceed the values indicated in Table 2.4.9.1.

### 2.3.2 Transverse Load

**2.3.2.1** The total design load  $F$  acting on steering nozzle and stabilizer shall be taken not less than that determined by the formula:

$$F = F_d + F_{st} \text{ [N]} \quad (2.3.2.1-1)$$

$F_d$  – design load acting on a nozzle, determined by the formula:

$$F_d = 9.81pD_d l_d v_p^2 \text{ [N]} \quad (2.3.2.1-2)$$

$F_{st}$  – design load acting on a stabilizer, determined by the formula:

$$F_{st} = 9.81qmA_{st}v_p^2 \text{ [N]} \quad (2.3.2.1-3)$$

$D_d$  – nozzle inside diameter, [m];

$l_d$  – nozzle length, [m];

$A_{st}$  – nozzle stabilizer area, [m<sup>2</sup>];

$v_p$  – speed determined by the formula:

$$v_p = v(1 - w) \text{ [knots]} \quad (2.3.2.1-4)$$

$v$  – maximum ahead speed of the ship at a draught to the summer load waterline, [knots], but not less than 10 knots;

$w$  – mean wake factor; if reliable experimental data are not available, the  $w$  factor shall be determined by a formula agreed with PRS;

$p$  and  $q$  – factors determined from Table 2.3.2.1-1, depending on the value of propeller thrust load coefficient  $\xi_T$  and on the relative nozzle length  $\lambda_d$ ;

$\xi_T$  shall be determined by the formula:

$$\xi_T = 9.4 \cdot 10^{-3} \frac{T_s}{D^2 v_p^2} \quad (2.3.2.1-5)$$

$T_s$  – propeller thrust at speed  $v$  [N];

$D$  – propeller diameter [m];

$\lambda_d$  – to be determined by the formula:

$$\lambda_d = \frac{l_d}{D_d} \quad (2.3.2.1-6)$$

**Table 2.3.2.1-1**

$\xi_T$	$\lambda_d = 0.5$		$\lambda_d = 0.7$		$\lambda_d = 0.9$	
	$p$	$q$	$p$	$q$	$p$	$q$
0.5	50	5.4	38	4.0	32	2.7
1	61	6.3	47	4.7	39	3.1
2	82	8.2	62	6.1	51	4.0
3	103	9.8	78	7.3	64	4.8
4	123	11.5	43	8.5	76	5.6
5	143	13.0	107	9.7	88	6.4

For intermediate values of  $\xi_T$  and  $\lambda_d$ , the values  $p$  and  $q$  shall be determined by linear interpolation.

$m$  – coefficient determined from Table 2.3.2.1-2, depending on the relative aspect ratio  $\lambda_{st}$  of the stabilizer;

$\lambda_{st}$  shall be determined by the formula:

$$\lambda_{st} = \frac{h_{st}}{l_{st}} \quad (2.3.2.1-7)$$

$h_{st}$  – nozzle stabilizer height, [m];

$l_{st}$  – nozzle stabilizer length, [m].

**Table 2.3.2.1-2**

$\lambda_{st}$	$m$
1	2.1
2	3.1
3	3.8
4	4.2
5	4.5

For intermediate values of  $\lambda_{st}$ , the value  $m$  shall be determined by linear interpolation.

**2.3.2.2** As the point of  $F_d$  load application, a point located on the horizontal plane passing through the longitudinal axis of the nozzle at a distance  $r_d$  from its leading edge shall be taken; this distance shall not be less than that determined by the formula:

$$r_d = l_d(bK + c) \text{ [m]} \quad (2.3.2.2-1)$$

$K$  – nozzle compensation factor determined by the formula:

$$K = \frac{l_{td}}{l_d} \quad (2.3.2.2-2)$$

$l_{td}$  – distance from the nozzle stock axis to the leading edge of the nozzle, [m];

$b$  and  $c$  – factors determined according to Table 2.3.2.2, depending on  $\xi_T$  value.

**Table 2.3.2.2**

$\xi_T$	$b$	$c$
0.5	0.30	0.096
1	0.38	0.064
2	0.51	0.030
3	0.60	0.000
4	0.68	- 0.026
5	0.75	- 0.044

For intermediate values of  $\xi_T$ , the values  $b$  and  $c$  shall be determined by linear interpolation.

**2.3.2.3** As the point of  $F_{st}$  load application, a point located on the horizontal plane passing through the longitudinal axis of the nozzle at a distance  $r_{st}$  from the leading edge of the stabilizer shall be taken; this distance shall not be less than that determined by the formula:

$$r_{st} = 0.25l_{st} \quad [\text{m}] \quad (2.3.2.3)$$

$l_{st}$  – see 2.3.2.1.

### 2.3.3 Torque

The total design torque  $M_l$  acting on a steering nozzle shall be determined by the formula:

$$M_l = M_d - M_{st} \quad [\text{Nm}] \quad (2.3.3-1)$$

$M_d$  – design torque due to  $F_d$  load, determined by the formula:

$$M_d = F_d (l_{td} - r_d) \quad [\text{Nm}] \quad (2.3.3-2)$$

$M_{st}$  – design torque due to  $F_{st}$  load, determined by the formula:

$$M_{st} = F_{st} (a - r_{st}) \quad [\text{Nm}] \quad (2.3.3-3)$$

$a$  – distance from the nozzle stock axis to the stabilizer leading edge, [m].

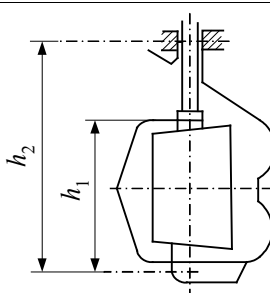
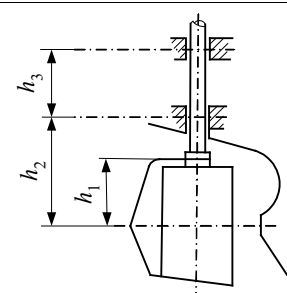
$F_{st}, F_d, r_{st}, r_d$  – see 2.3.2.

### 2.3.4 Bending Moments and Support Reaction Forces

Design bending moments acting on the steering nozzle, as well as design reaction forces of supports shall be taken not less than those indicated in Table 2.3.4, depending on the type of the nozzle.

In the table formulae, all linear dimensions shall be expressed in metres [m], while loads – in newtons [N]. It is permitted to take values less than the tabular ones, provided more detailed calculations of bending moments and support reaction forces are submitted to PRS.

**Table 2.3.4**

Type of calculations	Type of steering nozzles	
	supported	spade
		
Design bending moment at the nozzle stock – on the stock bearing level, [Nm]	$M_2 = 0.13Fh_1 \cdot (1.17 \frac{h_2}{h_1} - 1)$	$M_2 = 1.1 Fh_2$
Design bending moment at the stock to nozzle connection, [Nm]	$M_3 = 0.21Fh_1 \cdot (1.05 \frac{h_2}{h_1} - 1)$	$M_3 = 1.1 Fh_1$
Design reaction force of supports at the lower bearing of the stock, [N]	$R_1 = F \cdot [0.53 + 0.24 (\frac{h_2}{h_1} - 1.1)]$	$R_1 = 1.1F \cdot (1 + \frac{h_2}{h_3})$
Design reaction force of supports at the pintle, [N]	$R_2 = F \cdot [0.57 + 0.24 (\frac{h_2}{h_1} - 1.1)]$	-
Design reaction force of supports at the upper bearing, [N]	-	$R_3 = 1.1F \frac{h_2}{h_3}$

*F* – see 2.3.2.1.

## 2.4 Rudder Design

### 2.4.1 General

The section modulus and the web area of a horizontal section of the rudder blade shall be such that the following stress values are not exceeded:

a) in general, except in way of rudder recess sections where b) applies:

$$\begin{aligned} \text{bending stress} & \quad \sigma = 110/k \text{ MPa,} \\ \text{shear stress} & \quad \tau = 50/k \text{ MPa,} \\ \text{equivalent stress} & \quad \sigma_{zr} = \sqrt{\sigma^2 + 3\tau^2} = 120/k \text{ MPa;} \end{aligned}$$

*k* – material factor for rudder plating as given in 2.1.7.

b) in way of the recess for the rudder horn pintle on semi-spade rudders (the stresses apply equally to high tensile and ordinary steels):

$$\begin{aligned} \text{bending stress} & \quad \sigma = 75 \text{ MPa,} \\ \text{shear stress} & \quad \tau = 50 \text{ MPa,} \\ \text{equivalent stress} & \quad \sigma_{zr} = \sqrt{\sigma^2 + 3\tau^2} = 100 \text{ MPa.} \end{aligned}$$

### 2.4.2 Streamline Rudder Blade

2.4.2.1 The thickness of the rudder side, top and bottom plating shall not be less than:

$$s = 5.5a_2\beta\sqrt{k}\sqrt{T_{sc} + \frac{F \cdot 10^{-4}}{A}} + 2.5 \text{ [mm]} \quad (2.4.2.1-1)$$

$T_{sc}$  – scantling draught, [m];

*F* – rudder blade force, [N], according to 2.2.2.1;

*A* – rudder blade area, [m<sup>2</sup>];

$$\beta = \sqrt{1.1 - 0.5 \left(\frac{a_2}{a'_2}\right)^2} \quad (2.4.2.1-2)$$

$$\beta_{max} = 1.0 \text{ when } \frac{a'_2}{a_2} \geq 2.5 \quad (2.4.2.1-3)$$

$a_2$  – the minimum unsupported distance between the horizontal or vertical web plates, [m]; this value shall not be greater than 1.2 times the frame spacing in the after part of the ship;

$a'_2$  – the maximum unsupported distance between the horizontal or the vertical web plates, [m];

*k* – material factor for the rudder plating as given in 2.1.7.

The rudder plating in way of the solid part shall be of increased thickness per 2.4.10.4.

2.4.2.2 The thickness of the nose plates of the rudder blade shall not be less than 1.25 times the thickness of the rudder blade side plating determined by formula 2.4.2.1-1.

2.4.2.3 The thickness of vertical or horizontal webs shall not be less than 0.7 times the rudder blade side plating and not less than 8 mm. Where higher strength steel has been used, the suitable material factor *k*, given in 2.1.7, shall be applied.

2.4.2.4 The rudder blade side plating, as well as the top and bottom plates shall be stiffened inside by means of horizontal and vertical stiffeners or web plates.

**2.4.2.5** The plating and stiffeners shall be welded together with fillet welding or plug weld with oblong cut-outs. Such connection shall be made according to the requirements of Chapter 4, *Part II – Hull*.

### 2.4.3 Single Plate Rudder Blade

**2.4.3.1** Single plate rudders shall be provided with a rudder-piece extending over the full height of the rudder blade. The diameter of the rudder-piece shall be determined according to 2.4.4. For spade rudders, the lower 1/3 of the rudder piece may taper down to 0.75 times the rudder stock diameter.

**2.4.3.2** The thickness of the single-plate rudder blade shall not be less than that determined from the formula:

$$s = 1.5a_3v\sqrt{k} + 2.5 \text{ [mm]} \quad (2.4.3.2)$$

$a_3$  – spacing of horizontal stiffening arms, [m], not to exceed 1 m;

$v$  – ship speed (see 2.2.2.1), [knots];

$k$  – material factor for the rudder plating as given in 2.1.7.

**2.4.3.3** Horizontal stiffening arms shall be fitted at both sides of single-plate rudder blade, in the upper and lower ends of the rudder blade and in line with each pintle, if provided. The vertical distance between the arms shall not exceed 1 m. For this purpose, intermediate arms shall be provided, where necessary. The arm thickness shall not be less than the rudder plate thickness.

**2.4.3.4** The section modulus of the horizontal arm at the rudder-piece shall not be less than that determined by the formula:

$$W = 0.5a_3c_1^2v^2k \text{ [cm}^3\text{]} \quad (2.4.3.4)$$

$a_3$  – see formula 2.4.3.2;

$c_1$  – horizontal distance from the after edge of the rudder blade to the rudder stock axis, [m];

$k$  – material factor as given in 2.1.5 or 2.1.7 respectively.

### 2.4.4 Rudder Stock

**2.4.4.1** The diameter of the rudder stock in way of the tiller required for transmission of the rudder torque shall be determined for shear stress not exceeding  $\tau_t = \frac{68}{k_t}$  [MPa] and shall not be less than determined by the formula:

$$d_t = 4.2\sqrt[3]{M_s k_t} \text{ [mm]} \quad (2.4.4.1)$$

$M_s$  – total rudder torque acting upon steering gear according to 2.2.3.1 or 2.2.3.2, [Nm];

$k_t$  – rudder stock material factor (see 2.1.5).

**2.4.4.2** The diameter of the rudder stock, where exposed to simultaneous bending and torsion, shall not be less than:

$$d_c = d_t \sqrt[6]{1 + \frac{4}{3} \left(\frac{M}{M_s}\right)^2} \text{ [mm]} \quad (2.4.4.2-1)$$

$d_t$  – according to 2.4.4.1, [mm];

$M$  – bending moment at the cross-section considered according to 2.2.4, [Nm];

$M_s$  – torque at the cross-section considered according to 2.2.3, [Nm].

In the above formula, the following values of  $\sigma$ ,  $\tau$  and  $\sigma_{zr}$  have been assumed:

$\sigma$  – bending stress:

$$\sigma = \frac{10.2M}{d_c^3} 10^3 \text{ [MPa]} \quad (2.4.4.2-2)$$

$\tau$  – shear stress due to torsion:

$$\tau = \frac{5.1M_s}{d_c^3} 10^3 \text{ [MPa]} \quad (2.4.4.2-3)$$

$\sigma_{zr}$  – equivalent stress:

$$\sigma_{zr} = \sqrt{\sigma^2 + 3\tau^2} \text{ [MPa]} \quad (2.4.4.2-4)$$

but not more than  $\sigma_{zr} = \frac{118}{k}$  [MPa];

$k$  – material factor for the rudder stock (see 2.1.5).

For a spade rudder with trunk extending inside the rudder, the rudder stock scantlings shall be checked against the two cases defined in 2.2.4.3.2

**2.4.4.3** Before significant reduction in rudder stock diameter are granted due to the application of steel with specified minimum yield stress exceeding 235 MPa, PRS may require to estimate the rudder stock deformations. Large deformations of the rudder stock shall be avoided in order to avoid excessive edge pressures in way of bearings.

**2.4.4.4** The transition of rudder stock diameter from  $d_t$  to  $d_c$  value shall not be abrupt. Where the transition is made stepped, the steps shall be provided with fillets having as large as practicable radius. The transition of the rudder stock into the flange shall be made with a fillet radius not less than 0.12 times the stock diameter in way of flange.

## 2.4.5 Rudder Axle

**2.4.5.1** The rudder axle diameter at the lower bearing shall not be less than:

$$d_o = 39 \sqrt[3]{\frac{Fc_o(l_o - c_o)k}{l_o}} \text{ [mm]} \quad (2.4.5.1-1)$$

$k$  – material factor for rudder axle, according to 2.1.5;

$F$  – rudder force determined according to 2.2.2.1, [kN];

$a_o, b_o, l_o$  – see Fig. 2.4.5.1, [m];

$$c_o = \frac{a_o + b_o}{2} \quad (2.4.5.1-2)$$

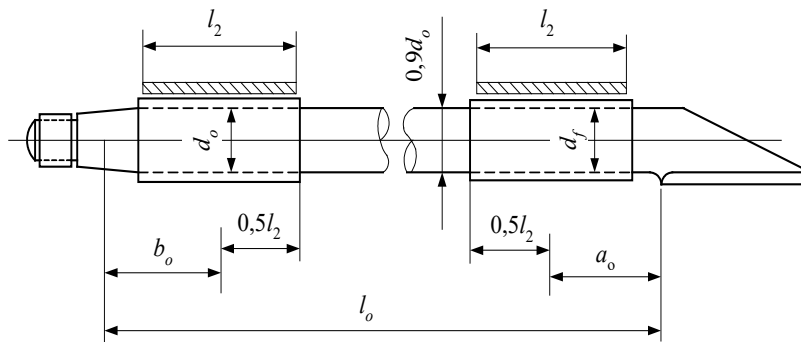


Fig. 2.4.5.1

The rudder axle diameter,  $d_f$ , between the lower edge of the coupling flange and the rudder bearing shall be by 10% greater than  $d_o$ . If, however, the rudder axle in this area is protected against corrosion by means of special corrosion-resistant composition,  $d_f$  may be equal to  $d_o$  (see

Fig. 2.4.5.1). The rudder axle diameter at the upper bearing shall be taken equal to  $d_f$ . The rudder axle diameter between the rudder blade bearings may be reduced by 10% in relation to  $d_o$ .

**2.4.5.2** Other parameters of the rudder axle, such as taper of the lower cone of the axle, coupling bolt diameter, coupling flange thickness, dimensions of nuts, key, etc., shall be determined according to 2.4.7 with the appropriate parameters of the rudder axle.

**2.4.5.3** All bolts shall be fitted bolts. When a key is applied, the number of fitted bolts may be reduced to two. The nuts shall be of standard proportions and shall be suitably protected against loosening by means of welded on strips (washers) or by means of cotter pins.

**2.4.5.4** Where the diameter of the rudder axle changes, suitable fillets shall be provided. A transition of the rudder axle into the flange shall be made with a fillet radius not less than 0.12 times the axle diameter.

**2.4.5.5** The rudder axle nut shall be protected against self-loosening by means of at least two welded on strips (washers) or one washer and one cotter pin.

**2.4.5.6** Rudder axle bearings located on the rudder blade and co-acting with the rudder axle shall fulfil the requirements of 2.4.6.6 set forth for pintles.

## 2.4.6 Rudder Pintles

**2.4.6.1** Pintles shall have a conical attachment to the gudgeons with a taper on diameter not greater than:

1:8 ÷ 1:12 – for keyed and other manually assembled pintles protected by slugging nuts;

1:12 ÷ 1:20 – for pintles mounted with oil injection and hydraulic nut.

**2.4.6.2** The pindle diameter shall not be less than:

$$D = 0.35\sqrt{Rk} \text{ [mm]} \quad (2.4.6.2)$$

$R$  – relevant bearing force according to 2.2.5, [N];

$k$  – pindle material factor (see 2.1.5).

**2.4.6.3** The minimum dimensions of threads and nuts shall be determined according to 2.4.8.1.67.

**2.4.6.4** The thickness of material in gudgeon bearings, including gudgeon bushing, shall not be less than 0.5 times the diameter of the pindle without liner. Possible deviation from this requirement is subject to special consideration of PRS.

**2.4.6.5** The pindle nut shall be reliably secured against loosening by means of at least two welded on strips (washers) or one washer and one cotter pin, and the pindle shall be effectively clamped in its seating.

**2.4.6.6** The selected dimensions of pintles shall be checked for surface pressure, taken as:

$$p = \frac{R}{d_e h} \text{ [MPa]} \quad (2.4.6.6)$$

$R$  – design reaction force at the pindle housing according to 2.2.5, [N];

$d_e$  – pindle diameter, including the liner, if fitted, [mm];

$h$  – height of the working part of the pindle, [mm].

The surface pressure shall not exceed the values specified in Table 2.4.9.1. The use of materials different from those specified in the Table will be specially considered by PRS.



**2.4.6.7** The required push-up pressure for pintle in case of dry fitting, in MPa, is to be determined by  $p_{req1}$  as given formula (2.4.6.7-1). The required push-up pressure for pintle in case of oil injection fitting, in MPa, is to be determined by the maximum pressure of  $p_{req1}$  and  $p_{req2}$  as given below:

$$p_{req1} = 0.4 \frac{R d_0}{d_m^2 \ell} \quad (2.4.6.7-1)$$

$$p_{req2} = \frac{6 M_{bp}}{\ell^2 d_m} 10^3 \quad (2.4.6.7-2)$$

$R$  – supporting force in the pintle, [N], e.g.  $R_1$  as defined in Figure 2.2.4.4.1-1

$d_0$  – pintle diameter, [mm], see Fig. 2.4.6.7

$$M_{bp} = B \ell_a \text{ [Nm]}$$

$\ell_a$  – length between middle of pintle-bearing and top of contact surface between cone coupling and pintle, [m], see Figure 2.4.6.7

The required push up length,  $\Delta \ell_1$ , is to be calculated similarly as in 2.4.8.2.3, using the required push-up pressure as defined above, and properties for the pintle.

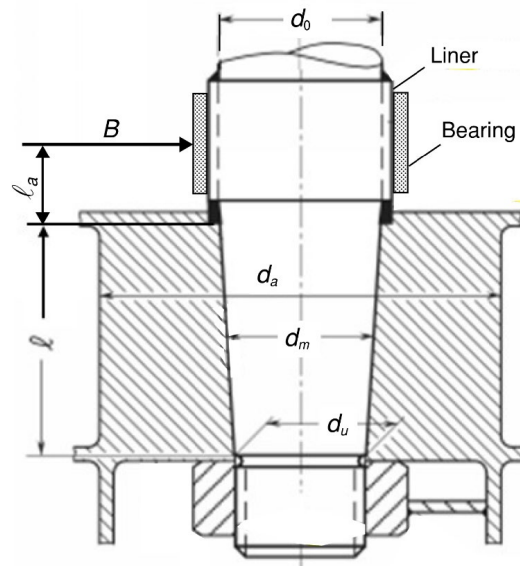


Fig. 2.4.6.7

**2.4.6.8** The minimum dimensions of threads and nuts shall be determined according to 2.4.8.1.7.

**2.4.6.9** The length of the pintle housing in the gudgeon shall not be less than the pintle diameter  $d_p$ . Diameter  $d_p$  shall be measured on the outside of liners.

The thickness of the pintle housing shall not be less than  $0.25 d_p$ .

## 2.4.7 Flange Couplings Connecting Rudder Stock with Rudder Blade

**2.4.7.1** Where a rudder stock is connected to the rudder blade by means of horizontal flange couplings, the diameter  $d_b$  of coupling bolts shall not be less than that determined by the formula:

$$d_b = 0.62 \sqrt{\frac{d^3 k_s}{z e_m k_t}} \text{ [mm]} \quad (2.4.7.1)$$

- $d$  – rudder stock diameter, [mm]; for calculations, taken equal to the greater of the values:  $d_t$  or  $d_c$ , determined in 2.4.4, shall be taken;
- $z$  – number of connecting bolts, which shall be not less than 6;
- $e_m$  – mean distance of the bolt axes from the centre of the bolt system for structures with axial symmetry, [mm];
- $k_s$  – material factor for the bolts (see 2.1.5);
- $k_t$  – material factor for the rudder stock (see 2.1.5).

**2.4.7.2** The distance from the centre of any bolt to the centre of flange shall not be less than 0.7 times the diameter of the rudder stock  $d_t$ , determined according to 2.4.4.1.

For rudders where the rudder stock is subjected both to torque and bending moment, it is additionally required that the distance from the centre of any bolt to the centre line of rudder blade shall not be less than 0.6 times the design diameter of rudder stock  $d_c$ , determined according to 2.4.4.2.

**2.4.7.3** All bolts shall be fitted bolts. Only in the case when a key is applied, the number of fitted bolts may be reduced to two. The nuts shall be of standard proportions. The bolts and nuts shall be effectively protected against loosening.

**2.4.7.4** The thickness of horizontal coupling flange shall not be less than that determined by the greater of the following formulae:

$$s = d_b \sqrt{\frac{k_k}{k_s}} \text{ [mm]} \quad (2.4.7.4-1)$$

$$s = 0.9d_b \quad (2.4.7.4-2)$$

$d_b, k_s$  – see 2.4.7.1,  $d_b$  determined for a number of bolts not exceeding 8;

$k_k$  – material factor for flange (see 2.1.5).

**2.4.7.5** The width of material between the perimeter of the bolt holes and the perimeter of the horizontal coupling flange shall not be less than  $0.67d_b$ .

**2.4.7.6** The welded joint between the rudder stock and the horizontal coupling flange shall be made in accordance with Figure 2.4.7.6 or equivalent.

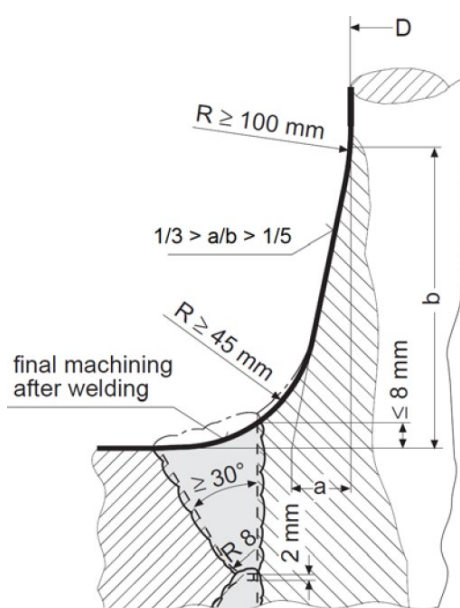


Fig. 2.4.7.6. Welded joint between rudder stock and coupling flange

**2.4.7.7** The diameter of bolts of vertical flange coupling shall not be less than that determined by the formula:

$$d_b = \frac{0.81d}{\sqrt{z}} \cdot \sqrt{\frac{k_s}{k_t}} \text{ [mm]} \quad (2.4.7.7-1)$$

- $d$  – rudder stock diameter in way of coupling flange, [mm];
- $z$  – total number of connecting bolts shall not be less than 8;
- $k_s$  – material factor for bolts, according to 2.1.5;
- $k_t$  – material factor for the rudder stock, according to 2.1.5.

The first moment of area of the bolts about the centre of the coupling  $m$  shall not be less than that determined by the formula ( $d$  – as per above definition):

$$m = 0.00043d^3 \text{ [cm}^3\text{]} \quad (2.4.7.7-2)$$

**2.4.7.8** The thickness of vertical coupling flanges shall be less than the diameter of bolts and the width of the flange material between the perimeter of the bolt holes and the perimeter of the flange shall not be less than  $0.67d_b$ .

**2.4.7.9** Coupling bolts shall be fitted bolts and their nuts shall be locked effectively.

## 2.4.8 Cone Couplings

### 2.4.8.1 Cone Couplings with Key

**2.4.8.1.1** Keyed cone couplings without hydraulic arrangement for mounting and dismounting the coupling shall have a taper  $c$  on diameter of 1:8 ÷ 1:12, where:

$$c = (d_o - d_u) / \ell_c \quad (2.4.8.1.1)$$

The diameters  $d_o$ , in  $mm$ , and  $d_u$ , in  $mm$ , are shown in Fig. 2.4.8.1.1 and the cone length  $\ell_c$ , in  $mm$ , is defined in Fig. 2.4.8.1.1b.

The taper shall pass into cylindrical portion without a step. The cone shapes shall fit exactly. The coupling length  $\ell$ , in  $mm$ , shall not, in general, be less than  $1.5d_o$ .

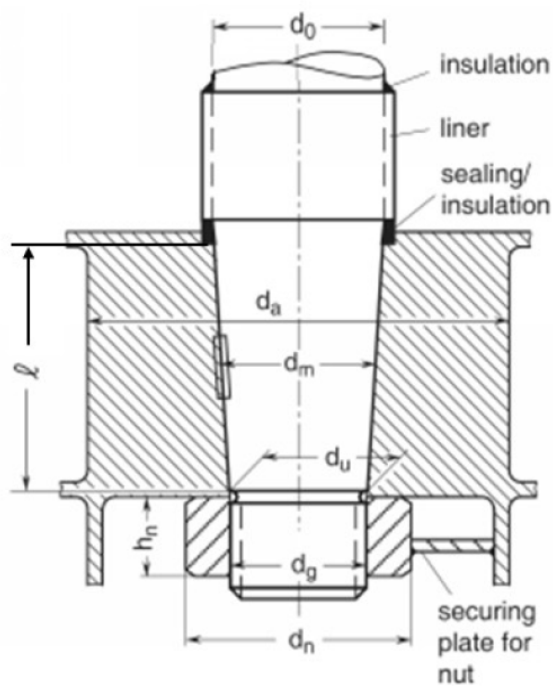


Fig. 2.4.8.1.1 Cone coupling with key

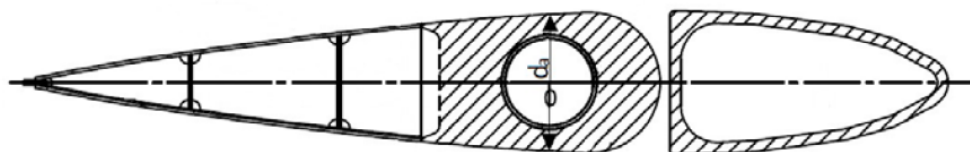


Fig. 2.4.8.1.1a Gudgeon outer diameter ( $d_{RaR}$ ) measurement

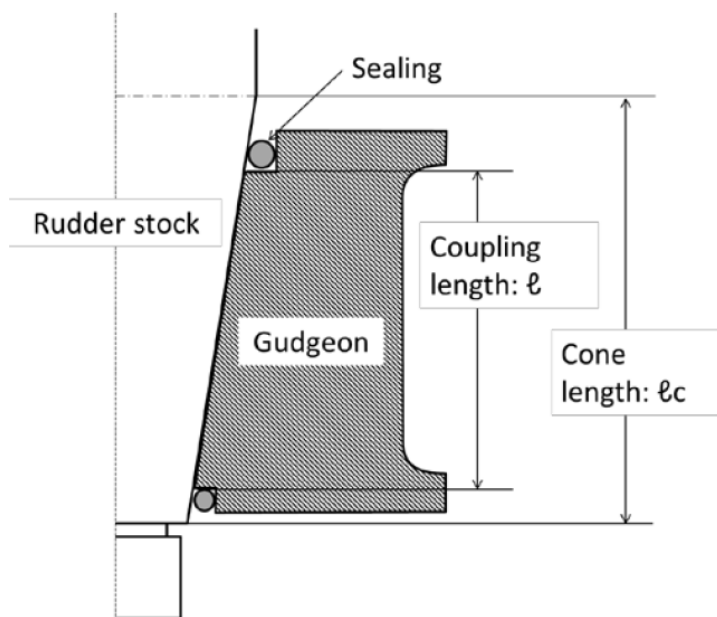


Fig. 2.4.8.1.1b Cone length and coupling length

**2.4.8.1.2** A key shall be set on the cone generatrix. The key ends shall be suitably rounded.

**2.4.8.1.3** For couplings between stock and rudder, a key shall be provided, the shear area of which shall not be less than that determined by the formula:

$$A_s = \frac{17.55M_{sk}}{d_k R_e} [\text{cm}^2] \quad (2.4.8.1.3)$$

$M_{sk}$  – design yield torque<sup>1</sup> of the rudder stock (see 2.4.8.1.4), [Nm];

$d_k$  – diameter of the conical part of the rudder stock at the key, [mm];

$R_e$  – specified minimum yield stress of the key material, [MPa].

**2.4.8.1.4** The effective surface area of the key (without rounded edges) between key and rudder stock or cone coupling shall not be less than that determined by the formula:

$$A_k = \frac{5M_{sk}}{d_k R_{ek}} [\text{cm}^2] \quad (2.4.8.1.4)$$

$R_{ek}$  – specified minimum yield stress of the rudder stock, coupling or key material, whichever is less, [MPa].

**2.4.8.1.5** The design yield torque of the rudder stock  $M_{sk}$  shall be determined by the formula:

$$M_{sk} = 0.02664 \frac{d_t^3}{k_t} [\text{Nm}] \quad (2.4.8.1.5)$$

$k_t$  – material factor for rudder stock (see 2.1.5);

$d_t$  – rudder stock diameter according to 2.4.4, [mm].

Where the actual diameter is greater than the required,  $d_t$ , to calculate  $M_{sk}$ , the actual diameter,  $d_{ta}$ , shall be taken. However,  $d_{ta}$  applied to the above formula need not be taken greater than 1.145  $d_t$ .

**2.4.8.1.6** The key height,  $h$ , shall not be less than 0.5 times its width  $b_s$ . The rudder stock key shall not extend beyond the conical connection.

**2.4.8.1.7** The cone coupling shall be secured by a slugging nut. The nut shall be secured, e.g. by a securing plate. The dimensions of the slugging nut shall be as follows (see Fig. 2.4.8.1.1):

- external thread diameter:  $d_g \geq 0.65d_o$ ;
- height:  $h_n \geq 0.6d_g$ ;
- outer diameter:  $d_4 \geq 1.2d_u$  or  $1.5d_g$ , whichever is the greater.

The thread shall be fine and the nut shall be secured against self-loosening by at least two welded on strips (washers) or one washer and one cotter pin.

**2.4.8.1.8** It shall be proved that 50% of the design yield moment is solely transmitted by friction in the cone couplings. This can be done by calculating the required push-up pressure and push-up length according to 2.4.8.2.2 and 2.4.8.2.3 for a torsional moment  $M'_{sk} = 0.5M_{sk}$ .

**2.4.8.1.9** Notwithstanding the requirements in 2.4.8.1.3, 2.4.8.1.4, 2.4.8.1.5 and 2.4.8.1.7, where a key is fitted to the coupling between stock and rudder and it is considered that the entire rudder torque is transmitted by the key at the couplings, then scantlings of the key as well as the push-up force and push-up length shall be at the discretion of PRS.

<sup>1</sup> Torque which causes equivalent stress on the surface of rudder stock equaling the yield point of the stock material.

### 2.4.8.2 Cone Couplings with Special Arrangements for Mounting and Dismounting the Couplings

**2.4.8.2.1** Where the stock diameter exceeds 200 mm, the press fit is recommended to be effected by a hydraulic pressure connection. In such cases the cone shall be more slender,  $c \approx 1:12$  to  $\approx 1:20$ .

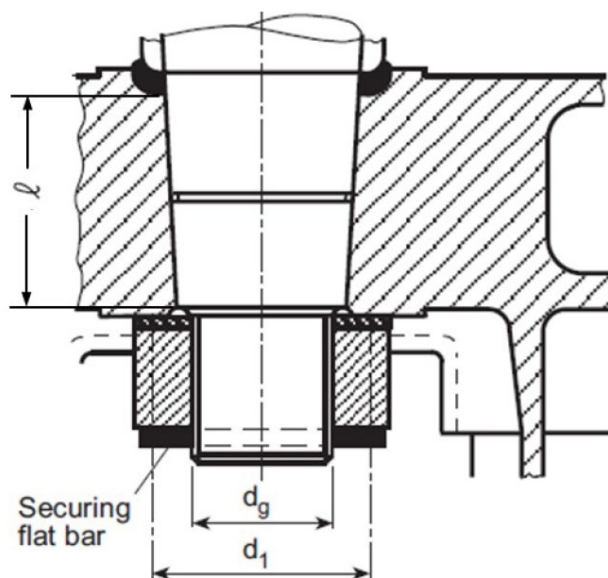


Fig.2.4.8.2.1. Cone coupling without key

In case of hydraulic pressure connections the nut shall be effectively secured against the rudder stock or the pintle.

For the safe transmission of the torsional moment by the coupling between rudder stock and rudder body the push-up pressure and the push-up length shall be determined according to 2.4.8.2.2 and 2.4.8.2.3 respectively.

**2.4.8.2.2** The push-up pressure shall not be less than the greater of the following values:

$$p_{req1} = \frac{2M_{sk}}{d_m^2 l \pi \mu_0} 10^3 \text{ [MPa]} \quad (2.4.8.2.2-1)$$

$$p_{req2} = \frac{6M_c}{l^2 d_m} 10^3 \text{ [MPa]} \quad (2.4.8.2.2-2)$$

$M_{sk}$  – design yield moment of rudder stock (as defined in 2.4.8.1.5), [Nm],

$d_m$  – mean cone diameter (see Fig.2.4.8.1.1), [mm];

$l$  – coupling length, [mm],

$\mu_0$  – frictional coefficient, equal to 0.15,

$M_c$  – bending moment in rudder stock at the top of the cone coupling (e.g. in case of spade rudders), [Nm].

For a spade rudder with trunk extending inside the rudder, the rudder stock scantlings shall be checked against the two cases defined in 2.2.4.3.2

It has to be proved by the designer that the push-up pressure does not exceed the permissible surface pressure in the cone. The permissible pressure shall be determined by the following formula:

$$p_{perm} = \frac{0.95R_e(1-\alpha^2)}{\sqrt{3+\alpha^4}} - p_b \text{ [MPa]} \quad (2.4.8.2.2-3)$$

$$p_b = \frac{3.5M_c}{d_m l^2} 10^3 \text{ [MPa]} \quad (2.4.8.2.2-4)$$

$R_e$  – specified minimum yield stress of the material of the gudgeon, [MPa];

$\alpha = d_m/d_a$

$d_m$  – diameter (see Fig.2.4.8.1.1), [mm];

$d_a$  – outer diameter of the gudgeon (see Fig.2.4.8.1.1 and Fig. 2.4.8.1.1a) [mm], the least diameter is to be considered.

The outer diameter of the gudgeon in mm shall not be less than  $1.25d_o$ , with  $d_o$  defined in Fig.2.4.8.1.1.

**2.4.8.2.3** The push-up length  $\Delta l$ , [mm], shall fulfil the following formula:

$$\Delta l_1 \leq \Delta l \leq \Delta l_2 \quad (2.4.8.2.3-1)$$

$$\Delta l_1 = \frac{p_{req} d_m}{E \left( \frac{1-\alpha^2}{2} \right) c} + \frac{0.8 R_{tm}}{c} \text{ [mm]} \quad (2.4.8.2.3-2)$$

$$\Delta l_2 = \frac{p_{perm} d_m}{E \left( \frac{1-\alpha^2}{2} \right) c} + \frac{0.8 R_{tm}}{c} \text{ [mm]} \quad (2.4.8.2.3-3)$$

$R_{tm}$  – mean roughness, taken equal to 0.01, [mm],

$c$  – taper on diameter defined in 2.4.8.1.1,

For other symbols see 2.4.8.2.2

**2.4.8.3** In case of hydraulic pressure connections, the required push-up force  $P_e$ , for the cone may be determined by the following formula:

$$P_e = p_{req} d_m \pi l \left( \frac{c}{2} + 0.02 \right) \text{ [N]} \quad (2.4.8.3)$$

The value 0.02 is a reference for the friction coefficient using oil pressure. It varies and depends on the mechanical treatment and roughness of the details to be fixed. Where due to the fitting procedure a partial push-up effect caused by the rudder weight is given, this may be taken into account when fixing the required push-up length, subject to approval by PRS.

## 2.4.9 Rudder Stock, Rudder Shaft and Pintle Bearings

**2.4.9.1** Liners or bushes shall be fitted in way of rudder stock bearings. For rudder stocks and pintles having diameter less than 200 mm, liners in way of bushes may be provided optionally. The minimum thickness of liners or bushes shall be equal to:

$t_{min.} = 8$  mm for metallic materials and synthetic material,

$t_{min.} = 22$  mm for lignum material.

**2.4.9.2** The thickness of any liner or bush, is neither to be less than:

$$t = 0.01\sqrt{R} \text{ [mm]} \quad (2.4.9.2)$$

where  $R$  – relevant bearing force [N], nor than the minimum thickness defined in 2.4.9.1

**2.4.9.3** The bearing surface  $A_b$ , (defined as the projected area: length x outer diameter of liner) shall not be less than that determined by the formula:

$$A_b = \frac{R}{p_a} \text{ [mm}^2\text{]} \quad (2.4.9.3)$$

$R$  – reaction force in bearing according to 2.1.10.2, [N];



$p_a$  – allowable surface pressure according to Table 2.4.9.3, [MPa].

The allowable surface pressure  $p_a$  for the various combinations shall be taken as reported in Table 2.4.9.3. Higher values than given in the Table may be taken in accordance with makers' specifications if they are verified by tests.

**Table 2.4.9.3**

Bearing material	$p_a$ [MPa]
lignum vitae	2.5
white metal, oil lubricated	4.5
synthetic material with hardness greater than 60 Shore D. <sup>1)</sup>	5.5 <sup>2)</sup>
steel. <sup>3)</sup> , bronze and hot-pressed bronze-graphite materials	7.0

- 1) Indentation hardness test at 23°C and with 50% moisture, shall be performed according to a recognized standard. Synthetic bearing materials shall be of a type approved by PRS.
- 2) Surface pressures exceeding 5.5 MPa may be accepted in accordance with bearing manufacturer's specification and tests, but in no case more than 10 MPa.
- 3) Stainless and wear-resistant steel in an PRS-approved combination with stock liner.

Pressure values higher than those specified in Table 2.4.9.1 may be applied if they are verified by tests and approved by PRS.

**2.4.9.4** The height/diameter ratio of the bearing surface shall not be greater than 1.2.

**2.4.9.5** For carrying the weight of a rudder blade and stock, a thrust bearing shall be applied. The deck under the thrust bearing shall be effectively strengthened. The rudder stock thrust bearings carrying the radial loads shall fulfil the requirements of 2.4.6 for pintles.

**2.4.9.6** Means shall be provided to protect a rudder blade and rudder stock against their axial displacement upward by a value greater than is provided in the steering gear design.

**2.4.9.7** Stuffing boxes shall be installed inside the opened rudder stock tube above the deepest load line in order to prevent water from entering into the steering gear compartment and washing out the thrust bearing lubricant.

Where the upper end of the rudder stock tube is located below the waterline at scantling draught (without trim), then two independent watertight seals / stuffing boxes shall be applied. The stuffing box shall be accessible for inspection and maintenance.

**2.4.9.8** With metal bearings, clearances shall be not less than  $d_w/1000 + 1.0$  [mm] on the diameter ( $d_w$  – the inner diameter of the bearing). If non-metallic material has been applied, the bearing clearance shall be determined taking into account the material's swelling and thermal expansion properties. This clearance shall not be less than 1.5 mm on the bearing diameter unless a smaller clearance is supported by the manufacturer's recommendation and there is documented evidence of satisfactory service history with a reduced clearance.

For spade rudders subjected to considerable bending moments causing significant deflections in the lower bearing, the design angular deflection at the bearing height shall be taken into account when determining the bearing clearance.

**2.4.9.9** The bearing length of the pintle  $L_p$  shall be such that:

$$D_p \leq L_p \leq 1.2 D_p \tag{2.4.9.9}$$

$D_p$  – actual pintle diameter measured on the outside of liners, [mm].



The length of the pintle housing in the gudgeon shall not be less than the pintle diameter  $D_p$ . The thickness of the pintle housing shall not be less than  $0.25D_p$ .

#### 2.4.10 Connections of Rudder Blade Structure with Solid Parts

**2.4.10.1** Solid parts in forged or cast steel, which house the rudder stock or the pintle, are to be provided with protrusions, except where not required as indicated below.

These protrusions are not required when the web plate thickness is less than:

- 10 mm for web plates welded to the solid part on which the lower pintle of a semi-spade rudder is housed and for vertical web plates welded to the solid part of the rudder stock coupling of spade rudders.
- 20 mm for other web plates.

**2.4.10.2** The solid parts are in general to be connected to the rudder structure by means of two horizontal web plates and two vertical web plates.

#### 2.4.10.3 Minimum section modulus of the connection with the rudder stock housing

The section modulus of the cross-section of the structure of the rudder blade, in  $\text{cm}^3$ , formed by vertical web plates and rudder plating, which is connected with the solid part where the rudder stock is housed shall not be less than:

$$W_s = c_s d_c^3 \left( \frac{H_E - H_X}{H_E} \right)^2 \frac{k}{k_s} 10^{-4} \quad [\text{cm}^3] \quad (2.4.10.3)$$

$c_s$  – coefficient, to be taken equal to:

- 1.0 if there is no opening in the rudder plating or if such openings are closed by a full penetration welded plate,
- 1.5 if there is an opening in the considered cross-section of the rudder;

$d_c$  – rudder stock diameter, [mm]

$H_E$  – vertical distance between the lower edge of the rudder blade and the upper edge of the solid part, [mm]

$H_X$  – vertical distance between the considered cross-section and the upper edge of the solid part, [mm]

$k$  – material factor for the rudder blade plating as given in 2.1.7.

$k_s$  – material factor for the rudder stock as given in 2.1.5.

The actual section modulus of the cross-section of the structure of the rudder blade shall be calculated with respect to the symmetrical axis of the rudder.

The breadth of the rudder plating to be considered for the calculation of section modulus shall not be greater than:

$$b = s_v + 2H_x/3 \quad [\text{m}]$$

$s_v$  – spacing between the two vertical webs (see Fig. 2.4.10.3), [m].

Where openings for access to the rudder stock nut are not closed by a full penetration welded plate, they shall be deducted.

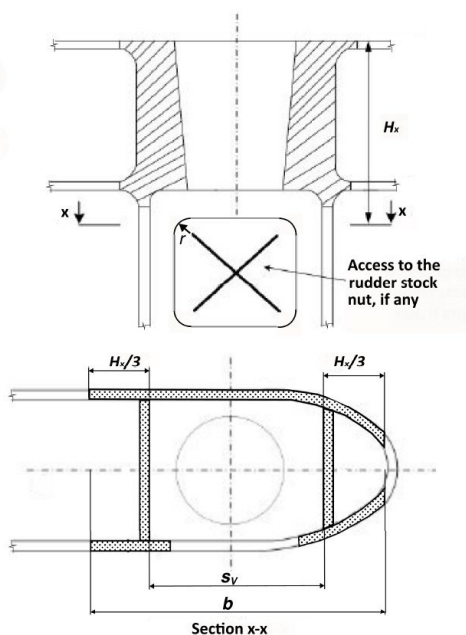


Fig. 2.4.10.3. Cross-section of the connection between rudder blade structure and rudder stock housing

**2.4.10.4** The thickness of the horizontal web plates connected to the solid parts  $t_H$ , in mm, as well as that of the rudder blade plating between these webs, shall not be less than the greater of the following values:

$$t_{H..} = 1.2t \text{ [mm]}$$

$$t_H = 0.045 d_S^2 / s_H \text{ [mm]}$$

$t$  – defined in 2.4.2.1;

$d_S$  – diameter, [mm], to be taken equal to:

$d_c$  – as per 2.4.4.2, for the solid part housing the rudder stock,

$d_p$  – as per 2.4.6.2, for the solid part housing the pintle,

$s_H$  – spacing between the two horizontal web plates, [mm].

The increased thickness of the horizontal webs shall extend fore and aft of the solid part at least to the next vertical web.

The thickness of the vertical web plates welded to the solid part where the rudder stock is housed as well as the thickness of the rudder side plating under this solid part shall not be less than the values obtained, in mm, from Table 2.4.10.4.

**Table 2.4.10.4**  
**Thickness of side plating and vertical web plates**

Type of rudder	Thickness of vertical web plate, [mm]		Thickness of rudder plating, [mm]	
	Rudder blade without opening	Rudder blade with opening	Rudder blade without opening	Area with opening
Rudder supported by sole piece	1.2t	1.6t	1.2t	1.4t
Semi-spade and spade rudders	1.4t	2.0t	1.3t	1.6t

$t$  – thickness of the rudder plating [mm], as defined in 2.4.2.1

The increased thickness shall extend below the solid piece at least to the next horizontal web.

## 2.5 Construction of Steering Nozzle

## 2.5.1 Steering Nozzle Plating

**2.5.1.1** The thickness of steering nozzle outer plating shall not be less than that determined by the formula:

$$s = K_1 l_1 \sqrt{\frac{98,1 D_d l_d T + 0,02 F_d}{D_d l_d R_e}} + 2 \text{ [mm]} \quad (2.5.1.1)$$

$D_d$  – inside diameter of nozzle [m];

$l_d$  – length of nozzle [m];

$F_d$  – design load acting on the nozzle, according to 2.3.2.1 [N];

$T$  – ship's draught [m];

$R_e$  – yield stress of the nozzle outer plating material [MPa];

$K_1$  – factor determined from Table 2.5.1.1, depending on  $u_1/l_1$  ratio;

**Table 2.5.1.1**

$u_1/l_1$	1.0	1.1	1.2	1.3	1.4	1.6	1.8 and over
$K_1$	5.7	6.0	6.3	6.6	6.8	7.0	7.2

$u_1$  – spacing of nozzle longitudinal stiffeners, measured on the outer plating, [m]; this spacing shall not exceed 1.0 m;

$l_1$  – spacing of nozzle stiffening rings or a distance of such ring from the centre or profile bounding inlet or outlet nozzle, [m]; this spacing shall not exceed 0.6 m.

For intermediate values of  $u_1/l_1$ ,  $K_1$  shall be determined by linear interpolation.

**2.5.1.2** The thickness of the inner plating of the steering nozzle, except for the middle strake, shall not be less than that determined by the formula:

$$s_w = 6.39 \frac{l_1}{D_d} \sqrt{T_s} \text{ [mm]} \quad (2.5.1.2-1)$$

$T_s$  – propeller thrust at speed  $v$  (for  $v$  – see 2.3.2.1) [kN];

$D_d$  and  $l_1$  – see 2.5.1.1.

The thickness of the middle strake of the steering nozzle shall not be less than that determined by the formula:

$$s_s = 7.34 \frac{l_2}{D_d} \sqrt{T_s} + 0.51 \frac{T_s}{D_d^2} \text{ [mm]} \quad (2.5.1.2-2)$$

$l_2$  – spacing of stiffening rings in way of middle strake of the nozzle inner plating, [m].

Where stainless or clad steel is used, the thickness  $s_s$  may be suitably reduced upon PRS' agreement.

**2.5.1.3** The minimum thickness of the outer or inner plating of the steering nozzle is in no case to be less than that determined by the formula:

$$s_{\min} = 24 \frac{L_0 + 37}{L_0 + 240} \text{ [mm]} \quad (2.5.1.3)$$

$L_0$  – design length of the ship [m].

**2.5.1.4** The middle strake of the nozzle inner plating shall have the width extending not less than to  $0.05D_d$  forward and not less than  $0.1D_d$  abaft the tips of the propeller blades. In no case shall the width of this strake be less than the maximum width of the lateral projection of the propeller blade.

**2.5.1.5** The outer and inner plating of the nozzle shall be reinforced by the stiffening rings and longitudinal stiffeners (webs). The spacing of these stiffening members shall fulfil the

requirements of 2.5.1.1. At least four equidistant longitudinal stiffeners shall be provided on the nozzle circumference.

The thickness of the stiffening members, except for those fitted in way of the middle strake of the nozzle inner plating, shall not be less than that of the outer plating as required by 2.5.1.1.

The stiffeners shall be welded with a double continuous full penetration weld. When the thickness of the stiffening is 10 mm and over – edge preparation shall be provided prior to welding. The stiffening rings and longitudinal stiffeners shall be provided with sufficient number of openings for free drainage of water which could penetrate inside the nozzle, and the top and bottom parts of the nozzle shall be fitted with drain plugs of stainless metal. The distance of edges of these openings from the inner and outer plating of the nozzle shall not be less than 0.25 times the height of the stiffening members.

No cover plates shall be welded to the inner plating of the nozzle.

**2.5.1.6** In way of middle strake of the nozzle inner plating, at least two continuous stiffening rings shall be provided. The thickness of these rings shall not be less than that of the inner plating outside the middle strake, as determined by formula 2.5.1.2-1.

**2.5.1.7** Particular attention shall be paid to the strength of steering nozzle connection with the flange, boss and other welded elements connecting the nozzle with the stock and pintle.

**2.5.1.8** The thickness of the stabilizer plating shall not be less than that determined by the formula:

$$s_{st} = K_1 l_1 \sqrt{\frac{98.1 A_{st} T + 0.02 F_{st}}{A_{st} R_e} + 2} \text{ [mm]} \quad (2.5.1.8)$$

$A_{st}$  – surface area of nozzle stabilizer [m<sup>2</sup>];

$T$  – ship's draught [m];

$F_{st}$  – design load acting on the stabilizer, according to 2.3.2.1-3 [N];

$K_1$  – factor determined from Table 2.5.1.1, depending on  $u_1/l_1$  ratio;

$R_e$  – yield stress of stabilizer plating material [MPa];

$u_1$  – spacing of horizontal web plates [m];

$l_1$  – spacing between the vertical web plates or distance between web plate and the leading or trailing edge of the stabilizer [m].

**2.5.1.9** The stabilizer plating shall be reinforced from the inside by continuous horizontal and vertical web plates of a thickness not less than that of the plating as required by 2.5.1.8.

The top and bottom plates of the stabilizer shall be of a thickness not less than 1.5 times the plate thickness required by 2.5.1.8. Vertical web plates shall be firmly connected to the top and bottom plates.

The horizontal and vertical web plates shall be provided with a sufficient number of openings for free drainage of water and the bottom and top plates shall be fitted with drain plugs of stainless material.

**2.5.1.10** In way of stabilizer to nozzle connection, one or several additional stiffeners shall be provided to ensure the general strength of the stabilizer structure. The section modulus of these stiffeners with the effective flanges shall be determined by the formula:

$$W_{st} = 1.39 \frac{F_{st} h_{st}}{R_e} \text{ [cm}^3\text{]} \quad (2.5.1.10)$$

$F_{st}$  – design load acting on stabilizer as determined by formula 2.3.2.1-3 [N];

$h_{st}$  – stabilizer height [m];  
 $R_e$  – yield stress of the material used [MPa].

The effective flange shall have a thickness equal to that of the stabilizer plating and a width equal to 0.20 times the stabilizer height.

**2.5.1.11** The stabilizer shall be firmly connected to the nozzle.

In strength calculations, the design load  $F_{st}$  acting on the stabilizer shall be determined from formula 2.3.2.1-3. Depending on the type of nozzle with stabilizer connection, the point of  $F_{st}$  load application shall be taken into account when determining the torque caused by this load (see 2.3.2.3). The working stresses acting in the connection (see 1.6) shall not exceed 0.4 times the yield stress of the material used.

## 2.5.2 Rudder Nozzle Stock

**2.5.2.1** The diameter of the upper part of rudder nozzle stock above the upper bearing in way of the tiller shall not be less than that determined by the formula:

$$d_0 = 4.03 \sqrt[3]{\frac{M_1}{471+R_e}} \text{ [cm]} \quad (2.5.2.1)$$

$M_1$  – design torque according to 2.3.3, [Nm];  
 $R_e$  – yield stress of the rudder nozzle stock material, [MPa].

**2.5.2.2** The diameter of the rudder nozzle stock in way of the lower bearing shall not be less than that determined by the formula:

$$d_1 = 4.24 \sqrt[3]{\frac{\sqrt{0.75M_1^2 + M_2^2}}{471+R_e}} \text{ [cm]} \quad (2.5.2.2)$$

$M_2$  – design bending moment according to 2.3.4, [Nm].

The diameter determined according to the above formula shall be maintained up to the flange.

**2.5.2.3** The diameter of the rudder nozzle stock in way of the upper bearing shall not be less than that determined by the formula:

$$d_7 = 4.24 \sqrt[3]{\frac{\sqrt{0.75M_5^2 + M_6^2}}{471+R_e}} \text{ [cm]} \quad (2.5.2.3-1)$$

$M_5$  – torque in the stock in question, generated by nozzle gear at the rated torque, [Nm];  
 $M_6$  – bending moment in way of the upper bearing, generated by nozzle gear and determined by the following formula:

$$M_6 = M_5 \frac{h_4}{r_1} \text{ [Nm]} \quad (2.5.2.3-2)$$

$h_4$  – distance from the centre of the upper bearing to the centre of quadrant or tiller fastening, measured along the stock axis, [m];

$r_1$  – distance from the stock axis to the line of force generated by the nozzle gear, acting on the quadrant or tiller, [m].

**2.5.2.4** The transition from  $d_0$  to  $d_1$  diameter shall be gradual and smooth. Where the transition of the nozzle stock diameter is stepped, the fillet radii, as great as practicable, shall be applied. The transition of the nozzle stock into the flange shall be made with a fillet radius not less than 0.12 times the stock diameter in way of the flange.

### 2.5.3 Steering Nozzle Pintles

**2.5.3.1** The pintle diameter (the liner thickness not included) shall not be less than that determined by the formula:

$$d_3 = \sqrt{\frac{R_2}{471+R_e}} \text{ [cm]} \quad (2.5.3.1)$$

$R_2$  – design reaction force, according to 2.3.4, [N];

$R_e$  – yield stress of the pintle material, [MPa].

**2.5.3.2** The length of the pintle tapered part, fitting the pintle into the sole piece, shall not be less than the diameter of the pintle determined according to 2.5.3.1; the taper on the diameter shall not exceed 1:6. The taper shall pass into cylindrical portion without a step.

The outer diameter of the threaded part of the pintle shall not be less than 0.8 times the minimum diameter of the taper. The outer diameter and length of the nut shall not be less than 1.5 and 0.6 times the outer diameter of the pintle threaded part, respectively.

**2.5.3.3** The length of cylindrical part of the pintle shall not be less than its diameter (including liner, if fitted), but not greater than 1.3 times this diameter.

**2.5.3.4** The material thickness in gudgeons, including gudgeon bushings in the bearing, shall not be less than 0.5 times the diameter of the pintle without bushing. Possible deviation from this requirement will be specially considered by PRS.

**2.5.3.5** To prevent self-loosening, the pintle nut shall be reliably locked by means of at least two welded on strips (washers) or one washer and a cotter pin, the pintle being effectively clamped in its seating.

**2.5.3.6** The selected dimensions of pintles shall be checked for surface pressure, taken as:

$$p = \frac{R_2}{d_3 h} 10^{-2} \text{ [MPa]} \quad (2.5.3.6)$$

$R_2$  – design reaction force in sternframe bearing, according to 2.3.4, [N];

$d_3$  – pintle diameter (including the liner, if fitted), [cm];

$h$  – height of pintle liner, [cm].

This surface pressure shall not exceed the values specified in Table 2.4.9.1. The use of materials different from those specified in this Table for rubbing parts will be specially considered by PRS.

### 2.5.4 Nozzle to Stock Coupling

**2.5.4.1** Where the nozzle stock is connected to the steering nozzle by means of horizontal flange couplings, the diameter of the coupling bolts shall not be less than that determined by the formula:

$$d_2 = 5.54 \sqrt{\frac{\sqrt{0.75M_l^2 + M_3^2}}{z\rho(471+R_e)}} \text{ [cm]} \quad (2.5.4.1)$$

$M_l$  – design torque according to 2.3.3 [Nm];

$M_3$  – design bending moment according to 2.3.4 [Nm];

$z$  – number of coupling bolts (studs);

$\rho$  – mean distance from the centre of the bolts to the flange centre [cm];

$R_e$  – yield stress of the bolts material [MPa].

The number of bolts shall not be less than 6. The distance from the centre of any bolt to the flange centre shall not be less than 0.7 times the diameter of the nozzle stock  $d_0$  according to 2.5.2.1. For nozzles, where the nozzle stock is subjected both to torque and bending, it is additionally required that the distance from the centre of any bolt to the centre line of the nozzle should be not less than 0.6 times the design diameter of the nozzle stock  $d_1$ , determined according to 2.5.2.2.

**2.5.4.2** All bolts shall be fitted bolts; only in the case when a key is applied, the number of fitted bolts may be reduced to two. The nuts shall be of standard proportions. The bolts and nuts shall be reliably protected against loosening.

**2.5.4.3** The thickness of coupling flanges shall not be less than the diameter of bolts. The distance between the centres of the bolt holes and the flange edge shall not be less than 1.15 times the bolt diameter.

**2.5.4.4** Where the connection between the stock and the nozzle is of a conical type, the length of a tapered part of the stock shall not be less than 1.5 times the stock diameter determined according to 2.5.2.2; the taper on diameter shall not exceed 1:6. The taper shall pass smoothly into the cylindrical portion.

**2.5.4.5** A key shall be set on the cone generatrix. The key ends shall be suitably rounded. The working area of the key cross-section (the product of the key length and width) shall not be less than that determined by the formula:

$$A_f = \frac{26M_l}{d_m(471+R_e)} \text{ [cm}^2\text{]} \quad (2.5.4.5)$$

$M_l$  – design torque determined according to 2.3.3 [Nm];

$d_m$  – diameter of the taper cross-section in the middle of the key length [cm];

$R_e$  – yield stress of the key material [MPa].

The key height shall not be less than half of its width.

**2.5.4.6** The outer diameter of the threaded part of the nozzle stock shall not be less than 0.9 times the minimum diameter of the taper. Fine thread shall be applied.

The outer diameter and length of the nut shall not be less than 1.5 and 0.8 times the outer diameter of the threaded part of the nozzle stock, respectively.

To prevent self-loosening, the nut shall be reliably locked by means of at least two welded on strips or one washer and a cotter pin.

**2.5.4.7** Where the nozzle stock is not made of one solid piece, its parts shall be jointed by means of a ribbed-clamp coupling. Such coupling shall be provided with at least 8 bolts. The total sectional area of the bolts shall not be less than that determined by the formula:

$$A_b = 0.44d^2 \text{ [cm}^2\text{]} \quad (2.5.4.7-1)$$

$d$  – nozzle stock diameter in way of connection, [cm].

The thickness of each flange of the ribbed-clamp coupling shall not be less than 0.3 times the nozzle stock diameter in way of the connection. Additionally, keys shall be provided at the connection; the area of their working cross-section shall not be less than that determined by the formula:

$$A_f = \frac{26M_l}{d(471+R_e)} \text{ cm}^2 \quad (2.5.4.7-2)$$

$M_l$  – design torque determined according to 2.3.3, [Nm];

$d$  – diameter of the nozzle stock in way of the connection, [cm];

$R_e$  – yield stress of the key material, [MPa].



**2.5.4.8** Where the steering nozzle coupling is not built in the structure of the nozzle but connected to the plates of the steering nozzle casing, the strength of such a structure shall be equivalent to that of the stock. The design stress shall not exceed 0.4 times the yield stress of the material used.

## **2.5.5 Steering Nozzle Stock Thrust Bearings**

**2.5.5.1** Thrust bearings of the stock carrying horizontal loads shall fulfil the requirements of 2.5.3.6 for pintles.

**2.5.5.2** For carrying the weight of a nozzle and stock, a thrust bearing shall be installed. The deck under the thrust bearing shall be effectively strengthened.

Effective means shall be provided to protect the nozzle and stock against their axial displacement upward by a value exceeding those provided in the steering gear design.

**2.5.5.3** A stuffing box shall be fitted in way of passage of the nozzle stock through the ship's plating to prevent water from entering the ship's space. The stuffing box shall be fitted in a place accessible for inspection and maintenance.

## **2.6 Power System**

### **2.6.1 Steering Gears**

**2.6.1.1** Each ship shall be provided with two steering gears: the main steering gear and the auxiliary steering gear, complying with the requirements of 2.6.1.2 and 2.6.1.3 respectively, unless stated otherwise. The main steering gear and the auxiliary steering gear shall be so arranged that the failure of one of them will not render the other one inoperative. (SOLAS II-1/29.1)

This requirement is considered satisfied for a ship fitted with a single steering-propulsion unit if the steering gear is provided with two or more steering actuating systems and is in compliance with 2.6.1.5. A detailed risk assessment is to be submitted in order to demonstrate that in the case of any single failure in the steering gear, control system and power supply the ship steering is maintained. (IACS UI SC242, Rev.2)

For a ship fitted with multiple steering propulsion units, such as but not limited to the azimuthing propulsors or water jet propulsion system each of the steering-propulsion units shall be provided with a main steering gear and an auxiliary steering gear or with two or more identical steering actuating systems in compliance with 2.6.1.5. The main steering gear and the auxiliary steering gear shall be so arranged that the failure of one of them will not render the other one inoperative. (IACS UI SC242, Rev.2)

All the steering gear components and the rudder stock shall be of sound reliable construction and comply with PRS requirements. Special consideration shall be given to the suitability of any essential component which is not duplicated. Any such essential component shall, where appropriate, utilize anti-friction bearings such as ball bearings, roller bearings or sleeve bearings which shall be permanently lubricated or provided with lubrication fittings.

All components used in steering arrangements for ship directional control are to be sound reliable construction to the satisfaction of the Administration or recognized organizations acting on its behalf. Special consideration shall be given to the suitability of any essential component which is not duplicated. Any such essential component shall, where appropriate, utilize anti-friction bearings such as ball bearings, roller bearings or sleeve bearings which shall be permanently lubricated or provided with lubrication fittings. (SOLAS II-1/29.2)



The steering gear compartment shall be:

- easily accessible and, as far as practicable, separated from machinery compartments,
- suitably arranged for ensuring working access to the steering gear and control system. For this purpose, guard rails and gratings or other non-slip surfaces to ensure suitable working conditions in the case of hydraulic fluid leakage shall be provided.

Steering gears shall fulfil the requirements of sub-chapter 6.2, *Part VII – Machinery, Boilers and Pressure Vessels*, as well as of sub-chapter 5.5, *Part VIII – Electrical Installations and Control Systems*.

**2.6.1.2** The main steering gear and rudder stock or the main steering arrangements for ship directional control shall be of adequate strength and capable of steering the ship at maximum ahead service speed which shall be demonstrated.

The main steering gear shall be capable of putting the rudder or steering nozzle over from 35° on one side to 35° on the other side with the ship at its deepest seagoing draught while running ahead with the maximum ahead service speed. Under the same conditions, the steering gear shall be capable of putting the rudder or steering nozzle over from 35° on either side to 30° on the other side in not more than 28 seconds at rated parameters of the ship power system.

Where it is impractical to demonstrate compliance with this requirement during sea trials with the ship at its deepest seagoing draught and running ahead at the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch, ships may demonstrate compliance with this requirement by one of the following methods:

- .1 during sea trials the ship is at even keel and the rudder fully submerged whilst running ahead at the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch; or
- .2 where full rudder immersion during sea trials cannot be achieved, an appropriate ahead speed shall be calculated using the submerged rudder blade area in the proposed sea trial loading condition. The calculated ahead speed shall result in a force and torque applied to the main steering gear which is at least as great as if it was being tested with the ship at its deepest seagoing draught and running ahead at the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch; or
- .3 the rudder force and torque at the sea trial loading condition have been reliably predicted and extrapolated to the full load condition. The speed of the ship shall correspond to the number of maximum continuous revolutions of the main engine and maximum design pitch of the propeller.

The main steering gear and rudder stock/the main steering arrangements for ship directional control shall be so designed that they will not be damaged at maximum astern speed, however this design requirement need not be proved by trials at maximum astern speed and maximum rudder angle.

For ships fitted with alternative propulsion and steering arrangements, such as but not only limited to azimuthing propulsors or water jet propulsion systems, the main steering arrangements for ship directional control shall be capable of changing direction of the steering-propulsion unit from one side to the other at declared steering angle limits<sup>1</sup> at an average turning speed of not less than 2.3°/s with the ship running ahead at maximum ahead service speed. (SOLAS II-1/29.3)

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<sup>1</sup> Declared steering angle limits – are the operational limits in terms of maximum steering angle, or equivalent, according to manufactures guidelines for safe operation, also taking into account the ship's speed or propeller torque/speed or other limitation. The "declared steering angle limits" shall be declared by the directional control system manufacturer for each ship specific non-traditional steering mean; ship's manoeuvrability tests, such as those in the

**2.6.1.3** The auxiliary steering gear or the auxiliary steering arrangements for ship directional control shall be of adequate strength and capable of steering the ship at navigable speed and of being brought speedily into action in an emergency.

The auxiliary steering gear shall be capable of putting the rudder or steering nozzle over from 15° on one side to 15° on the other side in not more than 60 seconds with the ship at the deepest seagoing draught while running ahead at one half of the maximum ahead service speed or 7 knots, whichever is the greater.

Where it is impractical to demonstrate compliance with this requirement during sea trials with the ship at its deepest seagoing draught and running ahead at one half of the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch or 7 knots, whichever is greater, ships may demonstrate compliance with this requirement by one of the following methods:

- .1 during sea trials the ship is at even keel and the rudder fully submerged whilst running ahead at one half of the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch or 7 knots, whichever is greater; or
- .2 where full rudder immersion during sea trials cannot be achieved, an appropriate ahead speed shall be calculated using the submerged rudder blade area in the proposed sea trial loading condition. The calculated ahead speed shall result in a force and torque applied to the auxiliary steering gear which is at least as great as if it was being tested with the ship at its deepest seagoing draught and running ahead at one half of the speed corresponding to the number of maximum continuous revolutions of the main engine and maximum design pitch or 7 knots, whichever is greater; or
- .3 the rudder force and torque at the sea trial loading condition have been reliably predicted and extrapolated to the full load condition.

The auxiliary steering gear shall be operated by power where necessary to meet the requirements of 2.6.1.3 and in any case when a rudder stock of over 230 mm diameter in way of the tiller is required, excluding strengthening for navigation in ice.

For ships fitted with alternative propulsion and steering arrangements such as but not only limited to azimuthing propulsors or water jet propulsion system, the auxiliary steering arrangements for ship directional control shall be capable of changing direction of the ship's directional control system from one side to the other at declared steering angle limits at an average turning speed, of not less than 0.5°/s with the ship running ahead at one half of the maximum ahead service speed or 7 knots, whichever is the greater. The auxiliary steering arrangements for ship directional control shall be operated by power where necessary to meet the requirements of 2.6.1.3 and in any ship having power of more than 2500 kW propulsion power per steering-propulsion unit. (SOLAS II-1/29.4)

**2.6.1.4** In ships of 70000 gross tonnage and upwards, the steering gear shall comprise at least two identical power units complying with the requirements of 2.6.1.7, the requirements of 2.6.1.2 being complied with when one of the power units is switched off.

**2.6.1.5** Where the main steering gear comprises two or more identical power units, the auxiliary steering gear need not be fitted, provided:

- that the main steering gear is capable of operating the rudder as required by paragraph 2.6.1.2 while operating with all power units, or

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Standards for ship manoeuvrability (resolution MSC.137(76)) shall be carried out with steering angles not exceeding the declared steering angle limits.

- the main steering gear is arranged so that after a single failure in its piping system or in one of the power units the defect can be isolated so that steering capability can be maintained or speedily regained.

For a ship fitted with a single steering-propulsion unit where the main steering gear comprises two or more identical power units and two or more identical steering actuators, an auxiliary steering gear need not be fitted provided that the steering gear:

- is capable of satisfying the requirements of 2.6.1.2 while operating with all power units; and
- is arranged so that after a single failure in its piping system or in one of the power unit, steering capability can be maintained or speedily regained.

For a ship fitted with multiple steering propulsion units, where each main steering system comprises two or more identical steering actuating systems, an auxiliary steering gear need not be fitted, provided that each steering gear:

- is capable of satisfying the requirements of 2.6.1.2 while operating with all steering gear steering actuating systems,
- is arranged so that after a single failure in its piping or in one of the steering actuating systems, steering capability can be maintained or speedily regained

the above capacity requirements apply regardless whether the steering systems are arranged with common dedicated power units.

**2.6.1.6** When the compartment of power units for the main and auxiliary steering gear is located below the deepest load waterline, an emergency propulsion located above the bulkhead deck shall be provided. This propulsion shall ensure putting the rudder or the steering nozzle over from one side to another at a draught to the summer load waterline while running ahead at a speed of at least 4 knots.

**2.6.1.7** Where the rudder stock is required to be over 230 mm in way of the tiller with diameter calculated for normal strength steel with  $R_e = 235$  MPa, excluding strengthening for navigation in ice, an alternative power supply, sufficient at least to supply the steering gear power unit which complies with the requirements of 2.6.1.3 and also its associated control system and the rudder angle indicator, shall be provided automatically, within 45 seconds, either from the emergency source of electrical power or from an independent source of power located in the steering gear compartment. This independent source of power shall be used only for this purpose. In every ship of 10000 gross tonnage and upwards, the alternative power supply shall have a capacity for at least 30 min of continuous operation and in any other ship for at least 10 min.

Where the propulsion power exceeds 2,500 kW per thruster unit, an alternative power supply, sufficient at least to supply the steering arrangements which complies with the requirements of paragraph 2.6.1.3 and also its associated control system and the steering gear response indicator, shall be provided automatically, within 45seconds, either from the emergence source of electrical power or from an independent source of power located in the steering gear compartment. This independent source of power shall be used only for this purpose. In every ship of 10000 gross tonnage and upwards, the alternative power supply shall have a capacity for at least 30 min of continuous operation and in any other ship for at least 10 min. This requirement is valid to the steering propulsion units having a certain proven steering capability due to ship speed also in case propulsion power has failed.

**2.6.1.8** The main steering gear may be hand-operated, provided the rudder stock diameter in way of the tiller or steering nozzle stock diameter, calculated for normal strength steel with  $R_e = 235$  MPa, does not exceed 120 mm (excluding strengthening for navigation in ice). In any other case the main steering gear shall be operated by a power unit.

**2.6.1.9** The auxiliary steering gear may be hand-operated, provided the required diameter of the rudder stock or steering nozzle stock, calculated for normal strength steel with  $R_e = 235$  MPa, does not exceed 230 mm (excluding ice strengthening). In any other case the auxiliary steering gear shall be operated by a power unit.

**2.6.1.10** The main and auxiliary steering gear shall act on the rudder stock or steering nozzle stock independent of one another; however, they may have some common parts (e.g. tiller, quadrant, gear box or cylinder block).

**2.6.1.11** The rudder tackle may be considered as an auxiliary or emergency steering gear only for:

- self-propelled ships of less than 500 gross tonnage,
- non-propelled ships.

**2.6.1.12** In order for ships to comply with the performance requirements stated in paragraphs 2.6.1.2 and 2.6.1.3 they shall have steering gear capable of meeting these performance requirements when at the deepest seagoing draught. In order to demonstrate this ability, the trials may be conducted in accordance with Section 6.1.5.1 of *ISO 19019:2005 Sea-going vessels and marine technology – Instructions for planning carrying out and reporting sea trials*.

On all occasions when trials are conducted with the ship not at the deepest seagoing draught, the loading condition can be accepted on the conditions that either:

- .1 the rudder is fully submerged (at zero speed waterline) and the ship is in an acceptable trim condition, or
- .2 the rudder torque at the trial loading condition has been reliably predicted (based on the system pressure measurement) and extrapolated to the maximum seagoing draught condition using the following method to predict the equivalent torque and actuator pressure at the deepest seagoing draught:

$$Q_F = Q_T \alpha \quad [\text{kNm}] \quad (2.6.1.12-1)$$

$$\alpha = 1.25 \left( \frac{A_F}{A_T} \right) \left( \frac{V_F}{V_T} \right)^2 \quad (2.6.1.12-2)$$

$\alpha$  – extrapolation factor;

$Q_F$  – rudder stock moment for the deepest service draught and maximum service speed condition, [kNm];

$Q_T$  – rudder stock moment for the trial condition, [kNm];

$A_F$  – total immersed projected area of the movable part of the rudder in the deepest seagoing condition, [m<sup>2</sup>];

$A_T$  – total immersed projected area of the movable part of the rudder in the trial condition, [m<sup>2</sup>];

$V_F$  – contractual design speed of the ship corresponding to the maximum continuous revolutions of the main engine at the deepest seagoing draught, [knots];

$V_T$  – measured speed of the ship (considering current) in the trial condition, [knots].

Where the rudder actuator system pressure is shown to have a linear relationship to the rudder stock torque the above equation can be taken as:

$$P_F = P_T \alpha \quad [\text{MPa}] \quad (2.6.1.12-3)$$

$P_F$  – estimated steering actuator hydraulic pressure in the deepest seagoing draught condition, [MPa];

$P_T$  – maximum measured actuator hydraulic pressure in the trial condition, [MPa].

Where constant volume fixed displacement pumps are utilized then the regulations can be deemed satisfied if the estimated steering actuator hydraulic pressure at the deepest draught is less than the specific maximum working pressure of the rudder actuator. Where a variable delivery pump is utilized, pump data shall be supplied and interpreted to estimate if the delivered flow rate corresponds to the deepest seagoing draught in order to calculate the steering time and allow it to be compared to the required time.

Where  $A_T$  is greater than  $0.95A_F$  there is no need for extrapolation methods to be applied.

- .3 alternatively, the designer or builder may use computational fluid dynamic (CFD) studies or experimental investigations to predict the rudder stock moment at the full seagoing draught condition and service speed. These calculations or experimental investigations shall be to the satisfaction of PRS.

In any case, for the main steering gear trial, the speed of the ship, corresponding to the maximum number of continuous revolution of main engine and maximum design pitch, applies.

## 2.6.2 Rudder Angle Limiters

**2.6.2.1** The steering gear shall be provided with rudder angle limiters permitting to put the rudder or steering nozzle over either side only to an angle  $\beta$ , which shall be:

$$(\alpha + 1^\circ) \leq \beta \leq (\alpha + 1.5^\circ) \quad (2.6.2.1)$$

$\alpha$  – maximum rudder or steering nozzle deflection angle to which the steering gear control system is set, but not more than  $35^\circ$ .

The use of greater maximum angle is subject to PRS agreement in each particular case.

**2.6.2.2** All parts of limiters, including those which are at the same time the parts of the steering gear, shall be designed to withstand overloading by the rudder stock torque not less than:

$$M_{skr} = 1.135R_e d^3 10^{-4} \quad (2.6.2.2)$$

$M_{skr}$  – design torque of the rudder stock, [kNm];

$d$  – actual diameter of the upper part of the rudder stock, [cm];

$R_e$  – yield stress of the rudder stock material, [MPa].

The stresses in these parts shall not exceed 0.95 times the yield stress of the material used.

**2.6.2.3** The rudder angle limiters may be attached to the sternframe, as well as to a deck, platform, bulkhead or other structural members of the ship's hull.

## 2.6.3 Steering Gear Control System

**2.6.3.1** Control of the main steering gear shall be provided both on the navigation bridge and in the steering gear compartment.

**2.6.3.2** If the main steering gear is made in compliance with 2.6.1.4, two independent control systems shall be provided. Duplication of the steering wheel or steering handle is not required. Where the control system comprises a hydraulic telemotor, the second independent control system need not be installed, except for gas carriers, tankers and chemical carriers of 10 000 gross tonnage and upwards, and for passenger ships of 70 000 gross tonnage and upwards.

**2.6.3.3** The auxiliary steering gear shall be operated from the steering gear compartment.

Power driven auxiliary steering gear shall be provided with a control system operated also from the navigation bridge. The system shall be independent of the control system for the main steering gear.

**2.6.3.4** Indicators of angular position of the rudder or steering nozzle shall be installed at the main and auxiliary steering gear control stations, as well as at the compartments of these gears. The accuracy of readings relative to the actual position of the rudder blade or the longitudinal axis of the steering nozzle shall not exceed:

- 1° – when the rudder blade or the longitudinal axis of the steering nozzle is set in the ship centre plane or parallel to it,
- 1.5° – for rudder angles less than 5°,
- 2.5° – for rudder angles from 5° to 35°.

Indicators of angular position of the rudder or the steering nozzle in the wheelhouse shall be independent of the steering gear remote control system.

**2.6.3.5** For ships having additional marks in their symbol of class, in addition to the above requirements, the requirements set forth in Chapters 11, 12, 13, 14, 16 and 18 are also applicable.

## **2.7 Standards for Ship Manoeuvrability**

### **2.7.1 General**

#### **2.7.1.1 Application**

**2.7.1.1.1** The Standards should be applied to ships of all rudder and propulsion types, of 100 m in length and over, and chemical tankers and gas carriers regardless of the length.

**2.7.1.1.2** In the event that the ships referred to in paragraph 2.7.1.1.1 undergo repairs, alterations or modifications, which, in the opinion of PRS, may influence their manoeuvrability characteristics, the continued compliance with the Standards should be verified.

**2.7.1.1.3** Whenever other ships, originally not subject to the Standards, undergo repairs, alterations or modifications, which, in the opinion of PRS, are of such an extent that the ship may be considered to be a new ship, then that ship should comply with these Standards. Otherwise, if the repairs, alterations and modifications, in the opinion of PRS, may influence the manoeuvrability characteristics, it should be demonstrated that these characteristics do not lead to any deterioration of the manoeuvrability of the ship.

**2.7.1.1.4** The Standards should not be applied to high-speed craft.

#### **2.7.1.2 Ship Manoeuvrability Tests**

**2.7.1.2.1** The following two methods can be used to demonstrate ship's compliance with these standards to PRS:

- .1 scale model tests and/or computer predictions using mathematical models can be performed to predict compliance at the design stage. In this case full-scale trials should be conducted to validate these results. The ship should then be considered to meet these Standards regardless of full-scale trial results, except where PRS determines that the prediction efforts were substandard and/or the ship performance is in substantial disagreement with these Standards;
- .2 the compliance with the Standards can be demonstrated based on the results of the full-scale trials conducted in accordance with the Standards. If a ship is found in substantial disagreement with the Standards, then PRS will take remedial action, as appropriate.

The trials shall be performed according to paragraphs 2.7.2 and 2.7.3. The detailed description of the trials is given by *Publication 25/I – Explanatory Notes to the Standards for Ship Manoeuvrability*.



### 2.7.1.3 Definitions

#### 2.7.1.3.1 Terminology Associated with Ship's Geometry

*Length (L)* – the length measured between the aft and forward perpendiculars.

*Midship point* – the point on the centreline of a ship midway between the aft and forward perpendiculars and on the summer load waterline.

#### 2.7.1.3.2 Terminology Associated with Standard Manoeuvres

*Advance* – the distance travelled in the direction of the original course by the midship point of a ship from the position at which the rudder order is given to the position at which the heading has changed 90° from the original course.

*Full astern stopping test* – the manoeuvre to determine the track reach of a ship from the time an order for full astern is given until the ship stops in the water.

*Overshoot angle (the first and the second)* – the additional heading deviation experienced in the zig-zag test (following the second execute and the third execute, respectively – the executes are described in detail in 2.7.3.3).

*Tactical diameter* – the distance travelled by the midship point of a ship from the position at which the rudder order is given to the position at which the heading has changed 180° from the original course. It is measured in a direction perpendicular to the original heading of the ship.

*Test speed (V)* – a speed of at least 90% of the ship's speed corresponding to 85% of the maximum engine output.

*Track reach* – the distance along the path described by the midship point of a ship measured from the position at which an order for full astern is given to the position at which the ship stops in the water.

*Turning circle manoeuvre* – the manoeuvre to be performed to both starboard and port with 35° rudder angle or the maximum rudder angle permissible at the test speed, following a steady approach with zero yaw rate.

*Zig-zag test* – the manoeuvre where a known amount of helm is applied alternately to either side when a known heading deviation from the original heading is reached.

#### 2.7.1.4 Tests Records

The stopping times, ship headings and distances recorded on trials, together with the result of trials to determine the ability of ships having multiple propulsion/steering arrangements to navigate and manoeuvre with one or more of these devices inoperative shall be available on board for the use of the master or designated personnel.

### 2.7.2 Conditions for Standard Manoeuvres Performance

**2.7.2.1** The standard manoeuvres shall be performed without the use of any manoeuvring aids which are not continuously and readily available in normal operation.

**2.7.2.2** In order to evaluate the performance of a ship, manoeuvring trials should be conducted to both port and starboard and at conditions specified below:

- .1 deep, unrestricted water;
- .2 calm environment;
- .3 full load (summer load line draught), even keel condition; and
- .4 steady approach at the test speed.

**2.7.2.3** For ships with non-conventional steering and propulsion systems (other than shaft driven, with conventional rudders ), PRS may permit the use of steering angles specified in paragraph 2.7.3.

**2.7.2.4** Where standard manoeuvres indicate dynamic instability, alternative tests may be conducted to define the degree of instability. Guidelines for alternative tests such as a spiral test or pull-out manoeuvre are included in *Publication 25/I – Explanatory Notes to the Standards for Ship Manoeuvrability*.

In case the standard trials are conducted at a condition different from those specified in paragraph 2.7.2.2, necessary corrections should be made in accordance with the guidelines contained in *Publication 25/I*.

## **2.7.3 Evaluation of Ship Manoeuvrability during Manoeuvres**

### **2.7.3.1 Turning ability**

**2.7.3.1.1** Ship's turning ability should be tested in the turning circle manoeuvre.

**2.7.3.1.2** Turning circle manoeuvre is the manoeuvre performed to both starboard and port with 35° rudder angle or the maximum rudder angle permissible at the test speed, following a steady approach with zero yaw rate.

**2.7.3.1.3** Manoeuvrability of the ship is considered satisfactory if the advance does not exceed 4.5 ship lengths ( $L$ ) and the tactical diameter does not exceed 5 ship lengths in the turning circle manoeuvre.

### **2.7.3.2 Initial turning ability**

Initial turning ability is considered satisfactory if with the application of 10° rudder angle to port/starboard, the ship has not travelled more than 2.5 ship lengths by the time the heading has changed by 10° from the original heading.

### **2.7.3.3 Yaw-checking and course-keeping abilities**

**2.7.3.3.1** Yaw-checking and course-keeping abilities should be checked in two zig-zag tests: the 10°/10° zig-zag and the 20°/20° zig-zag test – as specified below.

**2.7.3.3.2** The 10°/10° zig-zag test is conducted by shifting the rudder angle by 10° alternately to either side following a 10° deviation from the ship's original heading, according to the following procedure:

- .1 after a steady approach with zero yaw rate, the rudder is put over to 10° to starboard or port (first execute);
- .2 when the heading has changed to 10° off the original heading, the rudder is reversed to 10° to port or starboard (second execute);
- .3 after the rudder has been turned to port/starboard, the ship will continue turning in the original direction with decreasing turning rate. In response to the rudder, the ship should then turn to port/starboard. When the ship has reached a heading of 10° to port/starboard of the original course the rudder is again reversed to 10° to starboard/port (third execute).

**2.7.3.3.3** The 20°/20° zig-zag test should use the procedure given in 2.7.3.3.2 with 20° rudder angles coupled with a 20° change of heading from the original course, instead of, respectively, 10° rudder angles coupled with a 10° change of heading.

**2.7.3.3.4** Manoeuvrability of the ship is considered satisfactory if:



- (i) the value of the first overshoot angle in the 10°/10° zig-zag test does not exceed:
  - .1 10° if  $L/V$  is less than 10 s;
  - .2 20° if  $L/V$  is 30 s or more; and
  - .3  $(5 + 1/2(L/V))$  degrees if  $L/V$  is 10 s or more, but less than 30 s, where  $L$  and  $V$  are expressed in m and m/s, respectively.
- (ii) the value of the second overshoot angle in the 10°/10° zig-zag test does not exceed:
  - .1 25°, if  $L/V$  is less than 10 s;
  - .2 40°, if  $L/V$  is 30 s or more; and
  - .3  $(17.5 + 0.75(L/V))^\circ$ , if  $L/V$  is 10 s or more, but less than 30 s.
- (iii) and the value of the first overshoot angle in the 20°/20° zig-zag test does not exceed 25°.

#### **2.7.3.4 Stopping ability**

**2.7.3.4.1** Stopping ability should be determined in the stopping test.

**2.7.3.4.2** Stopping ability is considered satisfactory if the track reach in the full astern stopping test does not exceed 15 ship lengths. However, this value may be modified by PRS where ships of large displacement make this criterion impracticable, but should in no case exceed 20 ship lengths.

**2.7.3.4.3** The stopping times, ship headings and distances recorded on trials, together with the results of trials to determine the ability of ships having multiple propellers/multiple propulsion-steering arrangements to navigate and manoeuvre with one or more propellers/a. m. devices inoperative, shall be available on board for the use of the master or designated personnel.

#### **2.7.3.5 Means of going astern**

**2.7.3.5.1** The ability of the machinery to reverse the direction of thrust of the propeller/thruster in sufficient time, and so to bring the ship to rest within a reasonable distance from maximum ahead service speed, shall be demonstrated and recorded.

### 3 ANCHORING EQUIPMENT

#### 3.1 General

**3.1.1** Each ship shall be provided with an anchoring equipment consisting of anchors, chain cables, stoppers for securing the anchor in its voyage position and used when the ship is laying at anchor, devices for securing and releasing the inboard ends of the anchor chains and machinery for dropping and hoisting the anchors, as well as for holding the ship at the anchors dropped within a harbour or sheltered area where the vessel is awaiting berth, tide, etc.

IACS Recommendation No. 10/Rev.5 'Chain Anchoring, Mooring and Towing Equipment'<sup>1</sup> may be referred to for recommendations concerning anchoring equipment for ships in deep and unsheltered water.

The anchoring equipment is not designed to hold a ship off fully exposed coasts in rough weather or to stop a ship which is moving or drifting. In this condition, the loads on the anchoring equipment increase to such a degree that its components may be damaged or lost owing to the high energy forces generated, particularly in large ships.

The anchoring equipment required herewith is designed to hold a ship in good holding ground in conditions such as to avoid dragging of the anchor. In poor holding ground the holding power of the anchors is significantly reduced.

It is assumed that under normal circumstances a ship uses only one bower anchor and chain cable at a time.

In addition to planned anchoring for normal operations, anchoring equipment is also important for ship safety in emergency situations such as loss of manoeuvrability, unscheduled repairs and other unexpected situations.

For those ships to which the requirements of *Common Structural Rules (CSR)* refer, requirements concerning anchoring equipment in chapter 11 of *CSR* Part I shall be applied in the first place.

**3.1.2** If a ship, in addition to the anchoring equipment specified in 3.1.1, is provided with some other anchoring equipment (e.g. special anchors and winches on dredgers, mooring anchors on lightships, etc.), such equipment is considered as a special one and is not subject to PRS' survey.

The use of anchoring equipment, specified in 3.1.1, as an operational arrangement (e.g. for moving the ship or holding her in a place of operation, etc.) will be specially considered by PRS upon submission of the required data (information on dynamic loads, intensity of work, wearing rate, etc.).

**3.1.3** Anchoring equipment shall be chosen from Table 3.1.3 in accordance with the equipment number determined in 1.7.<sup>2</sup>

<sup>1</sup> For ships of length less than 90m, alternative methodology using direct force calculation for anchoring equipment described in appendix B of Rec. 10 may be used. Dredgers with unusual design of the underwater part of the hull are not covered by alternative methodology using direct force calculation for anchoring equipment described in appendix B of Rec. 10.

<sup>2</sup> The equipment number formulae for anchoring equipment required are based on assumed max. current speed of 2.5 m/s, max. wind speed of 25 m/s and a min. scope of chain cable of 6, the scope being the ratio between length of chain paid out and water depth. For ships with an length  $L_0$  greater than 135 m, alternatively the required anchoring equipment can be considered applicable to a max. current speed of 1.54 m/s, a max. wind speed of 11 m/s and waves with max. significant height of 2 m.

<sup>2</sup> The total length of chain given in Table 3.1.3 – is to be divided in approximately equal parts between the two bower anchors.

**Table 3.1.3**  
**Anchoring Equipment**

Equipment number		Stockless bower anchor		Stockless stream anchor	Stud link chains for bower anchors			Chain or wire of stream anchor		
		number	mass of each anchor [kg]	mass of stream anchor [kg]	total length of both chains <sup>2</sup> [m]	Min. diameter			length [m]	breaking force [kN]
Exceeding	Not exceeding	2	3	4		5	6	7		
50	70	2	180	60	220	14	12.5	12.5	80	64.7
70	90	2	240	80	220	16	14	14	85	73.5
90	110	2	300	100	247.5	17.5	16	16	85	80
110	130	2	360	120	247.5	19	17.5	17.5	90	89.2
130	150	2	420	140	275	20.5	17.5	17.5	90	98.1
150	175	2	480	165	275	22	19	19	90	107.9
175	205	2	570	190	302.5	24	20.5	20.5	90	117.7
205	240	2	660	-	302.5	26	22	20.5	-	-
240	280	2	780	-	330	28	24	22	-	-
280	320	2	900	-	357.5	30	26	24	-	-
320	360	2	1020	-	357.5	32	28	24	-	-
360	400	2	1140	-	385	34	30	26	-	-
400	450	2	1290	-	385	36	32	28	-	-
450	500	2	1440	-	412.5	38	34	30	-	-
500	550	2	1590	-	412.5	40	34	30	-	-
550	600	2	1740	-	440	42	36	32	-	-
600	660	2	1920	-	440	44	38	34	-	-
660	720	2	2100	-	440	46	40	36	-	-
720	780	2	2280	-	467.5	48	42	36	-	-
780	840	2	2460	-	467.5	50	44	38	-	-
840	910	2	2640	-	467.5	52	46	40	-	-

Equipment number		Stockless bower anchor		Stockless stream anchor	Stud link chains for bower anchors			Chain or wire of stream anchor		
		number	mass of each anchor [kg]	mass of stream anchor [kg]	total length of both chains <sup>2</sup> [m]	Min. diameter			length [m]	breaking force [kN]
						normal strength steel (Grade 1) [mm]	higher strength steel (Grade 2) [mm]	high strength steel (Grade 3) [mm]		
Exceeding	1 Not exceeding	2	3	4	5	6	7	8	9	10
910	980	2	2850	-	495	54	48	42	-	-
980	1060	2	3060	-	495	56	50	44	-	-
1060	1140	2	3300	-	495	58	50	46	-	-
1140	1220	2	3540	-	522.5	60	52	46	-	-
1220	1300	2	3780	-	522.5	62	54	48	-	-
1300	1390	2	4050	-	522.5	64	56	50	-	-
1390	1480	2	4320	-	550	66	58	50	-	-
1480	1570	2	4590	-	550	68	60	52	-	-
1570	1670	2	4890	-	550	70	62	54	-	-
1670	1790	2	5250	-	577.5	73	64	56	-	-
1790	1930	2	5610	-	577.5	76	66	58	-	-
1930	2080	2	6000	-	577.5	78	68	60	-	-
2080	2230	2	6450	-	605	81	70	62	-	-
2230	2380	2	6900	-	605	84	73	64	-	-
2380	2530	2	7350	-	605	87	76	66	-	-
2530	2700	2	7800	-	632.5	90	78	68	-	-
2700	2870	2	8300	-	632.5	92	81	70	-	-
2870	3040	2	8700	-	632.5	95	84	73	-	-
3040	3210	2	9300	-	660	97	84	76	-	-
3210	3400	2	9900	-	660	100	87	78	-	-
3400	3600	2	10500	-	660	102	90	78	-	-
3600	3800	2	11100	-	687.5	105	92	81	-	-
3800	4000	2	11700	-	687.5	107	95	84	-	-
4000	4200	2	12300	-	687.5	111	97	87	-	-

Equipment number		Stockless bower anchor		Stockless stream anchor	Stud link chains for bower anchors			Chain or wire of stream anchor		
		number	mass of each anchor [kg]	mass of stream anchor [kg]	total length of both chains <sup>2</sup> [m]	Min. diameter			length [m]	breaking force [kN]
						normal strength steel (Grade 1) [mm]	higher strength steel (Grade 2) [mm]	high strength steel (Grade 3) [mm]		
Exceeding	Not exceeding	2	3	4	5	6	7	8	9	10
4200	4400	2	12900	-	715	114	100	87	-	-
4400	4600	2	13500	-	715	117	102	90	-	-
4600	4800	2	14100	-	715	120	105	92	-	-
4800	5000	2	14700	-	742.5	122	107	95	-	-
5000	5200	2	15400	-	742.5	124	111	97	-	-
5200	5500	2	16100	-	742.5	127	111	97	-	-
5500	5800	2	16900	-	742.5	130	114	100	-	-
5800	6100	2	17800	-	742.5	132	117	102	-	-
6100	6500	2	18800	-	742.5	-	120	107	-	-
6500	6900	2	20000	-	770	-	124	11	-	-
6900	7400	2	21500	-	770	-	127	114	-	-
7400	7900	2	23000	-	770	-	132	117	-	-
7900	8400	2	24500	-	770	-	137	122	-	-
8400	8900	2	26000	-	770	-	142	127	-	-
8900	9400	2	27500	-	770	-	147	132	-	-
9400	10000	2	29000	-	770	-	152	132	-	-
10000	10700	2	31000	-	770	-	-	137	-	-
10700	11500	2	33000	-	770	-	-	142	-	-
11500	12400	2	35500	-	770	-	-	147	-	-
12400	13400	2	38500	-	770	-	-	152	-	-
13400	14600	2	42000	-	770	-	-	157	-	-
14600	16000	2	46000	-	770	-	-	162	-	-

**3.1.4** Anchoring equipment for ships without mechanical propulsion shall be chosen assuming equipment number by 25% greater than that required in 1.7.

**3.1.5** Anchoring equipment for mechanically propelled ships with the maximum speed at a draught to the summer load waterline not exceeding 6 knots shall be chosen as for non-propelled ships.

**3.1.6** For remote controlled anchoring systems, if provided, the selection of type, degree of automatic control and scope of remotely controlled operations are specified by the Owner. Additional requirements for the remotely controlled equipment are given in 3.4.6, as well as in *Part VII – Machinery, Boilers and Pressure Vessels* and in *Part VIII – Electrical Installations and Control Systems*.

## **3.2 Anchors**

### **3.2.1 General**

**3.2.1.1** Ships shall be provided with approved anchors, the number and mass of which shall fulfil the requirements of Table 3.1.3.

The use of stockless anchors is recommended.

**3.2.1.2** It is recommended that ships having the equipment number below 205 shall also be provided with a stream anchor (in addition to two bower anchors). The stream anchor shall fulfil the requirements of Table 3.1.3 and shall be ready to be connected with chain or wire rope.

**3.2.1.3** The requirements for materials, manufacture and tests of anchors are specified in Chapter 19, *Part IX – Materials and Welding*.

### **3.2.2 Number of Anchors**

**3.2.2.1** The bower anchors shall be connected to their cables and positioned on board ready for use.

### **3.2.3 Mass of Anchors**

**3.2.3.1** The mass of an individual bower anchors may vary by 7% from the value required in Table 3.1.3, provided that the total mass of all bower anchors is not less than that required for these anchors.

**3.2.3.2** Where high holding power anchors are used, the mass of each of them may be equal to 75% of the anchor mass required by Tables 3.1.3 and 14.3.1.

**3.2.3.3** The mass of the head of a stockless anchor, including pins and fittings, shall not be less than 60% of the total mass of the anchor. The mass of stocked anchors, when used, and that of stream anchors, excluding the stock should be 80% for ships having the equipment number below 205.

**3.2.3.4** In the case of stocked anchors, the mass of the stock shall be 20% of the total mass of the anchor, including the anchor shackle.

### **3.2.4 High Holding Power Anchors (HHP Anchors)**

**3.2.4.1** A high holding power anchor is an anchor with a holding power of at least twice that of an ordinary stockless anchor of the same mass. A HHP anchor shall be suitable for ship's use and shall not require prior adjustment or special placement on the sea bottom.

For approval and/or acceptance as a high holding power anchor (HHP anchor) satisfactory full scale tests according to the requirements of 3.2.4.2, 3.2.4.3 and 3.2.4.4 shall be made confirming that the anchor has a holding power of at least twice that of an previously approved ordinary stockless anchor of the same mass.

**3.2.4.2** Full scale tests shall be carried out at sea on various types of bottom, normally, soft mud or silt, sand or gravel and hard clay or similar compounded material. The tests shall be applied to anchors of mass which are, as far as possible, representative of the full range of HHP anchors sizes proposed.

For a definite group of the range, the two anchors selected for testing (approved ordinary stockless anchor and HHP anchor) shall be approximately the same mass and tested in association with the size of chain required for that anchor mass. Where an ordinary stockless anchor is not available, for testing of HHP anchors a previously approved HHP anchor may be used in its place. The tested anchor shall have a holding power at least twice that of an ordinary stockless anchor of the same mass. The length of cable with each anchor shall be such that the pull on the shank remains horizontal. For this purpose, a scope of 10 is considered normal, but a scope of not less than 6 may be accepted. Scope is defined as the ratio of length of cable to depth of water.

Three tests shall be taken for each anchor and each type of bottom. The stability of the anchor and ease at breaking out should be noted where possible. Tests shall be carried out from a tug but alternatively shore based tests may be accepted. The pull shall be measured by dynamometer. Measurements of pull, based on RPM/bollard pull curve of the tug may be accepted as an alternative to a dynamometer.

**3.2.4.3** For approval and/or acceptance for a range of HHP anchors sizes, tests shall be carried out for at least two anchor sizes. The mass of the maximum size approved shall not be more than 10 times the mass of the largest size tested.

**3.2.4.4** The holding power test load shall not exceed the proof load of the anchor.

### **3.2.5 Super High Holding Power (SHHP) Anchors**

**3.2.5.1** A super high holding power anchor is an anchor with a holding power of at least four times that of an ordinary stockless anchor of the same mass. A SHHP anchor is suitable for restricted service ships' use and does not require prior adjustment or special placement on the sea bottom. For approval and/or acceptance as a super high holding power anchor (SHHP anchor) satisfactory full tests according to the requirements of 3.2.5.5, 3.2.5.6 and 3.2.5.7 shall be made confirming the requirement of 3.2.5.2.

**3.2.5.2** SHHP anchor shall have a holding power of at least four times that of an ordinary stockless anchor or at least twice that of a previously approved HHP anchor, of the same mass.

**3.2.5.3** The use of SHHP anchors is limited to restricted service ships and their mass shall generally not exceed 1500 kg.

**3.2.5.4** When super high holding power anchors of the proven holding power are used as bower anchors, the mass of each such anchor may be reduced to not less than 50% of the mass required for ordinary stockless anchors specified in Table 3.1.3.

**3.2.5.5** Full scale tests shall be carried out at sea on various types of bottom, normally, soft mud or silt, sand or gravel and hard clay or similar compounded material. The tests shall be applied to anchors of mass which are, as far as possible, representative of the full range of sizes proposed.

For a definite group within the range, the two anchors selected for testing, i.e. ordinary stockless anchor and SHHP anchor shall be of approximately the same mass and tested in association with the size of chain required for that anchor mass and anchor type. Where an ordinary stockless anchor is not available, a previously approved HHP or SHHP anchor may be used in place of an ordinary stockless anchor. The length of the cable with each anchor shall be such that the pull on the shank remains horizontal. For this purpose a scope of 10 is considered normal but a scope of not less than 6 may be accepted. Scope is defined as the ratio of length of cable to depth of water.

Three tests shall be taken for each anchor and each type of bottom. The stability of the anchor and ease of breaking out shall be noted where possible. Tests shall be carried out from a tug but alternatively shore based tests may be accepted. The pull shall be measured by dynamometer. Measurements of pull, based on the RPM/bollard pull curve of the tug, may be accepted as an alternative to a dynamometer.

**3.2.5.6** For approval and/or acceptance for a range of SHHP anchor sizes, at least three anchor sizes shall be tested, indicative of the bottom, middle and top of the mass range.

**3.2.5.7** The holding power test load shall not exceed the proof load of the anchor.

### **3.3 Anchor Chains and Anchor Wire Ropes**

#### **3.3.1 General**

**3.3.1.1** The anchor chain diameters, specified in Table 3.1.3, refer to the chains with stud links. For ships with equipment number up to 90, as an alternative to stud link chain cables, short link chain cables may be used.

**3.3.1.2** Wire rope may be used in place of chain cable on ships:

- with less than 90 [m] in length and which will need an anchor for emergency purposes, i.e., not intended to use their anchor in normal temporary anchoring operation, or
- with the anchoring equipment used for positioning with a minimum of 4 points anchoring, e.g., for cable or pipe laying.

Use of wire rope is subject to the conditions specified in 3.3.3.

In ships having the equipment number not exceeding 205, the stud link or short link anchor chains cables may be replaced by anchor wire ropes for:

- bower anchors of ships below 40 m in length,
- stream anchor as stipulated in Tab.3.1.3.

**3.3.1.3** The requirements for materials and tests of anchor chains are specified in Chapters 11 and 20, *Part IX – Materials and Welding*.

**3.3.1.4** The requirements for material and properties of anchor wire ropes are specified in Chapter 21, *Part IX – Materials and Welding*.

#### **3.3.2 Anchor Chains**

**3.3.2.1** The anchor chains shall be composed of separate chain lengths. The lengths shall be interconnected with joining links. The use of joining shackles will be specially considered by PRS.

**3.3.2.2** The lengths, depending on their location in the chain, are divided into:

- anchor lengths, fastened to the anchor,
- intermediate lengths,
- chain locker lengths, secured in a chain locker to a chain releasing device.



**3.3.2.3** The anchor length shall contain a swivel. It is recommended that the swivel be connected to the anchor by means of a joining link, an end link and the anchor shackle. Other means of the swivel to anchor connection is subject to special consideration of PRS.

**3.3.2.4** The intermediate lengths shall be neither less than 25 m nor more than 27.5 m in length. The total length of two chains, specified in Table 3.1.3, is a summed up length of intermediate lengths only and does not include the anchor lengths and the chain locker lengths.

### **3.3.3 Wire Ropes**

**3.3.3.1** The breaking strength of an anchor wire rope shall not be less than the breaking load of the chain of Grade 1 and its length shall not be less than 1.5 times the length of the chain required by Table 3.1.3.

**3.3.3.2** The anchor weight shall be increased by 25 % compared to anchor associated with chain cable according to Table 3.1.3.

**3.3.3.3** The end of each anchor wire rope shall be spliced into a thimble, clamp or a socket. Each wire rope shall be connected to the anchor by means of a chain section of the same strength as the wire rope and of the length equal to the distance between the anchor in its voyage position and the windlass or 12.5 m, whichever is the lesser. The chain section shall be connected with the wire rope and with the anchor shackle by means of joining shackles of the same strength as that of the wire rope. The length of the chain section may be included into the required length of anchor wire rope.

**3.3.3.4** Anchor wire ropes shall have at least 114 wires and at least one natural fibre core. The wires used for anchor ropes shall be zinc coated according to the approved standards.

**3.3.3.5** All surfaces being in contact with the wire need to be rounded with a radius of not less than 10 times the wire rope diameter (including stem).

**3.3.3.6** Steel wire shall be selected to fit for purpose based on the manufacturer recommendation and shall be provided with guidance for maintenance and inspection.

## **3.4 Anchor Appliances**

### **3.4.1 Stoppers**

**3.4.1.1** A possibility for stopping each anchor chain or wire rope shall be provided both for ships laying at anchor and in voyage position. For ship laying at anchor, the anchor chain may be stopped by means of a stopper complying with the requirements of Chapter 6, *Part VII – Machinery, Boilers and Pressure Vessels*.

**3.4.1.2** If the stopper is designed only for securing the anchor in its voyage position, its parts shall be calculated for anchor chain or anchor wire rope force equivalent to double weight of the anchor plus 10 m of cable and the stresses in the stopper parts shall not exceed 0.4 times the yield stress of the material used. If the stopper includes a chain or rope, then, under load equivalent to double weight of the anchor, the strength shall be five times greater than the anchor chain breaking force or anchor wire rope ultimate strength.

**3.4.1.3** The stopper used when the ship is laying at anchor shall be designed for load equal to 0.8 times the breaking load of the anchor chain or wire rope. Stresses in the stopper parts, as well as in their connections with the deck shall not exceed 0.95 times the yield stress of the material used. If the stopper includes a chain or rope, their strength shall be equal to the anchor chain breaking force or anchor wire rope ultimate strength.

### 3.4.2 Anchor Chain Release Devices

**3.4.2.1** The last length of the anchor chain (chain locker length) shall be fixed in the chain locker in such a way as to permit, in case of emergency, an easy slipping of the chain cables to sea, operable from an accessible position outside the chain locker.

**3.4.2.2** The inboard ends of the chain cables shall be secured to the structures by a fastening able to withstand a force not less than 15% BL nor more than 30% BL (BL – the breaking load of the chain cable).

### 3.4.3 Hawse and Spurling Pipes

**3.4.3.1** Chains shall be led in a way ensuring their free run when dropping or hoisting the anchor.

**3.4.3.2** The anchor shank shall enter easily hawse pipe under the chain tension and shall take off hawse pipe readily when the chain is released.

**3.4.3.3** The thickness of the hawse pipe shall not be less than 0.4 times the diameter of the used chain.

**3.4.3.4** Hawse and spurling pipes shall be watertight up to the weather deck. (IACS UR L4/Rev.3/Corr.2, par.1)

**3.4.3.5** Spurling pipes through which anchor cables are led shall be provided with permanently attached closing appliances\* to minimize water ingress. (IACS UR L4/Rev.3/Corr.2, par.4)

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\* Examples of acceptable arrangements are such as:

- steel plates with cutouts to accommodate chain links or
- canvas hoods with a lashing arrangement that maintains the cover in the secured position.

### 3.4.4 Chain Lockers

**3.4.4.1** Chain lockers shall be fitted for stowing each chain of the bower anchor.

Where only one chain locker is intended for two chains, a division shall be provided for a separate stowage of each chain.

**3.4.4.2** The shape, capacity and depth of the chain locker shall be such as to ensure easy leading of the chains through the hawse pipe, their self-laying in the chain locker and free running out of the chain when dropping the anchor.

**3.4.4.3** The chain locker, as well as closures of openings leading to the chain locker inside shall be watertight up to the weather deck.

It is not required that bulkheads between separate chain lockers (see Fig. 3.4.4.3 – Arrangement 1) or which form a common boundary of chain lockers (see Fig. 3.4.4.3 – Arrangement 2) should be watertight. (IACS UR L4/Rev.3/Corr.2, par.1)

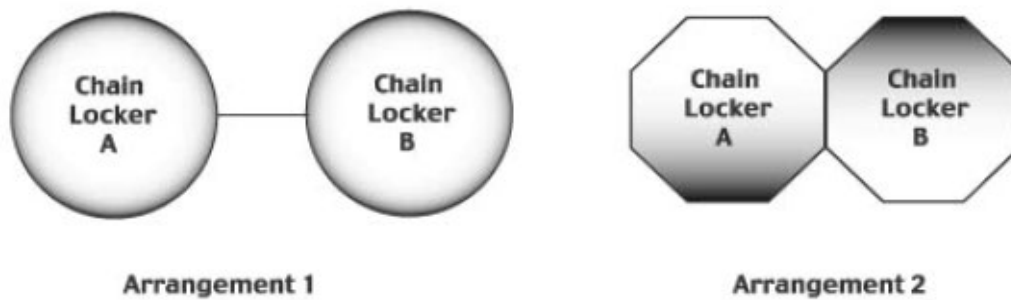


Fig. 3.4.4.3

**3.4.4.4** Where means of access is provided, it is to be closed by a substantial cover and secured by closely spaced bolts. (IACS UR L4/Rev.3/Corr.2, par.2)

**3.4.4.5** Where means of access to spurling pipes or cable lockers is located below the weather deck, the access cover and its securing arrangements are to be in accordance with recognized standards\* (their up-to-date versions) or equivalent for watertight manhole covers. Butterfly nuts and/or hinged bolts are prohibited as the securing mechanism for the access cover. (IACS UR L4/Rev.3/Corr.2, par.3)

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\* Examples of the recognized standards are such as:

- ISO 5894:2018,
- China: CB/T4392-2014 "Marine manhole cover",
- India: IS 15876-2009 "Ships and Marine Technology manholes with bolted covers",
- Japan: JIS F2304:2015, "Ship's Manholes" oraz JIS F2329:1975, "Marine Small Size Manhole",
- Korea KS VISO5894:2012,
- Norway: NS 6260:1985 "Manhole cover – overview",
- Russia: GOST 2021-90 "Ship's steel manholes. Specifications".

### 3.4.5 Windlasses

Windlasses shall be fitted on the deck in the fore part of the ship for dropping and hoisting the anchors, as well as for holding the ship with the bower anchors dropped.

Ships having the equipment number less than 205 may be fitted with hand operated windlasses; for such ships, the use of other deck machinery for dropping and hoisting the anchors is also permitted.

The requirements for the design and power of windlasses are specified in sub-chapter 6.3, *Part VII – Machinery, Boilers and Pressure Vessels*.

### 3.4.6 Additional Requirements for Anchoring Equipment with Remote Control System

**3.4.6.1** Stoppers and other components of anchoring equipment for which the remote control system is provided (see 3.1.6) shall also be fitted with devices for the local manual control.

**3.4.6.2** The design of anchoring equipment and devices for local manual control shall provide for their normal operation in the event of failure of particular components or the whole remote control system (see also Chapter 5, *Part VIII – Electrical Installations and Control Systems*).

### 3.4.7 Spare Parts

3 connecting links, one swivel and one end shackle shall be provided in each ship as the spare parts for anchors chains.

### 3.4.8 Supporting Hull Structure

**3.4.8.1** Above deck framing and hull structure supporting the windlass and its securing bolts shall be capable of transmitting forces specified for the windlass in *Part VII – Machinery, Boilers and Pressure Vessels, paragraph 6.3.8* at a level of stresses not exceeding that given in the above mentioned paragraph. Axial tensile and compressive lateral forces determined in *Part VII, paragraphs 6.3.10.4 and 6.3.10.5*, shall also be considered in the design of the supporting structure.

**3.4.8.2** Hull structure supporting a chain stopper and windlass, based on net thickness obtained by deducting the corrosion addition given in 3.4.9, are not to be greater than the following permissible values:

- .1 For strength assessment by means of beam theory or grillage analysis:
  - Normal stress:  $1.0 R_e$ ,
  - Shear stress:  $0.6 R_e$ .

The normal stress is the sum of bending stress and axial stress. The shear stress to be considered corresponds to the shear stress acting perpendicular to the normal stress. No stress concentration factors are to be taken into account.

- .2 For strength assessment by means of finite element analysis:
  - Normal stress:  $1.0 R_e$ ,

For strength assessment by means of finite element analysis the mesh is to be fine enough to represent the geometry as realistically as possible. The aspect ratios of elements are not to exceed 3. Girders are to be modelled using shell or plane stress elements. Symmetric girder flanges may be modelled by beam or truss elements. The element height of girder webs must not exceed one-third of the web height. In way of small openings in girder webs, the web thickness is to be reduced to a mean thickness over the web height in accordance with Chapter 14 of *Part II – Hull*. Large openings are to be modelled. Stiffeners may be modelled using shell, plane stress, or beam elements. The mesh size of stiffeners is to be fine enough to obtain proper bending stress. If flat bars are modelled using shell or plane stress elements, dummy rod elements are to be modelled at the free edge of the flat bars and the stresses of the dummy elements are to be evaluated. Stresses are to be read from the centre of the individual element. For shell elements the stresses are to be evaluated at the mid plane of the element.

### 3.4.9 Corrosion addition

The total corrosion addition is not to be less than the following values:

- .1 ships covered by *Common Structural Rules* for Bulk Carriers and Oil Tankers: total corrosion addition to be as defined in these Rules;
- .2 other ships: for the supporting hull structure, the total corrosion addition is defined according to p. 2.5 *Part II -Hull* for all considered structural members used in the model (e.g. deck structures).

## 4 MOORING EQUIPMENT

### 4.1 General

**4.1.1** Ships shall be provided with arrangements, equipment and fittings of sufficient safe working load to enable the safe conduct of all mooring operations associated with the normal operation of the ship. Among them, there is dragging up the ship to a quay or a floating harbour by the side or by the stern, mooring to another ship in the side-to-side mode (with possible change of relative positions), minor dislocations of the ship, with the main engine not working. (SOLAS II-1/3-8.4)

**4.1.2** Arrangements, equipment and fittings provided in accordance with paragraph 4 above shall meet the appropriate requirements of PRS or the Administration\*. (SOLAS II-1/3-8.5)

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\* Refer to *Guidance on shipboard towing and mooring equipment* (MSC.1/Circ.1175/Rev.1), IACS Recommendation No. 10/Rev.5 *Chain Anchoring, Mooring and Towing Equipment*. IACS UI SC212/Corr.3, IACS UI SC226/Rev.1 and MSC.1/Circ.1362/Rev.2

For those ships to which the requirements of Common Structural Rules (CSR) refer, requirements concerning mooring equipment in chapter 11 of CSR Part I shall be applied in the first place.

**4.1.3** Each fitting of item of mooring equipment provided under this chapter 4 requirements shall be clearly marked with any limitations associated with its safe operation, taking into account the strength of the supporting ship's structure and its attachment to it. (SOLAS II-1/3-8.6)

**4.1.4** The requirements of this chapter fully apply to ships defined as "conventional", i.e. with gross tonnage of 500 and above, excluding high-speed craft, special purpose ships and offshore units of all types. Ships other than "conventional" shall meet these requirements as far as practicable. (IACS UR A2/Rev.5)

**4.1.5** For ships of 3000 gross tonnage and above, the mooring arrangement shall be designed, and the mooring equipment including lines shall be selected, in order to ensure occupational safety and safe mooring of the ship, based on the *Guidelines* developed by IMO\*. Ship specific information shall be provided and kept on board\*\*. (SOLAS II-1/3-8.7)

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\* Refer to the *Guidelines on the design of mooring arrangements and the selection of appropriate mooring equipment and fittings for safe mooring* (MSC.1/Circ.1619).

\*\* Refer to towing and mooring arrangement plan in the *Guidelines on the design of mooring arrangements and the selection of appropriate mooring equipment and fittings for safe mooring* (MSC.1/Circ.1619)

**4.1.6** Ships of less than 3000 gross tonnage shall comply with the requirements of par 4.1.3 as far as reasonably practicable, or with applicable national standards of the Administration. (SOLAS II-1/3-8.8)

**4.1.7** For all ships, mooring equipment, including lines, shall be inspected and maintained in a suitable condition for their intended purposes\*. (SOLAS II-1/3-8.9)

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\* Refer to *Guidelines for inspection and maintenance of mooring equipment including lines* (MSC.1/Circ. 1620).

### 4.2 Mooring Equipment

#### 4.2.1 Mooring Lines

**4.2.1.1** The number, length and the breaking strength of the mooring lines for ships having an equipment number of less than or equal to 2000 shall be determined from Table 4.1.2 according

to the equipment number  $N_c$  determined in compliance with 1.7.1. For other ships the mooring lines are given in 2.1.2, IACS Recommendation No. 10/Rev.5 and MSC.1/Circ.1175/Rev.1.

As an alternative to requirements given in 4.2.1.1 of this chapter and 2.1.2, IACS Recommendation No. 10/Rev.5 the minimum recommendation for mooring lines may be determined by direct mooring analysis in line with the procedure given in Appendix A, of IACS Recommendation No. 10/Rev.5 this case, the designer should consider verifying the adequacy of mooring lines based on assessments carried out for the individual mooring arrangement, expected shore-side mooring facilities and design environmental conditions for the berth.

**Table 4.1.2**  
**Mooring lines for ships with  $N_c \leq 2000$**

EQUIPMENT NUMBER		MOORING LINES		
Exceeding	Not exceeding	No. of mooring lines	Minimum length of each line <sup>2</sup> (m)	Ship design minimum breaking load (kN)
50	70	3	80	37
70	90	3	100	40
90	110	3	110	42
110	130	3	110	48
130	150	3	120	53
150	175	3	120	59
175	205	3	120	64
205	240	4	120	69
240	280	4	120	75
280	320	4	140	80
320	360	4	140	85
360	400	4	140	96
400	450	4	140	107
450	500	4	140	117
500	550	4	160	134
550	600	4	160	143
600	660	4	160	160
660	720	4	160	171
720	780	4	170	187
780	840	4	170	202
840	910	4	170	218
910	980	4	170	235
980	1060	4	180	250
1060	1140	4	180	272
1140	1220	4	180	293
1220	1300	4	180	309
1300	1390	4	180	336

<sup>1</sup> If not otherwise specified by Recommendation No. 10/Rev.5, side projected area (p.1.7.3) including that of deck cargoes as given by the ship nominal capacity condition is to be taken into account for selection of mooring lines and the loads applied to shipboard fittings and supporting hull structures. The nominal capacity condition is defined in 1.2.3.

<sup>2</sup> Requirements of par. 4.2.1.2 shall be met.

EQUIPMENT NUMBER		MOORING LINES		
Exceeding	Not exceeding	No. of mooring lines	Minimum length of each line <sup>1</sup> (m)	Ship design minimum breaking load (kN)
1390	1480	4	180	352
1480	1570	5	190	352
1570	1670	5	190	362
1670	1790	5	190	384
1790	1930	5	190	411
1930	2000	5	190	437

**4.2.1.2** For ships with the ratio  $A/N_c$  (for ships with  $N_c \leq 2000$ ) exceeding 0.9, the number of mooring lines, as determined from Table 4.1.2, shall be increased by:

- 1 line – if  $0.9 < A/N_c \leq 1.1$ ;
- 2 lines – if  $1.1 < A/N_c \leq 1.2$ ;
- 3 lines – if  $1.2 < A/N_c$ .

( $A$  – windage area;  $N_c$  – equipment number according to 1.7).

**4.2.1.3** The length of individual mooring lines may be reduced by 7% as compared with that required by Table 4.1.2, provided the total length of mooring ropes is not less than that resulting from Table 4.1.2 and the requirements of 4.2.1.1.

**4.2.1.4** Where synthetic fibre ropes are used, the breaking load,  $F_s$ , shall not be less than that obtained from the following formula (see 4.2.1.5):

$$F_s = c_s F_n \quad [\text{kN}] \quad (4.1.5)$$

$F_n$  – breaking load according to table 4.1.2, [kN];

$c_s$  – coefficient equal to:

- 1.2 for polyamide ropes;
- 1.1 for ropes made of other synthetic fibres.

**4.2.1.5** Mooring lines may be of wire, natural fibre or synthetic fibre construction or of a mixture of wire and fibre. For synthetic fibre ropes it is recommended to use lines with reduced risk of recoil (snap-back) to mitigate the risk of injuries or fatalities in the case of breaking mooring lines. Notwithstanding the strength recommendations given in Table 4.1.2, no fibre rope should be less than 20 mm in diameter. For polyamide ropes the ship design minimum breaking load should be increased by 20% and for other synthetic ropes by 10% to account for strength loss due to, among others, aging and wear.

The rope wires shall be covered with thick zinc coating according to approved standards. In all other respects steel wire ropes shall meet the requirements of Chapter 21, *Part IX – Materials and Welding*.

**4.2.1.6** Natural fibre ropes shall be either manila or sisal ones. In ships having the equipment number not exceeding 205, the use of hemp ropes is permitted. The use of hemp ropes in ships with the equipment number exceeding 205 will be specially considered by PRS. In all other respects natural fibre ropes shall meet the requirements of Chapter 22, *Part IX – Materials and Welding*.

**4.2.1.7** Synthetic fibre ropes shall be made of homogeneous approved synthetic materials (nylon, polypropylene, capron, etc.). Combinations of different approved synthetic fibres in one rope will be specially considered by PRS. In all other respects synthetic fibre ropes shall meet the requirements of Chapter 22, *Part IX – Materials and Welding*.



## 4.2.2 Bollards, Bitts, Fairleads, Rollers-Guides, Chocks

**4.2.2.1** The number and position of mooring bollards, open and closed fairleads, stand rollers, chocks and other mooring appliances shall be determined on the basis of structure particulars, designation and general arrangement of the ship.

**4.2.2.2** Shipboard fittings may be selected from an industry standard<sup>1</sup> accepted by PRS and at least based on the ship design minimum breaking load of the mooring line according to Tab. 4.1.2 (for ships with  $N_c \leq 2000$ ) and IACS Recommendation No. 10/Rev.5 (for other ships).

Any weld or bolt or equivalent device connecting the shipboard fitting to the supporting structure is part of the shipboard fitting and subject to industry standard applicable to this shipboard fitting.

Mooring bitts (double bollards) are to be chosen for the mooring line attached in figure-of-eight fashion if the industry standard distinguishes between different methods to attach the line, i.e. figure-of-eight or eye splice attachment.

When the shipboard fitting is not selected from an accepted industry standard, the strength of the fitting and of its attachment to the ship shall be in accordance with the requirements of paragraphs 4.2.2.4, 4.2.2.5 and 4.2.3. Mooring bitts (double bollards) are required to resist the loads caused by the mooring line attached in figure-of-eight fashion<sup>2</sup>. For strength assessment beam theory or finite element analysis using net scantlings is to be applied, as appropriate. Corrosion additions are to be as defined in 4.2.3.4. A wear down allowance is to be included as defined in 4.2.3.4. Load tests may be accepted as alternative to strength assessment by calculations.

**4.2.2.3** Shipboard fittings, winches and capstans for mooring shall be located on stiffeners and/or girders, which are part of the deck construction so as to facilitate efficient distribution of the mooring load.

**4.2.2.4** PRS may accept other arrangements (for chocks in bulwarks, etc) provided the strength is confirmed adequate for the intended service.

**4.2.2.5** The minimum design load applied to hull supporting structures for shipboard fittings shall be 1.15 times the ship design minimum breaking load of the mooring rope provided in accordance with Table 4.1.2 (for ships with  $N_c \leq 2000$ ) and IACS Recommendation No. 10/Rev.5 (for other ships). The minimum design load applied to supporting hull structures for capstans shall be 1.25 times the maximum hauling-in force and for winches 1.25 times the intended maximum brake holding load, where the maximum brake holding load is to be assumed not less than 80% of the ship design minimum breaking load of the mooring line.

When a safe working load (SWL) greater than that determined according to 4.2.4 is requested by the applicant, then the design load shall be increased in accordance with the appropriate SWL/design load relationship given by above and 4.2.4.

The increase of the line design break force for synthetic ropes needs not to be taken into account for the loads applied to shipboard fittings and supporting hull structures.

**4.2.2.6** The design loads shall applied to fittings in all directions that may occur by taking into account the arrangement shown on the mooring arrangements plan.

<sup>1</sup> See - ISO 13795 Ship's mooring and towing fittings – Welded steel bollards for sea-going vessels.

<sup>2</sup> With the line attached to a mooring bitt in the usual way (figure-of-eight fashion), either of the two posts of the mooring bitt can be subjected to a force twice as large as that acting on the mooring line. Disregarding this effect, depending on the applied industry standard and fitting size, overload may occur.



Possible variations of direction (horizontally and vertically) of the mooring forces shall be considered. The acting point of the mooring force on shipboard fittings shall be taken at the attachment point of a mooring line or at a change in its direction (these points may be defined according to OCIMF<sup>1</sup> Guidelines).

Where the mooring line takes a turn at a fitting the total design load applied to the fitting is equal to the resultant of the design loads acting on the line, refer to Fig. 4.2.2.5. However, in no case does the design load applied to the fitting need to be greater than twice the design load on the line.

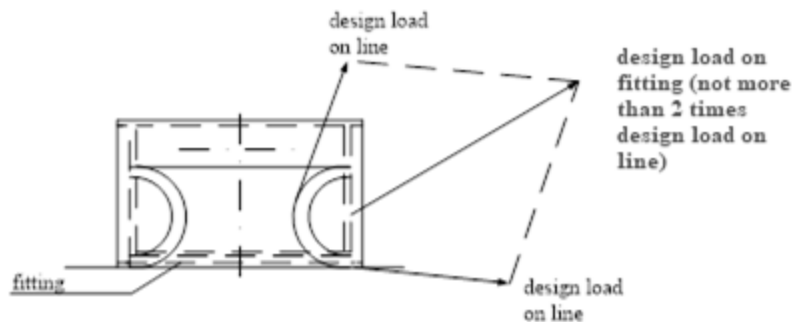


Fig. 4.2.2.5

For bollards and bitts the attachment point of the mooring line is to be taken not less than 4/5 of the tube height above the base, see a) in Fig.4.2.2.5.1. However, if fins are fitted to the bollard tubes to keep the mooring line as low as possible, the attachment point of the mooring line may be taken at the location of the fins, see b) in Fig. 4.2.2.5.1.

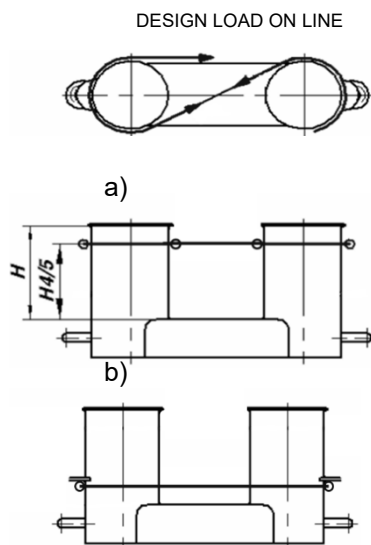


Fig. 4.2.2.5.1

**4.2.2.7** Bollards shall be made of steel or cast iron; they may be welded or cast. Bollards with seating arrangements put down below the deck shall not be applied on decks forming the upper shell of compartments intended for carrying or storing in bulk flammable liquids with ignition temperature below 60°C.

<sup>1</sup> Oil Companies International Maritime Forum.

**4.2.2.8** The outside diameter of the bollard columns shall not be less than 10 diameters of the steel wire rope, not less than 5.5 times the diameter of the synthetic fibre rope and not less than 1 circumference of the natural fibre rope according to the designation of the bollard. The distance between the axes of bollard columns shall not be less than 2.5 diameters of steel wire rope or 3 circumferences of natural fibre rope.

### 4.2.3 Supporting Hull Structure

**4.2.3.1** Supporting hull structure means that part of the ship structure on/in which the shipboard fitting is placed and which is directly submitted to the forces exerted on the shipboard fitting.

**4.2.3.2** The arrangement of reinforced members beneath shipboard fittings, winches and capstans shall to consider any variation of direction (horizontally and vertically) of the mooring forces acting upon the shipboard fittings, see Fig. 5.2.3.2 for a sample arrangement. Proper alignment of fitting and supporting hull structure is to be ensured. The resultant load shall be determined according to 4.2.2.5.

**4.2.3.3** The net minimum scantlings of the supporting hull structure, including the net thickness, shall fulfil the criteria given in 4.2.3.5.

**4.2.3.4** The required gross thickness of the structural member should be determined by adding the corrosion addition to the net thickness. The corrosion addition shall not be less than the following values:

- .1 ships covered by *Common Structural Rules* for Bulk Carriers and Oil Tankers: Total corrosion addition to be as defined in these rules;
- .2 other ships:
  - for the supporting hull structure, according to the PRS Rules for the surrounding structure (e.g. deck structures, bulwark structures),
  - for pedestals and foundations on deck which are not part of a fitting according to an accepted industry standard, 2.0 mm,
  - for shipboard fittings not selected from an accepted industry standard, 2.0 mm.

In addition to the corrosion addition given above the wear allowance, for shipboard fittings not selected from an accepted industry standard is not to be less than 1.0 mm, added to surfaces which are intended to regularly contact the line.

**4.2.3.5** Allowable stresses are as follows:

- .1 For strength assessment by means of beam theory or grillage analysis:
  - normal stress:  $1.0 R_e$ ;
  - shearing stress:  $0.6 R_e$ .

Normal stress shall be calculated as the sum of bending stress and axial stress. No stress concentration factors being taken into account.

- .2 For strength assessment by means of finite element analysis:
  - Von Mises:  $1.0 R_e$

For strength assessment by means of finite element analysis the mesh is to be fine enough to represent the geometry as realistically as possible. The aspect ratios of elements are not to exceed 3. Girders are to be modelled using shell or plane stress elements. Symmetric girder flanges may be modelled by beam or truss elements. The element height of girder webs must not exceed one-third of the web height. In way of small openings in girder webs the web thickness is to be reduced to a mean thickness over the web height as per PRS

rules. Large openings are to be modelled. Stiffeners may be modelled by using shell, plane stress, or beam elements. The mesh size of stiffeners is to be fine enough to obtain proper bending stress. If flat bars are modeled using shell or plane stress elements, dummy rod elements are to be modelled at the free edge of the flat bars and the stresses of the dummy elements are to be evaluated. Stresses are to be read from the centre of the individual element. For shell elements the stresses are to be evaluated at the mid plane of the element.

#### 4.2.4 Safe Working Load (SWL). The Towing and Mooring Arrangements Plan

**4.2.4.1** Unless a greater SWL is requested by the applicant according to 4.2.2.4, the SWL is not to exceed the ship design minimum breaking load of the mooring line according to Table 4.1.2 (for ships with  $N_c \leq 2000$ ) or IACS Recommendation No. 10/Rev.5 (for other ships).

**4.2.4.2** The safe working load (SWL), in t, of each shipboard fitting is to be marked (by weld bead or equivalent) on the deck fittings used for mooring. For fittings intended to be used for, both, mooring and towing, TOW, in t, according to 5.2.4 is to be marked in addition to SWL.

**4.2.4.3** The towing and mooring arrangements plan (required in 1.4.2.4) is to define the method of use of mooring lines. It is to be noted that SWL is the load limit for mooring purpose. Information provided on the plan shall to include in respect of each shipboard fitting:

- .1 location on the ship;
- .2 fitting type;
- .3 SWL;
- .4 purpose (mooring);
- .5 method of applying mooring lines load including limiting fleet angles i.e. angle of change in direction of a line at the fittings.

Item .3 with respect to items .4 and .5, is subject to approval by the PRS.

Furthermore, information provided on the plan, shall to include:

- the arrangement of mooring lines showing number of lines (N),
- the ship design minimum breaking load ( $MBL_{SD}$ ),
- the length of each mooring line;
- restrictions or limitations on the type (including material and construction), stiffness and diameter of mooring lines which are compatible with the mooring equipment and fittings; and
- the acceptable environmental conditions (refer for minimum conditions to IACS Recommendation No. 10/Rev.5 for the recommended ship design minimum breaking load for ships with Equipment Number  $N_c > 2000$ ):
  - 30 second mean wind speed from any direction ( $v_w$  or  $v_w^*$  according to IACS Recommendation No. 10/Rev.5).
  - Maximum current speed acting on bow or stern ( $\pm 10^\circ$ ).

Note: When the applied design environmental criteria exceed the above given criteria, information provided in the plan should include the design environmental criteria, similar to the parameters:

- wind speed and direction;
- current speed and direction.

**4.2.4.4** The above requirements on SWL apply for the use with no more than one mooring line.

**4.2.4.5** Mooring lines in the same service should be of the same characteristic in terms of strength and elasticity.

As far as possible, sufficient number of mooring winches should be fitted to allow for all mooring lines to be belayed on winches. This allows for an efficient distribution of the load to all mooring lines in the same service and for the mooring lines to shed load before they break. If the mooring arrangement is designed such that mooring lines are partly to be belayed on bitts or bollards, it should be considered that these lines may not be as effective as the mooring lines belayed on winches.

Mooring lines should have as straight a lead as is practicable from the mooring drum to the fairlead.

At points of change in direction sufficiently large radii of the contact surface of a rope on a fitting should be provided to minimize the wear experienced by mooring lines and as recommended by the rope manufacturer for the rope type intended to be used.

#### **4.2.5 Surveys**

The condition of deck fittings, their pedestals or foundations, and the hull structures in the vicinity of the fittings shall be examined in accordance with the requirements of *Part I – Classification Regulations*.

#### **4.2.6 Mooring Winches**

**4.2.6.1** Special mooring machinery (capstans, winches, etc.), as well as other deck machinery (windlasses, cargo winches, etc.) fitted with mooring brakes may be used for warping the mooring ropes.

**4.2.6.2** The number and type of mooring machinery are left to the Owner's and designer's discretion, provided that the rated pull of this machinery is not less than 0.22 nor more than 0.33 times the ship design minimum breaking load of the mooring rope and that the winches comply with the requirements of sub-chapter 6.4, *Part VII – Machinery, Boilers and Pressure Vessels*.

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## 5 TOWING ARRANGEMENTS

### 5.1 General

**5.1.1** The requirements of this chapter do not apply to towing equipment for emergency towing arrangements for tankers, provided in accordance with subchapter 11.6 (SOLAS II-1/3-4). (SOLAS II-1/3-8.3)

**5.1.2** Ship shall be provided with towing arrangements, equipment and fittings of sufficient safe working load to enable the safe conduct of all towing operations associated with the normal operation of the ship. (SOLAS II-1/3-8.4).

**5.1.3** Arrangements, equipment and fittings provided in accordance with paragraph 5.1.2 shall meet the requirements of subchapter 5.2 or appropriate requirements of the Administration\*. (SOLAS II-1/3-8.5)

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\* Refer to *Guidance on shipboard towing and mooring equipment* (MSC.1/Circ.1175/Rev.1), IACS Recommendation No. 10/Rev.5 *Chain Anchoring, Mooring and Towing Equipment*. IACS UI SC212/Corr.3, IACS UI SC226/Rev.1 and MSC.1/Circ.1362/Rev.2

For those ships to which the requirements of Common Structural Rules (CSR) refer, requirements concerning mooring equipment in chapter 11 of CSR Part I shall be applied in the first place.

**5.1.4** Each fitting or item of equipment provided under this chapter requirements shall be clearly marked with any limitations associated with its safe operation, taking into account the strength of the supporting ship's structure and its attachment to it. (SOLAS II-1/3-8.6)

**5.1.5** The requirements of this chapter fully apply to ships defined as "conventional", i.e. with gross tonnage of 500 and above, excluding high-speed craft, special purpose ships and offshore units of all types. Ships other than "conventional" shall meet these requirements as far as practicable. (IACS UR A2/Rev.5)

**5.1.6** For ships, not subject to par. 11.6.1 (SOLAS II-1/3-4.1), relating to emergency towing equipment on tankers, but intended to be fitted with equipment for towing by another ship or a tug, e.g. such as to assist the ship in case of emergency as given in par. 11.6.2 (SOLAS II-1/3-4.2), the requirements designated as 'other towing' are to be applied to design and construction of those shipboard fittings and supporting hull structures. (IACS UR A2/Rev.5)

**5.1.7** The requirements of this chapter are not applicable to design and construction of shipboard fittings and supporting hull structures used for special towing services defined as:

- **Escort towing:** Towing service, in particular, for laden oil tankers or LNG carriers, required in specific estuaries. Its main purpose is to control the ship in case of failures of the propulsion or steering system. It should be referred to local escort requirements and guidance given by, e.g., the Oil Companies International Marine Forum (OCIMF).
- **Canal transit towing:** Towing service for ships transiting canals, e.g. the Panama Canal. It should be referred to local canal transit requirements.
- **Emergency towing for tankers:** Towing service to assist tankers in case of emergency. For the emergency towing arrangements, ships subject to par. 11.6.1 (SOLAS II-1/3-4.1) shall comply with requirements given in subchapter 11.6 and in res. MSC.35(63) *Guidelines for emergency towing arrangements on tankers*. (IACS UR A2/Rev.5)

## 5.2 Towing Equipment

### 5.2.1 Towing Lines

**5.2.1.1** The length and breaking strength of the tow line\* shall be determined from Table 5.2.1.1 according to the equipment number  $N_c$ , calculated in accordance with subchapter 1.7<sup>1</sup> and shall be intended as own tow line of a ship to be towed by a tug or other ship. The designer should consider verifying the adequacy of towing lines based on assessments carried out for the individual towing arrangements.

**Table 5.2.1.1**  
**Tow lines**

EQUIPMENT NUMBER		TOW LINE	
Exceeding	Not exceeding	Minimum length (m)	Ship design minimum breaking load (kN)
50	70	180	98
70	90	180	98
90	110	180	98
110	130	180	98
130	150	180	98
150	175	180	98
175	205	180	112
205	240	180	129
240	280	180	150
280	320	180	174
320	360	180	207
360	400	180	224
400	450	180	250
450	500	180	277
500	550	190	306
550	600	190	338
600	660	190	370
660	720	190	406
720	780	190	441
780	840	190	479
840	910	190	518
910	980	190	559
980	1060	200	603
1060	1140	200	647
1140	1220	200	691
1220	1300	200	738
1300	1390	200	786
1390	1480	200	836
1480	1570	220	888
1570	1670	220	941
1670	1790	220	1024

\* Requirements 5.2.1.1 are not obligatory for special purpose ships and high speed crafts.

<sup>1</sup> Side projected area (p. 1.7.3) including that of deck cargoes as given by the loading manual is to be taken into account for selection of towing lines and the loads applied to shipboard fittings and supporting hull structure.

EQUIPMENT NUMBER		TOW LINE	
Exceeding	Not exceeding	Minimum length (m)	Ship design minimum breaking load (kN)
1790	1930	220	1109
1930	2080	220	1168
2080	2230	240	1259
2230	2380	240	1356
2380	2530	240	1453
2530	2700	260	1471
2700	2870	260	1471
2870	3040	260	1471
3040	3210	280	1471
3210	3400	280	1471
3400	3600	280	1471
3600	-	300	1471

**5.2.1.2** Tow lines may be of wire, natural fibre or synthetic fibre construction or of a mixture of wire and fibre. For synthetic fibre ropes it is recommended to use lines with reduced risk of recoil (snap-back) to mitigate the risk of injuries or fatalities in the case of breaking mooring lines. Notwithstanding the strength recommendations given in Table 5.2.1.1, no fibre rope should be less than 20 mm in diameter. For polyamide ropes the line design break force should be increased by 20% and for other synthetic ropes by 10% to account for strength loss due to, among others, aging and wear. The requirements of 4.1.6 and 4.2.1.2 ÷ 4.2.1.4 for mooring ropes are also applicable to towing ropes.

**5.2.2 Bollards, Bitts, Fairleads, Rollers-Guides, Chocks**

**5.2.2.1** The number and position of towing bollards and fairleads shall be determined on the basis of the structure particulars, designation and general arrangement of the ship.

**5.2.2.2** Shipboard fittings may be selected from an industry standard<sup>1</sup> accepted by PRS and at least based on the following loads.

- .1 For normal towing operations, the intended maximum towing load (e.g. static bollard pull) as indicated on the towing and mooring arrangements plan,
- .2 For other towing service, the ship design minimum breaking load of the tow line according to Tab. 5.2.1.1,
- .3 For fittings intended to be used for, both, normal and other towing operations, the greater of the loads according to .1 and .2.

Any weld or bolt or equivalent device connecting the shipboard fitting to the supporting structure is part of the shipboard fitting and subject to industry standard applicable to this shipboard fitting.

Towing bitts (double bollards) may be chosen for the towing line attached with eye splice if the industry standard distinguishes between different methods to attach the line, i.e. figure-of-eight or eye splice attachment.

When the shipboard fitting is not selected from an accepted industry standard, the strength and of the fitting and of its attachment to the ship shall to be in accordance with the requirements of paragraphs 5.2.2.4, 5.2.2.5 and 5.2.3. Towing bitts (double bollards) are required to resist the loads caused by the towing line attached with eye splice. For strength assessment beam theory or

<sup>1</sup> See - ISO 13795 Ship’s mooring and towing fittings – Welded steel bollards for sea-going vessels.



finite element analysis using net scantlings is to be applied, as appropriate. Corrosion additions are to be as defined in 5.2.3.4. A wear down allowance is to be included as defined in 5.2.3.4. Load tests may be accepted as alternative to strength assessment by calculations.

**5.2.2.3** Shipboard fittings for towing shall be located on stiffeners and/or girders, which are part of the deck construction so as to facilitate efficient distribution of the towing load.

PRS may accept other arrangements (for chocks in bulwarks, etc) provided the strength is confirmed adequate for the intended service.

**5.2.2.4** The minimum design load applied to supporting hull structures for shipboard fittings shall be:

- .1 For normal towing operations, 1.25 times the intended maximum towing load (e.g. static bollard pull), as indicated on the towing and mooring arrangements plan.
- .2 For other towing services the ship design minimum breaking load given in Table 5.2.1.1.
- .3 For fittings intended to be used for, both, normal and other towing operations, the greater of the design loads according to .1 and .2.

When a safe towing load (TOW) greater than that determined according to 5.2.4 is requested by the applicant, then the design load shall be increased in accordance with the appropriate TOW/design load relationship given by above and 5.2.4.

**5.2.2.5** The design load as specified in 5.2.2.4 shall be applied to fittings in all directions that may occur by taking into account the arrangement shown on the towing and mooring arrangements plan.

Possible variations of direction (horizontally and vertically) of the towing forces shall be considered.

The acting point of the towing force on shipboard fittings shall be taken at the attachment point of a towing line or at a change in its direction (these points may be defined according to OCIMF<sup>2</sup> Guidelines).

Where the towing line takes a turn at a fitting the total design load applied to the fitting is equal to the resultant of the design loads acting on the line, see Fig. 4.2.2.5. However, in no case does the design load applied to the fitting need to be greater than twice the design load on the line.

For bollards and bitts the attachment point of the towing line is to be taken not less than 4/5 of the tube height above the base, see Fig. 5.2.2.5.

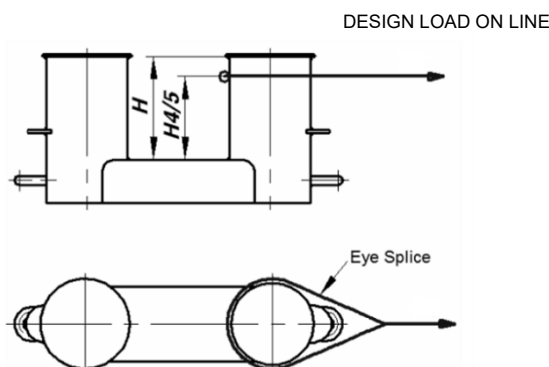


Fig. 5.2.2.5

**5.2.2.6** Towing bollards shall also fulfil the requirements of paragraphs 4.2.2.6 and 4.2.2.7.



### 5.2.3 Supporting Hull Structure

**5.2.3.1** Supporting hull structure means that part of the ship structure on/in which the shipboard fitting is placed and which is directly submitted to the forces exerted on the shipboard fitting.

**5.2.3.2** The reinforced members beneath shipboard fittings shall to be effectively arranged for any variation of direction (horizontally and vertically) of the towing forces acting upon the shipboard fittings, see Fig. 5.2.3.2 for a sample arrangement. Proper alignment of fitting and supporting hull structure is to be ensured. The resultant load shall be determined according to 5.2.2.5.

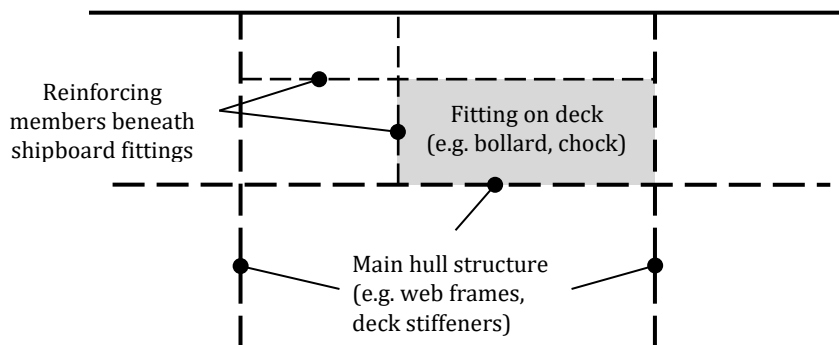


Fig. 5.2.3.2

**5.2.3.3** The net minimum scantlings of the supporting hull structure, including the net thickness, shall fulfil the criteria given in 5.2.3.5.

**5.2.3.4** The required gross thickness of the structural member should be determined by adding the corrosion addition to the net thickness. The total corrosion addition shall not be less than the following values:

- .1 ships covered by *Common Structural Rules* for Bulk Carriers and Oil Tankers: Total corrosion addition to be as defined in these Rules;
- .2 other ships:
  - for the supporting hull structure, according to the PRS Rules for the surrounding structure (e.g. deck structures, bulwark structures),
  - for pedestals and foundations on deck which are not part of a fitting according to an accepted industry standard, 2.0 mm,
  - for shipboard fittings not selected from an accepted industry standard, 2.0 mm.

In addition to the corrosion addition given above the wear allowance, for shipboard fittings not selected from an accepted industry standard is not to be less than 1.0 mm, added to surfaces which are intended to regularly contact the line.

**5.2.3.5** Allowable stresses are as follows:

- .1 For strength assessment by means of beam theory or grillage analysis:
  - normal stress:  $1.0 R_e$ ;
  - shearing stress:  $0.6 R_e$ .

Normal stress shall be calculated as the sum of bending stress and axial stress with the corresponding shearing stress acting perpendicular to the normal stress. No stress concentration factors being taken into account.

- .2 For strength assessment by means of finite element analysis:
  - Von Mises stress:  $1.0 R_e$ .

For strength assessment by means of finite element analysis the mesh is to be fine enough to represent the geometry as realistically as possible. The aspect ratios of elements are not to exceed 3. Girders are to be modelled using shell or plane stress elements. Symmetric girder flanges may be modelled by beam or truss elements. The element height of girder webs must not exceed one-third of the web height. In way of small openings in girder webs the web thickness is to be reduced to a mean thickness over the web height in accordance with requirements of Chapter 14 of *Part II – Hull*. Large openings are to be modelled. Stiffeners may be modelled by using shell, plane stress, or beam elements. The mesh size of stiffeners is to be fine enough to obtain proper bending stress. If flat bars are modeled using shell or plane stress elements, dummy rod elements are to be modelled at the free edge of the flat bars and the stresses of the dummy elements are to be evaluated. Stresses are to be read from the centre of the individual element. For shell elements the stresses are to be evaluated at the mid plane of the element.

#### **5.2.4 Safe Towing Load (TOW). The Towing and Mooring Arrangements Plan**

**5.2.4.1** The save towing load (TOW) shall comply with the requirements given below.

- .1 The save towing load (TOW) used for normal towing operations shall not exceed 80% of the design load specified in paragraph 5.2.2.4, .1.
- .2 The save towing load (TOW) used for other towing operations shall not exceed 80% of the design load specified in paragraph 5.2.2.4, .2.

For fittings used for both normal and other towing operations, the greater of the safe towing loads according to .1 and .2 shall be used.

**5.2.4.2** The save towing load (TOW), in t, of each shipboard fitting is to be marked (by weld bead or equivalent) on the deck fittings used for towing. For fittings intended to be used for, both, towing and mooring, SWL, in t, according to 4.2.4 is to be marked in addition to TOW.

**5.2.4.3** The towing and mooring arrangements plan (required in 1.4.2.4) is to define the method of use of towing lines. It is to be noted that TOW is the load limit for towing. If not otherwise chosen, for towing bitts it is to be noted that TOW is the load limit for a towing line attached with eye-splice. Information provided on the plan shall to include in respect of each shipboard fitting:

- .1 location on the ship;
- .2 fitting type;
- .3 TOW;
- .4 purpose (normal towing or other towing);
- .5 method of applying towing line load including limiting fleet angles i.e. angle of change in direction of a line at the fittings.

Item .3 with respect to items .4 and .5, is subject to approval by the PRS.

**5.2.4.4** The above requirements on TOW apply for the use with no more than one line. If not otherwise chosen, for towing bitts (double bollards) TOW is the load limit for a towing line attached with eye-splice.

**5.2.4.5** Towing lines should be led through a closed chock. The use of open fairleads with rollers or closed roller fairleads should be avoided.

For towing purpose it is recommended to provide at least one chock close to centreline of the ship forward and aft. It is also beneficial to provide additional chocks on port and starboard side at the transom and at the bow.

Towing lines should have a straight lead from the towing bitt or bollard to the chock.

For the purpose of towing, bitts or bollards serving a chock should be located slightly offset and in a distance of at least 2 m away from the chock, see Fig.5.2.4.5:

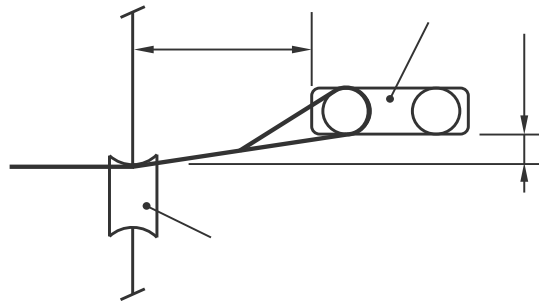


Fig. 5.2.4.5

Warping drums should preferably be positioned not more than 20 m away from the chock, measured along the path of the line.

Attention should be given to the arrangement of the equipment for towing and mooring operations in order to prevent interference of mooring and towing lines as far as practicable. It is beneficial to provide dedicated towing arrangements separate from the mooring equipment.

For emergency towing arrangements for tankers reference should be made to SOLAS Chapter II-1, Regulation 3-4. For all ships other than tankers it is recommended to provide towing arrangements fore and aft of sufficient strength for 'other towing' service as defined in 5.1.3

### 5.2.5 Surveys

The condition of deck fittings, their pedestals or foundations, if any, and the hull structures in the vicinity of the fittings shall be examined in accordance with the requirements of *Part I – Classification Regulations*. The wastage allowances shall not exceed the corrosion addition as specified in 5.2.3.4.

### 5.2.6 Equipment of Unmanned Vessels

The basic towing equipment for unmanned vessels shall be determined according to the equipment number  $N_c$ , calculated in accordance with the requirements of sub-chapter 1.7. Irrespective of the basic towing equipment, the vessel shall be fitted with emergency towing set chosen according to the same equipment number.

### 5.2.7 Emergency Towing Procedures on Ships

**5.2.7.1** Ships shall be provided with a ship-specific emergency towing procedure. Such a procedure shall be carried aboard the ship for use in emergency situations and shall be based on existing arrangements and equipment available on board the ship. (SOLAS II-1/3-4.2.2)

**5.2.7.2** On ships subject to the SOALS Convention, the procedure\* required in par. 5.2.7.1 shall include:

- .1 drawings of fore and aft deck showing possible emergency towing arrangements;
- .2 inventory of equipment on board that can be used for emergency towing;
- .3 means and methods of communication; and
- .4 sample procedures to facilitate the preparation for and conducting of emergency towing operations. (SOLAS II-1/3-4.2.3)

\* Refer to *Guidelines for owners/operators on preparing emergency towing procedures* (MSC.1/Circ.1255).

## 6 SIGNAL MASTS

### 6.1 General

**6.1.1** The requirements given in the present Chapter 6 apply only to signal masts, i.e. the masts intended exclusively for carrying the signal means, e.g. lights, day signals, aerials, etc.

Where the masts or their parts carry derricks or other cargo handling gear in addition to the signal means, such masts or their parts shall fulfil the requirements of *Part VI – Lifting Appliances*, of the *Rules for Statutory Survey of Sea-going Ships*.

**6.1.2** The arrangement and height of signal masts, as well as the number of signal means fitted shall fulfil the requirements of *Part III – Signal Means*, of the *Rules for Statutory Survey of Sea-going Ships*.

### 6.2 Stayed Masts

**6.2.1** The diameter,  $d$ , and wall thickness,  $t$ , at the heel of masts made of steel with yield stress from 215 up to 255 MPa and stayed by two shrouds on each side of the ship shall not be less than:

$$d = 22l \quad (6.2.1-1)$$

$$t = 0.2l + 3 \quad (6.2.1-2)$$

$d$  – diameter at the mast heel, [mm];

$t$  – wall thickness at the mast heel, [mm];

$l$  – mast length from the heel to the shroud eyeplates, [m].

The mast diameter may be gradually reduced upwards to a value of  $0.75d$  at the shroud eyeplates, provided that the thickness of the mast wall is maintained constant throughout the length  $l$ . The remaining length of the mast from the shroud eyeplates to the top shall not exceed  $l/3$ .

**6.2.2** The mast shall be stayed by the shrouds as follows:

- .1 horizontal distance  $a$  from the deck (or bulwark) stay eyeplate to the transverse plane through the mast stay eyeplate shall not be less than:

$$a = 0.15h \text{ [m]} \quad (6.2.2-1)$$

$h$  – vertical distance from the mast stay eyeplate to the deck (or bulwark) stay eyeplate, [m];

- .2 horizontal distance  $b$  from the deck (or bulwark) stay eyeplate to the longitudinal plane through the mast stay eyeplate shall not be less than:

$$b = 0.30h \text{ [m]} \quad (6.2.2-2)$$

- .3  $a$  shall be less than  $b$ .

**6.2.3** The actual breaking strength of ropes intended for shrouds which stay the mast in the way specified in 6.2.2 shall not be less than:

$$F = 0.49 (l^2 + 10l + 25) \text{ [kN]} \quad (6.2.3)$$

Shroud fittings (shackles, turnbuckles, etc.) shall be such that their safe working load is not less than 0.25 times the actual breaking strength of the above-mentioned ropes.

In all other respects the ropes for shrouds shall meet the requirements of Chapters 21 and 22, *Part IX – Materials and Welding*.

**6.2.4** The requirements, specified in 6.4, shall be fulfilled where:

- .1 the mast is made of higher tensile steel, light alloys or wood (the wood shall be of grade I);
- .2 the mast is stayed in a way other than that specified in 6.2.2;

- .3 in addition to a yard, lights and day signals, the mast is fitted with other equipment of considerable weight (e.g. radar scanners with platforms for their servicing, "crow's-nests", etc.).

### 6.3 Unstayed Masts

**6.3.1** The diameter,  $d$ , and wall thickness,  $t$ , at the heel of masts made of steel with yield stress from 215 up to 255 MPa shall not be less than:

$$d = 3l^2(0.674l + a + 13) \left( 1 + \sqrt{1 + \frac{51.5 \cdot 10^4}{l^2(0.674l + a + 13)^2}} \right) 10^{-2} \text{ [mm]} \quad (6.3.1-1)$$

$$t = \frac{1}{70} d \text{ [mm]} \quad (6.3.1-2)$$

- $l$  – mast length from the heel to the top, [m],  
 $a$  – elevation of the mast heel above the ship rotation axis, [m],  
 $d, t$  – see 6.2.1.

The ship rotation axis shall be determined according to Chapter 16, *Part II – Hull*.

The diameter of the mast may be gradually decreased upwards to a value of  $0.5d$  at a height equal to  $0.75l$  from the heel. The thickness of the mast wall is in no case to be less than 4 mm. The mast heel shall be effectively supported in all directions.

**6.3.2** The requirements, specified in 6.4, shall be fulfilled where:

- .1 the mast is made of higher tensile steel, light alloys or wood (the wood shall be of grade I);  
 .2 in addition to a yard, lights and day signals, the mast is fitted with other equipment of considerable weight (e.g. radar scanners with platforms for their servicing, "crow's-nests", etc.).

### 6.4 Masts of Special Construction

**6.4.1** In the cases specified in 6.2.4 and 6.3.2, as well as where bipod, tripod and other similar masts are installed, detailed strength analysis of these masts shall be performed. The calculations shall be submitted to PRS for consideration.

**6.4.2** The mast structure shall be calculated to withstand stresses due to  $F_{xi}$  and  $F_{yi}$  forces applied to the centre of mass of each component part of the mast and its equipment. These forces shall be calculated from the following formulae:

$$F_{xi} = m_i a_L + p A_{xi} \quad (6.4.2-1)$$

$$F_{yi} = m_i a_T + p A_{yi} K \quad (6.4.2-2)$$

- $F_{xi}$  – horizontal force parallel to the ship centre plane, [N];  
 $F_{yi}$  – horizontal force parallel to the midship section, [N];  
 $m_i$  – mass of the component part of the mast or its equipment (the height of each component part of the mast or its equipment shall be assumed as not greater than 1/10 of the mast height), [kg];  
 $p$  – unit wind pressure equal to 1960 Pa;  
 $A_{xi}$  – projection area of the considered component part of the mast or its equipment on the midship section, [m<sup>2</sup>];  
 $A_{yi}$  – projection area of the considered component part of the mast or its equipment on the ship centre plane, [m<sup>2</sup>];  
 $K$  – coefficient determined by the formula:

$$K = 0.947 - \frac{20.7}{L_0} \quad (6.4.2-3)$$

The value of  $K$  shall not be taken less than 0.766.

$a_L, a_T$  – linear accelerations, [m/s<sup>2</sup>], to be taken according to the requirements of Chapter 17.4, *Part II – Hull*.

Forces  $F_{xi}$  and  $F_{yi}$  shall be considered as acting separately, neglecting their simultaneous action.

**6.4.3** Under the loads specified in 6.4.2, the stresses in the parts of masts shall not exceed 0.7 times the yield stress of the material where they are made of metal and 12 MPa – where they are made of wood.

Under these loads, the safety factor of the ropes used for stays shall not be less than 3.

## 7 CLOSING APPLIANCES OF OPENINGS IN HULL AND SUPERSTRUCTURES

### 7.1 General

**7.1.1** The requirements of the present Chapter 7 apply to ships of unrestricted service, as well as to ships of restricted service **I** and **II** engaged on international voyages.

**7.1.2** The requirements of the present Chapter apply to ships with minimum freeboard assigned. Departure from these requirements may be permitted for ships to which greater than minimum freeboard is assigned, provided that PRS is satisfied with safety measures taken.

**7.1.3** The arrangement of openings and their closing appliances shall fulfil the relevant requirements of *Part V – Fire Protection* and *Part VIII – Electrical Installations and Control Systems*.

**7.1.4** As far as deck openings are concerned, the following two positions are distinguished in the present Chapter:

**position 1:**

1. on exposed parts of:
  - freeboard deck,
  - raised quarterdeck,
  - superstructure and deckhouse deck of the first tier situated forward of a point located 0.25 of the ship length,  $L$ , from the forward perpendicular;
2. on the same parts within the superstructures and deckhouses which are not enclosed;

**position 2:**

1. on exposed parts of superstructure and deckhouse deck of the first tier situated abaft 0.25 of the ship's length,  $L$ , from the forward perpendicular;
2. on the same parts within the superstructures and deckhouses of the second tier which are not enclosed and are situated within  $0.25L$  from the forward perpendicular.

**7.1.5** All the openings in the freeboard deck, except those mentioned in 7.2.4, 7.1.1, 7.6, 7.7, 7.8 and 7.10, shall be protected by enclosed superstructure or an enclosed deckhouse. Similar openings in the deck of the enclosed superstructure or enclosed deckhouse shall be protected by an enclosed deckhouse of the second tier.

**7.1.6** Superstructures and deckhouses are considered enclosed if:

- their construction meets the requirements of 10.2, *Part II – Hull*;
- openings leading to their inside meet the requirements of 7.3 and 7.6;
- all other openings in their outer plating meet the requirements of 7.2, 7.4, 7.5, 7.6, 7.7, 7.8 and 7.10.

**7.1.7** When designing the closure for openings in the hull and superstructures, the information contained in MSC.429/Rev.2 shall be taken into account.

### 7.2 Side Scuttles and Windows

#### 7.2.1 Arrangement of Side Scuttles and Windows

**7.2.1.1** Side scuttles are defined as being round or oval openings with an area not exceeding 0.16 square metres. Round or oval openings having areas exceeding 0.16 m<sup>2</sup> shall be treated as windows.



The number of side scuttles in the shell plating below the freeboard deck shall be reduced to a minimum compatible with the design and proper operation of the ship. Vessels which are designed for being moored to other ships at sea shall have, as far as possible, no side scuttles located below the freeboard deck in way of mooring appliances. Where, however, side scuttles are located in that region, they shall be so arranged as to exclude the risk of being damaged during the mooring operations.

**7.2.1.2** Where consistent with the *International Convention on Load Lines* in force, in no case the lowermost edges of side scuttles shall be positioned below a line drawn parallel to the freeboard deck. The lowermost point of this line shall be located at 0.025 of the ship breadth,  $B$ , or 500 mm (whichever is the greater) above the summer load waterline or – where timber lines are assigned to the ship – above the summer timber load waterline.

**7.2.1.3** Side scuttles in the shell plating below the freeboard deck and in end bulkheads of enclosed superstructures and deckhouses of the first tier, as well as in end bulkheads of enclosed superstructures and deckhouses of the second tier within  $0.25L$  from the forward perpendicular<sup>1</sup> shall be of a heavy type (see 7.2.2.1.1). These side scuttles shall be provided with efficient hinged inside deadlights. The deadlights shall be capable of being effectively closed and secured watertight if fitted below freeboard deck and weathertight if fitted above.

**7.2.1.4** Side scuttles in enclosed superstructures and deckhouses of the first tier, and in enclosed superstructures and deckhouses of the second tier within  $0.25L$  from the forward perpendicular, except those in their fore and after bulkheads, may be of normal type.

The side scuttles shall be fitted with deadlights, specified in 7.2.1.3. For side scuttles in passenger ships, the requirements of Chapter 13 of the present *Part III* additionally apply.

**7.2.1.5** Side scuttles in enclosed superstructures and deckhouses of the second tier, except those fitted in a position within  $0.25L$  from the forward perpendicular shall be of a type as required by 7.2.1.4 if they provide a direct access to the open stairway leading to spaces situated below. Where the side scuttles at the sides of enclosed superstructures are accessible, they may be provided with permanently attached external storm covers in lieu of the inside deadlights. In accommodation and other similar spaces in enclosed superstructures and deckhouses of the second tier, which do not provide a direct access to spaces below, in lieu of the side scuttles required by 7.2.1.4, side scuttles or windows without deadlights may be fitted.

**7.2.1.6** In other regions of superstructures, not mentioned above, ship type windows, complying with the requirements of 7.2.3, may be used. The arrangement of the windows shall be such as not to affect the structural rigidity of the superstructure.

**7.2.1.7** Arrangement of windows on ships of 55 m in overall length<sup>2</sup> and over shall meet the following requirements:

- .1** The view of the sea surface from the conning position shall not be obscured by more than two ship lengths, or 500 m, whichever is the less, forward of the bow to  $10^\circ$  on either side under all conditions of draught, trim and deck cargo.
- .2** No blind sector caused by cargo, cargo gear or other obstructions outside of the wheelhouse forward of the beam which obstructs the view of the sea surface as seen from the conning position, shall exceed  $10^\circ$ . The total arc of blind sectors shall not exceed  $20^\circ$ .

<sup>1</sup> The use of windows is not allowed in those areas.

<sup>2</sup> On fishing ships of 24 m in length,  $L$ , and over.



- The clear sectors between blind sectors shall be at least 5°. However, in the view described in paragraph .1, each individual blind sector shall not exceed 5°.
- .3 The horizontal field of vision from the conning position shall extend over an arc of not less than 225°, that is from right ahead to not less than 22.5° abaft the beam on either side of the ship.
  - .4 From each bridge wing the horizontal field of vision shall extend over an arc of not less than 225°, that is from at least 45° on the opposite bow through right ahead and then from right ahead to right astern through 180° on the same side of the ship.
  - .5 From the main steering position the horizontal field of vision shall extend over an arc from right ahead to at least 60° on each side of the ship.
  - .6 The ship's side shall be visible from the bridge wing. This requirement is accomplished when:
    - a) a view from the bridge wing plus a distance corresponding to a reasonable and safe distance of a seaman leaning over the side of the bridge wing, which need not be more than 400 mm, to the location vertically right under the maximum beam of the ship at the lowest seagoing draught is not obscured<sup>1</sup>; or
    - b) the sea surface at the lowest seagoing draught and with a transverse distance of 500 mm and more from the maximum beam throughout the ship's length is visible from the side of the bridge wing<sup>2</sup>;
    - c) for particular ship types, such as tug/tow boat, offshore supply vessel (OSV), rescue ship, work ship (e.g. floating cranes), etc., that are designed such that, in normal operations they come along side of, or operate in close proximity to, other vessels or offshore structures at sea, the bridge wings extend at least to a location from which the sea surface, at the lowest seagoing draught and at a transverse distance of 1500 mm from the maximum beam throughout the ship's length, is visible.
  - .7 The height of the lower edge of the navigation bridge front windows above the bridge deck shall be kept as low as possible. In no case shall the lower edge present an obstruction to the forward view as described in this regulation.
  - .8 The upper edge of the navigation bridge front windows above a forward view of the horizon, for a person with a height of eye of 1800 mm above the bridge deck at the conning position, when the ship is pitching in heavy seas. The Administration, if satisfied that a height of eye of 1800 mm is unreasonable and impractical, may allow reduction of the height of eye but to less than 1600 mm.
  - .9 Sufficient navigation bridge visibility shall be provided during all the operations included by the ship's ballast water management plan.

<sup>1</sup> See Fig. 7.2.1.7 a).

<sup>2</sup> See Fig. 7.2.1.7 b).

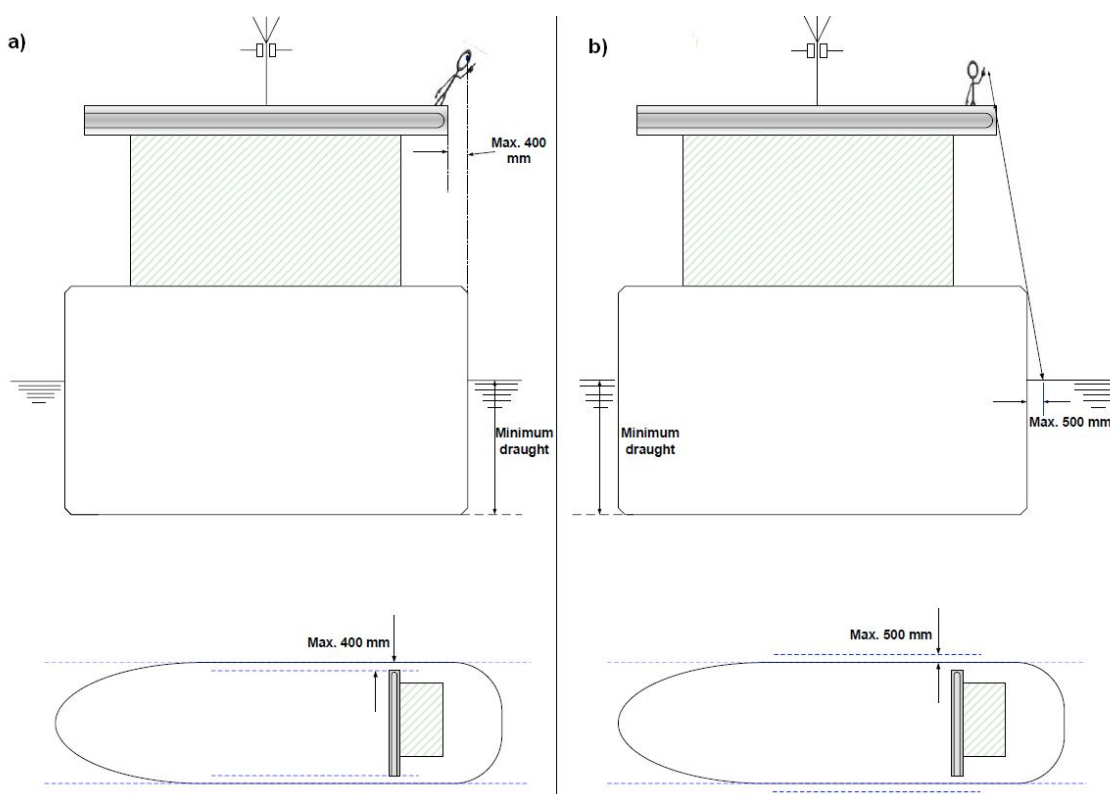


Fig. 7.2.1.7

- .10** On ships of unconventional design – other than those mentioned in 7.2.1.7.6 c) – which cannot comply with the above requirements, arrangements shall be provided to achieve a level of navigation bridge visibility that is as near as practical to that described in this paragraph.

The use of remote camera system may be accepted as means for achieving the view of the ship's side from the bridge wing, under the conditions that:

- the view provided by the remote camera system complies with the requirements in 7.2.1.7.6 and is also displayed at locations where the manoeuvring of the ship may take place;
- the upper edge of the ship's side abeam is directly visible from locations where the manoeuvring of the ship may take place;
- the technical characteristics of the remote camera system are compliant with the relevant requirements as described in IACS UI SC 235.

**7.2.1.8** For ships of 55 m in overall length and over, navigation bridge visibility plan showing compliance with the requirements of 7.2.1.7 shall be submitted to PRS H.O. for approval.

## 7.2.2 Construction of Side Scuttles

**7.2.2.1** Due to the method of construction, the present *Part III* distinguishes the following types of side scuttle:

- .1** heavy type with the glass thickness not less than 10 mm for inner diameter less than 200 mm or: 15 mm for 300 mm to 350 mm and 19 mm for inner diameter of 400 mm, respectively, the inner diameter not exceeding 400 mm; for intermediate inner diameters (200 to 300 mm and 350 to 400 mm), the glass thickness shall be determined by linear interpolation;

- .2 normal type with the glass thickness not less than 8 mm for inner diameter less than 250 mm and at least 12 mm for inner diameter from 350 mm to 400 mm, the inner diameter not exceeding 400 mm; for intermediate inner diameters, the glass thickness shall be determined by linear interpolation;
- .3 light type with the glass thickness not less than 6 mm for inner diameter less than 250 mm and at least 10 mm for inner diameter equal to 400 mm; for intermediate inner diameters, the glass thickness shall be determined by linear interpolation.

**7.2.2.2** Heavy and normal type side scuttles may be of non-opening type, i.e. with the glass fixed in the main frame or of opening type, i.e. with the glass fixed in the glazing bead efficiently hinged on the main frame.

Side scuttle glasses shall be reliably and weathertightly fixed by means of a metal ring with bolts or by other equivalent device, using seal gasket in each case.

**7.2.2.3** The main frame, glazing bead and deadlight of side scuttles shall have sufficient strength. The glazing bead and deadlight shall be fitted with gaskets and shall be capable of being effectively closed and secured weathertight by means of ear-nuts or nuts which can be unscrewed with the aid of a special wrench only.

**7.2.2.4** The main frame, glazing bead, deadlight and ring securing the glass shall be made of steel, brass or other suitable material approved by PRS.

The ear-nuts and nuts that can be unscrewed by a special wrench only shall be made of corrosion-resistant material. Glass used for side scuttles shall be hardened.

**7.2.2.5** Side scuttles should comply with the requirements of ISO 1751. Glass should be according to ISO 21005 requirements.

**7.2.2.6** The glass thickness shall be determined according to ISO 1751 or – for thermally toughened glass – according to ISO 21005. The design pressure shall be in accordance with subchapters 10.4, 16.2.2, 16.2.3 *Part II – Hull*. For scuttles situated in 2nd tier and below the design load shall not be less than determined according to ISO/5779 and 5780. The glass thickness should not be less than that determined in 7.2.2.1.

**7.2.2.7** Tests and marking of scuttles glass should be in accordance with ISO 614.

### **7.2.3 Construction of Windows**

**7.2.3.1** Windows shall comply with the requirements of ISO 3903. Glass panes shall be according to ISO 3254 or – for thermally toughened glass – according to ISO 21005.

**7.2.3.2** The glass panes thickness shall be determined according to ISO 3903 or – for thermally toughened – according to ISO 21005.

The design pressure shall be in accordance with subchapters 10.4, 16.2.2, 16.2.3 of *Part II – Hull*. For windows situated in 2nd tier, the design load shall not be less than that determined according to ISO/DIS 5779.

**7.2.3.3** The thickness of glass shall not be less than 8 mm. Where laminated toughened glass are used, the sum of second powers of each layer thickness should be at least equal to the second power of thickness required for single toughened glass.

Glass testing and marking should be according to the requirements of ISO 614.

**7.2.3.4** The construction of frame and the frame fastening to the superstructure shall be weathertight and corrosion resistant.

**7.2.3.5** Additionally to the requirements of 7.2.1.7 the windows on the navigation bridge of ships of 55 m in overall length and over shall fulfil the following requirements:

- .1 To help avoid reflections, the bridge front windows shall be inclined from the vertical plane top out, at an angle of not less than 10° and not more than 25°;
- .2 Framing between navigation bridge windows shall be kept to a minimum and not be installed immediately forward of any workstation;
- .3 Polarized and tinted windows shall not be fitted; and
- .4 At all times, regardless of weather conditions, at least two of the navigation bridge front windows shall provide a clear view, and in addition, depending on the bridge configuration, an additional number of windows shall provide a clear view.

**7.2.3.6** Windows installed in walls treated as fire divisions, depending on the type of ship, shall meet the applicable requirements specified in *Part V* of the Rules.

## **7.2.4 Flush Scuttles**

**7.2.4.1** Flush scuttles in positions 1 and 2 shall be provided with a deadlight hinged or attached by other method (for instance, by means of a chain) and capable of being easily and efficiently closed and secured.

**7.2.4.2** The inner diameter of flush scuttles shall not exceed 200 mm, with the glass being not less 15 mm in thickness. Flush scuttles shall be fastened to the deck plating by means of frames.

**7.2.4.3** When secured, the deadlights of flush scuttles shall be weathertight. The tightness of deadlights, as well as the tightness of glasses along their contour shall be ensured by gaskets made of rubber or other suitable material.

**7.2.4.4** The strength and materials of the components of flush scuttles shall fulfil the requirements of 7.2.2.3 and 7.2.2.4.

## **7.3 Doors**

### **7.3.1 Arrangement of Doors**

**7.3.1.1** All access openings in end bulkheads of closed superstructures and in outside walls of enclosed deckhouses shall be fitted with doors.

**7.3.1.2** The height of sills of the access openings, specified in 7.3.1.1, shall be 380 mm.

If a bridge or a poop cannot be considered as enclosed according to paragraph 10 (b), Regulation 3 of *ICLL*, the height of sills of access openings in such a bridge or poop shall be at least 600 mm in position 1 and 380 mm in position 2.

**7.3.1.3** The sill height shall be measured from the upper surface of deck steel plating (or wood sheathing, if applied), under the door opening.

**7.3.1.4** Doors installed in walls treated as fire divisions, depending on the type of ship, shall meet the applicable requirements specified in *Part V* of the Rules.

## 7.3.2 Construction

**7.3.2.1** In strength calculations of doors, the design pressure  $p$  determined in accordance with Chapters 10 and 16, *Part II – Hull* shall be taken into account assuming the point of application at the mid-height of the door. Stresses in the door structural members caused by this pressure shall not exceed 0.8 times the yield stress of the material used.

**7.3.2.2** Irrespective of the value of stresses, the thickness of the door plating shall not be less than the plating of the wall in which the doors are fitted. When the steel doors are made by stamping, the minimum thickness of their plating may be reduced by 1 mm.

The minimum thickness of doors made of other materials will be specially considered by PRS in each particular case.

**7.3.2.3** Doors shall be permanently attached to the bulkhead or wall and fitted with quick acting means for their opening and closing operated from both sides.

**7.3.2.4** Closing appliances of the door shall be operable from both sides.

**7.3.2.5** The direction of opening of doors on a ship shall generally be consistent with the designated direction of escape, as specified in *Part V* of the Rules.

**7.3.2.6** Doors installed in the external walls of superstructures and deckhouses, other than watertight bulkheads, shall be weathertight when closed. The tightness shall be ensured by gaskets made of rubber or other suitable material.

**7.3.2.7** The external doors shall be of steel or other equivalent material approved by PRS.

## 7.4 Bow Doors and Inner Doors

### 7.4.1 General

**7.4.1.1** The requirements of sub-chapter 7.4 relate to the arrangement, strength and securing of bow doors and inner doors leading to a complete or long forward enclosed superstructures or to a long non-enclosed superstructure, where fitted to attain minimum bow height equivalence.

The present requirements apply to all ro-ro passenger ships and ro-ro cargo ships engaged on international voyages and also to ro-ro passenger ships and ro-ro cargo ships engaged only in domestic (non-international) voyages, except where specifically indicated otherwise herein.

The present requirements are not applicable to high speed, light displacement craft as defined in the *International Code of Safety for High-Speed Craft (HSC Code)*.

**7.4.1.2** Two types of bow doors are provided for:

- visor doors opened by rotating upwards and outwards about a horizontal axis through two or more hinges located near the top of the door and connected to the primary structure of the door by longitudinally arranged lifting arms,
- side-opening doors opened either by rotating outwards about a vertical axis through two or more hinges located near the outboard edges or by horizontal translation by means of linking arms arranged with pivoted attachments to the door and the ship. It is anticipated that side-opening bow doors are arranged in pairs.

Other types of bow doors are subject to special consideration of PRS.

**7.4.1.3** Bow doors shall be situated above the freeboard deck. A watertight recess in the freeboard deck located forward of the collision bulkhead and above the deepest waterline fitted for arrangement of ramps or other related mechanical devices may be regarded as a part of the freeboard deck for the purpose of this requirement.

**7.4.1.4** Where a ship has a long forward superstructure, an inner door shall be fitted in way of the bow door as part of collision bulkhead extension to the deck next above the bulkhead deck. The inner door needs not be fitted in the same plane as the bulkhead below provided that it is located within the limits specified for the location of collision bulkhead, as prescribed in subchapter 9.2.2 of *Part II – Hull*.

Where a sloping loading ramp shall perform the role of the inner door, it shall meet the above mentioned requirements concerning the location of collision bulkhead, except as provided in 7.4.1.5. Such a ramp shall be weathertight.

**7.4.1.5** In cargo ships the part of the ramp which is more than 2.3 m above the bulkhead deck may extend forward of the limit specified in paragraph 7.4.1.4.

**7.4.1.6** Bow doors shall be so fitted as to ensure tightness consistent with operational conditions and to give effective protection to inner doors. Inner doors forming part of the collision bulkhead shall be weathertight over the full height of the cargo space and arranged with fixed sealing supports on the aft side of the doors.

**7.4.1.7** Bow doors and inner doors shall be so arranged as to preclude the possibility of the bow door causing structural damage to the inner door or to the collision bulkhead in the case of damage to or detachment of the bow door. If this is not possible, a separate inner weathertight door shall be installed, as indicated in 7.4.1.4.

**7.4.1.8** The requirements for inner doors are based on the assumption that vehicles are effectively lashed and secured against movement in stowed position.

#### **7.4.1.9 Definitions**

*Locking device* – a device that locks a securing device in the closed position.

*Ro-ro passenger ship, ro-ro spaces, special category spaces* – see *Part V* of the Rules, subchapter 1.2.

*Securing device* – a device used to keep the door closed by preventing it from rotating about its hinges.

*Supporting device* – a device used to transmit external or internal loads from the door to a securing device and from the securing device to the ship's structure, or a device other than a securing device, such as a hinge, stopper or other fixed device that transmits loads from the door to the ship's structure.

#### **7.4.2 Strength Criteria**

**7.4.2.1** The scantlings of the primary members, securing and supporting devices of bow doors and inner doors shall be determined to withstand the design loads as defined in 7.4.3, using the following permissible stresses:

- shear stress:  $\tau = 80 / k$  [MPa],
- bending stress:  $\sigma = 120 / k$  [MPa], and
- equivalent stress:  $\sigma_c = \sqrt{\sigma^2 + 3\tau^2} = 150/k$  [MPa],

where  $k$  is material factor equal to 0.78 for  $R_e = 315$  MPa and 0.72 for  $R_e = 355$  MPa, but shall not be taken less than 0.72 unless a direct fatigue analysis is carried out.



**7.4.2.2** The buckling strength of primary members shall be verified as being adequate.

**7.4.2.3** For steel used in steel bearings in securing and supporting devices, the nominal bearing pressure, calculated by dividing the design force by the projected bearing area, shall not exceed  $0.8R_e$ , where  $R_e$  is the yield stress of the bearing material.

For other bearing materials, the permissible bearing pressure shall be determined according to the manufacturer's specification.

**7.4.2.4** The arrangement of securing and supporting devices shall be such that threaded bolts do not carry support forces. The maximum tension in way of threads of bolts not carrying support forces shall not exceed  $125/k$  [MPa], for  $k$  specified in 7.4.2.1.

### 7.4.3 Design Loads of Bow Doors

**7.4.3.1** The design external pressure, [kPa], to be considered for the scantlings of primary members, securing and supporting devices of bow doors, shall not be less than the pressure given in 16.2, *Part II – Hull*, nor than:

$$p_e = 2.75\lambda C_H (0.22 + 0.15\text{tg}\alpha) (0.4V\sin\beta + 0.6L_0^{0.5})^2 \text{ [kPa]} \quad (7.4.3.1)$$

$V$  – contractual ship's speed, [knots];

$L_0$  – ship's length, [m], to be taken not greater than 200 m;

$\lambda$  = 1 for sea-going ships (operated in unrestricted area),

$\lambda$  = 0.8 for ships operated in navigation area III,

$\lambda$  = 0.5 for ships operated in sheltered waters;

$C_H$  =  $0.0125L_0$  for  $L_0 < 80$  m, [m],

$C_H$  = 1 for  $L_0 \geq 80$  m, [m];

$\alpha$  – flare angle at the considered point, defined as the angle between a vertical line and the tangent to the side shell plating, measured in a vertical plane normal to the horizontal tangent to the shell plating;

$\beta$  – entry angle at the point to be considered, defined as the angle between a longitudinal line parallel to the centre plane and the tangent to the shell plating in a horizontal plane.

**7.4.3.2** The design external forces considered for the scantlings of securing and supporting devices of bow doors shall not be less than:

$$F_x = p_e A_x \text{ [kN]} \quad (7.4.3.2-1)$$

$$F_y = p_e A_y \text{ [kN]} \quad (7.4.3.2-2)$$

$$F_z = p_e A_z \text{ [kN]} \quad (7.4.3.2-3)$$

$A_x$  – area of the transverse vertical projection of the door between the levels of the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is the lesser. Where the flare angle of the bulwark is at least 15 degrees less than the flare angle of the adjacent shell plating, the height from the bottom of the door may be measured to the upper deck or to the top of the door, whichever is the lesser. In determining the height from the bottom of the door to the upper deck or to the top of the door, the bulwark shall be excluded, [m<sup>2</sup>];

$A_y$  – area of the longitudinal vertical projection of the door between the levels of the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is the lesser. Where the flare angle of the bulwark is at least 15 degrees less than the flare angle of the adjacent shell plating, the height from the bottom of the door may be measured to the upper deck or to the top of the door, whichever is the lesser, [m<sup>2</sup>];

- $A_z$  – area of the horizontal projection of the door between the bottom of the door and the top of the upper deck bulwark, or between the bottom of the door and the top of the door, including the bulwark, where it is part of the door, whichever is the lesser. Where the flare angle of the bulwark is at least 15 degrees less than the flare angle of the adjacent shell plating, the height from the bottom of the door may be measured to the upper deck or to the top of the door, whichever is the lesser, [m<sup>2</sup>];
- $h$  – height of the door between the levels of the bottom of the door and the upper deck or between the bottom of the door and the top of the door, whichever is the lesser, [m];
- $l$  – length of the door at a height  $h/2$  above the bottom of the door, [m];
- $w$  – breadth of the door at a height  $h/2$  above the bottom of the door, [m];
- $p_e$  – external pressure, [kPa], as given in 7.4.3.1.1 with angles  $\alpha$  and  $\beta$  defined as follows:
- $\alpha$  – flare angle measured at the point on the bow door,  $l/2$  aft of the stem line on the plane  $h/2$  above the bottom of the door (see Fig. 7.4.3.2),
  - $\beta$  – entry angle measured at the same point as  $\alpha$ .

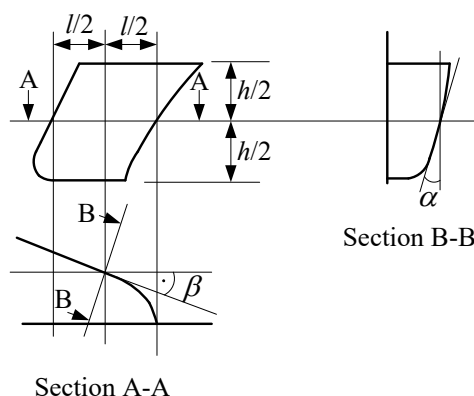


Fig. 7.4.3.2

For bow doors, including bulwark, of unusual form or proportions, e.g. ships with a rounded nose and large stem angles, the areas and angles used for determination of the design values of external forces may require to be specially considered.

**7.4.3.3** For visor doors, the closing moment  $M_y$  under external loads shall be taken as:

$$M_y = F_x a + 10Wc - F_z b \quad [\text{kNm}] \quad (7.4.3.3)$$

- $W$  – mass of the visor door [t];
- $a$  – vertical distance from visor pivot to the centroid of the transverse vertical projected area of the visor door, as shown in Fig. 7.4.3.3 [m];
- $b$  – horizontal distance from visor pivot to the centroid of the horizontal projected area of the visor door, as shown in Fig. 7.4.3.3 [m];
- $c$  – horizontal distance from visor pivot to the centre of gravity of visor mass, as shown in Fig. 7.4.3.3 [m].



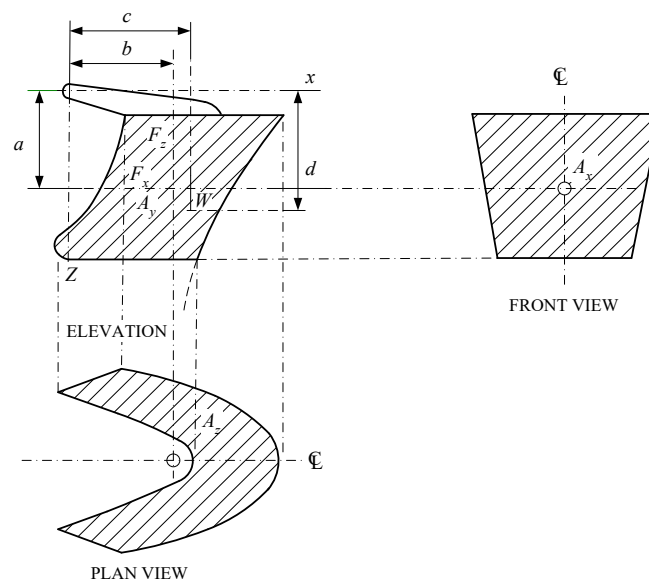


Fig. 7.4.3.3

**7.4.3.4** Moreover, the lifting arms of a visor door and their supports shall be dimensioned for the static and dynamic forces applied during the lifting and lowering operations. A minimum wind pressure of 1.5 kPa shall also be taken into account.

#### 7.4.4 Design Loads of Inner Doors

**7.4.4.1** The design external pressure considered for the scantlings of primary members, securing and supporting devices and surrounding structure of inner doors shall be taken as the greater of the following values:

- $p_e = 0.45L_0$  [kPa];
- hydrostatic pressure  $p_h = 10h$ , where  $h$  is the distance from the load point to the top of the cargo space, [m];

$L_0$  – the ship's length, as determined in 7.4.3.1.

**7.4.4.2** The design internal pressure,  $p_i$ , considered for the scantlings of securing devices of inner doors shall not be less than 25 kPa.

#### 7.4.5 Scantlings of Bow Doors

**7.4.5.1** The strength of the bow doors shall be commensurate to the strength of the surrounding structure.

**7.4.5.2** Bow doors shall be adequately stiffened and means shall be provided to prevent lateral or vertical movement of the doors when closed. For visor doors, adequate strength for the opening and closing operations shall be provided in the connections of the lifting arms to the door structure and to the ship structure.

**7.4.5.3** The thickness of the bow door plating shall not be less than that required for the side shell plating, using bow door stiffener spacing, but in no case less than the minimum required thickness of fore end shell plating.

**7.4.5.4** The section modulus of horizontal and vertical stiffeners shall not be less than those required for end framing. Consideration shall be given, where necessary, to differences in fixity between the ship's frames and bow doors stiffeners.

**7.4.5.5** The stiffener webs shall have a net sectional area not less than:

$$A = \frac{Qk}{10} \text{ [cm}^2\text{]} \quad (7.4.5.5)$$

$Q$  – shear force in the stiffener calculated by using uniformly distributed external pressure  $p_e$ , as given in 7.4.3.1 [kN];

$k$  – material factor, according to 7.4.2.1.

**7.4.5.6** The bow door secondary stiffeners shall be supported by primary members constituting the main stiffening of the door.

**7.4.5.7** The primary members of the bow door and the hull structure in way shall have sufficient stiffness to ensure integrity of the boundary support of the door.

**7.4.5.8** The scantlings of primary members are generally to be supported by direct strength calculations in association with the external pressure given in 7.4.3.1 and permissible stresses given in 7.4.2.1. Normally, formulae for simple beam theory may be applied to determine the bending stress. Members shall be considered to have simply supported end connections.

#### **7.4.6 Scantlings of Inner Doors**

**7.4.6.1** The scantlings of primary members are generally to be supported by direct strength calculations in association with the external pressure given in 7.4.4.1 and permissible stresses given in 7.4.2.1. Normally, formulae for simple beam theory may be applied.

**7.4.6.2** Where inner doors also serve as vehicle ramps, the scantlings shall not be less than those required for vehicle decks.

**7.4.6.3** The distribution of the forces acting on the securing and supporting devices is generally to be supported by direct calculations taking into account the flexibility of the structure and the actual position and stiffness of the supports.

#### **7.4.7 Securing and Supporting of Bow Doors**

**7.4.7.1** Bow doors shall be fitted with adequate means of securing and supporting so as to be equivalent to the strength and stiffness of the surrounding structure. The hull supporting structure in way of the bow doors shall be suitable for the same design loads and design stresses as the securing and supporting devices. Where packing is required, the packing material shall be of a comparatively soft type, and the supporting forces shall be performed the steel structure only. Other types of packing may be considered. Maximum design clearance between securing and supporting devices shall not generally exceed 3 mm. Means shall be provided for mechanically fixing the door in the open position.

**7.4.7.2** Only the active supporting and securing devices having an effective stiffness in the relevant direction shall be included and considered to calculate the reaction forces acting on the devices.

Small and/or flexible devices, such as cleats intended to provide load compression of the packing material are not generally to be included in the calculations, referred to in 7.4.7.8.

The number of securing and supporting devices is generally to be the minimum practical whilst taking into account the requirements for redundant requirements specified in 7.4.7.9 and 7.4.7.10 and the available space for adequate support in the hull structure.

**7.4.7.3** For opening outwards visor doors, the pivot arrangement is generally to be such that the visor is self-closing under external loads, that is  $M_y > 0$ . Moreover, the closing moment  $M_y$ , as given in 7.4.3.3, shall not be less than:

$$M_{y0} = 10Wc + 0,1\sqrt{a^2 + b^2}\sqrt{F_x^2 + F_z^2} \text{ [kNm]} \quad (7.4.7.3)$$

**7.4.7.4** Securing and supporting devices shall be adequately designed so that they can withstand the reaction forces within the permissible stresses, as given in 7.4.2.1.

**7.4.7.5** For visor doors, the reaction forces applied on the effective securing and supporting devices, assuming the doors as a rigid body, are determined for the following combination of external loads acting simultaneously with the self weight of the door:

- .1 case 1:  $F_x$  and  $F_z$ ,
- .2 case 2:  $0.7F_y$  acting on each side separately, together with  $0.7F_x$  and  $0.7F_z$ ,

where  $F_x$ ,  $F_y$  and  $F_z$  are determined in 7.4.3.2 and applied at the centroid of projected areas.

**7.4.7.6** For side-opening doors, the reaction forces applied on the effective securing and supporting devices, assuming the doors as a rigid body, are determined for the following combination of external loads acting simultaneously with the self weight of the door:

- .1 case 1:  $F_x$ ,  $F_y$  and  $F_z$  acting on both doors,
- .2 case 2:  $0.7F_x$  and  $0.7F_z$  acting on both doors and  $0.7F_y$  acting on each door separately,

where  $F_x$ ,  $F_y$  and  $F_z$  are determined in 7.4.3.2 and applied at the centroid of projected areas.

**7.4.7.7** The support forces, determined according to 7.4.7.5.1 and 7.4.7.6.1, shall give, in general, rise to a zero moment about the transverse axis through the centroid of the area  $A_x$ . For visor doors, longitudinal reaction forces of pin and/or wedge supports at the door base contributing to this moment shall not be of the forward direction.

**7.4.7.8** The distribution of the reaction forces acting on the securing and supporting devices may require to be supported by direct calculations taking into account the flexibility of the hull structure and the actual position and stiffness of the supports.

**7.4.7.9** The arrangement of securing and supporting devices in way of these securing devices shall be designed with redundancy so that in the event of failure of any single securing or supporting device the remaining devices are capable to withstand the reaction forces without exceeding by more than 20 per cent the permissible stresses given in 7.4.2.1.

**7.4.7.10** For visor doors, two securing devices shall be provided at the lower part of the door, each capable of providing the full reaction force required to prevent opening of the door within the permissible stresses given in 7.4.2.1. The opening moment  $M_o$ , to be balanced by this reaction force, shall not be taken less than:

$$M_o = 10 Wd + 5 A_x a \text{ [kNm]} \quad (7.4.7.10)$$

$d$  – vertical distance from the hinge axis to the centre of gravity of the door, as shown in Fig. 7.4.3.3, [m];

$a$  – as defined in 7.4.3.3.

**7.4.7.11** For visor doors, the securing and supporting devices, excluding the hinges, shall be capable of resisting the vertical design force ( $F_z - 10W$ , where  $W$  – the door mass [t]), [kN], within the permissible stresses given in 7.4.2.1.

**7.4.7.12** All load transmitting elements in the design load path, from door through securing and supporting devices into the ship structure (pins, supporting brackets and back-up brackets), including welded connections, shall be to the same strength standard as required for the securing and supporting devices.

**7.4.7.13** For side-opening doors, thrust bearing shall be provided in way of girder ends at the closing of the two leaves to prevent one leaf to shift towards the other one under effect of unsymmetrical pressure (see example in Fig. 7.4.7.13).

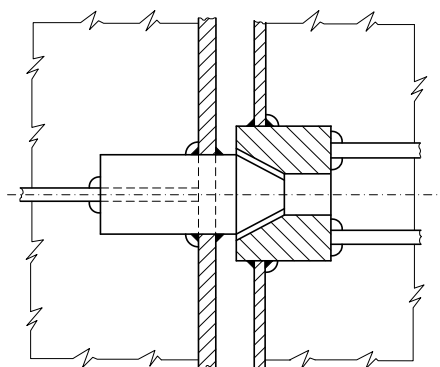


Fig. 7.4.7.13

Each part of the thrust bearing shall be kept secured on the other part by means of securing devices. Any other arrangement serving the same purpose may be proposed.

#### 7.4.8 Securing and Locking Arrangement

**7.4.8.1** Securing devices shall be simple to operate and easily accessible. They shall be equipped with mechanical locking arrangement (self-locking or a separate arrangement) or to be of the gravity type. The opening and closing systems, as well as securing and locking devices shall be interlocked in such a way that they can only operate in the proper sequence.

Bow doors of large dimensions, when manual devices would not be readily accessible, shall be normally secured by means of power systems.

Alternative means of securing shall also be provided for emergency use in case of failure of the power systems.

**7.4.8.2** Bow doors and inner doors giving access to vehicle decks shall be provided with an arrangement for remote control, from a position above the freeboard deck, of:

- the closing and opening of the doors,
- associated securing and locking devices for every door.

Indication of the open/closed position of every door and every securing and locking device shall be provided at the remote control stations. The operating panels for operation of doors shall be inaccessible to unauthorized persons.

A notice plate, giving instructions to the effect that all securing devices shall be closed and locked before leaving harbour, shall be placed at each operating panel and shall be supplemented by warning indicator lights.

**7.4.8.3** Where hydraulic securing devices are applied, the system shall be mechanically lockable in closed position. This means that in the event of loss of the hydraulic fluid, the securing devices remain locked. The hydraulic system for securing and locking devices shall be isolated from other hydraulic circuits, when in closed position.

**7.4.8.4** The requirements, specified in *Part VIII – Electrical installations and control system*, shall be fulfilled for a water leakage detection system and indicator system to show that the bow door and inner door are closed and that their securing and locking devices are properly positioned.

## **7.4.9 Operation and Maintenance Manual**

**7.4.9.1** An Operating and Maintenance Manual for the bow door and inner door shall be provided on board and shall contain the necessary information on:

- main particulars and design drawings:
  - special safety precautions,
  - details of vessel,
  - equipment and design loading (for ramps),
  - key plan of equipment (doors and ramps),
  - the manufacturer’s recommended testing for equipment,
  - description of equipment for bow doors, inner bow doors, bow ramp/doors, side doors, stern doors, central power pack, bridge panel, engine control room panel,
- service conditions:
  - limiting heel and trim of ship for loading/unloading,
  - limiting heel and trim for door operations,
  - doors/ramps operating instructions,
  - doors/ramps emergency operating instructions,
- maintenance:
  - schedule and extent of maintenance,
  - trouble shooting and acceptable clearances,
  - manufacturer’s maintenance procedures,
- register of inspections, including inspection of locking, securing and supporting devices:
  - repairs and renewals.

This Manual shall be submitted for approval to ensure that it contains the above-mentioned data and information.

### **Note:**

It is recommended that recorded inspections of the door supporting and securing devices be carried out by the ship’s staff at monthly intervals or following incidents that could result in damage, including heavy weather or contact in the region of the doors shell. Any damages recorded during such inspections shall be reported to PRS.

**7.4.9.2** Documented operating procedures for closing and securing the bow door and inner door shall be kept on board and posted at appropriate place.

## **7.5 Side Shell Doors and Stern Doors**

### **7.5.1 General**

**7.5.1.1** The requirements of the present sub-chapter relate to the arrangement, strength and securing of side shell doors (abaft the collision bulkhead) and stern doors leading into enclosed spaces.

The present requirements apply to ro-ro passenger ships and ro-ro cargo ships engaged on domestic or international voyages, except where specifically indicated otherwise herein.

The present requirements are not applicable to high speed, light displacement craft as defined in *International Code of Safety for High-Speed Craft (HSC Code)*.

**7.5.1.2** Stern doors in passenger ships shall be situated above the freeboard deck. Stern doors in cargo ro-ro ships and side shell doors may be situated either below or above the freeboard deck.

**7.5.1.3** Side shell doors and stern doors shall be so fitted as to ensure tightness and structural integrity commensurate with their location and the surrounding structure.

**7.5.1.4** The sill of any side shell and stern door shall not be below a line drawn parallel to the bulkhead deck in passenger ships and the freeboard deck in cargo ship, which is at its lowest point at least 230 mm above the upper edge of the uppermost load line.

**7.5.1.5** PRS may allow to locate cargo ports and similar openings below the line defined in 7.5.1.4 provided that additional arrangements for securing water tightness are applied. One acceptable solution may be fitting of a second door of equivalent strength and watertightness. In that case leakage detection device shall be provided in the compartment between the cargo port and the door. Drainage of this compartment to the bilges, controlled by an easily accessible screw down valve, shall be arranged. The outer door shall open outwards.

**7.5.1.6** Doors shall preferably open outwards.

#### **7.5.1.7 Definitions**

*Securing device* – a device used to keep the door closed by preventing it from rotating about its hinges or about pivoted attachments to the ship.

For other definitions, see 7.4.1.9.

### **7.5.2 Strength Criteria**

**7.5.2.1** The scantlings of the primary members, securing and supporting devices of side shell doors and stern doors shall be determined to withstand the design loads specified in 7.5.3, using the following permissible stresses:

- shear stress:  $\tau = 80 / k$  [MPa],
- bending stress:  $\sigma = 120 / k$  [MPa], and
- equivalent stress:  $\sigma_c = \sqrt{\sigma^2 + 3\tau^2} = 150/k$  [MPa],

where  $k$  is the material factor equal to 0.78 for  $R_e = 315$  MPa and 0.72 for  $R_e = 355$  MPa, but shall be taken not less than 0.72, unless a direct strength analysis with regard to relevant modes of failures is carried out.

**7.5.2.2** The buckling strength of primary members shall be verified as being adequate.

**7.5.2.3** For steel used in steel bearings in securing and supporting devices, the nominal bearing pressure calculated by dividing the design force by the projected bearing area shall not exceed  $0.8R_e$ , where  $R_e$  is the yield stress of the bearing material.

For other bearing materials, the permissible bearing pressure shall be determined according to the manufacturer's specification.

**7.5.2.4** The arrangement of securing and supporting devices shall be such that threaded bolts do not carry support forces.

The maximum tension in way of threads of bolts not carrying support forces shall not exceed  $125/k$ , [MPa], with  $k$  defined in 7.5.2.1.

### 7.5.3 Design Loads

**7.5.3.1** The design forces considered for the scantlings of primary members, securing and supporting devices of side shell doors and stern doors shall not be less than:

(I) Design forces for securing or supporting devices of doors opening inwards:

$$\text{external force: } F_e = Ap_e + F_p \text{ [kN]} \quad (7.5.3.1-1)$$

$$\text{internal force: } F_i = F_o + 10W \text{ [kN]} \quad (7.5.3.1-2)$$

(II) Design forces for securing or supporting devices of doors opening outwards:

$$\text{external force: } F_e = Ap_e \text{ [kN]} \quad (7.5.3.1-3)$$

$$\text{internal force: } F_i = F_o + 10W + F_p \text{ [kN]} \quad (7.5.3.1-4)$$

(III) Design forces for primary members:

$$\text{external force: } F_e = Ap_e \text{ [kN]} \quad (7.5.3.1-5)$$

$$\text{internal force: } F_i = F_o + 10W \text{ [kN]} \quad (7.5.3.1-6)$$

whichever is the greater.

$A$  – area of the door opening, [m<sup>2</sup>];

$W$  – mass of the door, [t];

$F_p$  – total packing force, [kN]. Packing line pressure shall normally not be taken less than 5 N/mm;

$F_o$  – the greater of  $F_c$  and  $5A$ , [kN];

$F_c$  – accidental force, [kN], due to loose cargo, etc., to be uniformly distributed over the area  $A$  and to be taken not less than 300 kN. For small doors such as bunker doors and pilot doors, the value of  $F_c$  may be appropriately reduced. However, the value of  $F_c$  may be taken as zero, provided an additional structure such as an inner ramp is fitted, which is capable of protecting the door from accidental forces due to loose cargoes;

$p_e$  – external design pressure, determined at the centre of gravity of the door opening and taken not less than:

$$10 (T - Z_G) + 25 \text{ [kPa]} \text{ for } Z_G < T \quad (7.5.3.1-7)$$

$$25 \text{ kPa for } Z_G \geq T$$

Moreover, for stern doors of ships fitted with bow doors,  $p_e$  shall not be taken less than:

$$p_e = 0.6\lambda C_H (0.8 + 0.6\sqrt{L_0})^2 \text{ [kPa]} \quad (7.5.3.1-8)$$

$L_0, \lambda, C_H$  – to be taken according to 7.4.3.1;

$T$  – draught at the deepest subdivision load line [m];

$Z_G$  – height of the centre of area of the door above the base plane [m].

### 7.5.4 Scantlings of Side Shell Doors and Stern Doors

**7.5.4.1** The strength of side shell doors and stern doors shall be commensurate with that of the surrounding structure.

**7.5.4.2** Side shell doors and stern doors shall be adequately stiffened and means shall be provided to prevent any lateral or vertical movement of the doors when closed. Adequate strength shall be provided in the connections of the lifting/ manoeuvring arms and hinges to the door structure and to the ship's structure.

**7.5.4.3** Where doors also serve as vehicle ramps, the design of the hinges shall take into account the ship angle of trim and heel which may result in uneven loading on the hinges.



**7.5.4.4** Shell door openings shall have well-rounded corners and adequate compensation shall be arranged with web frames at sides and stringers or equivalent above and below.

**7.5.4.5** The thickness of the door plating shall not be less than the required thickness for the side shell plating, using the door stiffener spacing, but in no case less than the minimum required thickness of shell plating. Where doors serve as vehicle ramps, the plating thickness shall not be less than required for vehicle decks.

**7.5.4.6** The section modulus of horizontal or vertical stiffeners shall not be less than that required for side framing. Consideration shall be given, where necessary, to differences in fixity between the ship's frames and door stiffeners. Where doors serve as vehicle ramps, the stiffener scantlings shall not be less than those required for vehicle decks.

**7.5.4.7** The secondary stiffeners shall be supported by primary members constituting the main stiffening of the door.

**7.5.4.8** The primary members and the hull structure in way shall have sufficient stiffness to ensure structural integrity of the boundary of the door.

**7.5.4.9** The scantlings of the primary members are generally to be supported by direct strength calculations in association with the design forces given in 7.5.3 and permissible stresses given in 7.5.2.1. Normally, formulae for simple beam theory may be applied to determine the bending stresses. Members shall be considered to have simply supported end connections.

## **7.5.5 Securing and Supporting of Doors**

**7.5.5.1** Side shell doors and stern doors shall be fitted with adequate means of securing and supporting so as to be commensurate with the strength and stiffness of the surrounding structure. The hull supporting structure in way of the doors shall be suitable for the same design loads and design stresses as the securing and supporting devices. Where packing is required, the packing material shall be of a comparatively soft type, and the supporting forces shall be carried by the steel structure only. Other types of packing may be considered. Maximum design clearance between securing and supporting devices shall not generally exceed 3 mm. Means shall be provided for mechanically fixing the door in the open position.

**7.5.5.2** Only the active supporting and securing devices having an effective stiffness in the relevant direction shall be included and considered to calculate the reaction forces acting on the devices. Small and/or flexible devices such as cleats intended to provide local compression of the packing material are not generally to be included in the calculations referred to in 7.5.5.4.

The number of securing and supporting devices is generally to be the minimum practical whilst taking into account the requirement for redundant requirements given in 7.5.5.5 and the available space for adequate support in the hull structure.

**7.5.5.3** Securing and supporting devices shall be adequately designed so that they can withstand the reaction forces within the permissible stresses given in 7.5.2.1.

**7.5.5.4** The distribution of the reaction forces acting on the securing devices and supporting devices may require to be supported by direct calculations taking into account the flexibility of the hull structure and the actual position of the supports.

**7.5.5.5** The arrangements of securing devices and supporting devices in way of these securing devices shall be designed with redundancy so that in the event of failure of any single securing or supporting device, the remaining devices are capable to withstand the reaction forces without exceeding by more than 20 per cent the permissible stresses given in 7.5.2.1.

**7.5.5.6** All load transmitting elements in the design load path, from the door through securing and supporting devices into the ship's structure (pins, support brackets and back-up brackets), including welded connections, shall be to the same strength standard as required for the securing and supporting devices.

### **7.5.6 Securing and Locking Arrangement**

**7.5.6.1** Securing devices shall be simple to operate and easily accessible. They shall be equipped with mechanical locking arrangement (self-locking or a separate arrangement) or to be of the gravity type. The opening and closing systems, as well as securing and locking devices shall be interlocked in such a way that they can only operate in the proper sequence.

Stern and side doors of large dimensions, when manual devices would not be readily accessible, shall be normally secured by means of power systems.

Alternative means of securing shall also be provided for emergency use in case of failure of the power systems.

**7.5.6.2** Doors with a clear opening area greater than 6 m<sup>2</sup>, located partly or totally below the freeboard deck, shall be provided with an arrangement for remote control, from a position above the freeboard deck, of:

- the closing and opening of the doors,
- associated securing and locking devices.

For doors which are required to be equipped with a remote control arrangement, indication of the open/closed position of the door and the securing and locking device shall be provided at the remote control stations. The operating panels for operation of doors shall be inaccessible to unauthorized persons.

A notice plate, giving instructions to the effect that all securing devices shall be closed and locked before leaving harbour, shall be placed at each operating panel and shall be supplemented by warning indicator lights.

**7.5.6.3** Where hydraulic securing devices are applied, the system shall be mechanically lockable in closed position. This means that in the event of loss of the hydraulic fluid, the securing devices remain locked.

The hydraulic system for securing and locking devices shall be isolated from other hydraulic circuits, when in closed position.

**7.5.6.4** The requirements, specified in *Part VIII – Electrical installations and control system*, shall be fulfilled for a water leakage detection system and indicator system to show that the doors are closed and that their securing and locking devices are properly positioned.

### **7.5.7 Operation and Maintenance Manual**

**7.5.7.1** To side shell and stern doors, the requirements of 7.4.9 apply in their entirety.

**7.5.7.2** Documented operating procedures for closing and securing side shell and stern doors shall be kept on board and posted at appropriate place.

**Note:** The external pressure applied on stern doors is derived from formula 7.4.3.1 for bow doors, assuming :  $\alpha = 0$  degree,  $\beta = 90$  degrees,  $V = 2$  knots.

## 7.6 Companion Hatches, Skylights and Ventilating Trunks

**7.6.1** Deck openings in positions 1 and 2 intended for stairways leading to the spaces located below, as well as light and air openings to these spaces shall be protected by companion hatches, skylights or ventilating trunks of adequate strength. Where the openings leading to the spaces located below are protected by superstructures or deckhouses instead of the protections mentioned above, these superstructures or deckhouses shall fulfil the requirements of 7.3.

**7.6.2** The height of coamings of companion hatches, skylights and ventilating trunks shall be at least 600 mm in position 1 and 450 mm in position 2.

The construction of the coamings shall fulfil the requirements of sub-chapter 8.6 in *Part II – Hull*.

**7.6.3** All companion hatches, skylights and ventilating trunks shall be provided with covers permanently attached to the coamings with the use of hinges and made of steel or other material approved by PRS.

Where the covers are made of steel, the thickness of their plating shall be equal to at least 0.01 times the spacing of stiffeners but not less than 6 mm. The minimum required thickness may be reduced if the cover is made by stamping, in accordance with Fig. 7.6.3 and Table 7.6.3.

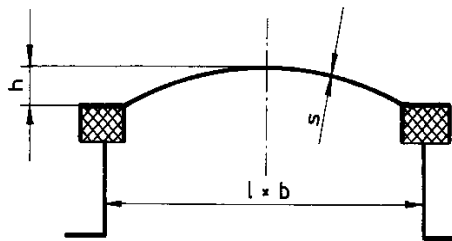


Fig. 7.6.3

**Table 7.6.3**

Inner size of hatch opening $l \times b$ [mm]	Cover material	$h$ [mm]	Minimum thickness, $s$ [mm]
450 × 600	Steel	25	4
	Aluminium alloy		
600 × 600	Steel	28	4
	Aluminium alloy		
700 × 700	Steel	40	4
	Aluminium alloy		6
800 × 800	Steel	55	4
	Aluminium alloy		6
800 × 1200	Steel	55	5
	Aluminium alloy		6
1000 × 1400	Steel	90	5

With respect to companion hatches, specified in 7.6.4, the minimum thickness of covers shall be determined from Table 7.6.4.

**7.6.4** Small hatches<sup>1</sup> fitted on ships of length  $L_0 \geq 80$  m (except those ships to which the requirements of *CSR* apply) and:

- designed for access to spaces below the exposed deck,
  - located over the forward  $0.25L_0$ ,
  - located on the exposed deck, the height of which in way of the hatch is less than  $0.1L_0$  or 22 m above the summer load waterline, whichever is the lesser,
- shall be capable to be closed weathertight or watertight, as applicable, and shall fulfil the requirements given below.

This paragraph does not apply to small hatches on container ship giving access to a cargo hold which comply with IACS UI LL64 except the requirement of clause 4 & 5. Such hatch covers are considered non-weathertight regardless of whether it is actually weathertight or not. However, for scantlings of small hatches, the strength requirements in **7.6.4.2** could be applied instead of clause 6 of IACS UI LL64.

**Table 7.6.4**  
**Scantlings for small steel hatch covers on the fore deck**

Nominal size [mm × mm]	Cover plate thickness [mm]	Primary stiffeners	Secondary stiffeners
		Flat bar [mm × mm]; number	
630 × 630	8	–	–
630 × 830	8	100 × 8; 1	–
830 × 630	8	100 × 8; 1	–
830 × 830	8	100 × 10; 1	–
1030 × 1030	8	120 × 12; 1	80 × 8; 2
1330 × 1330	8	150 × 12; 2	100 × 10; 2

**7.6.4.1 Hatches designed for use as emergency escape**

Hatches designed for use as emergency escape shall fulfil the requirements of 7.6.4, except the requirements given in 7.6.4.3.1 a) and b), 7.6.4.4.3 and 7.6.4.5.

Securing devices of hatches designed for emergency escape shall be of a quick-acting type (e.g., one action wheel handles are provided as central locking devices for latching/unlatching of hatch cover) operable from both sides of the hatch cover.

It is necessary to provide means of escape in cargo spaces so that persons on board can safely and swiftly escape to the lifeboat and liferaft embarkation deck. For this purpose, the following functional requirements shall be met:

- safe escape routes shall be provided,
- escape routes shall be maintained in a safe condition, clear of obstacles,
- additional aids for escape shall be provided as necessary to ensure accessibility, clear marking and adequate design for emergency situations.

To facilitate a swift and safe means of escape to the lifeboat and liferaft embarkation deck, the following requirements apply to overhead hatches fitted along the escape routes:

- the securing devices shall be of a type which can be opened from both side,
- the maximum force needed to open the hatch cover should not exceed 150 N,
- the use of a spring equalizing, counterbalance or other suitable device on the hinge side to reduce the force needed for opening is acceptable.

<sup>1</sup> Small hatches – the hatches with opening of 2.5 m<sup>2</sup> or less.

### 7.6.4.2 Strength

- .1 For small rectangular steel hatch covers, the plate thickness, stiffener arrangement and scantlings shall be in accordance with Table 7.6.4 and Fig. 7.6.4.2.

Stiffeners, where fitted, shall be aligned with the metal-to-metal contact points, required in 7.6.4.4.1, see Fig. 7.6.4.2. Primary stiffeners shall be continuous. All stiffeners shall be welded to the inner edge stiffener, see Fig. 7.6.4.3.

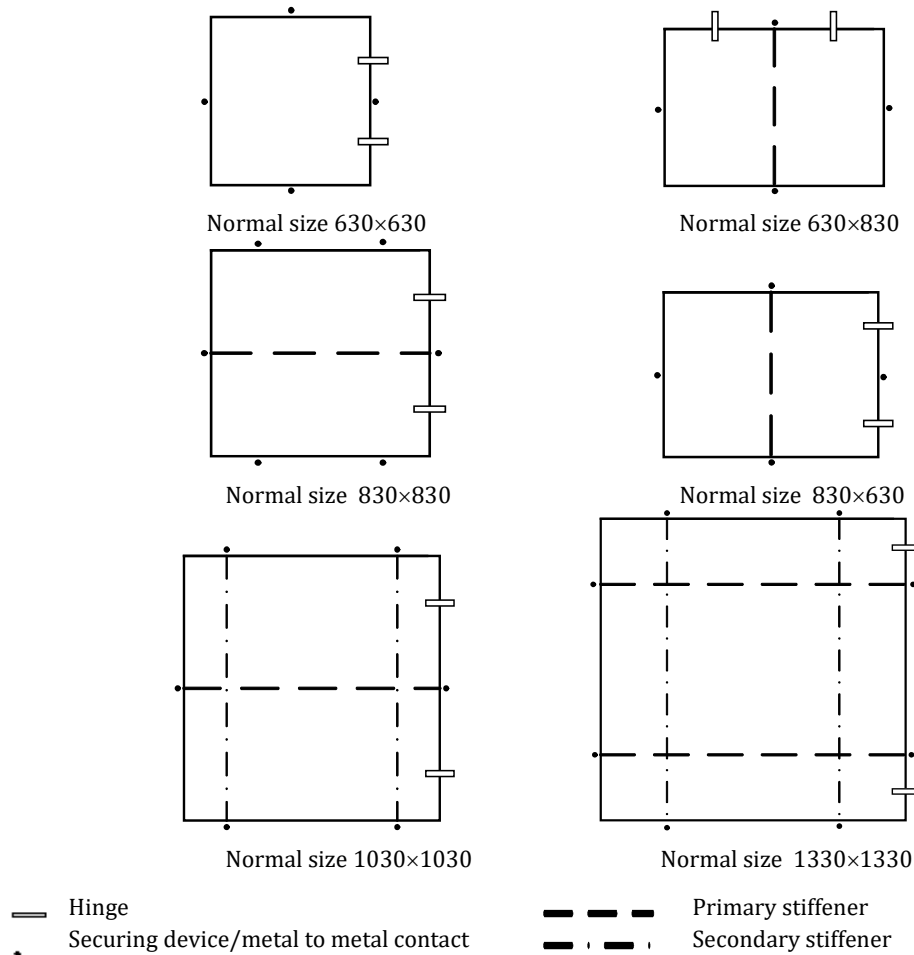


Fig. 7.6.4.2. Arrangement of stiffeners

- .2 The upper edge of the hatchway coamings shall be properly reinforced by a horizontal section, not more than 170 to 190 mm from the upper edge of the coamings.
- .3 For small hatch covers of circular or similar shape, the cover plate thickness and reinforcement is subject to PRS consideration in each particular case.
- .4 For small hatch covers constructed of materials other than steel, the required scantlings shall provide equivalent strength.

### 7.6.4.3 Primary Securing Devices

- .1 Small hatches located on exposed fore deck subject to the application of paragraph 7.6.4 shall be fitted with primary securing devices such that their hatch covers can be secured in place and weathertight by means of a mechanism employing any one of the following methods:

- a) butterfly nuts tightening onto forks (clamps),
  - b) quick acting cleats, or
  - c) central locking device.
- .2 Dogs (twist tightening handles) with wedges are not acceptable.

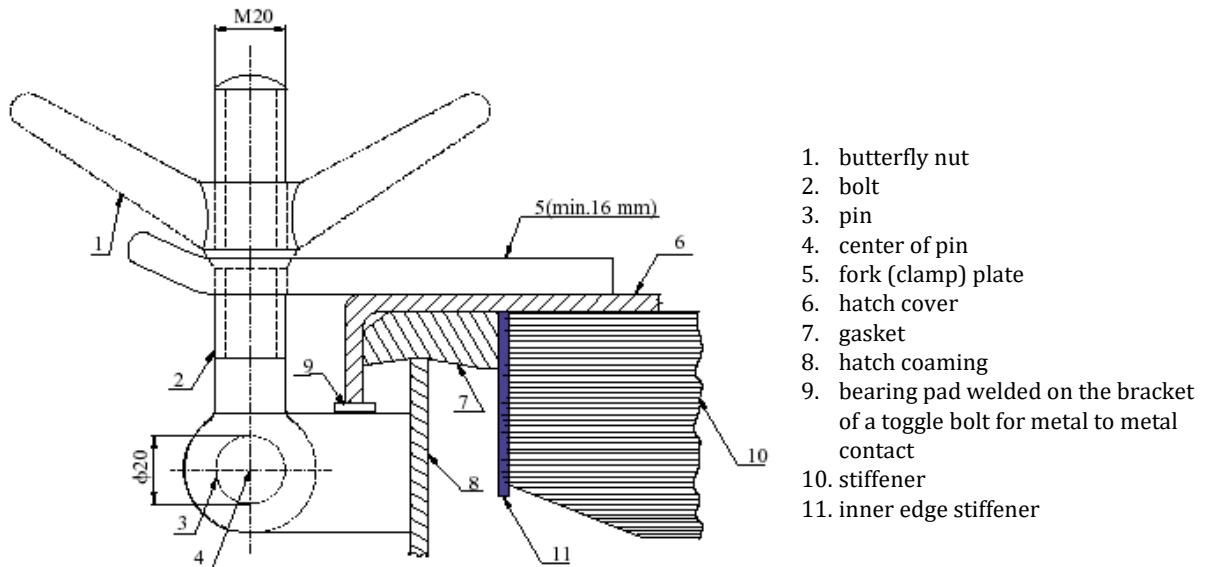


Fig. 7.6.4.3. Example of a primary securing method

#### 7.6.4.4 Requirements for Primary Securing Devices

- .1 The hatch cover shall be fitted with a gasket of elastic material. This shall be designed to allow a metal-to-metal contact at a designed compression and to prevent over compression of the gasket by green sea forces that may cause the securing devices to be loosened or dislodged. The metal-to-metal contacts shall be arranged close to each securing device (see Fig. 7.6.4.2) and of sufficient capacity to withstand the bearing force.
- .2 The primary securing method shall be designed and manufactured such that the designed compression pressure is achieved by one person without the need of any tools.
- .3 For a primary securing method using butterfly nuts, the forks (clamps) shall be of robust design. They shall be designed to minimize the risk of butterfly nuts being dislodged while in use – by means of curving the forks upward, a raised surface on the free end or a similar method. The plate thickness of unstiffened steel forks shall not be less than 16 mm. An example arrangement is shown in Fig. 7.6.4.3.
- .4 For small hatch covers located on the exposed deck forward of the fore-most cargo hatch, the hinges shall be fitted such that the predominant direction of green sea will cause the cover to close, which means that the hinges are normally to be located on the fore edge.
- .5 On small hatches located between the main hatches, for example between Nos. 1 and 2, the hinges shall be placed on the fore edge or outboard edge, whichever is practicable for protection from green water in beam sea and bow quartering conditions.

#### 7.6.4.5 Secondary Securing Devices

Small hatches on the fore deck shall be fitted with an independent secondary securing device, e.g. by means of a sliding bolt, a hasp or a backing bar of slack fit, which is capable of keeping the hatch cover in place, even in the event that the primary securing device became loosened or dislodged. It shall be fitted on the side opposite to the hatch cover hinges.

**7.6.5** Covers of companion hatches, skylights and ventilating trunks shall have closing devices capable of being operated at least from outside of the hatch. However, where the hatches are used as emergency exits in addition to their primary purpose, the securing devices shall be capable of being operated from each side of the cover. The covers shall be weathertight when closed. The tightness shall be provided by rubber or other suitable gaskets.

**7.6.6** The glass of scuttles in the skylight covers shall be hardened and its thickness shall be at least 6 mm if the inner diameter is 150 mm and less and at least 12 mm if the inner diameter is 450 mm. For intermediate inner diameters, the glass thickness shall be determined by linear interpolation. Where wire-reinforced glass is used, its thickness may be 5 mm. Such glass need not be hardened.

The glass shall be effectively attached to the cover by means of a frame and shall have on its contour a weathertight gasket of rubber or other suitable material.

The glasses of skylights fitted in machinery spaces shall fulfil the requirements of 2.1, *Part V – Fire Protection*.

**7.6.7** Each scuttle or a group of scuttles arranged in one row shall be provided with portable shields of the same material as the cover, at least 3 mm in thickness and capable of being efficiently fastened outside the cover by means of earnuts. Such portable shields shall be stowed close to the skylights.

## **7.7 Ventilating ducts and trunks**

**7.7.1** Ventilating ducts in position 1 or 2 to spaces below the freeboard deck or decks of enclosed superstructures and deckhouses decks shall be fitted with coamings of steel or other equivalent material, substantially constructed and efficiently connected to the deck.

Ventilating ducts passing through superstructures or open deckhouses shall be fitted with substantially constructed coamings of steel or other equivalent material at the freeboard deck.

Ventilating ducts for cargo holds shall not have mutual walls with (or to border) ventilating ducts for accommodation, service spaces and control stations.

The coamings of ventilating ducts shall be at least 900 mm in height in position 1 and at least 760 mm in position 2.

The construction of coamings shall fulfil the requirements of 8.6.4, *Part II – Hull*.

**7.7.2** Ventilators in position 1, the coamings of which extend to more than 4500 mm above the deck, and in position 2, the coamings of which extend to more than 2300 mm above the deck, need not be fitted with any closing arrangements.

In all other cases each ventilator shall be fitted with a strong cover of steel or other material approved by PRS. In ships of less than 100 m in length, the covers shall be permanently attached with the use of hinges. In ships of 100 m in length and over, covers may be of a portable type and shall be stowed near ventilators.

**7.7.3** The ventilator covers shall be weathertight when closed. The tightness shall be provided by rubber or other suitable gasket.

**7.7.4** Watertight trunks and ventilating ducts shall be of the same strength as watertight bulkheads at corresponding levels. The means used for making them watertight, and the arrangements adopted for closing openings in them, shall be to the satisfaction of the Administration. Watertight ventilating ducts and trunks shall be carried at least up to the bulkhead deck in passenger ships and up to the freeboard deck in cargo ships. (SOLAS II-1/16-1.1)



**7.7.5** The watertight integrity of trunks and ventilating ducts shall be checked in accordance with *Publication 21/P – Testing of the Hull Structures*.

## **7.8 Manholes**

**7.8.1** PRS Rules do not cover the height of coamings of manholes for tanks (except fuel tanks in double bottom), empty spaces, cofferdams, etc.

**7.8.2** Covers of manholes shall be made of steel or other material approved by PRS. The thickness of the covers shall not, as a rule, be less than that of the plating on which they are fitted. In justified cases, PRS may permit to decrease the thickness of covers in places where they are likely to be damaged, provided that suitable protection of such cover is ensured.

**7.8.3** The covers of manholes shall be effectively attached to the coaming or doubling ring by means of bolts or pins with nuts.

**7.8.4** When closed, the covers shall be tight under inner pressure of water or other liquids for which the tanks are intended, according to the requirements set forth in *Publication 21/P – Testing of the Hull Structures*.

The tightness shall be provided by a gasket made of rubber or other suitable material, resistant to the liquid for which the tank is intended.

## **7.9 Closing Appliances of Openings in Subdivision Bulkheads**

**7.9.1** Ships subdivided in accordance with sub-chapter 9.2, *Part II – Hull* shall meet the applicable requirements of 7.13, 13.9 and 21.2.

Watertight doors, including doors leading from pump room/engine room to duct keel shall be compliant with requirements in 21.2.1.

On small cargo ships, not subject to any subdivision and damage stability requirements hinged doors with quick acting closing devices may be applied in watertight bulkheads.

These doors shall have notices affixed to each side stating:

***To be kept closed at sea.***

**7.9.2** No doors are permitted:

- in the collision bulkhead below the bulkhead deck;
- in watertight subdivision bulkheads separating two adjacent cargo spaces, except cases when PRS would acknowledge the necessity of installing such doors. In this case, the requirements set forth in 21.2.1.14 shall be fulfilled.

**7.9.3** Covered manholes fitted in watertight bulkheads shall, as a rule, meet the requirements relating to the manholes located on the freeboard deck, raised quarter deck or the first tier of superstructures (see 7.8).

Covered manholes are not permitted:

- in the collision bulkhead below the freeboard deck;
- in watertight subdivision bulkheads separating a cargo space from other cargo space or from a fuel tank, except cases when PRS would acknowledge the necessity of installing a manhole. In such case, the cover of each manhole shall be attached thereto prior to the commencement of the voyage.

**7.9.4** Pipes shall be led through watertight bulkheads according to requirements of subchapter 1.16.11 of *Part VI – Ship and Machinery Piping Systems*.

**7.9.5** Ventilation ducts shall not penetrate watertight bulkheads below the bulkhead deck, except for the cases described in paragraph 11.2.1 of *Part VI – Ship and Machinery Piping systems*.

**7.9.6** Cables penetrations of collision bulkhead below the bulkhead deck are not permitted.

**7.9.7** The number of openings in the extension of the collision bulkhead above the freeboard deck shall be restricted to the minimum compatible with the design and normal operation of the ship. All such openings shall be capable of being closed weathertight.

## **7.10 Cargo Hatches**

### **7.10.1 General**

The following subchapter 7.10 contains the requirements of IACS UR S21, Rev.6 – *Evaluation of Scantlings of Hatch Covers and Hatch Coamings and Closing Arrangements of Cargo Holds of Ships*.

Regulations of *ICLL* have been included into subchapter 7.10 also. The requirements of this subchapter apply to all ships except CSR bulk carriers and oil tankers, and are for all cargo hatch covers and coamings on exposed decks.

As specified in this sub-chapter, parts of the requirements are for some specific ship types as categorized below:

- Type – 1 ships, including all ships except bulk carriers, self – unloading bulk carriers, ore carriers and combination carriers, as defined in *Annex 2 of Part 2 – Classification Regulations*.
- Type – 2 ships, including all bulk carriers, self – unloading bulk carriers, ore carriers and combination carriers, as defined in *Annex 2 of Part 2 – Classification Regulations*.

Hatch covers and hatch coamings of fishing vessels shall be comply with sub-chapter 14.4.

**7.10.1.1** Cargo hatches shall be protected by coamings and covers of adequate construction and strength.

The weight of covers and any cargo stowed thereon, together with inertial forces generated by ship motions, shall be transmitted to the ship structure through suitable contact, such as continuous steel to steel contact of the cover skirt plate with the ship's structure or by means of defined bearings pads.

**7.10.1.2** The requirements of the sub-chapter 7.10 apply to steel coamings and hatch covers of cargo holds and cargo tanks intended for the carriage of dry and liquid cargoes, as well as water ballast, made of hull structural steel.

The use of other materials is subject to special consideration of PRS.

The requirements of subchapter 7.10 apply to single skin hatch covers and double skin hatch covers.

**Single skin cover** means a hatch cover made of steel or equivalent material that is designed to comply with *ICLL* Regulation 16. The cover has continuous top and side plating, but is open underneath with the stiffening structure exposed. The cover is weathertight and fitted with gaskets and clamping devices unless such fittings are specifically excluded.

**Double skin cover** means a hatch cover as above but with continuous bottom plating such that all the stiffening structure and internals are protected from the environment.

The requirements of subchapter 7.10 do not apply to portable covers secured weathertight by tarpaulins and battening devices, or pontoon covers, as defined in *ICLL* Regulation 15.

Hatch covers and coamings shall be made of material in accordance with the definition of chapter 2 of *Part II – Hull* of the *Rules for the Classification and Construction of Sea-going Ships*. A material class I shall be applied for top plating, bottom plating and primary supporting members.

**7.10.1.3** If the hatches are situated in positions 1 or 2 (see 7.1.4), their covers shall be weathertight. Weathertight sealings shall be obtained by a continuous gasket of relatively soft elastic material compressed to achieve the necessary weathertightness. Similar sealing shall be arranged between cross-joint elements.

Where fitted, compression flat bars or angles shall be well rounded where in contact with the gasket and shall be made of a corrosion-resistant material. For more details see 7.10.6.2.

**7.10.1.4** The strength requirements are applicable to hatch covers of stiffened plate construction and its closing arrangements.

The secondary stiffeners and primary supporting members of the hatch covers shall be continuous over the breadth and length of the hatch covers, as far as practical. When this is impractical, appropriate arrangements shall be adopted to ensure sufficient load carrying capacity. Snipped end connections shall not be used.

The spacing of primary supporting members parallel to the direction of secondary stiffeners shall not exceed 1/3 of the span of primary supporting members. If sufficient strength based on FE analysis can be verified, this requirement may be waived.

**7.10.1.5** Unless otherwise quoted, the thicknesses,  $t$ , referred to in the following sections are net thicknesses.

The net thicknesses,  $t_{net}$ , are the member thicknesses necessary to obtain the minimum net scantlings required by 7.10.4 and 7.10.5.

The required gross thicknesses are obtained by adding the corrosion additions,  $t_k$ , given in 7.10.4.2. Strength calculations using FEM shall be performed with net scantlings.

**7.10.1.6** Load bearing connections between the hatch cover panels shall be fitted with the purpose of restricting the relative vertical displacements.

Hatch covers shall be constructed so as to prevent their accidental opening under the action of the sea.

In order to avoid excessive deformation of gaskets, the covers, when closed, shall rest on the coaming structure.

Precautions shall be taken against penetration of oil from the hatch cover driving gear into the hold.

**7.10.1.7** Hydraulic driving gears provided for closing, opening and locking hatch covers shall fulfil the requirements specified in Chapter 7, *Part VII – Machinery, Boilers and Pressure Vessels*.

Provision shall be made for locking the covers in the open position.

**7.10.1.8** Dry cargo holds intended for the carriage of dangerous goods (see chapter 2, *Part V – Fire Protection*) shall be provided with steel hatch covers on the upper deck. The construction of hatch covers and their driving gear shall enable closing and securing the hatches in the event of damage to the main drive. The driving gear of hatch covers on the lower and upper decks shall ensure a smooth motion of the covers and their parts.

The drive construction shall be such as to prevent unintended closing of covers during their closing or opening operations in the case of driving gear damage.

Precautions shall be taken against penetration of oil from the hatch cover driving gear into the hold.

**7.10.1.9** Ships with hatches of large dimensions, in which considerable strains of hatch coamings are likely to occur during navigation in rough sea, shall meet the following requirements:

- .1 the construction of the closing appliance shall provide for horizontal displacement of this appliance at the point of pressing to the hatch coaming, over the length of the assumed horizontal shift of the cover;
- .2 the hinged connections between the cover sections and between the section and the hatch coaming shall have adequate clearance allowing for their relative horizontal shifts;
- .3 the bearing surface of the hatch coaming shall ensure suitable sliding contact permitting the cover sections to be shifted along it;
- .4 the bearing flange of the hatch coaming shall be reinforced in such a way as to ensure continuous contact with the cover sections (metal-to-metal).

**7.10.1.10** The protection of hatches and coamings from grab wire damage may be achieved by fitting protection bars (e.g. half-round bars) on the hatch-side girder (e.g. the upper portion), hatch-end beams and the upper portion of hatch coamings.

### **7.10.2 Hatch Coamings**

**7.10.2.1** The height of hatch coamings in positions 1 and 2 shall be at least 600 mm and 450 mm, respectively.

For combination carriers the requirements specified in subchapter 12.2, shall be taken into account (see also 7.10.1.1).

**7.10.2.2** The height of hatch coamings in positions 1 and 2 shall be at least 600 mm and 450 mm, respectively.

For combination carriers the requirements specified in subchapter 12.2, shall be taken into account (see also 7.10.1.1).

### **7.10.3 Design Loads for Hatch Covers and Coamings**

#### **7.10.3.1 General**

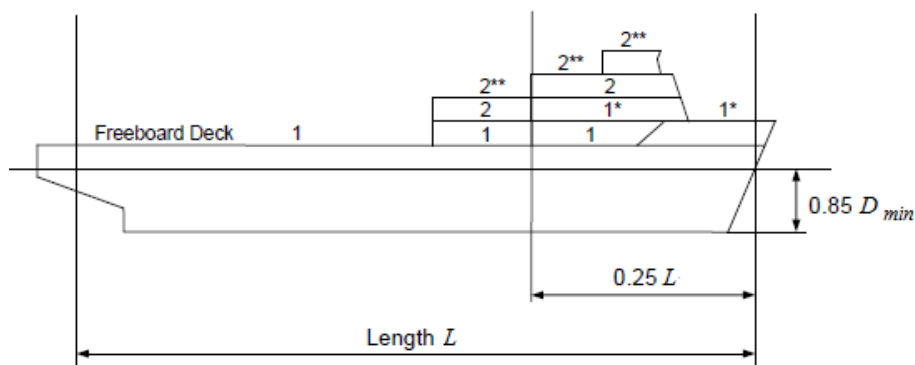
Scantlings of steel hatch covers (plating thickness, dimensions of the stiffeners and the primary supporting members) and hatch coamings shall be determined taking into account design loads, specified in 7.10.3.2 ÷ 7.10.3.8, where applicable.

Where two or more panels of the cover are connected by hinges, each individual panel shall be considered separately.

#### **7.10.3.2 Vertical Weather Design Load**

For hatch covers in position 1 and 2 (see definitions in 7.1.4 and Fig.7.10.3.2-1, Fig. 7.10.3.2-2 where the positions 1 and 2 are illustrated for example ships), external sea pressure shall be taken into account, which shall be equal to pressure  $p_{15}$ , determined according to Table 7.10.3.2.

The vertical weather design loads need not be combined with cargo loads calculated according to 7.10.3.3 and 7.10.3.6.



$DR_{min}R$  – the least moulded depth, [m], as defined in *ICLL*, Regulation 3.

- \* reduced load upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck;
- \*\* reduced load upon exposed superstructure decks of vessels with  $L > 100$  m located at least one superstructure standard height above the lowest position 2 deck.

Fig. 7.10.3.2-1. Positions 1 and 2 for an example ship

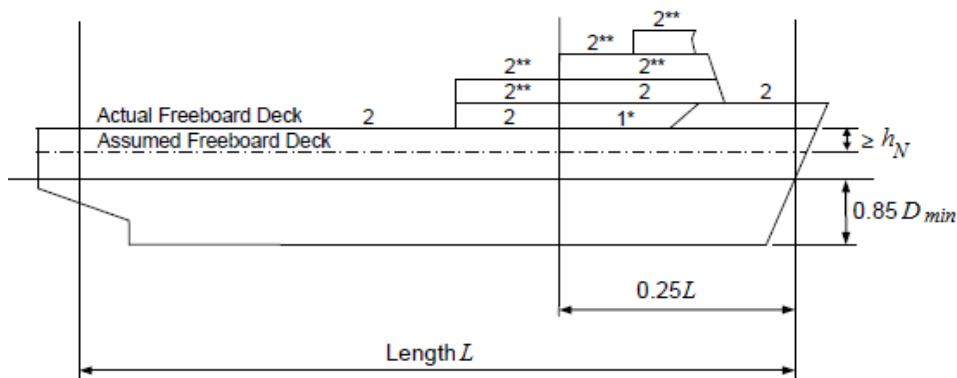
Where an increased freeboard is assigned, the design load for hatch covers according to Table 7.10.3.2 on the actual freeboard deck may be as required for a superstructure deck, provided the summer freeboard is such that the resulting draught will not be greater than that corresponding to the minimum freeboard calculated from an assumed freeboard deck situated at a distance at least equal to the standard superstructure height  $h_N$  below the actual freeboard deck, see Fig. 7.10.3.2-2, where:

$$h_N = 1.05 + 0.01L - \text{standard superstructure height, [m]} \quad (7.10.3.2-1)$$

Applied value of  $h_N$  shall fulfil the condition:

$$1.8 \leq h_N \leq 2.3 \text{ [m]} \quad (7.10.3.2-2)$$

For hatch covers of cargo holds designed for carriage of ballast or liquid cargo, the internal lateral pressures are also to be considered. Their values are to be computed according to requirements of Part II – Hull, chapter 16.



$DR_{min}R$  – the least moulded depth, [m], as defined in *ICLL*, Regulation 3.

- \* reduced load upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck;
- \*\* reduced load upon exposed superstructure decks of vessels with  $L > 100$  m located at least one superstructure standard height above the lowest position 2 deck.

Fig. 7.10.3.2-2. Positions 1 and 2 for an example ship with increased freeboard

**Table 7.10.3.2**  
**Design load,  $p_{15}$ , of weather deck hatches**

Position	Design load $p_{15}$ [kPa]	
	$\frac{x_1}{L} \leq 0.75$	$0.75 < \frac{x_1}{L} \leq 1.0$
1	for $24 \text{ m} \leq L \leq 100 \text{ m}$	
	$\frac{9.81}{76}(1.5L + 116)$	on freeboard deck $\frac{9.81}{76}[(4.28L + 28)\frac{x_1}{L} - 1.71L + 95]$
		upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck $\frac{9.81}{76}(1.5L + 116)$
	for $L > 100 \text{ m}$	
	9.81·3.5	on freeboard deck for type B ships according to <i>ICLL</i> $9.81[(0.0296L_1 + 3.04)\frac{x_1}{L} - 0.0222L_1 + 1.22]$
		on freeboard deck for ships with less freeboard than type B according to <i>ICLL</i> $9.81[(0.1452L_1 - 8.52)\frac{x_1}{L} - 0.1089L_1 + 9.89]$ $L_1 = L$ but not more than 340 m
upon exposed superstructure decks located at least one superstructure standard height above the freeboard deck 9.81·3.5		
2	for $24 \text{ m} \leq L \leq 100 \text{ m}$	
	$\frac{9.81}{76}(1.1L + 87.6)$	
	for $L > 100 \text{ m}$	
	9.81·2.6	
	upon exposed superstructure decks located at least one superstructure standard height above the lowest position 2 deck 9.81·2.1	

Symbols used in Table 7.10.3.2:

$L$  - see 1.2.1,

$x_1$  - longitudinal co-ordinate of midpoint of assessed structural member measured from aft end of length  $L$ , [m].

### 7.10.3.3 Horizontal Weather Design Load

The horizontal weather design loads  $p_A$  and  $p_{coam}$  need not be included in the direct strength calculation of the hatch cover, unless it is utilized for the design of substructures of horizontal support according to 7.10.9.3.

#### 7.10.3.3.1 General horizontal weather design load

The horizontal weather design load for determining the scantlings of outer edge girders (skirt plates) of weather deck hatch covers and of hatch comings is:

$$p_A = ac(bc_L f - z) \text{ [kPa]} \quad (7.10.3.3.1)$$

$$f = \frac{L_0}{25} + 4.1 \quad \text{for } L_0 < 90 \text{ m};$$

$$f = 10.75 - \left(\frac{300-L_0}{100}\right)^{1.5} \quad \text{for } 90 \text{ m} \leq L_0 < 300 \text{ m};$$

$$f = 10.75 \quad \text{for } 300 \text{ m} \leq L_0 < 350 \text{ m};$$

$$f = 10.75 - \left(\frac{L_0-350}{150}\right)^{1.5} \quad \text{for } 350 \text{ m} \leq L_0 \leq 500 \text{ m};$$

$$c_L = \sqrt{\frac{L_0}{90}} \quad \text{for } L_0 < 90 \text{ m;}$$

$$c_L = 1 \quad \text{for } L_0 \geq 90 \text{ m;}$$

$$a = 20 + \frac{L_1}{12} \quad \text{for unprotected front coamings and hatch cover skirt plates}$$

$$a = 10 + \frac{L_1}{12} \quad \text{for unprotected front coamings and hatch cover skirt plates, where the distance from the actual freeboard deck to the summer load line exceeds the minimum non-corrected tabular freeboard according to ICLL by at least one standard superstructure height } h_N \text{ (} h_N \text{ is defined in 7.10.3.2)}$$

$$a = 5 + \frac{L_1}{15} \quad \text{for side and protected front coamings and hatch cover skirt plates}$$

$$a = 7 + \frac{L_1}{100} - 8 \frac{x'}{L_0} \quad \text{for aft end of coamings and aft hatch cover skirt plates abaft amidships}$$

$$a = 5 + \frac{L_1}{100} - 4 \frac{x'}{L_0} \quad \text{for aft ends of coamings and aft hatch cover skirt plates forward of amidships}$$

$L_1 = L_0$ , need not be taken greater than 300 m;

$$b = 1.0 + \left( \frac{\frac{x'}{L_0} - 0.45}{\delta + 0.2} \right)^2 \quad \text{for } \frac{x'}{L_0} < 0.45;$$

$$b = 1.0 + 1.5 \left( \frac{\frac{x'}{L_0} - 0.45}{\delta + 0.2} \right)^2 \quad \text{for } \frac{x'}{L_0} \geq 0.45.$$

$0.6 \leq \delta \leq 0.8$ ; when determining scantlings of aft ends of coamings and aft hatch cover skirt plates forward of amidships,  $\delta$  need not be taken less than 0.8;

$x'$  – distance, [m], between the transverse coaming or hatch cover skirt plate considered and aft end of the length  $L_0$ . When determining side coamings or side hatch cover skirt plates, the side shall be subdivided into parts of approximately equal length, not exceeding  $0.15L_0$  each, and  $x'$  shall be taken as the distance between aft end of the length  $L_0$  and the centre of each part considered;

$z$  – vertical distance [m] from the summer load line to the midpoint of stiffener span, or to the middle of the plate field;

$$c = 0.3 + 0.7 \frac{b'}{B'};$$

$\frac{b'}{B'}$  – shall not be taken less than 0.25;

$b'$  – breadth of coaming [m] at the position considered;

$B'$  – actual maximum breadth of ship [m] on the exposed weather deck at the position considered.

The design load  $p_A$  taken for calculations shall not be less than the minimum values obtained from Table 7.10.3.3.1.

**Table 7.10.3.3.1**  
**Minimum design load  $p_{Amin}$**

$L_0$ [m]	$p_{Amin}$ [kPa]	
	For unprotected fronts	For elsewhere
$\leq 50$	30	15
$> 50$	$25 + \frac{L_0}{10}$	$12.5 + \frac{L_0}{20}$
$< 250$		
$\geq 250$	50	25



**Note:**

The horizontal weather design load need not be included in the direct strength calculation of the hatch cover, unless it is utilized for the design of substructures of horizontal support according to 7.10.9.3.

**7.10.3.3.2 Horizontal weather design load applicable to coamings of Type – 2 ships**

The pressure  $p_{coam}$  [kPa] on the No. 1 forward transverse hatch coaming is given by:

$p_{coam} = 220$  kPa, when a forecastle is fitted in accordance with 20.10.2 of *Part II – Hull*,

$p_{coam} = 290$  kPa in the other cases.

The pressure  $p_{coam}$  [kPa] on the other coamings is given by:

$p_{coam} = 220$  kPa.

**7.10.3.4 Distributed cargo loads**

The load on hatch covers due to distributed cargo loads  $p_L$ , [kPa], resulting from heave and pitch (i.e. ship in upright condition) shall be determined according to the following formula:

$$p_L = p_C (1 + a_v) \quad (7.10.3.4)$$

$p_C$  – uniform cargo load [kPa],

$a_v = F \cdot m$  – vertical acceleration addition,

$$F = 0.11 \frac{v_0}{\sqrt{L_0}};$$

$$m = m_0 - 5(m_0 - 1) \frac{x_1}{L_0} \text{ for } 0 \leq \frac{x_1}{L_0} \leq 0.2;$$

$$m = 1.0 \text{ for } 0.2 < \frac{x_1}{L_0} \leq 0.7;$$

$$m = 1 + \frac{m_0 + 1}{0.3} \left[ \frac{x_1}{L_0} - 0.7 \right] \text{ for } 0.7 < \frac{x_1}{L_0} \leq 1.0;$$

$$m_0 = 1.5 + F;$$

$v_0$  – maximum speed at summer load line draught; the value of  $v_0$  taken for calculations is not be less than  $\sqrt{L_0}$  [knots];

$x_1$  – see Table 7.10.3.2.

**7.10.3.5 Point Loads**

The load  $P$  due to a single concentrated force  $P_S$ , except for container load, resulting from heave and pitch (i.e. ship in upright condition) shall be determined as follows:

$$P = P_S (1 + a_v) \text{ [kN]} \quad (7.10.3.5)$$

$a_v$  – acceleration addition according to 7.10.3.4,

$P_S$  – single concentrated force [kN].

Stiffeners loaded with point forces are subject to special consideration of PRS.

**7.10.3.6 Container Loads**

**7.10.3.6.1** The loads defined in 7.10.3.6.2 and 7.10.3.6.4 shall be applied where containers are stowed on the hatch cover.

**7.10.3.6.2** The load,  $P$ , applied at each corner of a container stack, and resulting from heave and pitch (i.e. ship in upright condition) shall be determined as follows:

$$P = 9.81 \frac{M}{4} (1 + a_v) \text{ [kN]} \quad (7.10.3.6.2)$$

$a_v$  – acceleration addition according to 7.10.3.4,

$M$  – maximum designed mass of container stack [t].

**7.10.3.6.3** The loads applied at each corner of a container stack, and resulting from heave, pitch and the ship's rolling motion (i.e. ship in heel condition) shall be determined as follows (see also Fig. 7.10.3.6.3):

$$A_z = 9.81 \frac{M}{2} (1 + a_v) \left( 0.45 - 0.42 \frac{h_m}{b} \right) \quad [\text{kN}] \quad (7.10.3.6.3-1)$$

$$B_z = 9.81 \frac{M}{2} (1 + a_v) \left( 0.45 + 0.42 \frac{h_m}{b} \right) \quad [\text{kN}] \quad (7.10.3.6.3-2)$$

$$B_y = 2.4M \quad [\text{kN}] \quad (7.10.3.6.3-3)$$

$a_v$  – acceleration addition according to 7.10.3.4,

$M = \sum W_i$  – maximum designed mass of container stack [t],

$h_m$  – designed height of centre of gravity of stack above hatch cover top [m],

– may be calculated as weighed mean value of the stack, where the centre of gravity of each tier is assumed to be located at the centre of each container,  $h_m = \sum (z_i \cdot W_i) / M$

$z_i$  – distance from hatch cover top to the centre of  $i$ -th container [m],

$W_i$  – weight of  $i$ -th container [t],

$b$  – distance between midpoints foot points [m],

$A_z, B_z$  – support forces in  $z$ -direction at the forward and aft stack corners [kN],

$B_y$  – support force in  $y$ -direction at the forward and aft stack corners [kN].

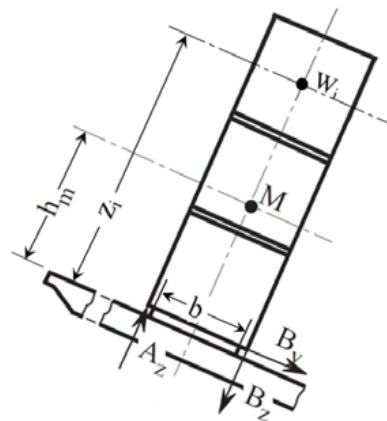


Fig. 7.10.3.6.3 Forces due to container loads

Values of  $A_z$  and  $B_z$  applied for the assessment of hatch cover strength shall be shown in the drawings of the hatch covers.

**Note:** It is recommended that container loads as calculated above are considered as limit for foot point loads of container stacks in the calculations of cargo securing (container lashing).

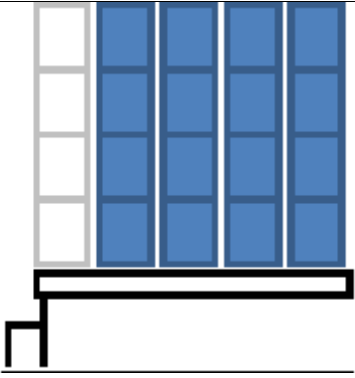
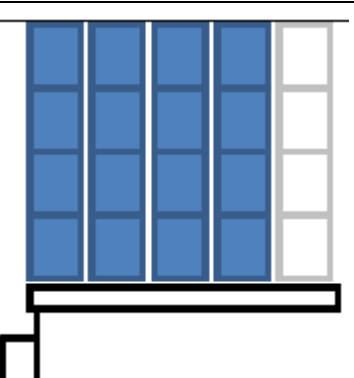
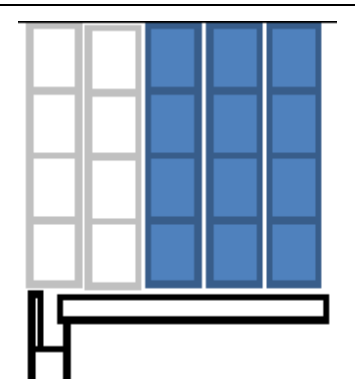
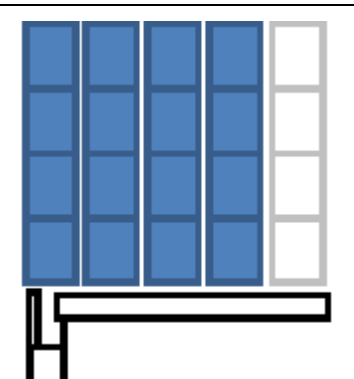
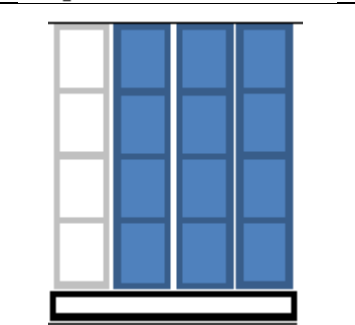
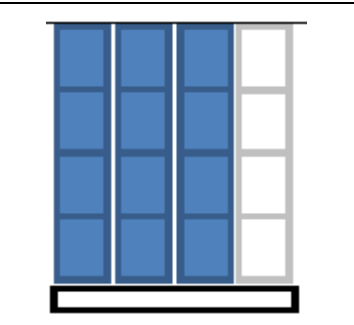
**7.10.3.6.4** The load cases defined in 7.10.3.6.2 and 7.10.3.6.3 shall also be considered for partial non-homogeneous loading which may occur in practice, e.g. where specified container stack places are empty. For each hatch cover, the heel directions, as shown in Tab 7.10.3.6.4 shall be considered.

The load case “partial loading of container hatch covers” can be evaluated using a simplified approach, where the hatch cover is loaded without the outermost stacks that are located completely on the hatch cover. If there are additional stacks that are supported partially by the hatch cover and partially by container stanchions then the loads from these stacks shall also be neglected, refer to Table 7.10.3.6.4 “Partial loading of container hatch covers”.

In addition, the case where only the stack places supported partially by the hatch cover and partially by container stanchions are left empty shall be assessed in order to consider the maximum loads in the vertical hatch cover supports.

It may also be necessary to consider partial load cases where more or different container stack places are left empty. Therefore, PRS may require that additional partial load cases be considered.

**Table 7.10.3.6.4**  
**Partial loading of container hatch covers**

Heel direction	←	→
Hatch covers supported by the longitudinal hatch coaming with all container stacks located completely on the hatch cover		
Hatch covers supported by the longitudinal hatch coaming with the outermost container stack supported partially by the hatch cover and partially by container stanchions		
Hatch covers not supported by the longitudinal hatch coaming (center hatch covers)		

**7.10.3.6.5** In the case of mixed stowage (20'+40' container combined stack), the foot point forces at the fore and aft end of the hatch cover shall not be higher than resulting from the design stack weight for 40' containers, and the foot point forces at the middle of the cover shall not be higher than resulting from the design stack weight for 20' containers.

**7.10.3.7 Loads Due to Elastic Deformations of the Ship's Hull**

Hatch covers, which in addition to the loads according to 7.10.3.2 to 7.10.3.6 are loaded in the ship's transverse direction by forces due to elastic deformations of the ship's hull, shall be designed such that the sum of stresses does not exceed the permissible values given in 7.10.4.1.1.

**7.10.3.8 Wheel Loading**

When a hatch cover is under design load due to cargo forklifts, requirements of subchapter 19.4 in *Part II* of the *Rules for the Classification and Construction of Sea-going Ships* shall be taken into account when determining the scantlings of the hatch cover elements.

**7.10.4 Hatch Cover Strength Criteria****7.10.4.1 Permissible stresses and deflections****7.10.4.1.1 Yield strength**

All hatch cover structural members are to comply with the following formulae:

$$\sigma_{vm} \leq \sigma_a \text{ for shell elements in general} \quad (7.10.4.1.1-1)$$

$$\sigma_{axial} \leq \sigma_a \text{ for rod or beam elements in general} \quad (7.10.4.1.1-2)$$

where:

$\sigma_a$  – allowable stress as defined in Table 7.10.4.1.1,

$R_e$  – specified minimum yield stress of the material, [MPa],

$\sigma_{vm}$  – Von Mises stress, [MPa] may be taken as follows:

$$\sigma_{vm} = \sqrt{\sigma_x^2 - \sigma_x \sigma_y + \sigma_y^2 + 3\tau_{xy}^2} \quad (7.10.4.1.1-3)$$

$\sigma_x$  – normal stress in x-direction [MPa],

$\sigma_y$  – normal stress in y-direction [MPa],

$\tau_{xy}$  – shear stress in the x-y plane [MPa],

$\sigma_{axial}$  – axial stress in rod or beam elements [MPa].

Indices x and y are coordinates of a two-dimensional Cartesian system in the plane of the considered structural element.

In case of FEM calculations using shell or plate elements, the stresses shall be read from the centre of the individual element. It shall be observed that, in particular, at flanges of unsymmetrical girders, the evaluation of stress from element centre may lead to non-conservative results. Thus, a sufficiently fine mesh shall be applied in these cases or, the stress at the element edges shall not exceed the allowable stress. Where shell elements are used, the stresses shall be evaluated at the mid plane of the element.

Stress concentrations shall be assessed to the satisfaction of PRS.

For steel with a minimum yield stress of more than 355 MPa, the value  $R_e$  to be applied throughout this requirement is subject to the individual PRS recognition but shall not to be more than the minimum yield stress of the material.

Stress concentrations will be considered by PRS on case-by-case basis.

**Table 7.10.4.1.1**  
**Allowable stresses**

Members of hatch cover structure	Subject to	$\sigma_a$ [MPa]
	External pressure, as defined in 7.10.3.2	0.8R <sub>e</sub>
Other loads, as defined in 7.10.3.3 to 7.10.3.7	0.9R <sub>e</sub> for static + dynamic load case 0.72R <sub>e</sub> for static load case	

#### 7.10.4.1.2 Deflection

The vertical deflection of primary supporting members due to the vertical weather design load according to 7.10.3.2 shall not be more than  $0.0056l$  where  $l$  is the greatest span of primary supporting members.

Where hatch covers are arranged for carrying containers and mixed stowage is allowed, i.e., a 40'-container stowed on top of two 20'-containers, particular attention should be paid to the deflections of hatch covers. Further the possible contact of deflected hatch covers within hold cargo has to be observed.

**7.10.4.1.3** When a hatch cover is under design load to cargo forklifts, scantlings of the hatch cover elements shall be determined taking into account requirements specified in subchapter 19.4 of *Part II – Hull*.

#### 7.10.4.2 Corrosion Addition and Steel Renewal

**7.10.4.2.1** The scantlings requirements of the following sections imply the corrosion additions  $t_k$  given in Table 7.10.4.2.1.

**Table 7.10.4.2.1**  
**Corrosion additions  $t_k$  for hatch covers and hatch coamings**

Application	Structure	$t_k$ [mm]
Weather deck cargo hatches of container ships, car carriers, paper carriers, passenger vessels	Hatch covers	1.0
	Hatch coamings	according to PRS individual recognition but not less than 1.0 mm
Weather deck cargo hatches of Type-2 ships	Hatch covers in general	2.0
	Top and bottom plating of double skin hatch cover	2.0
	Internal structure of double skin hatch covers	1.5
	Hatch coamings and coaming stays	1.5
Weather deck cargo hatches of all other ship types covered by this subchapter	Hatch cover in general	2.0
	Weather exposed plating and bottom plating of double skin hatch covers	1.5
	Internal structure of double skin hatch covers and closed box girders	1.0
	Hatch coaming which is not a part of the longitudinal hull structure	1.5
	Hatch coaming which is a part of the longitudinal hull structure	According to PRS individual recognition but not less than 1.5 mm
	Coaming stays and stiffeners	1.5

**7.10.4.2.2** Steel renewal is required where the gauged thickness is less than  $t_{net} + 0.5$  mm ( $t_{net}$  – net thickness) for:

- single skin hatch cover,
- the plating of double skin hatch cover, and
- coaming structures the corrosion additions  $t_k$  of which are provided in Table 7.10.4.2.1.

Where the gauged thickness is within the range  $t_{net} + 0.5$  mm and  $t_{net} + 1.0$  mm, coating (applied in accordance with the coating manufacturer’s requirements) or annual gauging may be adopted as an alternative to steel renewal. Coating is to be maintained in GOOD condition, as defined in 1.2 of *Publication 39/P – Hull Surveys of Bulk Carriers*.

For the internal structure of double skin hatch covers, thickness gauging is required when hatch cover top or bottom plating renewal shall be carried out or when this is deemed necessary, at the discretion of the individual PRS surveyor, on the basis of the plating corrosion or deformation condition. In these cases, steel renewal for the internal structures is required where the gauged thickness is less than  $t_{net}$ .

For corrosion addition  $t_k = 1$  mm the thickness for steel renewal is  $t_{net}$  and the thickness for coating or annual gauging is when gauged thickness is between  $t_{net}$  and  $t_{net} + 0.5$  mm.

For coaming structures, the corrosion addition  $t_k$  of which are not provided in Table 7.10.4.2.1, steel renewal and coating or annual gauging are to be according to PRS individual recognition.

**7.10.4.2.3** For structural members made of aluminium alloys, corrosion addition may not be applied.

**7.10.4.3 Strength Calculations for Hatch Covers Members**

The stresses in hatch covers shall be determined by FE analysis.

The stress calculation model in this section shall be used for both yielding and buckling strength assessments in accordance with 7.10.4.1.1 and 7.10.5.4, respectively.

The net scantlings as defined in 7.10.1.5 shall be used.

For the strength assessments of hatch covers by means of FE analysis, the hatch cover geometry shall be idealized as realistically as possible. In no case shall element width be larger than stiffener spacing. In way of force transfer points and cutouts the mesh is to be refined where applicable. The ration of element length to width shall not exceed 3.

The element size along the height of webs of primary supporting member is not to exceed one-third of the web height. Stiffeners, which support plates subjected to lateral pressure loads, are to be included in the FE model idealization. Stiffeners may be modelled by using beam elements, or shell/plate elements. Buckling stiffeners may be disregarded for the stress calculation.

Hatch covers fitted with U-type stiffeners as shown in Fig. 7.10.4.3 are to be assessed by means of FE analysis. The geometry of the U-type stiffeners is to be accurately modelled using shell/plate elements. Nodal points are to be properly placed on the intersections between the webs of a U-type stiffener and the hatch cover plate, and between the webs and flange of the U-type stiffener.

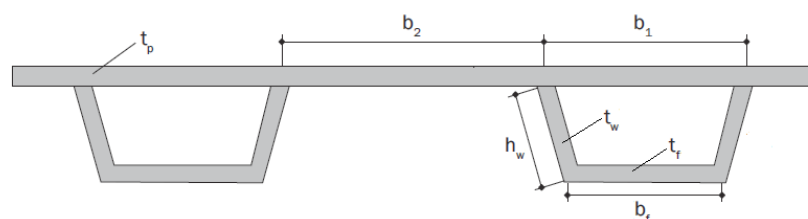


Fig. 7.10.4.3 Example of hatch cover fitted with U-type stiffeners

Wherever applicable the following boundary conditions are to be applied to the FE model:

- Boundary nodes in way of a bearing pad on the hatch coamings are to be fixed against displacement in the direction perpendicular to the pad.
- Lifting stoppers are to be fixed against displacements in the direction determined by the stoppers.
- For a folding type hatch cover, the FE nodes connected through a hinge are to have the same translational displacement in the direction perpendicular to the hatch cover top plating.

## 7.10.5 Scantlings of Structural Elements of Hatch Covers

### 7.10.5.1 Local Net Plate Thickness

The local net plate thickness of the hatch cover top plating shall not be less than:

$$t = F_p \cdot 15.8s \sqrt{\frac{p}{0.95R_e}} \text{ [mm]} \quad (7.10.5.1-1)$$

The plate thickness shall not be less than 1% of the stiffener spacing or 6 mm if that be greater.

$F_p$  – factor for combined membrane and bending response,

$F_p = 1.50$  in general,

$F_p = 1.90 \sigma/\sigma_a$ , for  $\sigma/\sigma_a \geq 0.8$ , for the attached plate flange of primary supporting members,

$s$  – stiffener spacing [m],

$p$  – pressure  $p_{15}$  determined acc. to 7.10.3.2 or pressure  $p_L$  determined acc. to 7.10.3.4 [kPa],

$\sigma$  – maximum normal stress [MPa] of hatch cover top plating; determined according to Fig. 7.10.5.1,

$\sigma_a$  – as defined in Table 7.10.4.1.1 [MPa].

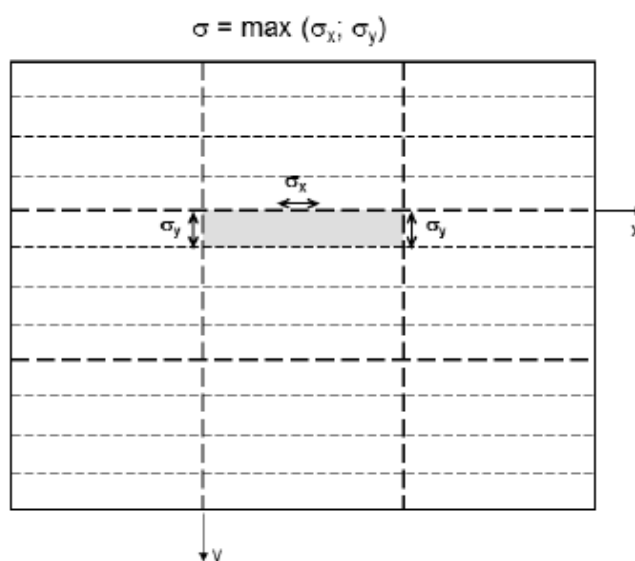


Fig. 7.10.5.1. Determination of normal stress of the hatch cover plating

For flange plates under compression, sufficient buckling strength according to 7.10.5.4 shall be demonstrated.

The local net plate thickness of hatch covers for wheel loading will be subjected to PRS acceptance in each particular case.

The thickness of lower plating of double skin hatch covers and box girders to fulfil the strength requirements shall be obtained from the calculation according to 7.10.4.3 under consideration of permissible stresses according to 7.10.4.1.1. When the lower plating is taken into account as



a strength member of the hatch cover, the net thickness, in mm, of lower plating shall be taken not less than 5 mm. When project cargo is intended to be carried on a hatch cover, the net thickness shall not be less than:

$$t = 6.5s \text{ [mm]} \quad (7.10.5.1-2)$$

$s$  – spacing of hatch cover plating stiffeners [m].

**Note:**

Project cargo means especially large or bulky cargo lashed to the hatch cover. Examples are parts of cranes or wind power stations, turbines, etc. Cargoes that can be considered as uniformly distributed over the hatch cover, e.g., timber, pipes or steel coils need not be considered as project cargo.

When the lower plating is not considered as a strength member of the hatch cover, the thickness of the lower plating will be subject to PRS acceptance in each particular case.

### 7.10.5.2 Net Scantlings of Stiffeners

The net section modulus  $W$  and net shear area  $A_s$  of uniformly loaded hatch cover stiffeners constraint at both ends must not be less than:

$$W = \frac{1000psl^2}{f_{bc}\sigma_a} [\text{cm}^3] \quad (7.10.5.2-1)$$

$$A_s = \frac{8.7psl}{\sigma_a} 10^{-3} [\text{cm}^2] \quad (7.10.5.2-2)$$

where:

$l$  – stiffener span, [m]. It shall be taken as the spacing of primary supporting members or the distance between a primary supporting member and the edge support, as applicable. When brackets are fitted at both ends of all stiffener spans, the secondary stiffener span may be reduced by an amount equal to 2/3 of the minimum brackets arm length, but not greater than 10% of the unsupported span, for each bracket,

$s$  – secondary stiffener spacing [m],

$p$  – pressure, determined acc. to 7.10.3.2 or 7.10.3.4 [kPa],

$f_{bc}$  – boundary coefficient of stiffener, taken equal to:

$f_{bc} = 8$ , in case of stiffener simply supported at both ends or simply supported at one and clamped at the other end,

$f_{bc} = 12$ , in the case of stiffener clamped at both ends,

$\sigma_a$  – allowable stress as defined in Table 7.10.4.1.1.

For stiffeners of lower plating of double skin hatch covers, requirements mentioned above are not applied due to the absence of lateral loads. For double skin hatch covers of holds designed for ballast or liquid cargo, the stiffeners on lower plating are to be strengthened taking into account requirements of subchapter 12.2.

The net thickness, in mm, of the stiffener (except U-type/trapeze stiffeners) web shall not be taken less than 4 mm.

The net section modulus of the secondary stiffeners shall be determined based on an attached plate width assumed equal to the stiffener spacing.

Stiffeners parallel to primary supporting members must be continuous at crossing primary supporting member and may be regarded for calculating the cross sectional properties of primary supporting members. It shall be verified that the combined stress of those stiffeners induced by the bending of primary supporting members and lateral pressures does not exceed the permissible stresses according to 7.10.4.1.1. The requirements of this paragraph are not applied to stiffeners of lower plating of double skin hatch covers if the lower plating is not considered as strength member.

For hatch cover stiffeners under compression, sufficient safety against lateral and torsional buckling according to 7.10.5.4.3 shall be verified.

For hatch covers subject to wheel loading or point loads, stiffener scantlings shall be determined under consideration of the permissible stresses according to 7.10.4.1.1 or shall be subject to PRS acceptance in each particular case.

### 7.10.5.3 Net Scantlings of Primary Supporting Members

**7.10.5.3.1** Net scantlings of primary supporting members shall be determined by FE calculations according to 7.10.4.3 under consideration of permissible stresses according to 7.10.4.1.1.

For all components of primary supporting members sufficient safety against buckling must be verified according to 7.10.5.4.

The net thickness, in [mm], of webs of primary supporting members shall not be less than:

$$t = 6.5s \text{ [mm]} \quad (7.10.5.3.1-1)$$

$$t_{\min} = 5 \text{ mm} \quad (7.10.5.3.1-2)$$

$s$  – spacing of hatch cover plating stiffeners, [m].

**7.10.5.3.2** Scantlings of edge girders (skirt plates) shall be determined by the calculations according to 7.10.4.3 under consideration of permissible stresses according to 7.10.4.1.1.

The net thickness, in [mm], of the outer edge girders exposed to wash of sea shall not be less than the largest of the following values:

$$t = 15.8s \sqrt{\frac{p_A}{0.95R_e}} \text{ [mm]} \quad (7.10.5.3.2-1)$$

$$t = 8.5s \text{ [mm]} \quad (7.10.5.3.2-2)$$

$$t_{\min} = 5 \text{ mm} \quad (7.10.5.3.2-3)$$

$p_A$  – horizontal pressure as defined in 7.10.3.3.1 [kPa],

$s$  – spacing of hatch cover plating stiffeners [m].

### 7.10.5.4 Buckling strength of hatch cover structures

#### 7.10.5.4.1 General

**7.10.5.4.1.1** Hatch cover structure shall fulfil requirements of IACS UR S35 Buckling Strength Assessment of Ship Structural Elements.

The form and content of p.7.10.5.4 text where many requirements of Chapter 8 *Buckling* of IACS *Common Structural Rules for Bulk Carriers and Oil Tankers* (CSR) are indicated to fulfil gives a set of requirements for buckling of hatch cover structures fully covering and amending the requirements of UR S35.

**Note:**

1. UR S35 c is to be applied by IACS Societies to ships according to the application dates, on or after 1 July 2024, of the individual IACS Unified Requirements requiring compliance with this UR S35.

**7.10.5.4.1.2** Buckling strength of all hatch cover structures is to be checked in the scope and applying methods of computations and buckling strength criteria as given in points 7.10.5.4.2 and 7.10.5.4.3 below.

For hatch covers special cases not covered in point 7.10.5.4.3 below, such as a whole plate structure with stiffeners in two directions (i.e., a stiffened panel with both primary and secondary stiffeners), other more advanced methods, such as finite element analysis methods, can be used and they will be considered by PRS on case-by-case basis.

**7.10.5.4.1.3** The net scantlings as defined in p.7.10.1.4 for corrosion additions values listed in Table 7.10.4.2.1 are to be used for buckling check.

#### **7.10.5.4.2 Slenderness requirements**

Hatch covers stiffener elements except for U-type stiffeners are to comply with the applicable slenderness and proportion requirements given in CSR, Chapter 8, Section 2, p.3.1. Scantling parameters (dimensions) for popular types of the stiffeners are defined in CSR, Chapter 8, Section 2, Figure 1.

The slenderness requirements need not be applied to the lower boundary of double skin hatch covers stiffeners unless the cargo hold is designed for carriage of ballast or liquid cargo.

Proportions of hatch covers primary supporting members web plate and flange are to comply with the applicable requirements given in CSR, Chapter 8, Section 2, p.4.1.

Proportions of web and bending stiffness of primary supporting members web stiffeners are to comply with requirements given in CSR, Chapter 8, Section 2, p.4.2.

Application of tripping brackets of primary supporting members may be necessary to fulfil the requirements of CSR, Chapter 8, Section 2, p.5.1 for unsupported flange length.

The breadth of the primary supporting member flange is to be not less than 40% of their depth for laterally unsupported spans greater than 3.0 m. Tripping brackets attached to the flange may be considered as a lateral support for primary supporting members.

#### **7.10.5.4.3 Buckling requirements based on computed stress level**

##### **7.10.5.4.3.1 Application**

These requirements apply to the buckling assessment of hatch cover structural members based on direct strength analysis (by finite elements method) and subjected to compressive and shear stresses and lateral pressures.

All structural elements in the direct strength analysis carried out according to requirements of p. 7.10.4.3 are to be assessed individually, applying the requirements of p. 7.10.5.4.3.2 to p. 7.10.5.4.3.6 for scope of analysis and FE models and requirements of p. 7.10.5.4.3.7 for buckling utilization assessment and buckling criteria.

The buckling assessment is to be performed for the following structural elements:

- Stiffened and unstiffened panels, including curved panels and panels stiffened with U-type stiffeners.
- Web panels of primary supporting members in way of openings.

The buckling strength assessment of coaming parts is to be performed applying requirements of Chapter 13 of Part II – *Hull* PRS Rules.

##### **7.10.5.4.3.2 Definitions and basic assumptions for buckling strength assessment by FE method**

Below some items and terms used to formulate the buckling strength requirements for the hatch covers are defined.

Elementary plate panel (EPP) – unstiffened part of the plating between stiffeners and/or primary supporting members. For panel length and breadth – see CSR, Chapter 3, Section 7, p.2.1.1.

Standard types of stiffeners – see CSR, Chapter 8, Section 2, Figure 1.

For the U-type stiffener which is usually fitted in some hatch covers, the definition of its cross-sectional dimensions is shown in Figure 7.10.4.3 above.

Stiffened panel (SP) and Unstiffened panel (UP)

For a panel with relatively strong interactive effect between the stiffener and its attached plate, each stiffener with its attached plate as a whole is to be modelled as a stiffened panel (SP), so as to be able to consider both of its local and global buckling modes.

However, for an EPP, if its buckling strength can be checked without considering its interactive effect with stiffeners fitted along its edges, it's to be modelled as an unstiffened panel (UP).

Precise requirements for application of SP or UP models is given in Table 7.10.5.4.3.4 below.

Sign convention for stress values

In computations required for the buckling strength assessment compressive and shear stresses are to be taken as positive, tension stresses are to be taken as negative.

Method A and Method B

The buckling assessment of hatch covers is to be carried out according to one of the following two methods taking into account different boundary condition types:

- Method A: All the edges of the EPP are forced to remain straight (but free to move in the in-plane directions) due to the surrounding structure/neighbouring plates;
- Method B: The edges of the EPP are not forced to remain straight due to low in-plane stiffness at the edges and/or no surrounding structure/neighbouring plates.

SP-A, SP-B, UP-A and UP-B models

For the buckling assessment of the stiffened panel (SP) and unstiffened panel (UP) structural models defined above with application of either Method A or Method B for the plate buckling assessment, the following four buckling assessment models are established:

- SP-A: a stiffened panel with application of Method A.
- SP-B: a stiffened panel with application of Method B.
- UP-A: an unstiffened panel with application of Method A.
- UP-B: an unstiffened panel with application of Method B.

#### **7.10.5.4.3.3 Stress values for buckling capacity of the hatch cover assessment**

Requirements of p. 7.10.4.3 apply for FE model that is used to compute stress values used for buckling strength assessment according to acceptance criteria given in p. 7.10.5.4.3.8.

#### **7.10.5.4.3.4 Stiffened and Unstiffened Panels**

The plate panel of a hatch cover structure is to be modelled as stiffened panel (SP) or unstiffened panel (UP) as defined in p. 7.10.5.4.3.2.

Assessment Method A (-A) and Method B (-B) as defined in p. 7.10.5.4.3.2 are to be used in accordance with Tab. 7.10.5.4.3.4, Fig. 7.10.5.4.3.4-1 and Fig. 7.10.5.4.3.4-2.

For a web panel with opening, the procedure for opening should be used for its buckling assessment (see p. 7.10.5.4.3.7).

For a hatch cover fitted with U-type stiffeners, the additional buckling assessment requirements specific for panels with U-type stiffeners in p.7.10.5.4.3.8 are to be followed.

**Table 7.10.5.4.3.4**  
**Structural members and assessment methods**

Structural elements	Assessment method <sup>(1)(2)</sup>	Normal panel definition
Hatch cover top/bottom plating structures, see Fig. 7.10.5.4.3.4-1		
Hatch cover top/bottom plating	SP-A	Length: between transverse girders Width: between longitudinal girders
Irregularly stiffened panels	UP-B	Plate between local stiffeners/PSM
Hatch cover web panels of primary supporting members, see Fig. 7.10.5.4.3.3-2		
Web of transverse/longitudinal girder (single skin type)	UP-B	Plate between local stiffeners/face plate/PSM
Web of transverse/longitudinal girder (double skin type)	SP-B <sup>(3)</sup>	Length: between PSM Width: full web depth
Web panel with opening	Procedure for opening	Plate between local stiffeners/face plate/PSM
Irregularly stiffened panels	UP-B	Plate between local stiffeners/face plate/PSM
Note 1: SP and UP stand for stiffened and unstiffened panel respectively. Note 2: A and B stand for Method A and Method B respectively. Note 3: In case that the buckling carlings/brackets are irregularly arranged in the web of transverse/longitudinal girder, UP-B method may be used.		

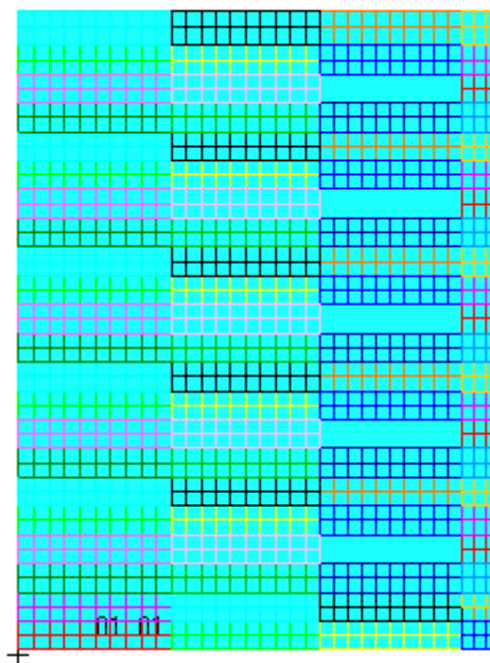


Fig. 7.10.5.4.3.4-1 Hatch cover top/bottom plating structures

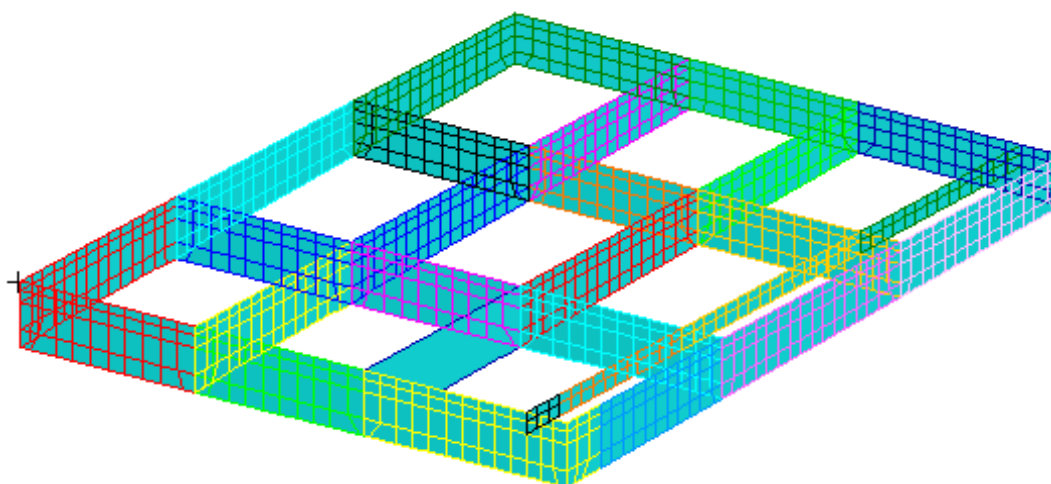


Fig. 7.10.5.4.3.4-2 Hatch cover webs of primary supporting members

Additional requirements for stiffened panels

For a stiffened panel (SP), each stiffener with attached plate is to be idealized as a stiffened panel model.

If the stiffener properties or stiffener spacing varies within the stiffened panel, the calculations of buckling capacity are to be performed separately for all configurations of the panels, i.e. for each stiffener and plate between the stiffeners. Plate thickness, stiffener properties and stiffener spacing at the considered location are to be assumed for the whole panel.

The buckling check of the stiffeners of stiffened panels is only applicable to the stiffeners fitted along the longer side edges of the buckling panel.

Additional requirements for unstiffened panels

Geometry of the panel (i.e. plate bounded by web stiffeners/face plate) may not have a rectangular shape. In this case, for buckling assessment, an equivalent rectangular panel is to be defined according to CSR, Chapter 8, Section 4, p.2.3.2 for irregular geometry and CSR, Chapter 8, Section 2, p.2.3.3 for triangular geometry and to comply with buckling assessment.

**7.10.5.4.3.5 Reference stress**

The stress distribution is to be taken from the direct strength analysis according to the requirements of p. 7.10.4.3 and applied to the buckling model.

For FE analysis, the reference stresses are to be calculated using the stress-based reference stresses as defined in CSR, Chapter 8, Appendix 1.

**7.10.5.4.3.6 Lateral pressure**

The lateral pressure applied to the direct strength analysis according to requirements of p. 7.10.4.3 is also to be applied to the buckling assessment.

For FE analysis, where the lateral pressure is not constant over a buckling panel defined by a number of finite plate elements, an average lateral pressure, in [N/mm<sup>2</sup>], is calculated using the following formula:

$$P_{avr} = \frac{\sum_1^n A_i P_i}{\sum_1^n A_i}$$

where:

$A_i$  – area of the  $i$ -th plate element, in [mm<sup>2</sup>];

$P_i$  – lateral pressure of the  $i$ -th plate element, in [N/mm<sup>2</sup>];

$n$  – number of finite elements in the buckling panel.

#### 7.10.5.4.3.7 Buckling acceptance criteria

A structural member of hatch cover is considered to have an acceptable buckling strength if it satisfies the following criterion:

$$\eta_{act} \leq \eta_{all} \quad (7.10.5.4.3.6)$$

where:

$\eta_{act}$  – buckling utilisation factor defined in CSR, Chapter 8, Section 1, p. 3.2, based on the applied stress, as defined in p. 7.10.5.4.3.5, computed as described below for the assessment methods chosen according to Table 7.10.5.4.3.4;

$\eta_{all}$  – allowable buckling utilisation factor, taken as given in Tab. 7.10.5.4.3.7.

**Table 7.10.5.4.3.7**  
**Allowable buckling utilisation factors**

Structural component	Subject to	$\eta_{all}$ , allowable buckling utilisation factor
Plates and stiffeners Web of PSM	External pressure, as defined in p.7.10.3.2	0.80
	Other loads, as defined in points 7.10.3.3 to 7.10.3.8	0.90 for static + dynamic load case 0.72 for static load case

#### UP-A

The buckling utilization factor  $\eta_{act} = \eta_{UP-A}$  is to be computed applying the requirements of CSR, Chapter 5, Section 5, p.2.2 where UP-A model is to be used assuming  $S = 1.0$ .

#### UP-B

The buckling utilization factor  $\eta_{act} = \eta_{UP-B}$  is to be computed applying the requirements of CSR, Chapter 5, Section 5, p.2.2 where UP-B model is to be used assuming  $S = 1.0$ ;

#### SP-A

The buckling utilization factor  $\eta_{act} = \eta_{SP-A}$  is to be taken as the maximum of the buckling utilization factors calculated as follows:

- the overall stiffened panel buckling utilization factor  $\eta_{overall}$  computed applying the requirements of CSR, Chapter 5, Section 5, p. 2.1;
- the plate buckling utilization factor  $\eta_{plate}$  computed applying the requirements of CSR, Chapter 5, Section 5, p. 2.2 where SP-A model is to be used assuming  $S = 1.0$ ;
- the stiffener buckling utilization factor  $\eta_{stiffener}$  computed applying the requirements of CSR, Chapter 5, Section 5, p. 2.3 considering separately the properties (thickness, dimensions), the pressures defined in p.7.10.5.4.3.5 and the reference stresses of each EPP at both sides of the stiffener and assuming  $S = 1.0$ .

**Note1:** the stiffener buckling strength check can only be fulfilled when the overall stiffened panel capacity check, as defined in CSR, Chapter 5, Section 5, p.2.1 is satisfied.

#### SP-B

The buckling utilization factor  $\eta_{act} = \eta_{SP-B}$  is to be taken as the maximum of the buckling utilization factors calculated as follows:

- the overall stiffened panel buckling utilization factor  $\eta_{overall}$  computed applying the requirements of CSR, Chapter 5, Section 5, p.2.1;



- b) the plate buckling utilization factor  $\eta_{plate}$  computed applying the requirements of CSR, Chapter 5, Section 5, p.2.2 where SP-B model is to be used assuming  $S = 1.0$ ;
- c) the stiffener buckling utilization factor  $\eta_{stiffener}$  computed applying the requirements of CSR, Chapter 5, Section 5, p.2.3 considering separately the properties (thickness, dimensions), the pressures defined in p.7.10.5.4.3.6 and the reference stresses of each EPP at both sides of the stiffener and assuming  $S = 1.0$ .

Note1: the stiffener buckling strength check can only be fulfilled when the overall stiffened panel capacity check, as defined in CSR, Chapter 5, Section 5, p.2.1 is satisfied.

Web plate in way of openings

The buckling utilization factor  $\eta_{act} = \eta_{opening}$  is to be computed applying the requirements of CSR, Chapter 5, Section 5, p. 2.4.

**7.10.5.4.3.8 Buckling strength check of stiffened panels with U-type stiffeners**

Local plate buckling

For stiffened panels with U-type stiffeners, local plate buckling is to be checked for each of the plate panels EPP  $b_1$ ,  $b_2$ ,  $b_f$  and  $h_w$  (see Figure 7.10.4.3) separately as follows:

- a) the attached plate panels EPP  $b_1$  and  $b_2$  are to be assessed using SP-A model, where in the calculation of buckling factors  $K_x$  as defined in CSR, Chapter 8, Section 5, Case 1 of Table 3, the correction factor  $F_{long}$  for U-type stiffeners as defined in CSR, Chapter 8, Section 5, Table 2 is to be used; and in the calculation of  $K_y$  as defined in CSR, Chapter 8, Section 5 Case 2 of Table 3, the  $F_{trans}$  for U-type stiffeners as defined below is to be used.

For the attached plate of a U-type stiffener fitted on a hatch cover:

$$F_{trans} = \text{Max}(3 - 0.08(F_{tran0} - 6)^2, 1.0) \leq 2.25$$

where:

$$F_{tran0} = \text{Min}\left(\frac{b_2}{b_1} + \frac{6b_2^2}{\pi^2 h_w(b_1+b_2)} \left(\frac{t_w}{t_p}\right)^3, 6\right) - \text{for EPP } b_2$$

$$F_{tran0} = \text{Min}\left(\frac{b_1}{b_2} + \frac{6b_1^2}{\pi^2 h_w(b_2+b_1)} \left(\frac{t_w}{t_p}\right)^3, 6\right) - \text{for EPP } b_1$$

with  $b_1$ ,  $b_2$  and  $h_w$  as defined in Fig. 7.10.5.4.3.6;

Coefficient  $F$  defined in CSR, Chapter 8, Section 5, Case 2 of Table 3 is to be replaced by the following formula:

$$F = \left[1 - \left(\frac{K_y}{0.91F_{trans}} - 1\right) / \lambda_p^2\right] c_1 \geq 0$$

- b) the face plate and web plate panels  $b_f$  and  $h_w$  are to be assessed using UP-B model with  $F_{long} = 1.0$  and  $F_{trans} = 1.0$ .

Overall stiffened panel buckling and stiffener buckling

For a stiffened panel with U-type stiffeners, the overall buckling capacity (see CSR, Chapter 8, Section 5, p.2.1) and ultimate capacity of the stiffeners (see CSR, Chapter 8, Section 5, p.2.3) are to be checked with warping stress  $\sigma_w = 0$ , and with bending moment of inertia including effective width of attached plating being calculated based on the following assumptions:

- a) The two web panels of a U-type stiffener are to be taken as perpendicular to the attached plate with thickness equal to  $t_w$  and height equal to the distance between the attached plate and the face plate of the stiffener;
- b) effective width of the attached plating,  $b_{eff}$ , taken as the sum of the  $b_{eff}$  calculated for the EPP  $b_1$  and  $b_2$  respectively according to SP-A model (see definition of  $b_{eff}$  in *CSR, Chapter 8, Section 5, p. 2.3.5*);
- c) effective width of the attached plating of a stiffener without shear lag  $b_{eff1}$ , taken as the sum of the  $b_{eff1}$  calculated for the EPP  $b_1$  and  $b_2$  respectively (see definition of  $b_{eff1}$  in *CSR, Chapter 8, Section 5, Symbols*).

## 7.10.6 Details of Hatch Covers and Weathertightness

### 7.10.6.1 Container Foundations on Hatch Covers

Container foundations design will be subject to PRS acceptance in each particular case. The substructures of container foundations shall be designed for cargo and container loads according to 7.10.3, applying the permissible stresses according to 7.10.4.1.1.

### 7.10.6.2 Weathertightness

Further to the following requirements IACS Rec.14 is applicable to hatch covers.

#### 7.10.6.2.1 Packing Material

The packing material shall be suitable for all expected service conditions of the ship and shall be compatible with the cargoes to be transported. The packing material shall be selected with regard to dimensions and elasticity in such a way that expected deformations can be carried. Forces shall be carried by the steel structure only.

The packing material shall be effectively secured to the cover.

The packings shall be compressed so as to give the necessary tightness effect for all expected operating conditions. Special consideration shall be given to the packing arrangement in ships

with large relative movements between hatch covers and coamings or between hatch cover sections. The specification or grade of the packing material shall be indicated on the drawing.

#### 7.10.6.2.2 Dispensation of Weather Tight Gaskets

For hatch covers of cargo holds solely for the transport of containers, upon request by the owners and subject to compliance with the following conditions, the fitting of weather tight gaskets according to 7.10.6.2.1 may be dispensed with:

- The hatchway coamings shall be not less than 600 mm in height.
- The exposed deck on which the hatch covers are located is situated above a depth  $H(x_1)$ .  $H(x_1)$  shall be shown to fulfil the following criteria:

$$H(x_1) \geq T_{fb} + f_b + h \text{ [m]}$$

$T_{fb}$  – draught [m], corresponding to the assigned summer load line,

$f_b$  – minimum required freeboard [m], determined in accordance with *ICLL Reg. 28* as modified by further regulations as applicable,

$$h = 4.6 \text{ m for } \frac{x_1}{L} \leq 0.75,$$

$$h = 6.9 \text{ m for } \frac{x_1}{L} > 0.75.$$

- Labyrinths, gutter bars or equivalents shall be fitted proximate to the edges of each panel in way of the coamings. The clear profile of these openings shall be kept as small as possible.
- Where a hatch is covered by several hatch cover panels, the clear opening of the gap in between the panels shall be not wider than 50 mm.
- The labyrinths and gaps between hatch cover panels shall be considered as unprotected openings with respect to the requirements of intact and damage stability calculations.
- With regard to drainage of cargo holds and the necessary fire-fighting system reference is made to the sections Piping Systems, Valves and Pumps and Fire Protection and Fire Extinguishing Equipment of the *PRS Rules (Part V and Part VI)*.
- Bilge alarms should be provided in each hold fitted with non-weather-tight covers.
- Furthermore, Chapter 3 of IMO MSC/Circ. 1087 shall be referred to concerning the stowage and segregation of containers containing dangerous goods.

### 7.10.6.2.3 Drainage arrangements

Cross-joints of multi-panel covers are to be provided with efficient drainage arrangements.

## 7.10.7 Hatch Coamings strength and local details

### 7.10.7.1 Local Net Plate Thickness of Coamings

The net thickness of weather deck hatch coamings shall not be less than the larger of the following values:

(1) For Type-1 ships:

$$t = 14.2s \sqrt{\frac{p_A}{0.95R_e}} \text{ [mm]} \quad (7.10.7.1-1)$$

$$t_{\min} = 6 + \frac{L_1}{100} \text{ [mm]} \quad (7.10.7.1-2)$$

(2) For Type-2 ships:

$$t = 16s \sqrt{\frac{p_{coam}}{0.95R_e}} \text{ [mm]} \quad (7.10.7.1-3)$$

$$t_{\min} = 9.5 \text{ [mm]} \quad (7.10.7.1-4)$$

$s$  – stiffener spacing of hatch coaming [m],

$p_A$  – pressure determined according to 7.10.3.3.1 [kPa],

$p_{coam}$  – pressure determined according to 7.10.3.3.2 [kPa],

$L_1 = L_0$ , need not be taken greater than 300 m.

In addition, for both Type-1 and Type-2 ships, longitudinal strength aspects shall be observed.

### 7.10.7.2 Net Scantling of Stiffeners of Coamings

The stiffeners must be continuous at the coaming stays. For stiffeners with both ends constraint the elastic net section modulus  $Z$  and net shear area  $A_s$  calculated on the basis of net thickness, must not be less than:

(1) For Type-1 ships:

$$Z = \frac{1000p_A s l^2}{f_{bc} R_e} \text{ [cm}^3\text{]} \quad (7.10.7.2-1)$$

$$A_s = \frac{10slp_A}{R_e} \text{ [cm}^2\text{]} \quad (7.10.7.2-2)$$

$f_{bc}$  – boundary coefficient of stiffener, taken equal to:

$$f_{bc} = 12 \text{ in general,}$$

$f_{bc} = 8$  for the end spans of stiffeners sniped at the coaming corners,  
 $l$  – secondary stiffener span [m] to be taken as the spacing of coaming stays,  
 $s$  – stiffener spacing [m],  
 $p_A$  – pressure determined according to 7.10.3.3.1 [kPa].

Note that for sniped stiffeners of coaming at hatch corners shear area at the fixed support has to be increased by 35%. The gross thickness of the coaming plate at the sniped stiffener end shall not be less than:

$$t = 19.6 \sqrt{\frac{p_A s (l - 0.5s)}{R_e}} \text{ [mm]} \quad (7.10.7.2-3)$$

(2) For Type-2 ships:

$$Z = 1.21 \frac{1000 p_{coam} s l^2}{f_{bc} c_p R_e} \text{ [cm}^3\text{]} \quad (7.10.7.2-4)$$

where:

$f_{bc}$  – boundary coefficient of stiffener taken equal to:

$f_{bc} = 16$  in general,

$f_{bc} = 12$  for the end spans of stiffeners sniped at the coaming corners,

$c_p$  – ratio of the plastic section modulus to the elastic section modulus of the stiffeners with an attached plate breadth [mm], equal to  $40t$ , where  $t$  is the plate net thickness or  $c_p = 1.16$  in the absence of more precise evaluation,

$l$  – secondary stiffener span, [m],

$s$  – stiffener spacing [m],

$p_{coam}$  – pressure determined according to 7.10.3.3.2 [kPa].

In addition, for both Type-1 and Type-2 ships, horizontal stiffeners on hatch coamings, which are part of the longitudinal hull structure will be subject to PRS acceptance in each particular case.

### 7.10.7.3 Coaming Stay Section Modulus and Web Thickness

Coaming stays shall be designed for the loads transmitted through them and permissible stresses according to 7.10.4.1.1.

At the connection with deck, the net section modulus,  $Z$ , and the net thickness,  $t_w$ , of the coaming stays designed as beams with flange (examples 1 and 2 are shown in Fig. 7.10.7.3) shall be taken not less than:

$$Z = \frac{p s_c H_c^2}{1.9 R_e} \text{ [cm}^3\text{]} \quad (7.10.7.3-1)$$

$$t_w = \frac{2 p s_c H_c}{h R_e} \text{ [mm]} \quad (7.10.7.3-2)$$

$H_c$  – stay height [m],

$s_c$  – stay spacing [mm],

$h$  – stay depth at the connection with the deck [mm],

$p$  – pressure on coaming [kPa], taken as  $p_A$  defined in 7.10.3.3.1 in general and as  $p_{coam}$  defined in 7.10.3.3.2 for Type-2 ships.

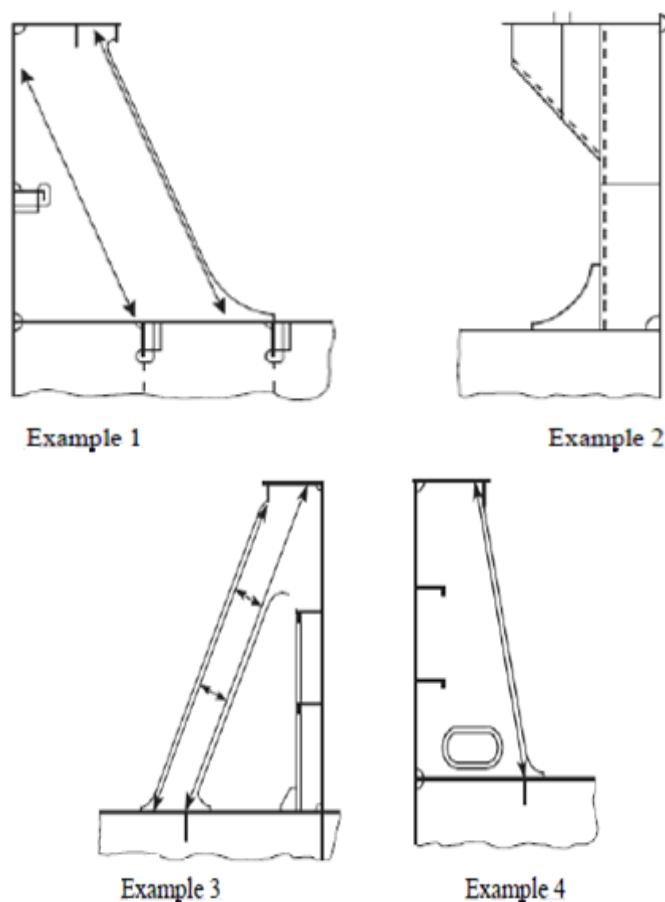


Fig. 7.10.7.3. Examples of coaming stays

For other designs of coaming stays, such as those shown in Fig. 7.10.7.3, examples 3 and 4, the stresses shall be determined through FEM. The calculated stresses shall fulfil the permissible stresses according to 7.10.4.1.1.

Coaming stays shall be supported by appropriate substructures. For calculating the section modulus of coaming stays, their face plate area shall be taken into account only when it is welded with full penetration welds to the deck plating and adequate underdeck structure is fitted to support the stresses transmitted by it.

Webs shall be connected to the deck by fillet welds on both sides with a throat thickness not lesser than  $a = 0.44t_w$ .

For Type-2 ships, toes of stay webs are to be connected to the deck plating with full or partial penetration double bevel welds extending over a distance not less than 15% of the stay width.

For other ship types the size of welding for toes of webs at the lower end of coaming stays be subject to PRS acceptance in each particular case.

#### 7.10.7.4 Coaming Stays Under Friction Load

For coaming stays, which transfer friction forces at hatch cover supports, fatigue strength shall be considered applying calculation methods and criteria given in *Publication 45/P – Fatigue Strength Analysis of Ship Steel Hull Structure* (see also 7.10.9.2).

### 7.10.7.5 Further Requirements for Hatch Coamings

#### 7.10.7.5.1 Longitudinal Strength

Hatch coamings which are part of the longitudinal hull structure shall be designed according to the requirements for longitudinal strength of *Part II of the Rules*.

For structural members welded to coamings and for cutouts in the top of coamings, sufficient fatigue strength shall be verified in accordance with the requirements specified in *Publication 45/P – Fatigue Strength Analysis of Ship Steel Hull Structure*.

Longitudinal hatch coamings with a length exceeding  $0.1L_0$  [m] shall be provided with tapered brackets or equivalent transitions and a corresponding substructure at both ends. At the end of the brackets they shall be connected to the deck by full penetration welds of minimum 300 mm in length.

#### 7.10.7.5.2 Local Details

Design of local details which the requirements of 7.10.7 do not apply to, will be subject to PRS acceptance in each particular case for the purpose of transferring the loads on the hatch covers to the hatch coamings and, through them, to the deck structures below. Hatch coamings and supporting structures shall be adequately stiffened to accommodate the loading from hatch covers, in longitudinal, transverse and vertical directions.

Structures under deck shall be checked against the load transmitted by the stays.

Unless otherwise stated, dimensions of weld connections and material selection which the requirements of 7.10.7 do not apply to, will be subject to PRS acceptance in each particular case.

#### 7.10.7.6 Spacing of Stays

On ships carrying cargo on deck, such as timber, coal or coke, the stays shall be spaced not more than 1.5 m apart.

#### 7.10.7.7 Extent of Coaming Plates

Coaming plates shall extend to the lower edge of the deck beams or hatch side girders shall be fitted that extend to the lower edge of the deck beams. Extended coaming plates and hatch side girders shall be flanged or fitted with face bars or half-round bars. Fig. 7.10.7.7 gives an example.

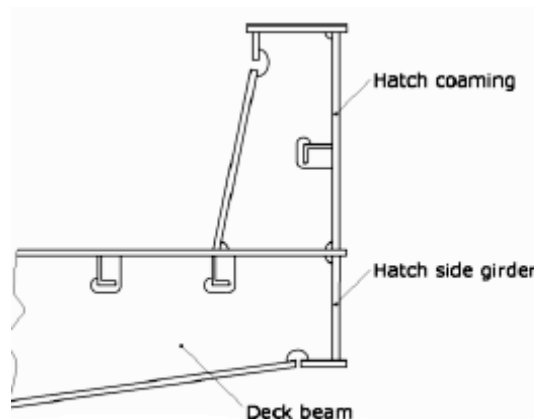


Fig.7.10.7.7 Example for the extent of coaming plates

### 7.10.7.8 Drainage arrangement at the coaming

If drain channels are provided inside the line of gasket by means of a gutter bar or vertical extension of the hatch side and end coaming, drain openings are to be provided at appropriate positions of the drain channels.

Drain openings in hatch coamings are to be arranged with sufficient distance to areas of stress concentration (e.g. hatch corners, transitions to crane posts).

Drain openings are to be arranged at the ends of drain channels and are to be provided with non-return valves to prevent ingress of water from outside. It is unacceptable to connect fire hoses to the drain openings for this purpose.

If a continuous outer steel contact between cover and ship structure is arranged, drainage from the space between the steel contact and the gasket is also to be provided for.

### 7.10.8 Securing Devices

#### 7.10.8.1 General

Securing devices between cover and coaming and at cross-joints, shall be installed to provide weathertightness. Sufficient packing line pressure shall be maintained.

Securing devices must be appropriate to bridge displacements between cover and coaming due to hull deformations.

Securing devices shall be of reliable construction and effectively attached to the hatchway coamings, decks or covers. Individual securing devices on each cover shall have approximately the same stiffness characteristics.

Sufficient number of securing devices shall be provided at each side of the hatch cover considering the requirements of 7.10.5.3.2. This also applies to hatch covers consisting of several parts.

The materials of stoppers, securing devices and their weldings will be subject to PRS acceptance in each particular case. Specifications of the materials shall be shown in the drawings of the hatch covers.

#### 7.10.8.2 Rod Cleats

Where rod cleats are fitted, resilient washers or cushions shall be incorporated.

#### 7.10.8.3 Hydraulic Cleats

Where hydraulic cleating is adopted, a positive means shall be provided so that it remains mechanically locked in the closed position in the event of failure of the hydraulic system.

#### 7.10.8.4 Cross-sectional Area of the Securing Devices

**7.10.8.4.1** The cross-sectional area of the securing devices of the covers on exposed decks shall not be less than:

$$A = 0.28q s_{SD} k_l \text{ [cm}^2\text{]} \quad (7.10.8.4.1-1)$$

Correspondingly, the stiffness of edge girders shall be sufficient to maintain adequate sealing pressure between securing devices. The moment of inertia, of edge girders shall not to be less than:

$$I = 6q s_{SD}^4 \text{ [cm}^4\text{]} \quad (7.10.8.4.1-2)$$

$q$  – packing line pressure [N/mm], minimum 5 N/mm,

$s_{SD}$  – spacing between securing devices [m], not to be taken less than 2 m,



$k_l = \left(\frac{235}{R_e}\right)^e$ ,  $R_e$  is the minimum yield strength of the material [MPa], but is not be taken greater than  $0.7R_m$ , where  $R_m$  is the tensile strength of the material [MPa],  
 $e = 0.75$  for  $R_e > 235$  [MPa],  
 $e = 1.00$  for  $R_e \leq 235$  [MPa].

Rods or bolts shall have a gross diameter not less than 19 mm for hatchways exceeding 5 m<sup>2</sup> in area.

Securing devices of special design in which significant bending or shear stresses occur may be designed as anti-lifting devices according to 7.10.8.5. The packing line pressure  $q$  shall be specified, and as load,  $q$  multiplied by the spacing between securing devices  $s_{SD}$  shall be applied.

**7.10.8.4.2** The cross-sectional area of the securing devices of the covers on tanks shall not be less than:

$$A = n \cdot s_{SD} \cdot c \cdot k_l \text{ [cm}^2\text{]} \quad (7.10.8.4.2)$$

where:

$s_{SD}, k_l$  – defined in 7.10.8.4.1;

$n = 3,0$  – for covers of deep or cargo tanks, secured to other cover parts;

$n = 0,08 (0,5lp + q)$  –for covers secured to hatch coamings;

$l$  – primary structure member or transverse stiffener span in relation to the given cover edge [m].

If the primary structure members or transverse stiffeners have not been applied, the  $l$  value shall be taken as half of the distance between the cover edge and the nearest PSM parallel to the edge;

$p$  – pressure of the greatest value from among the following:  $p = 1.5p_7, p = p_8, p = p_9, p = p_{10}$ , [kPa]; the values of pressures  $p_7 \div p_{10}$  shall be defined according to the requirements of subchapter 16.3 of Part II – Hull;

$q$  – continuous load defined in 7.10.8.4.1 [N/mm];

$c = 0.2q$ , however, the value taken for calculations shall be not less than 1.0.

**7.10.8.4.3** The securing devices of covers designed based on direct strength calculations shall be chosen for the forces transferred.

For securing devices in the form of bolts, permissible value of tension stresses is equal to  $\sigma = 125/k$  [MPa].

For securing devices other than the above, permissible stress values are as follows:

– normal stresses:  $\sigma = 120/k$  [MPa];

– shear stresses:  $\tau = 80/k$  [MPa];

– equivalent stresses:  $\sigma_{zr} = \sqrt{\sigma^2 + 3\tau^2} = 150/k$  [MPa].

The  $k$  coefficient is defined in 7.5.2.1.

### 7.10.8.5 Anti Lifting Devices

**7.10.8.5.1** The securing devices of hatch covers, on which cargo shall be lashed, shall be designed for the lifting forces resulting from loads according to 7.10.3.6, refer to Fig. 7.10.8.5.1. Unsymmetrical loadings, which may occur in practice, shall be considered. Under these loadings, the equivalent stress in the securing devices shall not exceed:

$$\sigma_{vm} = \frac{150}{k_l} \text{ [MPa]} \quad (7.10.8.4.1)$$

$k_l$  – see 7.10.8.4.1.

**Note:** The partial load cases given in Tab. 7.10.3.6.4 may not cover all unsymmetrical loadings, critical for hatch cover lifting. Chapter 5.6 of IACS Rec.14 should be referred to for the omission of anti-lifting devices.

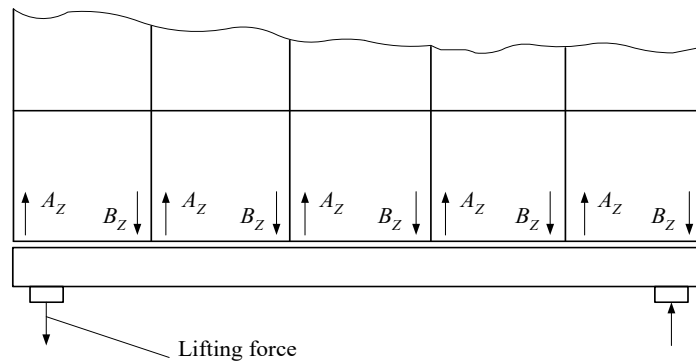


Fig. 7.10.8.5.1. Lifting forces at a hatch cover

**7.10.8.5.2** If loads generated by ship rolling do not result in cover lifting forces, the securing devices for non-weathertight covers need not be applied. In such cases it shall be proven, using FE model, that the cover balance is ensured when the vertical reaction forces of all vertical cover supports are directed upwards.

Where the securing devices are not applied, the guides preventing transverse displacements of the cover shall effectively block the displacements up to the  $h_E$  level above the level of cover supports, with the value not less than the lesser of the below two values:

$$h_E = \sqrt{1.75(2se + d^2)} - 0.75d \text{ [mm]} \quad (7.10.8.5.2-1)$$

$$h_{E,min} = h_e + 150 \text{ [mm]} \quad (7.10.8.5.2-2)$$

where:

$e$  – the greatest distance measured from the inner edge of the guide to the end of the side of the cover [mm] (see Fig. 7.10.8.5.2),

$s$  – total clearance in the guide; the applied value shall comply with the condition:  $10 \leq s \leq 40$  [mm],

$d$  – the distance between the upper plane of transverse stopper and the cover supports surface [mm],

$h_e$  – the height of the cover side wall [mm].

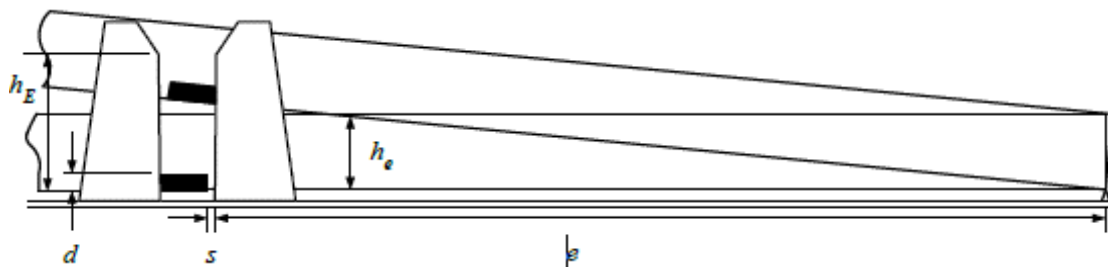


Fig. 7.10.8.5.2 The height of the cover transverse guides

Transverse guides and their supporting structures shall be dimensioned relatively to transverse loads acting on the height  $h_E$ , defined according to 7.10.9.1.

The values of permissible stresses are as defined in 7.10.4.1.

## 7.10.9 Hatch Cover Supports, Stoppers and Supporting Structures

### 7.10.9.1 Horizontal Mass Forces

For the design of hatch cover supports, the horizontal mass forces  $F_h = ma$  shall be calculated with the following accelerations:

$a = 0.2g$  in longitudinal direction,

$a = 0.5g$  in transverse direction,

$m$  – sum of mass of cargo lashed on the hatch cover and mass of hatch cover.

The accelerations in longitudinal direction and in transverse direction do not need to be considered as acting simultaneously.

### 7.10.9.2 Hatch Cover Supports

For the transmission of the support forces resulting from the load cases specified in 7.10.3 and of the horizontal mass forces specified in 7.10.9.1, supports shall be provided which shall be designed such that the nominal surface pressures in general do not exceed the following values:

$$p_{n\max} = dp_n \text{ [N/mm}^2\text{]} \quad (7.10.9.2-1)$$

where:

$$d = 3.75 - 0.015L_0,$$

$$d_{\max} = 3.0,$$

$$d_{\min} = 1.0 \text{ in general,}$$

$$d_{\min} = 2.0, \text{ for partial loading conditions defined in 7.10.3.6.1,}$$

$$p_n - \text{ see Tab. 7.10.9.2.}$$

For metallic supporting surfaces not subjected to relative displacements, the nominal surface pressure applies:

$$p_{n\max} = 3p_n \text{ [N/mm}^2\text{]} \quad (7.10.9.2-2)$$

**Note:**

When the maker of vertical hatch cover support material can provide proof that the material is sufficient for the increased surface pressure, not only statically but under dynamic conditions including relative motion for adequate number of cycles, permissible nominal surface pressure may be relaxed at the discretion of PRS. However, realistic long term distribution of spectra for vertical loads and relative horizontal motion should be assumed and agreed with PRS.

Drawings of the supports must be submitted to PRS. In the drawings of supports, the permitted maximum pressure given by the material manufacturer related to long time stress must be specified.

**Table 7.10.9.2**  
**Permissible nominal surface pressure,  $p_n$**

Support material	$p_n$ [N/mm <sup>2</sup> ] when loaded by	
	Vertical force	Horizontal force (on stoppers)
Hull structural steel	25	40
Hardened steel	35	50
Lower friction materials	50	-

Where large relative displacements of the supporting surfaces shall be expected, the use of material having low wear and frictional properties is recommended.

The substructures of the supports must be of such a design, that a uniform pressure distribution is achieved.

Irrespective of the arrangement of stoppers, the supports must be able to transmit the following force  $P_h$  in the longitudinal and transverse direction:

$$p_h = \mu \frac{P_V}{\sqrt{a}} \text{ [kN]} \quad (7.10.9.2-3)$$

where:

$P_V$  – vertical supporting force [kN],

$\mu$  – frictional coefficient,  $\mu = 0.5$  in general.

For non-metallic, low-friction support materials on steel, the friction coefficient may be reduced but not to be less than 0.35 – according to individual PRS acceptance.

Supports as well as the adjacent structures and substructures shall be designed such that the permissible stresses according to 7.10.4.1.1 are not exceeded.

For substructures and adjacent structures of supports subjected to horizontal forces  $P_h$ , a fatigue strength shall be considered according to *Publication 45/P – Fatigue Strength Analysis of Steel Hull Structures*.

### 7.10.9.3 Hatch Cover Stoppers

Hatch covers shall be sufficiently secured against horizontal shifting. Stoppers shall be provided for hatch covers on which cargo is carried.

The greater of the loads resulting from 7.10.3.3 and 7.10.9.1 shall be applied for the dimensioning of the stoppers and their substructures.

The permissible stress in stoppers and their substructures, in the cover, and of the coamings shall be determined according to 7.10.4.1.1. In addition, the provisions in 7.10.9.2 shall be observed.

Specifically for Type-2 ships, the following additional requirements shall be complied with:

- Hatch covers shall be effectively secured, by means of stoppers, against the transverse forces arising from a pressure of 175 kPa.
- With the exclusion of No.1 hatch cover, hatch covers shall be effectively secured, by means of stoppers, against the longitudinal forces acting on the forward end arising from a pressure of 175 kPa.
- No. 1 hatch cover shall be effectively secured, by means of stoppers, against the longitudinal forces acting on the forward end arising from a pressure of 230 kPa.
- This pressure may be reduced to 175 kPa when a forecastle is fitted in accordance with 20.10.2 of *Part II – Hull*.

The equivalent stress in stoppers and their supporting structures and calculated in the throat of the stopper (for thickness of weld defined on Fig. 4.2.3.1 of *Part II – Hull*) welds shall not to exceed the allowable value of  $0.8R_e$ .

### 7.10.10 Non-weathertight Hatch Covers above Superstructure Deck on Container Ships

7.10.10.1 Non-weathertight hatch covers may be accepted subject to the approval of the Administration and under the following condition:

- .1 they are located at a height not less than  $H_p$  above the freeboard deck,
  - $H_p$  –three standard superstructure heights in the case of hatchways located at  $0.25L$  from the forward perpendicular;
  - two standard superstructure heights in the case of hatchways located otherwise;
- .2 the hatchway coamings are not less than 600 mm in height;
- .3 the non-weathertight gaps between hatch cover panels are considered as unprotected openings with respect to intact and damage stability calculations;
- .4 the a.m. gaps are as small as possible. In no case should they exceed 50 mm;
- .5 gutter bars or equivalents are fitted proximate to the edges of the each panel in way of the gaps to minimize the amount of water that can enter the hold from the top surface of each panel;
- .6 bilge alarms are provided in each hold fitted with non-weathertight covers.

## 7.11 Machinery and Boiler Room Casings

**7.11.1** Openings in decks located in positions 1 and 2 above machinery and boiler spaces shall be protected with casings of adequate strength, raised above decks to the suitable height. The casings shall be covered with decks or skylights shall be installed above them. The design of the casings shall fulfil the requirements of sub-chapters 10.3 and 23.2.4, *Part II – Hull*.

**7.11.2** Casings shall be weathertight.

**7.11.3** Casings shall be made of steel or other material approved by PRS (see also sub-chapter 2.1 in *Part V – Fire Protection*).

**7.11.4** Openings in casings leading to machinery and boiler spaces shall be provided with permanently attached doors complying with the requirements of 7.3.2.3 ÷ 7.3.2.7. The height of door opening sills shall be at least 600 mm in position 1 and at least 380 mm in position 2.

**7.11.5** In all type A ships, as well as in type B ships permitted to have freeboard less than the tabular one (prescribed by tables, regulation 28 of the *ICLL 1966*), the machinery-boiler space casings shall be protected by poop or bridge of at least standard height, or with a deckhouse of the same height and strength; the casings without access openings leading directly from the freeboard decks need not have such protection.

Doors meeting the requirements of 7.3.2.1 ÷ 7.3.2.3, as well as 7.3.2.6 and 7.3.2.7 may be applied in machinery casings, provided they lead to a space or corridor of the same strength as the casing and are separated from the access to the machinery-boiler space by the second similar door. The height of the sill shall be at least 600 mm for the outside door and 230 mm for the inner door.

Where the machinery-boiler space is not protected by other structure, double weathertight doors are required; the height of the sills: the outside door – 600 mm, the inner door – 230 mm.

## 7.12 Protection of Openings in Raised Quarterdecks

**7.12.1** Deckhouses situated on a raised quarterdeck or on a superstructure of less than standard height may be treated as being on the second tier as far as the requirements of deadlights and side scuttles and windows is concerned, provided the height of the raised quarterdeck or superstructure on which they are situated is equal to or greater than the standard quarterdeck height.

**7.12.2** Openings in the top of a deckhouse, situated as in 7.12.1 on a raised quarterdeck or superstructure shall be provided with an acceptable means of closing but need not be protected by an efficient deckhouse or companionway, provided the height of the deckhouse is at least the height of superstructure.

## 7.13 Openings in Watertight Bulkheads and Internal Decks in Cargo Ships

The requirements of this subchapter are fully applicable to ships subject to SOLAS Convention. Other ships shall meet these requirements as far as possible.

**7.13.1** The number of openings in watertight subdivisions\* is to be kept to a minimum compatible with the design and proper working of the ship. Where penetrations of watertight bulkheads and internal decks are necessary for access, piping, ventilation, electrical cables, etc., arrangements are to be made to maintain the watertight integrity. The Administration may permit relaxation in the watertightness of openings above the freeboard deck, provided that it is demonstrated that any progressive flooding can be easily controlled and that the safety of the ship is not impaired (SOLAS II-1/13-1.1).

\* See Explanatory Note on SOLAS Reg. II-1/13-1.1 (Res. MSC.429/Rev.2)

**7.13.2** Doors provided to ensure the watertight integrity of internal openings which are used while at sea are to be sliding watertight doors capable of being remotely closed from the bridge and are also to be operable locally from each side of the bulkhead. Indicators are to be provided at the control position showing whether the doors are open or closed, and an audible alarm is to be provided at the door closure. The power, control and indicators are to be operable in the event of main power failure. Particular attention is to be paid to minimizing the effect of control system failure. Each power-operated sliding watertight door shall be provided with an individual hand-operated mechanism. It shall be possible to open and close the door by hand at the door itself from both sides (SOLAS II-1/13-1.2).

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\* See interpretations given in MSC.1/Circ.1362/Rev.2 and IACS UI SC156/Rev.2

**7.13.3** Access doors and access hatch covers normally closed at sea, intended to ensure the watertight integrity of internal openings, shall be provided with means of indication locally and on the bridge showing whether these doors or hatch covers are open or closed. A notice is to be affixed to each such door or hatch cover to the effect that it is not to be left open (SOLAS II-1/13-1.3).

**7.13.4** Watertight doors or ramps of satisfactory construction may be fitted to internally subdivide large cargo spaces, provided that the Administration is satisfied that such doors or ramps are essential. These doors or ramps may be hinged, rolling or sliding doors or ramps, but shall not be remotely controlled\*. Should any of the doors or ramps be accessible during the voyage, they shall be fitted with a device which prevents unauthorized opening (SOLAS II-1/13-1.4).

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\* See interpretations of SOLAS regulations of Part B-1 of Chapter II-1 of the Convention (MSC/Circ.651)

**7.13.5** Other closing appliances which are kept permanently closed at sea to ensure the watertight integrity of internal openings shall be provided with a notice which is to be affixed to each such closing appliance to the effect that it is to be kept closed. Manholes fitted with closely bolted covers need not be so marked (SOLAS II-1/13-1.5).

#### **7.14 Openings in the Shell Plating below the Bulkhead Deck of Passenger Ships and the Freeboard Deck of Cargo Ships**

The requirements of this subchapter are fully applicable to ships subject to SOLAS Convention. Other ships shall meet these requirements as far as possible.

**7.14.1** The number of openings in the shell plating shall be reduced to the minimum compatible with the design and proper working of the ship. (SOLAS II-1/15.1)

**7.14.2** The arrangement and efficiency of the means for closing any opening in the shell plating shall be consistent with its intended purpose and the position in which it is fitted and generally to the satisfaction of the Administration. (SOLAS II-1/15.2)

**7.14.3** Subject to the requirements of the International Convention on Load Lines in force, no sidescuttle shall be fitted in such a position that its sill is below a line drawn parallel to the bulkhead deck at side and having its lowest point 2.5% of the breadth of the ship above the deepest subdivision draught, or 500 mm, whichever is the greater. (SOLAS II-1/15.3.1)

**7.14.4** All sidescuttles the sills of which are below the bulkhead deck of passenger ships and the freeboard deck of cargo ships, as permitted by paragraph 7.14.3, shall be of such construction as will effectively prevent any person opening them without the consent of the master of the ship. (SOLAS II-1/15.3.2)



**7.14.5** Efficient hinged inside deadlights so arranged that they can be easily and effectively closed and secured watertight, shall be fitted to all sidescuttles except that abaft one eighth of the ship's length from the forward perpendicular and above a line drawn parallel to the bulkhead deck at side and having its lowest point at a height of 3.7 m plus 2.5% of the breadth of the ship above the deepest subdivision draught, the deadlights may be portable in passenger accommodation other than that for steerage passengers, unless the deadlights are required by the *International Convention on Load Lines* in force to be permanently attached in their proper positions. Such portable deadlights shall be stowed adjacent to the sidescuttles they serve. (SOLAS II-1/15.4)

**7.14.6** No sidescuttles shall be fitted in any spaces which are appropriated exclusively to the carriage of cargo or coal. (SOLAS II-1/15.5.1)

**7.14.7** Sidescuttles may, however, be fitted in spaces appropriated alternatively to the carriage of cargo or passengers, but they shall be of such construction as will effectively prevent any person opening them or their deadlights without the consent of the master. (SOLAS II-1/15.5.2)

**7.14.8** Automatic ventilating sidescuttles shall not be fitted in the shell plating below the bulkhead deck of passenger ships and the freeboard deck of cargo ships without the special sanction of the Administration. (SOLAS II-1/15.6)

**7.14.9** Moving parts penetrating the shell plating below the deepest subdivision draught shall be fitted with a watertight sealing arrangement acceptable to the Administration. The inboard gland shall be located within a watertight space of such volume that, if flooded, the bulkhead deck of passenger ships and the freeboard deck of cargo ships will not be submerged. The Administration may require that if such compartment is flooded, essential or emergency power and lighting, internal communication, signals or other emergency devices must remain available in other parts of the ship. (SOLAS II-1/15.8.4)

**7.14.10** Cargo ports and other similar openings (e.g. gangway and fuelling ports) in the side of ships below the bulkhead deck of passenger ships and the freeboard deck of cargo ships shall be fitted with doors so designed as to ensure the same watertightness and structural integrity as the surrounding shell plating. Unless otherwise granted by the Administration, these openings shall open outwards. The number of such openings shall be the minimum compatible with the design and proper working of the ship. In no case shall these openings be so fitted as to have their lowest point below the deepest subdivision draught. (SOLAS II-1/15.10)

## **7.15 External Openings in Cargo Ships**

The requirements of this subchapter are fully applicable to ships subject to SOLAS Convention. Other ships shall meet these requirements as far as possible.

**7.15.1** All external openings\* leading to compartments assumed intact in the damage analysis, which are below the final damage waterline, are required to be watertight. (SOLAS II-1/15-1.1)

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\* See Explanatory Note on SOLAS Reg. II-1/15-1 (Res. MSC.429/Rev.2)

**7.15.2** External openings required to be watertight in accordance with paragraph 1 shall, except for cargo hatch covers, be fitted with indicators on the bridge. (SOLAS II-1/15-1.2)

**7.15.3** Openings in the shell plating below the deck limiting the vertical extent of damage shall be fitted with a device that prevents unauthorized opening if they are accessible during the voyage. (SOLAS II-1/15-1.3)



**7.15.4** Other closing appliances which are kept permanently closed at sea to ensure the watertight integrity of external openings shall be provided with a notice affixed to each appliance to the effect that it is to be kept closed. Manholes fitted with closely bolted covers need not be so marked. (SOLAS II-1/15-1.4)

### **7.16 Construction and Initial Tests of Watertight Closures\***

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\* See Explanatory Note on SOLAS Reg. II-1/16 (Res. MSC.429/Rev.2)

**7.16.1** The design, materials and construction of all watertight closures such as doors, hatches, sidescuttles, gangway and cargo ports, valves and pipes, referred to in these *Part III* shall be to the satisfaction of PRS. (SOLAS II-1/16.1.1)

**7.16.2** Such valves, doors, hatches and mechanisms shall be suitably marked to ensure that they may be properly used to provide maximum safety. (SOLAS II-1/16.1.2)

**7.16.3** The frames of vertical watertight doors shall have no groove at the bottom on which dirt might lodge and prevent the door closing properly. (SOLAS II-1/16.1.3)

**7.16.4** Watertight doors and hatches\* shall be tested by water pressure to the maximum head of water they might sustain in a final or intermediate stage of flooding. For cargo ships not covered by damage stability requirements, watertight doors and hatches shall be tested by water pressure to a head of water measured from the lower edge of the opening to one metre above the freeboard deck. Where testing of individual doors and hatches is not carried out because of possible damage to insulation or outfitting items, testing of individual doors and hatches may be replaced by a prototype pressure test of each type and size of door or hatch with a test pressure corresponding at least to the head required for the individual location. The prototype test shall be carried out before the door or hatch is fitted. The installation method and procedure for fitting the door or hatch on board shall correspond to that of the prototype test. When fitted on board, each door or hatch shall be checked for proper seating between the bulkhead, the frame and the door or between deck, the coaming and the hatch. (SOLAS II-1/16.2)

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\* See Explanatory Note on SOLAS Reg. II-1/16.2 (Res. MSC.429/Rev.2)

### **7.17 Damage Control Information\***

The requirements of this subchapter are fully applicable to ships subject to SOLAS Convention. Other ships shall meet these requirements as far as possible.

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\* Refer to the *Guidelines for damage control plans and information to the master* (MSC.1/Circ.1245) as amended by MSC.1/Circ.1570) and to *Guidelines for verification of damage stability requirements for tankers* (MSC.1/Circ.1461)

**7.17.1** There shall be permanently exhibited, or readily available on the navigation bridge, for the guidance of the officer in charge of the ship, plans showing clearly for each deck and hold the boundaries of the watertight compartments, the openings therein with the means of closure and position of any controls thereof, and the arrangements for the correction of any list due to flooding. In addition, booklets containing the aforementioned information shall be made available to the officers of the ship. (SOLAS II-1/19.1)

**7.17.2** General precautions to be included shall consist of a listing of equipment, conditions, and operational procedures, considered by the Administration to be necessary to maintain watertight integrity under normal ship operations. (SOLAS II-1/19.2)

**7.17.3** Specific precautions to be included shall consist of a listing of elements (i.e. closures, security of cargo, sounding of alarms, etc.) considered by the Administration to be vital to the survival of the ship, passengers and crew. (SOLAS II-1/19.3)

**7.17.4** In case of ships to which damage stability requirements of part B-1 apply, damage stability information shall provide the master a simple and easily understandable way of assessing the ship's survivability in all damage cases involving a compartment or group of compartments. (SOLAS II-1/19.4)

**7.17.5** For passenger ships to which SOLAS regulation II-1/8-1.3 applies (complying with Safe Return to Port (SRtP) requirements), the damage control information shall include a reference to activation of damage stability support from the onboard stability computer, if installed, and to shore-based support when provided. (SOLAS II-1/19.5)

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\* See *Publication 90/P*.

## **7.18 Prevention and Control of Water Ingress, etc.**

Ships subject to SOLAS Convention shall be provided with operational procedures containing the information given below.

**7.18.1** All watertight doors shall be kept closed during navigation except that they may be opened during navigation as specified in paragraph 7.18.3 (SOLAS II-1/22.3). Watertight doors of a width of more than 1.2 m in machinery spaces as permitted by par. 13.9.13 (SOLAS II-1/13.9) may only be opened in the circumstances detailed in that regulation. Any door which is opened in accordance with this paragraph shall be ready to be immediately closed. (SOLAS II-1/22.1)

**7.18.2** Watertight doors located below the bulkhead deck of passenger ships and the freeboard deck of cargo ships having a maximum clear opening width of more than 1.2 m shall be kept closed during navigation, except for limited periods when absolutely necessary as determined by the Administration. (SOLAS II-1/22.2)

**7.18.3** A watertight door may be opened during navigation\* to permit the passage of passengers or crew, or when work in the immediate vicinity of the door necessitates it being opened. The door must be immediately closed when transit through the door is complete or when the task which necessitated it being open is finished. The Administration shall authorize that such a watertight door may be opened during navigation only after careful consideration of the impact on ship operations and survivability taking into account guidance issued by IMO\*\*. A watertight door permitted to be opened during navigation shall be clearly indicated in the ship's stability information and shall always be ready to be immediately closed. (SOLAS II-1/22.3)

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\* See Explanatory Note on SOLAS regulation II-1/22.3 (Res. MSC.429/Rev.2)

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\*\* See *Revised Guidelines for Watertight Doors in Passenger Ships Which May Be Open During Navigation* (MSC.1/Circ.1564).

**7.18.4** Portable plates on bulkheads shall always be in place before the voyage commences, and shall not be removed during navigation except in case of urgent necessity at the discretion of the master. The necessary precautions shall be taken in replacing them to ensure that the joints are watertight. Power-operated sliding watertight doors permitted in machinery spaces in accordance with par. 13.9.3 (SOLAS II-1/13.9) shall be closed before the voyage commences and shall remain closed during navigation except in case of urgent necessity at the discretion of the master. (SOLAS II-1/22.4)

**7.18.5** Watertight doors fitted in watertight bulkheads dividing cargo spaces on tween decks in accordance with par. 13.9.11 (SOLAS II-1/13.8.1) shall be closed before the voyage commences and shall be kept closed during navigation. The time at which such doors are opened or closed shall be recorded in such logbook as may be prescribed by the Administration. (SOLAS II-1/22.5)

**7.18.6** Gangway, cargo and fuelling ports fitted below the bulkhead deck of passenger ships and the freeboard deck of cargo ships and all watertight hatches shall be effectively closed and secured watertight before the voyage commences, and shall be kept closed during navigation. However, the master may permit a watertight hatch to be opened during navigation for a limited period of time sufficient to permit passage or for access. It shall then be closed. (SOLAS II-1/22.7)

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\* See Explanatory Note on SOLAS regulation II-1/22.7 (Res. MSC.429/Rev.2)

**7.18.7** The following doors, located above the bulkhead deck of passenger ships and the freeboard deck of cargo ships, shall be closed and locked before the voyage commences and shall remain closed and locked until the ship is at its next berth:

- .1 cargo loading doors in the shell or the boundaries of enclosed superstructures;
- .2 bow visors fitted in positions as indicated in paragraph.1;
- .3 cargo loading doors in the collision bulkhead; and
- .4 ramps forming an alternative closure to those defined in paragraphs .1 to .3 inclusive. (SOLAS II-1/22.8)

**7.18.8** Provided that where a door cannot be opened or closed while the ship is at the berth such a door may be opened or left open while the ship approaches or draws away from the berth, but only so far as may be necessary to enable the door to be immediately operated. In any case, the inner bow door must be kept closed. (SOLAS II-1/22.9)

**7.18.9** Notwithstanding the requirements of paragraphs 7.18.7.1 and 7.18.7.4 (SOLAS II-1/22.8.1 and 22.8.4), the Administration may authorize that particular doors can be opened at the discretion of the master, if necessary for the operation of the ship or the embarking and disembarking of passengers when the ship is at safe anchorage and provided that the safety of the ship is not impaired. (SOLAS II-1/22.10)

**7.18.10** The master shall ensure that an effective system of supervision and reporting of the closing and opening of the doors referred to in paragraph 7.18.7 (SOLAS II-1/22.8) is implemented. (SOLAS II-1/22.11)

**7.18.11** The master shall ensure, before any voyage commences, that an entry in such log-book as may be prescribed by the Administration is made of the time the doors specified in paragraph 7.18.12 (SOLAS II-1/22/13) are closed and the time at which particular doors are opened in accordance with paragraph 7.18.13 (SOLAS II-1/22.14). (SOLAS II-1/22.12)

**7.18.12** Hinged doors, portable plates, sidescuttles, gangway, cargo and bunkering ports and other openings, which are required by these regulations to be kept closed during navigation, shall be closed before the voyage commences. The time at which such doors are opened and closed (if permissible under these regulations) shall be recorded in such log-book as may be prescribed by the Administration. (SOLAS II-1/22.13)

**7.18.13** Where in a between-deck, the sills of any of the sidescuttles referred to in par. 7.2.1.3 (SOLAS II-1/15.3.2) are below a line drawn parallel to the bulkhead deck at side of passenger ships and the freeboard deck at side of cargo ships, and having its lowest point 1.4 m plus 2.5% of the breadth of the ship above the water when the voyage commences, all the sidescuttles in that

between-deck shall be closed watertight and locked before the voyage commences, and they shall not be opened before the ship arrives at the next port. In the application of this paragraph the appropriate allowance for fresh water may be made when applicable.

- .1 The time at which such sidescuttles are opened in port and closed and locked before the voyage commences shall be recorded in such log-book as may be prescribed by the Administration.
- .2 For any ship that has one or more sidescuttles so placed that the requirements of paragraph 7.18.13 (SOLAS II-1/22.14) would apply when it was floating at its deepest subdivision draught, the Administration may indicate the limiting mean draught at which these sidescuttles will have their sills above the line drawn parallel to the bulkhead deck at side of passenger ships and the freeboard deck at side of cargo ships, and having its lowest point 1.4 m plus 2.5% of the breadth of the ship above the waterline corresponding to the limiting mean draught, and at which it will therefore be permissible for the voyage to commence without them being closed and locked and to be opened during navigation on the responsibility of the master. In tropical zones as defined in the *International Convention on Load Lines*, this limiting draught may be increased by 0.3 m. (SOLAS II-1/22.14)

**7.18.14** Sidescuttles and their deadlights which will not be accessible during navigation shall be closed and secured before the voyage commences. (SOLAS II-1/22.15)

**7.18.15** If cargo is carried in spaces referred to in par. 7.14.7 (SOLAS II-1/15.5.2), the sidescuttles and their deadlights shall be closed watertight and locked before the cargo is shipped and the time at which such scuttles and deadlights are closed and locked shall be recorded in such log-book as may be prescribed by the Administration. (SOLAS II-1/22.16)

#### **7.19 Additional Requirements for Prevention and Control of Water Ingress, etc. in Cargo Ships**

Ships subject to SOLAS Convention shall be provided with operational procedures containing the information given below.

**7.19.1** Openings in the shell plating below the deck limiting the vertical extent of damage shall be kept permanently closed during navigation. (SOLAS II-1/24.1)

**7.19.2** Notwithstanding the requirements of paragraph 7.19.3 below (SOLAS II-1/24.3), the Administration may authorize that particular doors may be opened at the discretion of the master, if necessary for the operation of the ship and provided that the safety of the ship is not impaired. (SOLAS II-1/24.2)

**7.19.3** Watertight doors or ramps fitted to internally subdivide large cargo spaces shall be closed before the voyage commences and shall be kept closed during navigation. The time at which such doors are opened or closed shall be recorded in such log-book as may be prescribed by the Administration. (SOLAS II-1/24.3)

**7.19.4** The use of access doors and hatch covers intended to ensure the watertight integrity of internal openings shall be authorized by the officer of the watch. (SOLAS II-1/24.4)

## 8 EQUIPMENT OF SHIP SPACES

### 8.1 General

**8.1.1** The requirements for the arrangement and equipment of such spaces as: machinery, electrical, refrigerating spaces, refrigerated cargo holds, etc. are set forth in the relevant Parts of *PRS Rules*.

**8.1.2** The chart room shall be located in a space adjacent to the wheelhouse. The chart room and the wheelhouse may be situated in a common space.

**8.1.3** The location and equipment of the wheelhouse shall meet the requirements of ISO 8468:2007. The requirements of the ISO standard which refer to navigation bridge visibility apply only to ships specified in 7.2.1.7.

**8.1.4** No accommodation spaces shall be arranged forward of the collision bulkhead or abaft the afterpeak bulkhead below the bulkhead deck.

### 8.2 Equipment of Cargo Holds

**8.2.1** When in ships not having a double bottom a wooden ceiling is fitted on top of the floors, it shall be tight and extend to the ship's sides over their bilge. It is recommended that the ceiling be made of portable sections of such dimensions and so constructed as to allow their easy removal at any place. The thickness of ceiling shall be at least:

- 40 mm for ships with  $L_0 \leq 30$  m,
- 60 mm for ships with  $L_0 > 30$  m,
- 70 mm under cargo hatches.

**8.2.2** When in ships with a double bottom a wooden ceiling is fitted, its thickness shall be at least:

- 50 mm for ships with  $L_0 \leq 60$  m,
- 65 mm for ships with  $L_0 > 60$  m.

The application of ceiling made of synthetic materials is subject to PRS consideration in each particular case.

**8.2.3** Where cargo is to be discharged by grabs or other similar equipment, it is recommended that the thickness of a wooden ceiling under the hatches be twice that required in 8.2.1 and 8.2.2.

**8.2.4** In holds intended for the carriage of grain and other similar cargoes in bulk, the wooden ceiling on the inner bottom or on the top floors shall be so fitted as to prevent bilge wells and suction pipes of the bilge pumping from clogging.

**8.2.5** The wooden ceiling shall be laid on a layer of mastic (approved by PRS) or on strips 25÷30 mm in thickness laid in line with the floors. The wooden ceiling over the bilges shall be so laid as to allow its easy removal.

**8.2.6** The bulkheads of deep tanks in places where they are likely to be hit by cargo shall be sheathed with wood from the hold side.

**8.2.7** In holds and spaces intended to carry general cargoes, the cargo battens made of wood or metal shall be fitted on the ship's sides. The thickness of the wooden battens shall be at least:

- 40 mm for ships with  $L_0 \leq 70$  m,
- 50 mm for ships with  $L_0 > 70$  m, see 8.2.1.

The battens shall be spaced not more than 305 mm apart. The battens shall be attached to the side framing so as to provide their easy removal or replacement. The battens need not be fitted if, in the opinion of PRS, this is justified in view of the ship's design and the nature of the carried cargo.

**8.2.8** All parts of equipment in the hold which are liable to damage by cargo or loading gear (manholes, air pipes, sounding pipes, etc.) shall be effectively protected (with screens, grids, chutes, etc).

**8.2.9** The construction and strength of equipment for the carriage of grain in bulk, preventing or limiting the effects of grain shifting, shall fulfil the requirements of *International Code for the Safe Carriage of Grain in Bulk* (IMO Resolution MSC.23(59) of 23 May 1991).

The equipment for the carriage of other loose cargoes is subject to special consideration of PRS.

The number and arrangement of the equipment shall be such as to ensure compliance with the requirements specified in *Part IV – Stability and Subdivision*.

### **8.3 Flooding Detection Systems for Single Hold Cargo Ships, other than Bulk Carriers**

Ships subject to SOLAS Convention shall be provided with water level detection systems in cargo hold, in accordance with the requirements specified in subchapter 7.9 of *Part VIII* of the Rules. (SOLAS II-1/25)

### **8.4 Flooding Detection Systems for Cargo Ships with Multiple Holds, other than Bulk Carriers**

Ships subject to SOLAS Convention shall be provided with water level detection systems in cargo holds, in accordance with the requirements specified in subchapter 7.10 of *Part VIII* of the Rules. (SOLAS II-1/25-1)



## 9 MEANS OF ACCESS TO SHIP SPACES

### 9.1 Means of Escape

Escape routes shall comply with the applicable requirements of *Part V* of the Rules.

### 9.2 Guard Railings, Bulwarks, Freeing Ports<sup>1</sup>

**9.2.1** All exposed parts of the freeboard deck, as well as those of the superstructure and deckhouse decks shall be provided with efficient guard rails<sup>2</sup> or bulwarks; in the case of ships intended for the carriage of timber deck cargo, portable railing or storm rails shall be fitted on this cargo.

**9.2.2** The height of the bulwark or guard rail above the deck shall not be less than 1 m. However, where this height would interfere with the normal operation of the ship, a lesser height may be approved, provided adequate protection of people is ensured to the satisfaction of PRS.

**9.2.3** The spacing between the guard railing stanchions shall not exceed 1.5 m. Provision shall be made for fastening removable and hinged stanchions in the upright position. At least every third stanchion shall be supported by a bracket or stay. In lieu of this, flat steel stanchions having increased breadth in relation to the required by the design standard, are acceptable (Fig. 9.2.3).

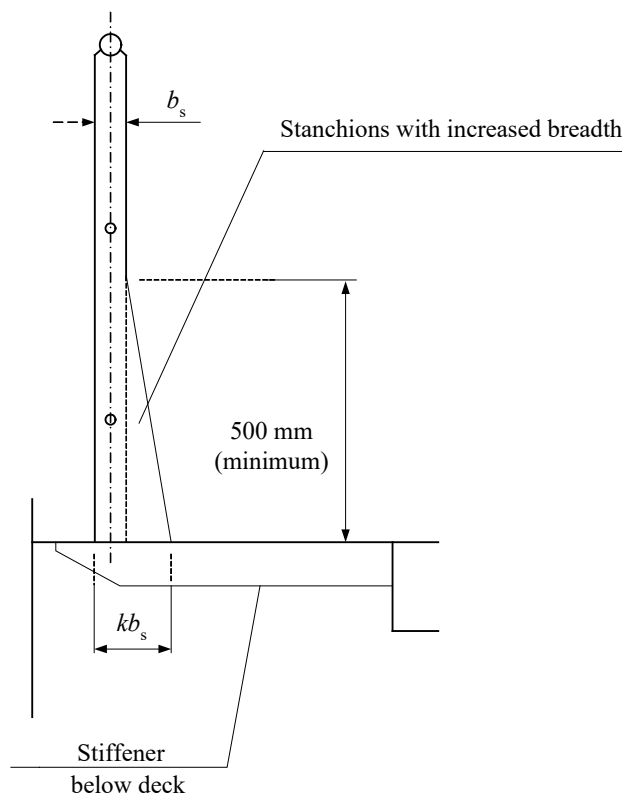


Fig. 9.2.3

Alternatively:

- at least every third stanchion shall be of increased breadth:  $kb_s = 2.9 b_s$ ;
- at least every second stanchion shall be of increased breadth:  $kb_s = 2.4 b_s$ ;

<sup>1</sup> For those ships to which the requirements of *CSR Rules* refer, the requirements of Chapter 11 of their Part I shall be applied in the first place.

<sup>2</sup> Including a guard rail for first-tier deckhouses and for superstructures' ends.



- every stanchion shall be of increased breadth:  $kb_s = 1.9 b_s$ ;  
 $b_s$  – breadth of normal stanchion according to the design standard.

The stanchions with increased breadth should be welded to deck plating with double continuous fillet weld with leg size min 7 mm or as specified by the design standard.

Stanchions with increased breadth shall be aligned with stiffening member below deck. Min. 100×12 flatbar, welded to deck by double continuous fillet weld, shall be applied. The stanchions with increased breadth need not be aligned with under deck structure for deck plating exceeding 20 mm.

**9.2.4** Handrails of bulwarks as well as guard railings shall, in general, be of a rigid construction. Steel ropes may be used as guard railings in special circumstances and only in section of limited length. In such cases, the steel ropes shall be tightened by means of turnbuckles. Where necessary for the normal operation of the ship, chains fitted between two fixed stanchions and/or bulwarks are acceptable instead of guard rails.

**9.2.5** The gap below the lowest rail of the guard railing shall not exceed 230 mm. The spacing between the other rails shall not exceed 380 mm. An exception is made for the railings set up on the timber deck cargo where the height from the base to the lowest rope, as well as the spacing between the other ropes shall not exceed 330 mm. In the case of ships with a rounded gunwale, the guard rails stanchions and handrails shall be placed on the flat part of the deck.

**9.2.6** Type "A" ships with bulwarks, as well as type "B" ships with reduced freeboard shall have guard railings fitted for at least half the length of the exposed part of the deck and, in the case of bulwark, a free discharge of water shall be ensured. The upper edge of the sheerstrake shall be kept as low as practicable.

**9.2.7** The bulwark shall fulfil the requirements of sub-chapter 10.5, *Part II – Hull*.

## **9.2.8 Freeing ports**

**9.2.8.1** Where bulwarks on the weather portions of freeboard or superstructure decks form wells, appropriate means shall be made for rapidly freeing the decks of water and for draining them. Where freeing ports are provided for these purposes, they shall meet the following requirements:

- .1** except as provided in sub-paragraph .2 and paragraph 9.2.8.2, the minimum freeing port area ( $A$ ) on each side of the ship for each well on the freeboard deck shall be that given by the following formulae in cases where the sheer in way of the well is standard or greater than standard.

The minimum area for each well on superstructure decks shall be one-half of the area given by the following formulae:

where the length of bulwark ( $l$ ) in the well is 20 m or less:

$$A = 0.7 + 0.035l \text{ [m}^2\text{]} \quad (9.2.8.1.1-1)$$

where  $l$ , [m] exceeds 20;

$$A = 0.07l \text{ [m}^2\text{]} \quad (9.2.8.1.1-2)$$

Length  $l$  need in no case be taken as greater than  $0.7L$ , [m].

If the bulwark is more than 1.2 m in average height, the required area shall be increased by  $0.004 \text{ m}^2$  per metre of length of well for each 0.1 m difference in height. If the bulwark is less than 0.9 m in average height, the required area may be decreased by  $0.004 \text{ m}^2$  per m of length of well for each 0.1 m difference in height.

- .2 In ships with no sheer, the area calculated according to paragraph 9.2.8.1.1 shall be increased by 50%. Where the sheer is less than the standard, the percentage shall be obtained by linear interpolation.
- .3 On a flush deck ship with a deckhouse amidships having a breadth at least 80% of the beam of the ship and the passageways along the side of the ship not exceeding 1.5 m in width, two wells are formed. Each shall be given the required freeing port area based upon the length of each well.
- .4 Where a screen bulkhead is fitted completely across the ship at the forward end of a midship deckhouse, the exposed deck is divided into two wells and there is no limitation on the breadth of the deckhouse.
- .5 Wells on raised quarterdecks shall be treated as being on freeboard decks.
- .6 Gutter bars greater than 300 mm in height fitted around the weather decks of tankers in way of cargo manifolds and cargo piping shall be treated as bulwarks. Freeing ports shall be arranged in accordance with this subchapter. Closures attached to the freeing ports for use during loading and discharge operations shall be so arranged that jamming cannot occur while at sea.

**9.2.8.2** Where a ship:

- .1 is fitted with a trunk and there are not open rails fitted on the weather parts of the freeboard deck in way of the trunk for at least half the length of those parts or it does not have freeing port area in the lower part of the bulwarks equaling 33% of the total area of the bulwarks; or
- .2 has continuous or substantially continuous hatchway side coamings fitted between detached superstructures;

then the minimum area of the freeing port openings shall be calculated from Table 9.2.8.2:

**Table 9.2.8.2**

Breadth of hatchway or trunk in relation to the breadth of ship	Area of freeing ports in relation to the total area of the bulwarks
40% or less	20%
75% or more	10%

The area of freeing ports at intermediate breadths shall be obtained by linear interpolation.

**9.2.8.3** The effectiveness of the freeing area in bulwarks required by paragraph 9.2.8.1 depends on the free flow area across the deck of a ship.

The free flow area on deck is the net area of gaps between hatchways, and of gaps between hatchways and superstructures and deckhouses up to the actual height of the bulwark.

**9.2.8.4** The freeing port area in bulwarks shall be assessed in relation to the net free flow area as follows:

- .1 if the free flow area is not less than the freeing area calculated from paragraph 9.2.8.2 as if the hatchway coamings were continuous, then the minimum freeing port area calculated from paragraph 9.2.8.1 shall be deemed sufficient.
- .2 if the free flow area is equal to, or less than the area calculated from paragraph 9.2.8.1, the minimum freeing area in the bulwarks shall be determined from paragraph 9.2.8.2.
- .3 if the free flow area is smaller than that calculated from paragraph 9.2.8.2, but greater than that calculated from paragraph 9.2.8.1, the minimum freeing area in the bulwark shall be determined from the following formula:

$$F = F_1 + F_2 - f_p \text{ [m}^2\text{]} \tag{9.2.8.4.3}$$

- $F_1$  – is the minimum freeing area calculated from paragraph 9.2.8.1, [m<sup>2</sup>];  
 $F_2$  – is the minimum freeing area calculated from paragraph 9.2.8.2, [m<sup>2</sup>]; and  
 $f_p$  – is the total net area of passages and gaps between hatch ends and superstructures or deckhouses up to the actual height of bulwark, [m<sup>2</sup>].

**9.2.8.5** In ships having superstructures on the freeboard deck or superstructure decks, which are open at either or both ends to wells formed by bulwarks on the open decks, adequate provision for freeing the open spaces within the superstructures shall be provided.

The minimum freeing port area on each side of the ship for the open superstructure,  $A_s$ , and for the open well,  $A_w$ , shall be calculated in accordance with the following procedure:

- .1 determine the total well length,  $l_t$ , equal to the sum of the length of the open deck enclosed by bulwarks,  $l_w$ , and the length of the common space within the open superstructure,  $l_s$ ,
- .2 to determine  $A_s$ :
  - (i) calculate the freeing port area,  $A$ , required for an open well of length in accordance with paragraph 9.2.8.1 with standard height bulwark assumed;
  - (ii) multiply the value  $A$  by a factor of 1.5 to correct for the absence of sheer, if applicable, in accordance with paragraph 9.2.8.1.2;
  - (iii) multiply the received value by the factor  $b_0/l_t$  to adjust the freeing port area for the breadth  $b_0$  of the openings in the end bulkhead of the enclosed superstructure;
  - (iv) to adjust the freeing port area for that part of the entire length of the well which is enclosed by the open superstructure, multiply by the factor  $1 - (l_w/l_t)^2$ , where  $l_w$  and  $l_t$  are defined in paragraph 9.2.8.5.1;
  - (v) to adjust the freeing port area for the distance of the well deck above the freeboard deck, multiply by the factor  $0.5 h_s/h_w$ ,  
where  $h_w$  – distance of the well deck above the freeboard deck,  $h_s$  – one standard superstructure height.

- .3 to determine  $A_w$ :
  - (i) the freeing port area for the open well  $A_w$  shall be calculated in accordance with paragraph 9.2.8.5.2 (i), using  $l_w$  to calculate a nominal freeing port area,  $A'$ , and then adjusted for the actual height of the bulwark  $h_b$  by the application of one of the following area corrections, whichever is applicable:

for bulwarks greater than 1.2 m in height:

$$A_c = 0.04(h_b - 1.2) l_w \text{ [m}^2\text{]} \quad (9.2.8.5-1)$$

for bulwarks less than 0.9 m in height:

$$A_c = 0.04(h_b - 0,9) l_w \text{ [m}^2\text{]} \quad (9.2.8.5-2)$$

for bulwarks between 0.9 m and 1.2 m in height there is no correction (i.e.  $A_c = 0$ );

- (ii) the corrected freeing port area, calculated from the formula:

$$A_w = A' + A_c \text{ [m}^2\text{]} \quad (9.2.8.5-3)$$

shall then be adjusted for absence of sheer, if applicable, and height above freeboard deck as in paragraphs 9.2.8.5.2 (ii) and 9.2.8.5.2 (v), using  $h_s$  and  $h_w$ .

- .4 the resulting freeing port areas for the open superstructure  $A_s$  and for the open well  $A_w$  shall be provided along each side of the open space covered by the open superstructure and each side of the open well, respectively.
- .5 the above relationships are summarized by the following equations, assuming  $l_t$ , the sum of  $l_w$  and  $l_s$ , is greater than 20 m:

freeing port area,  $A_w$ , for the open well:

$$A_w = (0.07 l_w + A_c) \text{ (sheer correction) } (0.5 h_s/h_w) \text{ [m}^2\text{]} \quad (9.2.8.5-4)$$

freeing port area,  $A_s$ , for the open superstructure:

$$A_s = (0.07 l_w) \text{ (sheer correction) } (b_0/l_t)[(1 - (l_w/l_t)^2)] (0.5 h_s/h_w) \text{ [m}^2\text{]} \quad (9.2.8.5-5)$$

where  $l_t$  is 20 m or less, the basic freeing port area is  $A = 0.7 + 0.035l_t$ , in accordance with paragraph 9.8.2.1.

**9.2.8.6** The lower edges of freeing ports shall be as near the deck as practicable; they shall leave the shear strake intact. Two thirds of the freeing port area required shall be provided in the half of the well nearest the lowest point of the sheer curve. One third of the freeing port area required shall be evenly spread along the remaining length of the well. With zero or little sheer on the exposed freeboard deck or an exposed superstructure deck the freeing port area shall be evenly spread along the length of the well.

**9.2.8.7** All freeing port openings shall be protected by rails or bars spaced approximately 230 mm apart. If shutters are fitted to freeing ports, ample clearance shall be provided to prevent jamming. Hinges shall have pins or bearings of non-corrodible material. Shutters shall not be fitted with securing appliances.

### 9.2.9 Freeing ports for type A ships

Ships of type A with bulwarks shall have open rails fitted for at least half the length of the weather deck or other equivalent freeing arrangements. A freeing port area, in the lower part of the bulwarks, of 33% of the total area of the bulwarks, is an acceptable equivalent freeing arrangement.

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

## 9.3 Gangways and Access Means

**9.3.1** Satisfactory means for safe passages required by 9.3.2÷9.3.6 (in the form of guard rails, lifelines, gangway or underdeck passages, etc.) shall be provided for the protection of the crew in getting to and from their quarters, the machinery space and any other spaces used in the essential operation of the ship.

**9.3.2** Deck cargo carried on any ship shall be so stowed that any opening which is in way of the cargo and which gives access to and from the crew's quarters, the machinery space and all other parts used in the essential operation of the ship can be closed and secured against water ingress. Protection for the crew in the form of guard rails or lifelines shall be provided above the deck cargo if there is no convenient passage on or below the deck of the ship.

**9.3.3** Acceptable arrangements referred to in Table 9.3.3-1 are defined as follows:

- (a) A well lighted and ventilated under-deck passageway (with a clear opening of at least 0.8 m wide and 2 m high), as close as practicable to the freeboard deck, connecting and providing access to the locations in question.
- (b) A permanent and efficiently constructed gangway, fitted at or above the level of the superstructure deck, on or as near as practicable to the centre line of the ship, providing a continuous platform at least 0.6 m in width and a non-slip surface and with guard rails extending on each side throughout its length. Guard rails shall be at least 1 m high with three courses and constructed as required in 9.2. A foot-stop shall be provided.

- (c) A permanent walkway at least 0.6 m in width, fitted at freeboard deck level and consisting of two rows of guard rails with stanchions spaced not more than 3 m. The number of course of rails and their spacing shall be in accordance with regulation 9.2.5. On type B ships, hatchway coamings not less than 0.6 m in height may be accepted as forming one side of the walkway, provided that two rows of guard rails are fitted between the hatchways.
- (d) A wire rope lifeline not less than 10 mm in diameter, supported by stanchions not more than 10 m apart, or a single hand rail or wire rope attached to hatch coamings, continued and supported between hatchways.
- (e) A permanent gangway that is:
- located at or above the level of the superstructure deck;
  - located on or as near as practicable to the centre line of the ship;
  - located so as not hinder easy access across the working areas of the deck;
  - providing a continuous platform at least 1 m in width;
  - constructed of fire resistant<sup>1</sup> and non-slip material;
  - fitted with guard rails extending on each side throughout its length; guard rails shall be at least 1 m high with courses as required by regulation 9.2.5 and supported by stanchions spaced not more than 1.5 m apart;
  - provided with a foot-stop on each side;
  - having openings, with ladders where appropriate, to and from the deck.
  - Openings shall not be more than 40 m apart; and
  - having shelters set in way of the gangway at intervals not exceeding 45 m if length of the exposed deck to be traversed exceeds 70 m. Every such shelter shall be capable of accommodating at least one person and be so constructed as to afford weather protection on the forward, port and starboard side.
- (f) A permanent walkway located at freeboard deck level, on or as near as practicable to the centre line of the ship, having the same specifications as those for a permanent gangway listed in (e), except for foot-stops. On type B ship (certified for the carriage of liquids in bulk) with a combined height of hatch coaming and fitted hatch cover of not less than 1 m in height, the hatchway coamings may be accepted as forming one side of the walkway, provided that two rows of guard rails are fitted between the hatchways.

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<sup>1</sup> Fibre Reinforced Plastic ((FRP) gratings used instead of steel gratings shall possess low flame spread characteristics, shall not generate excessive quantities of smoke and toxic products as per the International Code for Application of Fire Test Procedures, 2010 (2010 FTP Code), and shall have adequate structural fire integrity as per recognized standards after undergoing tests in accordance with the above standards (e.g. the Standard Specification for Fibre Reinforced Polymer (FRP) Gratings Used in Marine Construction and Shipbuilding (ASTM F3059-14)).

**Table 9.3.3**  
**Means for safe passage of crew**

Type of ship	Locations of access in ship	Assigned summer freeboard	Acceptable arrangements according to type of freeboard assigned ***				
			Type A	Type B-100	Type B-60	Type B or B+	
All ships other than oil tankers*, chemical tankers* and gas carriers*	<b>1.1</b> Access to midship quarters <b>1.1.1</b> Between poop and bridge, or <b>1.1.2</b> Between poop and deckhouse containing living accommodation or navigating equipment, or both.	≤ 3000 mm	(a) (b) (e)	(a) (b) (e)	(a) (b) (c)(i) (e) (f)(i)	(a) (b) (c)(i) (c)(ii) (c)(iv) (d)(i)	
		> 3000 mm	(a) (b) (e)	(a) (b) (e)	(a) (b) (c)(i) (c)(ii) (e) (f)(i) (f)(ii)	(d)(ii) (d)(iii) (e) (f)(i) (f)(ii) (f)(iv)	
	<b>1.2</b> Access to ends <b>1.2.1</b> Between poop and bow (if there is no bridge), <b>1.2.2</b> Between bridge and bow; or <b>1.2.3</b> Between a deckhouse containing living accommodation or navigating equipment, or both and bow; or <b>1.2.4</b> In the case of a flush deck ship, between crew accommodation and the forward and after ends of ship.	≤ 3000 mm	(a) (b) (c)(i) (e) (f)(i)	(a) (b) (c)(i) (c)(ii) (e) (f)(i) (f)(ii)	(a) (b) (c)(i) (c)(ii) (e) (f)(i) (f)(ii)		
		> 3000 mm	(a) (b) (c)(i) (d)(i) (e) (f)(i)	(a) (b) (c)(i) (c)(ii) (d)(i) (d)(ii) (e) (f)(i) (f)(ii)	(a) (b) (c)(i) (c)(ii) (c)(iv) (d)(i) (d)(ii) (d)(iii) (e) (f)(i) (f)(ii) (f)(iv)		
	Oil tankers*, chemical tankers* and gas carriers*	<b>2.1</b> Access to bow <b>2.1.1</b> Between bridge and bow; or <b>2.1.2</b> Between a deckhouse containing living accommodation or navigating equipment, or both; or <b>2.1.3</b> In the case of a flush deck ship, between crew accommodation and the forward end of ship.	≤(A <sub>F</sub> +H <sub>S</sub> )*			(a) (e) (f)(i) (f)(v)	
			>(A <sub>F</sub> +H <sub>S</sub> )*			(a) (e) (f)(i) (f)(ii)	
	<b>2.2</b> Access to after end In the case of a flush deck ship, between crew accommodation and the after end of ship.		As required in 1.2.4 for other types of ships				

\* Oil tankers, chemical tankers and gas carriers as defined in regulations II-1/2.22, VII/8 and VII/11.2, respectively, of the SOLAS Convention, as amended.

\*\* A<sub>F</sub> – the minimum summer freeboard calculated as type A ship regardless of the type freeboard actually assigned, H<sub>S</sub> – the standard height of superstructure as defined in ICLL 1966 regulation 33,

\*\*\* Arrangements (a) ÷ (f) are described in 9.3.3. Locations (i) ÷ (v) are described in 9.3.4.



**9.3.4** Permitted transverse locations for arrangements in 9.3.3 (c), (d) and (f) above, where appropriate, are as follows:

- (i) at or near the centre line of the ship; or fitted on hatchways at or near the centre line of the ship;
- (ii) fitted on each side of the ship;
- (iii) fitted on one side of the ship, provision being made for fitting on either side;
- (iv) fitted on one side of the ship only;
- (v) fitted on each side of the hatchways, as near to the centre line as practicable.

### **9.3.5 Additional requirements**

- .1 Where wire ropes are fitted, turnbuckles shall be provided to ensure their tautness.
- .2 Where necessary for the normal operation of the ship, steel wire ropes may be accepted in lieu of guard rails.
- .3 Where necessary for the normal operation of the ship, chains fitted between two fixed stanchions are acceptable in lieu of guard rails.
- .4 Where stanchions are fitted, every third stanchion shall be supported by a bracket or stay.
- .5 Removable or hinged stanchions shall be capable of being locked in the upright position.
- .6 A means of passage over obstructions such as pipes or other fittings of a permanent nature, shall be provided.
- .7 Generally, the width of the gangway or deck-level walkway should not exceed 1.5 m.

**9.3.6** For tankers less than 100 m in length, the minimum width of the gangway platform or deck-level walkway fitted in accordance with paragraphs 9.3.3(e) or (f) above, respectively, may be reduced to 0.6 m.

## **9.4 Ramps**

### **9.4.1 General**

**9.4.1.1** The requirements specified below apply to the external and internal movable ramps intended for loading and discharging vehicles in ports, together with their supporting structures.

The requirements concerning the arrangements for the raising, lowering and fixing of these structures are given in the *Part VI – Lifting Appliances* of the *Rules for Statutory Survey of Sea-going Ships*.

**9.4.1.2** When, in stowage position, the movable ramp is loaded with vehicles, the appropriate requirements for platform – specified in Chapter 19 – shall be fulfilled.

### **9.4.2 Structure**

**9.4.2.1** The ramp structure shall consist of the girder system supporting the stiffeners and plating.

**9.4.2.2** The ramp inclination shall not exceed 1:10.

**9.4.2.3** The ramp, together with associated equipment and gear shall ensure safe work in both working and manoeuvring positions, at simultaneous ship's heel equal to 5° and trim equal to 2°.

**9.4.2.4** The part of the external ramp resting on berth shall be flexible enough to put the ramp properly on the berth during loading/discharging operations when heel and trim are within the limits specified in 9.4.2.3.



### 9.4.3 Loads

**9.4.3.1** Loads occurring in all expected positions and types of operation shall be included in calculations, particular regard being paid to the following cases:

- case A – ramp at work,
- case B – ramp in stowage position,
- case C – ramp under overload tests.

**9.4.3.2** In case A, the assumed loads shall include:

- mass of the ramp,
- maximum or the most unfavourably distributed total mass of vehicles which may be simultaneously placed on the ramp.

Static load shall be calculated taking into account the heel and trim angles specified in 9.4.2.3, as well as the ramp inclination.

Static load shall be increased by a dynamic load due to motion of vehicles, as well as dynamic load due to raising and lowering the ramp. Dynamic loads may be considered separately.

**9.4.3.3** In case B, loads shall include static and dynamic loads due to the ship's motions in waves, calculated according to 16.2, *Part II – Hull*. Ramp icing and wind pressure shall be included in load calculations within appropriate extent.

**9.4.3.4** In case C, the assumed loads shall include the mass of the ramp (platform) and the testing load, taking into account dynamic component loads due to the ramp (platform) motion.

**9.4.3.5** Dynamic loads due to vehicles motion shall be calculated taking into account the vertical acceleration determined by the formula:

$$a_v = \frac{6}{\sqrt{M_0}} \text{ [m/s}^2\text{]} \quad (9.7.3.5)$$

$M_0$  – maximum mass per one axle, [t].

**9.4.3.6** Dynamic loads due to raising and lowering a ramp shall be calculated assuming the vertical acceleration not less than  $a_v = 4 \text{ m/s}^2$ .

### 9.4.4 Scantlings

**9.4.4.1** Plating and stiffeners of ramps shall fulfil the requirements of sub-chapter 19.4, *Part II – Hull*.

**9.4.4.2** The scantlings of girders of ramps and supporting structures shall, in general, be based on stress analysis.

The calculation model shall take into account the actual condition of supports and the nature of operation. The calculations shall be performed for the cases specified in 9.4.3.

**9.4.4.3** The following permissible stresses, [MPa] shall be taken for the calculations:

- for case A:  $\sigma = 145/k$ ,  $\tau = 80/k$ ,  $\sigma_{zr} = 160/k$ ,
- for case B:  $\sigma = 160/k$ ,  $\tau = 90/k$ ,  $\sigma_{zr} = 180/k$ ,
- for case C:  $\sigma = 185/k$ ,  $\tau = 105/k$ ,  $\sigma_{zr} = 200/k$ ,

$k$  – material factor equal to:

$k = 1.00$  for  $R_e = 235 \text{ MPa}$  (NS steel),

$k = 0.78$  for  $R_e = 315 \text{ MPa}$  (HS 32 steel),

$k = 0.72$  for  $R_e = 355 \text{ MPa}$  (HS 36 steel).

The factor  $k$  for steel having other  $R_e$  value is subject to PRS agreement in each particular case.

**9.4.4.4** The allowable deflection of the steel structure under load determined for cases A and B shall not exceed  $l/400$  ( $l$  – span supports in the ramp structure under the considered load).

## **9.5 Means of embarkation on and disembarkation from ships**

**9.5.1** Ships shall be provided with means of embarkation, on and disembarkation from, ships – for use in port and in similar situations – such as gangways and accommodation ladders, complying with requirements of this subchapter, unless Administration deems that compliance with a particular provision is unreasonable or impractical\*. (SOLAS II-1/3-9.1)

\* Circumstances where compliance may be deemed unreasonable or impractical may include where the ship:

- .1 has small freeboards and is provided with boarding ramps; or
- .2 is engaged in voyages between designated ports where appropriate shore accommodation/ embarkation ladders (platforms) are provided.

**9.5.2** As far as practicable, the means of embarkation and disembarkation shall be sited clear of the working area and shall not be placed where cargo or other suspended loads may pass overhead.

**9.5.3** Gangways and accommodation ladders shall be constructed and installed in accordance with applicable international standards such as ISO 5488, ISO 7061 and/or national standards and/or other requirements recognized by PRS. (SOLAS II-1/3-9.2)

**9.5.4** Each accommodation ladder shall be of such a length to ensure that, at a maximum design operating angle of inclination, the lowest platform will be not more than 600 mm above the waterline in the lightest seagoing condition, as defined in SOLAS regulation III/3.13.

**9.5.5** If the height of the embarkation/disembarkation desk exceeds 20 m above the waterline specified in 9.5.4 or if PRS considers compliance with the requirements of paragraph 9.5.4 impractical, PRS may accept alternative means of providing safe access to the ship or supplementary means of safe access to the bottom platform of the accommodation ladder.

**9.5.6** The construction of the accommodation ladder winch shall be in accordance with applicable international standards such as ISO 7364 and the winch shall meet the requirements of *Part VII – Machinery, Boilers and Pressure Vessels*.

**9.5.7** Adequate lighting shall be provided to illuminate the means of embarkation and disembarkation, the position on deck where persons embark or disembark and the controls of the arrangement.

**9.5.8** Each gangway and accommodation ladder shall be clearly marked at each end with a plate visible to any person approaching either end and showing the restrictions on the safe operation and loading, including the maximum permitted design angles of inclination, design load, maximum load on bottom end plate, etc. Where the maximum operational load is less than the design load, it shall also be shown on the marking plate.

**9.5.9** Gangways shall not be used at an angle of inclination greater than 30° from the horizontal and accommodation ladders shall not be used at an angle greater than 55° from the horizontal, unless designed and constructed for use at angles greater than these and marked as such, as required by paragraph 9.5.8.

**9.5.10** Gangways shall never be secured to a ship's guardrails unless they have been designed for that purpose. If positioned through an open section of bulwark or railing, any remaining gaps shall be adequately fenced.

**9.5.11** For all ships the means of embarkation and disembarkation shall be subjected to a static load test of the specified maximum working load upon installation and shall be inspected and maintained\* in suitable condition for their intended purpose, taking into account any restrictions related to safe loading. All wires used to support the means of embarkation and disembarkation shall be maintained as specified in SOLAS III/20.4. (SOLAS II-1/3-9.3)

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\* Refer to *Guidelines for construction, installation, maintenance and inspection/survey of means of embarkation and disembarkation* (MSC.1/Circ.1331) and IACS Rec. No. 119/Rev.1.

## 10 SHIPS OF RESTRICTED SERVICE

### 10.1 General

#### 10.1.1 Application

The requirements of the present Chapter 10 apply to ships assigned additional restricted service mark **I**, **II** or **III** in the symbol of class.

### 10.2 Anchoring Equipment

**10.2.1** When choosing anchoring equipment for ships of restricted service **II**, the equipment number shall be reduced by 15%, while for ships of restricted service **III** – by 25%.

The equipment number for passenger ships engaged in domestic voyages with assigned **Class C** or **Class D** may be reduced as follows:

- for **Class C** – by 30%,
- for **Class D** – by 35%.

**10.2.2** Anchoring equipment of ships of restricted service **I** and **II** with the maximum speed at draught to the winter load waterline not exceeding 6 knots and of ships of restricted service **III** with the speed in the same conditions not exceeding 5 knots shall be chosen as for non-propelled ships.

**10.2.3** Ships of restricted service **III** need not be provided with the stream anchor and the relevant chain or rope.

### 10.3 Closing Appliances of Openings in Hull and Superstructures

**10.3.1** For ships of restricted service **I** and **II** not engaged on international voyages, as well as ships of restricted service **III**, except specially specified cases, the requirements of Chapter 7 may be reduced. The degree of such reduction will be specially considered by PRS.

**10.3.2** In ships of restricted service **III**, the side scuttles with deadlights, required in 7.2.1.3, and the non-opening type side scuttles, required in 21.2.4, may be of the normal type, and the scuttles with deadlights, required in 7.2.1.4 (taking into account 7.2.1.5), may be of the light type.

**10.3.3** If a bridge or a poop is not considered as enclosed (see 7.1.6), the height of door sills may be reduced from 600 mm to 450 mm in position 1 and from 380 mm to 230 mm in position 2 in ships of restricted service **III**, except passenger ships.

**10.3.4** The height of sills of the access doors in the machinery and boiler room casings, required by 7.11.4, may be reduced from 600 mm to 450 mm in position 1 and from 380 to 230 mm in position 2 in ships of restricted service **III**, except passenger ships.

**10.3.5** The height of coamings of companion hatches, skylights and ventilating trunks, the access doors in the machinery and boiler room casings, required by 7.6.2, may be reduced from 600 mm to 450 mm in position 1 and from 450 to 380 mm in position 2 in ships of restricted service **III**, except passenger ships.

**10.3.6** The height of coamings of ventilation ducts, required by 7.7.1, may be reduced from 900 mm to 760 mm in position 1 and from 760 to 600 mm in position 2 in ships of restricted service **III**, except passenger ships.

**10.3.7** The height of hatch cover coamings, required by 7.10.2.1, may be reduced from 600 mm to 450 mm in position 1 and from 450 to 380 mm in position 2 in ships of restricted service **III**, except passenger ships.

**10.3.8** For ships of restricted service not engaged on international voyages, the design load for cargo hatch covers, as indicated in 7.10.4, may be reduced as follows:

- by 15% for ships of restricted service **II**,
  - by 30% for ships of restricted service **III**.
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## 11 TANKERS AND COMBINATION CARRIERS

### 11.1 General

#### 11.1.1 Application

**11.1.1.1** The requirements of the present Chapter 11 apply to ships assigned the additional marks: **CRUDE OIL TANKER, TANKER FOR ...**, **PRODUCT CARRIER, LIQUIFIED GAS TANKER** or **CHEMICAL TANKER** in the symbol of class or a combination of additional marks in the case of combination carriers affixed to the symbol of class in accordance with sub-chapter 3.4.2, of *Part I – Classification Regulations*.

The requirements for combination carriers are also given in Chapter 12.

**11.1.1.2** Ships assigned additional mark **OIL RECOVERY VESSEL**, affixed to the symbol of class, shall fulfil the requirements of sub-chapter 11.2.

#### 11.2 Hatchways of Cargo Tanks

**11.2.1** The openings for hatchways of the cargo tanks shall be round or oval. The height of coamings of cargo tank hatchways is not covered by PRS *Rules*. The construction of the coamings of cargo tank hatchways shall fulfil the requirements of sub-chapter 8.6, *Part II – Hull*.

**11.2.2** The covers of the cargo tank hatchways shall be permanently attached to the coamings and shall be tight, when secured, under the inner pressure of a liquid carried in tanks equal to the pressure exerted by the liquid column at least 2.5 m in height.

Tightness shall be provided by a gasket made of rubber or other suitable material. The gasket shall be resistant to the liquid which is carried in cargo tanks.

**11.2.3** The steel plating of tank hatchway covers shall be at least 12 mm in thickness. Where the cover plate is not of a spherical shape, it shall be reinforced by stiffeners made of flat bars not less than 80 × 12 mm in size and spaced every 600 mm.

**11.2.4** The hatchway cover shall be provided with a sighting port having an inner diameter of 150 mm and closed with a cover of the similar construction.

**11.2.5** The materials and design of cargo tank hatchway covers in ships intended to carry inflammable liquids shall be so selected as to exclude sparking when opening and closing the covers.

**11.2.6** The covers of cargo tank hatchways and of any other openings of cargo tanks shall not be fitted in enclosed or half-enclosed spaces.

**11.2.7** The covers of the cargo tank hatchways and of the openings intended for cleaning the cargo tanks shall be made of steel, bronze or brass. Applying other materials will be specially considered by PRS.

In ships carrying inflammable liquids, the covers of the cargo tank hatchways and of the openings intended for cleaning the cargo tanks shall not be made of aluminium or aluminium alloys.

**11.2.8** The hatchways of slop tanks shall fulfil the requirements of 11.2.1 through 11.2.7.

### 11.3 Steering Gear

- 11.3.1** The main steering gear in ships of 10 000 gross tonnage and upwards shall comprise:
- two independent and separate power units, each of which shall fulfil the requirements of 2.6.1.2, or
  - at least two identical power units, complying with the requirements of 2.6.1.2 when acting simultaneously in normal operation. Provision is made for interconnecting these two systems, when necessary. Damage to one of these units shall be signalled and the damaged system shall be automatically isolated so that full effectiveness of the remaining system is ensured.

Steering gears with other than hydraulic drive shall ensure the equivalent level of safety.

**11.3.2** The design of the main steering gear in ships of 10 000 gross tonnage and upwards shall be such that in the case of loss of steering capability of the ship due to a single damage in any part of one of the power units – except the tiller, quadrant or other elements provided for the same purpose, as well as excluding a seizure of an actuator – steering capability is restored within not more than 45 seconds after this damage.

**11.3.3** For ships mentioned in 11.3.2, the deadweight of which is less than 100 000 tonnes, PRS may agree to other solutions than those required therein, i.e. such that do not take into account a single damage of an actuator or a mechanism putting the rudder over, provided that equivalent safety is achieved and that:

- .1 after the loss of steering capability due to single damage in any part of the piping system or in one of the power units, the steering capability is restored within 45 s;
- .2 where the steering gear is provided with one actuator only, special consideration is given to stress analysis of the structure, including fatigue analysis and fracture mechanics analysis, as appropriate, to the material used, testing and inspection and to the provision of effective maintenance (see also IMO Resolution A. 467(XII)).

**11.3.4** Each of the power units of the power actuating systems, mentioned in 11.3.1, shall be provided with two independent control systems operated from the navigation bridge. The independent systems may have a common steering wheel or steering handle. Where the control system comprises a hydraulic telemotor, a second independent control system for each of the above-mentioned power units of the power actuating systems, except ships of 10 000 gross tonnage and upwards, need not, upon PRS' agreement, be fitted.

### 11.4 Deck Equipment

**11.4.1** In oil tankers, the use of steel wire ropes is permitted only on the superstructure decks which do not form the top of cargo tanks, provided no cargo pipelines are carried on these decks.

**11.4.2** In oil tankers, no deck machinery shall be fitted directly on the decks forming the top of cargo and fuel tanks, unless it is fitted on special foundations, the construction of which provides for free circulation of air underneath the machinery.

### 11.5 Safe Access to Tanker Bows

**11.5.1** Tankers subject to SOLAS Convention, including oil tankers, chemical tankers and gas carriers, shall be provided with means to enable the crew to gain safe access to the bow even in severe weather conditions. Such means of access shall be approved by the Administration\*. (SOLAS II-1/3-3)



The access shall be by means of either a walkway on the deck (greting) or a permanently constructed gangway of substantial strength at or above the level of the superstructure deck or the first tier of a deckhouse which shall:

- .1 be not less than 1 m in width, situated on or as near as practicable to the centre line of the ship and located so as not to hinder easy access across working areas of the deck;
- .2 be fitted at each side throughout its length with a footstop and guard rails supported by stanchions. Such rails shall consist of no less than 3 courses, the lowest being not more than 230 mm and the uppermost being at least 1 m above the gangway or walkway, and no intermediate opening shall be more than 380 mm in height. Stanchions shall be at intervals of not more than 1.5 m; .
- .3 be constructed of fire resistant\*\* and non-slip material;
- .4 have openings, with ladders where appropriate, to and from the deck. Openings shall not be more than 40 m apart;
- .5 if the length of exposed deck to be traversed exceeds 70 m, have shelters of substantial construction set in way of the gangways or walkways at intervals not exceeding 45 m. Every such shelter shall be capable of accommodating at least one person and be so constructed as to afford weather protection on the forward, port and starboard sides; and
- .6 if obstructed by pipes or other fittings of a permanent nature, be provided with means of passage over such obstruction. (Res. MSC.62(67)/Rev.1, par. 1)

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\* Interpretations regarding means of access are given in IACS UI LL50/Rev.6. (IACS UI SC138/Cor.1)

\*\* Fibre Reinforced Plastic ((FRP) gratings used instead of steel gratings shall possess:

1. low flame spread characteristics, shall not generate excessive quantities of smoke and toxic products as per the International Code for Application of Fire Test Procedures, 2010 (2010 FTP Code), and
2. adequate structural fire integrity as per recognized standards\*\*\* after undergoing tests in accordance with the above standards

\*\*\* For example, the Standard Specification for Fibre Reinforced Polymer (FRP) Gratings Used in Marine Construction and Shipbuilding (ASTM F3059-14)) (IACS UI SC253/Rev.1).

**11.5.2** The Administration may accept alternative or modified arrangements for tankers with space constraint, such as small tankers, or tankers with large freeboard, such as gas carriers, provided that such alternative or modified arrangements achieve an equivalent level of safety for access to the bow. (Res. MSC.62(67)/Rev.1, par. 2)

## **11.6 Emergency Towing Arrangements for Tankers**

**11.6.1** Emergency towing arrangements shall be fitted at both ends on board every tanker of 20 000 tonnes deadweight and above. (SOLAS II-1/3-4.1.1)

**11.6.2** The arrangements shall, at all times, be capable of rapid deployment in the absence of main power on the ship to be towed and easy connection to the towing ship. At least one of the emergency towing arrangements shall be pre-rigged ready for rapid deployment (in harbour conditions in not more than 15 min.). (SOLAS II-1/3-4.1.2.1)

**11.6.3** Emergency towing arrangements at both ends shall be of adequate strength taking into account the size and deadweight of the ship, and the expected forces during bad weather conditions. They shall be designed for working strength of not less than 1000 kN for ships of less than 50 000 tonnes deadweight and at not less than 2000 kN for larger ships, with a safety factor of 2. The components strength shall be sufficient for all relevant angles of towline, i.e. up to 90° from the ship's centre plane to port and starboard and up to 30° in vertical plane. (SOLAS II-1/3-4.1.2.2)

**11.6.4** The design and construction and prototype testing of emergency towing arrangements shall be approved by the Administration, based on the Guidelines developed by IMO\*. (SOLAS II-1/3-4.1.2.2)

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\* Refer to *Guidelines on emergency towing arrangements for tankers* (res. MSC.35(63), as amended) and LL.3/Circ.130, section 5, interpretation MSC/Circ.966, IACS UI SC113 and IACS UI LL50/Rev.6.

**11.6.5** Towing equipment components are subject to PRS acceptance.

**11.6.6** If the emergency towing arrangements are manufactured in a completed form, at the manufacturer's request they may obtain a *Type Approval Certificate*.

**11.6.7** Emergency towing arrangements, if are not provided with *Type Approval Certificate*, they shall subject to a strength test on board ship, to  $2 \times$  SWL.

## **11.7 Access to and Within Spaces in, and Forward of, the Cargo Area of Oil Tankers**

### **11.7.1 Application**

Oil tanker means a ship constructed or adapted to carry oil in bulk in its cargo spaces being integral parts of hull and includes combination carriers. Definition of oil is contained in Annex 1 of *MARPOL 73/78*. Independent oil tanks can be excluded.

Requirements of sub-chapter 11.6.5 do not apply to cargo tanks of combination chemical/oil tankers complying with the provisions of the *IBC Code*. A "combined chemical/oil tanker complying with the provisions of the *IBC Code*" is a tanker that holds both a valid IOPP certificate (*International Oil Pollution Prevention Certificate*) as a tanker and a valid certificate of fitness for the carriage of dangerous chemicals in bulk, i.e. a tanker that is certified to carry both oil cargoes under *MARPOL Annex I* and Chemical cargoes in chapter 17 of the *IBC Code* either as full or part cargoes. The technical provisions should be applied to ballast tanks of combined chemical/oil tankers complying with the provisions of the *IBC Code*.

Requirements of sub-chapter 11.6 do not apply to independent tanks.

Permanent means of access contained in table 11.6.5 shall not apply to tankers converting from single hull to double hull. However, if – in the course of conversion – substantial new structures<sup>1</sup> are added, these new structures shall meet the requirements of sub-chapter 11.6.

Requirements of sub-chapter 11.6 are not normally applied to FPSO or FSO unless the Administration decides otherwise.<sup>2</sup>

### **11.7.2 Means of Access to Cargo and Other Spaces**

Each space shall be provided with means of access to enable, throughout the life of a ship, overall and close-up inspections and thickness measurements of the ship's structures to be carried out. Such means of access shall comply with the requirements of sub-chapters 11.6.3 and 11.6.5.

Each space for which close-up inspection is not required such as fuel oil tanks and void spaces forward of cargo area, may be provided with a means of access necessary for overall survey intended to report on the overall conditions of the hull structure.

<sup>1</sup> Substantial new structures are hull structures that are entirely renewed or augmented by new double bottom and/or double side construction (e.g. an entirely replaced structure within cargo area or a new double bottom and/or double side section added in order to enhance the cargo area).

<sup>2</sup> Requirements of sub-chapter 11.6 are applicable to FPSO or FSO if they are subject to the scope of ESP as contained in resolution A.1049(27) (2011 ESP Code) as amended.

Where a permanent means of access may be susceptible to damage during normal cargo loading and unloading operations or where it is impracticable to fit permanent means of access, PRS may allow, in lieu thereof, the provision of movable or portable means of access, as specified in the subchapter 11.6.5 provided that the means of attaching, rigging, suspending or supporting the portable means of access forms a permanent part of the ship's structure. All portable equipment shall be capable of being readily erected or deployed by ship's personnel.

Some possible alternative means of access are listed in the paragraph 11.6.5.10. Always subject to acceptance as equivalent by the Administration, alternative means such as an unmanned root arm, ROVs and dirigibles with necessary equipment of the permanent means of access for overall and close-up inspections and thickness measurements of the deck head structure such as deck transverses and deck longitudinals of cargo oil tanks and ballast tanks, should be capable of:

- safe operation in ullage space in gas-free environment; and
- introduction into the place directly from a deck access.

The construction and materials of all means of access and their attachment to the ship's structure shall comply with PRS *Rules*. The means of access shall be subject to survey prior to, or in conjunction with, its use in carrying out surveys.

The means of access arrangements, including portable equipment and attachments, should be annually inspected by the crew or competent inspectors and the inspections should be recorded in Part 2 of the Ship Structure Access Manual . In addition, prior to any space examinations that utilized the permanent means of access, an inspection to confirm the condition of the permanent means of access should be recorded for each space. (MSC.1/Circ/1572/Rev.2)

Procedures:

- a) Any Company authorized person using the means of access should assume the role of inspector and check for obvious damage prior to using the access arrangements. Whilst using the means of access, the inspector should verify the condition of the sections used by close-up examination of those sections and note any deterioration in the requirements. Should any damage or deterioration be ascertained, it should be assessed if it affects the safety for continued use of the means of access. Deterioration found that is considered to affect safe use should be determined as "substantial damage" and measures should be put in place to ensure that the affected section(s) are not to be further used prior to effective repair. **Substantial damage should be reported in Part 2 of the Ship Structure Access Manual (MSC.1/Circ/1572/Rev.2).**
- b) Statutory survey of any space that contains means of access should include verification of the continued effectiveness of the means of access in that space. Survey of the means of access should not be expected to exceed the scope and extent of the survey being undertaken. If the means of access is found deficient the scope of survey should be extended if this is considered appropriate.
- c) Records of all inspections should be established based on the requirements detailed in the ship's Safety Management System. The records should be readily available to persons using the means of access and a copy attached to the Ship Structure Access Manual. The latest record for the portion of the means of access inspected should include as a minimum the date of the inspection, the name and title of the inspector, a confirmation signature, the sections of means of access inspected, verification of continued serviceable condition or details of any deterioration or substantial damage found. A file of permits issued should be maintained for verification. Inspection records of permanent means of access should be made available to classification society surveyors prior to survey. (MSC.1/Circ/1572/Rev.2)

### 11.7.3 Safe Access<sup>1</sup> to Cargo Tanks, Ballast Tanks and Other Spaces

**11.7.3.1** Access to cofferdams, vertical wing and double bottom space of ballast tanks, cargo tanks and other spaces in the cargo area shall be direct from the open deck and such as to ensure their complete inspection. Access to double bottom spaces, particularly with regard to double hull tankers, may be interpreted to include a ladder/platform arrangement that leads from the open deck to the double bottom space through the double hull space.

Access to double bottom spaces may be through a cargo pump-room, pump-room, deep cofferdam, pipe tunnel or similar compartments not intended for the carriage of oil or hazardous cargoes, subject to consideration of ventilation aspects. Access to double side skin space of bulk carriers may be either from a topside tank or double bottom tank or from both.

The wording “not intended for the carriage of oil or hazardous cargoes” applies only to “similar compartments” i.e. safe access can be through a pump room, deep cofferdam, pipe tunnel, cargo hold or double hull space.

The dimensions of any access hatchway shall be sufficient to allow a person wearing a self-contained breathing apparatus to ascend or descend the ladder without obstruction, and also to provide a clear opening to facilitate the removal of an injured person from the space. Alternatively, one of the deck access hatches can be enlarged and fitted with a hinged top ladder and with clear vertical straight access down to the tank bottom.

**11.7.3.2** Tanks, and subdivisions of tanks, having a lengths of 35 m and above, shall be fitted with at least two access hatchways and ladders, as far apart as practicable longitudinally. Tanks less than 35 m in length shall be served by at least one access hatchway and ladder. Where the tanks are of confined construction, two separate means of access from the weather deck are recommended, one each at either end of the tank space.

A cargo oil tank of less than 35 m length without a swash bulkhead requires only one access hatch.

Where rafting is indicated in the ship structures access manual as the means to gain ready access to the under-deck structure, the term “similar obstructions” referred to in the regulation includes internal structures (e.g. webs > 1.5 m deep) which restrict the ability to raft (at the maximum water level needed for rafting of under-deck structure) directly to the nearest access ladder and hatchway to deck. When rafts or boats alone, as an alternative means of access, are allowed under the conditions specified in the 2011 ESP Code, as amended, permanent means of access are to be provided to allow safe entry and exit. This means:

- a) access direct from the deck via a vertical ladder and small platform fitted approximately 2 m below the deck in each bay; or
- b) access to the deck from a longitudinal permanent platform having ladders to the deck in each end of the tank. The platform should, for the full length of the tank, be arranged in level with, or above, the maximum water level needed for rafting of the under-deck structure. For this purpose, the ullage corresponding to the maximum water level should not be assumed more than 3 m from the deck plate measured at the midspan of deck transverses and in the middle length of the tank (see figure below). A permanent means of access from the longitudinal permanent platform to the water level indicated above should be fitted in each bay (e.g. permanent rungs on one of the deck webs inboard of the longitudinal permanent platform).

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<sup>1</sup> See - IMO Res. A.1050(27).

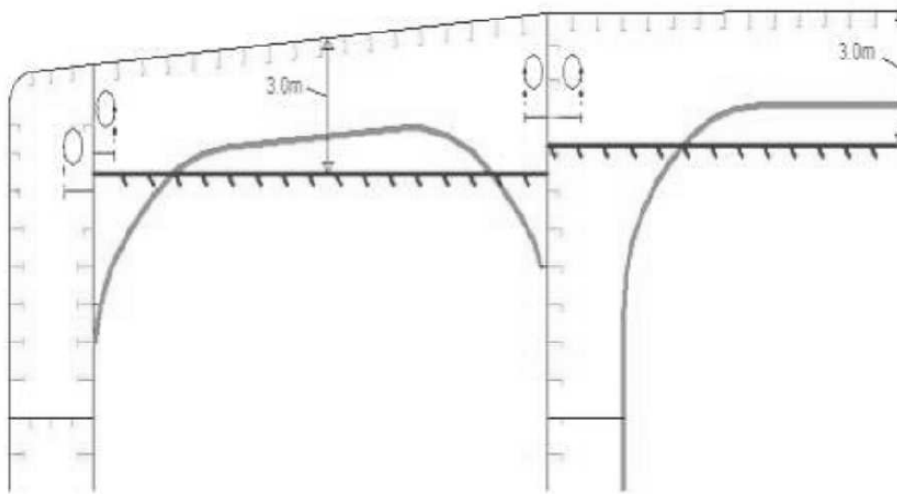


Fig. 11.7.3.2. Interpretation

#### 11.7.4 Ship Structure Access Manual

**11.7.4.1** A ship's means of access to carry out overall and close-up inspections and thickness measurements shall be described in a *Ship Structure Access Manual* approved by PRS on behalf of the Administration, an updated copy of which shall be kept on board. The *Ship Structure Access Manual* shall include the following for each space:

- .1 plans showing the means of access to the space, with appropriate technical specifications and dimensions;
- .2 plans showing the means of access within each space to enable an overall inspection to be carried out, with appropriate technical specifications and dimensions. The plans shall indicate from where each area in the space can be inspected;
- .3 plans showing the means of access within the space to enable close-up inspections to be carried out with appropriate technical specifications and dimensions. The plans shall indicate the positions of critical structural areas, whether the means of access is permanent or portable and from where each area can be inspected;
- .4 instructions for inspecting and maintaining the structural strength of all means of access and means of attachment, taking into account any corrosive atmosphere that may be within the space;
- .5 instructions for safety guidance when rafting is used for close-up inspections and thickness measurements;
- .6 instructions for the rigging and use of any portable means of access in a safe manner;
- .7 an inventory of all portable means of access; and
- .8 records of periodical inspections and maintenance of the ship's means of access.

For the purpose of this requirement “critical structural areas”<sup>1</sup> are locations which have been identified from calculations (i.e. advanced calculation techniques for structural strength and fatigue performance, if available) to require monitoring or from the service history of similar or sister ships to be sensitive to cracking, buckling, deformation or corrosion which would impair the structural integrity of the ship.

<sup>1</sup> Reference shall be made to the following publications for critical structural areas, where applicable:

- oil tankers: Guidance Manual for Tanker Structures by TSCF (Tanker Structure Cooperative Forum);
- bulk carriers: Guidelines for Surveys, Assessment and Repair of Hull Structure by IACS;
- oil tankers and bulk carriers: resolution A.1049(27), as amended.

- 11.7.4.2** *The Ship Structure Access Manual*<sup>1</sup> shall contain at least the following two parts:
- Part 1: Plans, instructions and inventory required by paragraphs 11.6.4.1.1 to 11.6.4.1.7. This part shall be approved by PRS;
  - Part 2: Form of record of inspections and maintenance, and change of inventory of portable equipment due to additions or replacement after construction. This part shall be approved only at new building.

The following matters shall be addressed in the ship structure access manual:

- a) the *Access Manual* shall clearly cover scopes specified in the regulations for use by crews, surveyors and Port State Control officers;
- b) approval/re-approval procedure for the manual, i.e. any changes of the permanent, portable, movable or alternative means of access within the scope of the regulation and the Technical provisions are subject to review and approval by PRS;
- c) verification of means of access shall be part of safety construction survey for continued effectiveness of the means of access in that space which is subject to the statutory survey;
- d) inspection of means of access by the crew and/or a competent inspector of the company as a part of regular inspection and maintenance (see paragraph 2.3 of *SOLAS* regulation II-1/3-6);
- e) actions to be taken if means of access is found unsafe to use;
- f) in case of use of portable equipment, plans showing the means of access within each space with indication from where and how each area in the space can be inspected.

See also IACS Recommendation No. 90 “Ship Structural Access Manual.”

## 11.7.5 Technical Provisions for Means of Access

### 11.7.5.1 Definitions

- .1 *Rung* means the step of a vertical ladder or step on the vertical surface, made as a single bar.
- .2 *Tread* means the step horizontal of an inclined ladder or horizontal step for the vertical access opening.
- .3 *Flight of an inclined ladder* means the actual stringer length of an inclined ladder. For vertical ladders, it is the distance between the platforms.
- .4 *Stringer* means:
  - the frame of a ladder; or
  - the stiffened horizontal plating structure fitted on the side shell, transverse bulkheads and/or longitudinal bulkheads in the space.

For the purpose of ballast tanks of less than 5 m in width forming double side spaces, the horizontal plating structure is credited as a stringer and a longitudinal permanent means of access, if it provides a continuous passage of 600 mm or more in width past frames or stiffeners on the side shell or longitudinal bulkhead. Openings in stringer plating utilized as permanent means of access shall be arranged with guard rails or grid covers to provide safe passage on the stringer or safe access to each transverse web.
- .5 *Vertical ladder* means a ladder of which the inclined angle is 70° and over up to 90°. A vertical ladder shall not be skewed by more than 2°.
- .6 *Inclined ladder* means a ladder of which the inclined angle is less than 70°.
- .7 *Overhead obstructions* mean the deck or stringer structure including stiffeners above the means of access.
- .8 *Distance below deck head* means the distance below the plating.

<sup>1</sup> The *Manual* shall address spaces listed in 11.6.3. As a minimum the English version shall be provided.



- .9 *Non-skid construction* – construction of such a characteristic that its surface on which personnel walks provides sufficient friction to the sole of boots even if the surface is wet and covered with thin sediment.
- .10 *Substantial construction* – construction to which the as-designed strength as well as the residual strength during the service life of the ship are referred. Durability of passageways together with guard rails should be ensured by the initial corrosion protection and inspection and maintenance during services.

**11.7.5.2** Structural members subject to the close-up inspections and thickness measurements of the ships structure except those in double bottom spaces, shall be provided with a permanent means of access to the extent as specified in Table 11.6.5, as applicable. For oil tankers approved by PRS, alternative methods may be used in combination with the fitted permanent means of access, provided that the structure allows for its safe and effective use. The permanent means of access to a space can be credited for the permanent means of access for inspection.

**11.7.5.3** Permanent means of access shall as far as possible be integral to the structure of the ships. The Administrations may allow reasonable deviations to facilitate such design. The deviation should be applied only to distance between integrated permanent means of access that are the subject of paragraph 2.1.2 of Table 11.6.5.15. Deviations should not be applied to the distances that determine whether permanent access is required or not, such as height of the spaces and height to elements of the structure (e.g. cross-ties).

**11.7.5.4** Elevated passageways forming sections of a permanent means of access, where fitted shall have a minimum clear width of 600 mm, except for going around vertical webs where the minimum clear width may be reduced to 450 mm, and have guard rails over the open side of their entire length (passageways which are not integrated with ship's construction shall have guard rails on both the sides). Sloping structure<sup>1</sup> providing part of the access shall be of a non-skid construction. Guard rails shall be at least 1000 mm in height and consist of a rail and intermediate rail of substantial construction. The distance between the passageway and the intermediate rail and the distance between intermediate rail and the top rail shall not be more than 500 mm. Guard rail stanchions shall be attached to the permanent means of access and shall be less than 3 m apart.

Discontinuous top handrails are permitted, provided the gap does not exceed 50 mm. The same maximum gap shall be considered between the top handrail and other structural members (i.e. bulkhead, web frame, etc.).

The maximum distance between the adjacent stanchions across the handrail gaps shall be 350 mm where the top and mid handrails are not connected together and 550 mm when they are connected together.

The maximum distance between the stanchion and other structural members shall not exceed 200 mm where the top and mid handrails are not connected together and 300 mm when they are connected together.

When the top handrail is bent at its ends, the outside radius of the bent part shall not exceed 100 mm (see Fig. 11.6.5.4).

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<sup>1</sup> „Sloping structures” are structures that are sloped by 5 or more degrees from horizontal plane when a ship is in upright position at even-keel.



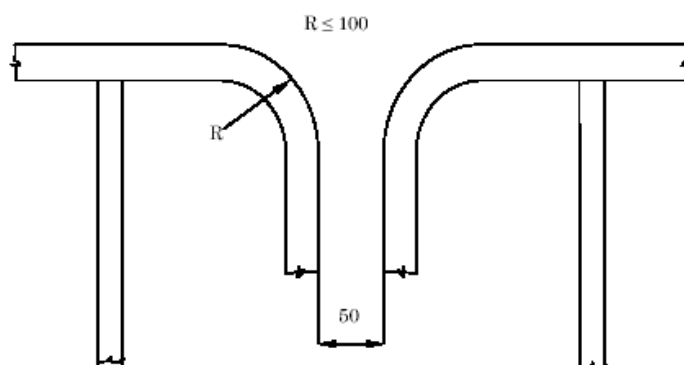


Fig. 11.7.5.4

Requirements for resting platforms placed between ladders should be equivalent to those applicable to elevated passageways.

**11.7.5.5** Access to permanent means of access and vertical openings from the ship's bottom shall be provided by means of easily accessible passageways, ladders or treads.

Treads shall be provided with lateral support for the foot. Where the rungs of ladders are fitted against a vertical surface, the distance from the centre of the rungs to the surface shall be at least 150 mm. Where vertical manholes are fitted higher than 600 mm above the walking level, access shall be facilitated by means of treads and hand grips with platform landings on both sides. It should be demonstrated that an injured person can be easily evacuated.

**11.7.5.6** Inclined ladders should be at an angle of not less than 70 degrees to the horizontal and should comprise one or more ladder linking platforms spaced not more than 6 m apart vertically and displaced to one side of the ladder. There shall be no obstruction within 750 mm of the face of the inclined ladder, except that in way of an opening this clearance may be reduced to 600 mm. Adjacent sections of ladder should be laterally offset from each other by at least the width of the ladder.

Ladders and handrails shall be constructed of steel or equivalent material<sup>1</sup> of adequate strength and stiffness and securely attached to the structure by stays. The method of support and length of stay shall be such that vibration is reduced to a practical minimum.

In cargo holds, ladders shall be designed and arranged so that not to cause difficulties in cargo handling and that the risk of damage from cargo handling gear is minimized.

Tunnels passing through cargo holds should be equipped with ladders or steps at each end of the hold so that personnel may easily get across such tunnels.

**11.7.5.7** The width of inclined ladders between stringers shall not be less than 400 mm, the width for access to a cargo hold shall be at least 450 mm.

The treads shall be equally spaced at a distance apart, measured vertically, of between 200 mm and 300 mm. When steel is used, the treads shall be formed of two square bars of not less than 22 mm by 2 mm in section, fitted to form a horizontal step with the edges pointing upward. The treads shall be carried through the side stringers and attached thereto by double continuous welding.

<sup>1</sup> For guard rails, use of alternative materials such as GRP, is to be subject to compatibility with the liquid carried in the tank. Non-fire resistant materials should not be used for means of access to a space with a view to securing an escape route at a high temperature.

All inclined ladders shall be provided with handrails of substantial construction on both sides. Vertical height of handrails shall not be less than 890 mm from the centre of the step. Two course handrails shall be provided where the gap between stringer and top handrail is greater than 500 mm.

**11.7.5.8** For vertical ladders or spiral ladders, the width and construction shall fulfil international or national standards accepted by the Administration. PRS recommendations are as follows:

- for vertical ladders when steel is used, the rungs shall be formed of single square bars of not less than 22 mm by 22 mm for the sake of safe grip;
- the minimum width of vertical ladders shall be 350 mm and the vertical distance between the rungs shall be equal and shall be between 250 mm and 350 mm;
- the vertical ladders shall be secured at intervals not exceeding 2.5 m apart to prevent vibration;
- a minimum climbing clearance in width shall be 600 mm for the ladders other than these placed between the hold frames.

**11.7.5.9** No free-standing portable ladder shall be more than 5 m long. Portable ladders more than 5 m long may only be utilized if fitted with a mechanical device to secure the upper end of the ladder. A mechanical device such as hooks for securing at the upper end of a ladder should be considered as an appropriate securing device if a movement fore/aft and sideways can be prevented at the upper end of the ladder.

Innovative design is to be accepted if it fits the functional requirement with due consideration for safe use.

**11.7.5.10** Alternative means of access include, but are not limited to, such devices as:

- hydraulic arm fitted with a stable base;
- wire lift platform;
- staging;
- rafting;
- robot arm or remotely operated vehicle (ROV);
- portable ladders more than 5 m long are only to be utilized if fitted with a mechanical device to secure the upper end of the ladder;
- other means of access, approved by, or acceptable to, the Administration.

Means for safe operation and rigging of such equipment to and from and within the spaces shall be clearly described in the *Ship Structure Access Manual*.

Guidelines for approval or acceptance of the alternative means of access are contained in *Publication 27/I*.

**11.7.5.11** For access through horizontal openings, hatches and manholes, the minimum clear opening should be not less than 600 mm × 600 mm. Openings of 600 mm by 600 mm minimum clearance, or larger, should be provided in each horizontal girder in vertical alignment within the vertical wing space. The term minimum clear opening of not less than 600 mm by 600 mm means that such openings may have corner radii up to 100 mm maximum, due regard being given to stress concentration. When it is considered appropriate to take measures to reduce the stress in corners, the larger opening with increased radii eg. 600 mm × 800 mm with 300 mm radii, shall be provided.

Any opening or open hatchway larger than 200 mm diameter on bulkhead stringers and horizontal girders should be fitted with gratings or safety guide rails of adequate design and construction. The free edge of walkways, bulkhead stringers and horizontal girders should be fitted with two-tier guide rails and vertical plate at least 50 mm high around edge of platform except in way of ladder. Guide rails or fencing should be free from sharp edges and should consist

of an upper rail at a height of 900 mm and an intermediate rail at a height of 500 mm. The rails may, where necessary, consist of taut wire or taut chain. Step rungs and grip rails should be provided on inclined or curved surfaces to assist footing.

Access hatch coamings having a height greater than 450 mm should be fitted with steps or footholds inside the coaming and, if greater than 900 mm, should also have steps on the outside in conjunction with cargo hold ladders.

Guidelines for approval or acceptance of the alternative means of access are contained in *Publication 27/I*.

**11.7.5.12** For access through vertical openings, or manholes providing passage through the length and breadth of the space, the minimum clear opening should be not less than 600 mm by 800 mm, at a height of not more than 600 mm from the bottom shell plating or stringer unless gratings or other footholds are provided. Such openings should be provided with grab bars.

The term minimum clear opening of not less than 600 mm by 800 mm also includes an opening with corner radii of 300 mm. An opening of 600 mm in height  $\times$  800 mm in width may be accepted as access opening in vertical structures where it is not desirable to make large openings in the structural strength aspects, i.e. in girders and floors in double bottom tanks. For inspection purposes, an adequate number of vertical access openings should be provided.

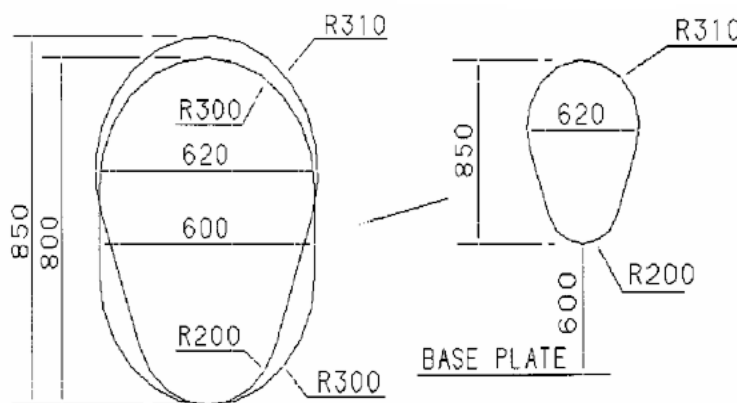


Fig. 11.7.5.12

Subject to verification of easy evacuation of injured person on a stretcher, the vertical opening 850 mm  $\times$  620 mm with upper half wider than 600 mm, while the lower half may be less than 600 mm with the overall height not less than 850 mm is considered an acceptable alternative to the traditional opening of 600 mm  $\times$  800 mm with corner radii of 300 mm.

If a vertical opening is at a height of more than 600 mm, steps and handgrips shall be provided. In such arrangements it shall be demonstrated that an injured person can be easily evacuated.

Where the dimensions of the bulkhead panel may hinder the cut of an opening compliant with the above requirements, smaller dimensions of openings, particularly for the access within the double bottom, may be accepted by PRS, provided that it is demonstrated that an injured person can be removed from the space.

**11.7.5.13** For oil tankers of less than 5000 tonnes deadweight, PRS may approve, in special circumstances smaller dimensions for the openings referred to in paragraphs 11.6.5.11 and 11.6.5.12, if the ability to traverse such openings or to remove an injured person can be proved to the satisfaction of PRS.

**11.7.5.14** Access ladders to ballast tanks, cargo tanks and spaces other than fore peak tanks shall be:

- .1 Tanks and subdivisions of tanks having a length of 35 m or more: equipped with two access hatchways.

First access hatchway: an inclined ladder or ladders shall be used.

Second access hatchway:

- .1 A vertical ladder may be used. In such a case where the vertical distance is more than 6 m, vertical ladders shall comprise one or more ladder linking platforms spaced not more than 6 m apart vertically and displaced to one side of the ladder.

The uppermost section of the vertical ladder, measured below the open deck structure in way of the tank entrance, shall not be less than 2.5 m but shall not exceed 3.0 m and shall comprise a ladder-linking platform which shall be displaced to one side of a vertical ladder. However, the vertical distance of the uppermost section of the vertical ladder may be reduced to 1.6 m, measured clear of the overhead obstructions in way of the tank entrance, if the ladder lands on a longitudinal or athwartship permanent means of access fitted within that range. Adjacent sections of the ladder shall be laterally offset from each other by at least the width of the ladder (see paragraph 20 of MSC/Circ.686 and refer to the interpretation of Technical Provision, resolution MSC.158(78), paragraph 3.13.2 and paragraph 3.13.6) ; or

- .2 Where an inclined ladder or combination of ladders is used for access to the space, the uppermost section of the ladder, measured below the open deck structure in way of the tank entrance, shall be vertical for not less than 2.5 m but not exceeding 3.0 m and shall comprise a landing platform continuing with the inclined ladder. However, the vertical distance of the uppermost section of the vertical ladder may be reduced to 1.6 m measured clear of the overhead obstructions in way of the tank entrance, if the ladder lands on a longitudinal or athwartship permanent means of access fitted within that range. The flights of the inclined ladders are normally to be not more than 6 m in vertical height. The lowermost section of the ladder may be vertical for the vertical distance not exceeding 2.5 m.

- .2 Tanks less than 35 m in length and served by one access hatchway: an inclined ladder or combination of ladders shall be used to the space as specified in .1.2 above.
- .3 In spaces of less than 2.5 m width the access to the space may be by means of vertical ladders that meet the requirements specified in 1.1. Adjacent sections of the ladder shall be laterally offset from each other by at least the width of the ladder (see paragraph 20 of MSC/Circ.686 and refer to the interpretation of Technical Provision, resolution MSC.158(78), paragraph 3.13.2 and paragraph 3.13.6).
- .4 Access from deck to a double bottom space may be by means of vertical ladders through a trunk. The vertical distance from deck to a resting platform, between resting platforms or a resting platform and the tank bottom shall not be more than 6 m unless otherwise approved by the Administration.

#### **11.7.5.15 Means of Access for Inspection of the Vertical Structure of Oil Tankers**

Vertical ladders provided for means of access to the space may be used for access for inspection of the vertical structure.

Unless stated otherwise in Table 11.6.5.15, vertical ladders that are fitted on vertical structures for inspection shall comprise one or more ladder linking platforms spaced not more than 6 m apart vertically and displaced to one side of the ladder. Adjacent sections of ladder shall be laterally offset

from each other by at least the width of the ladder (see paragraph 20 of MSC/Circ.686/Rev.1 and refer to the interpretation of Technical Provision, resolution MSC.158(78), paragraph 3.13.2 and paragraph 3.13.6).

The minimum distance between the inclined ladder face and obstructions, i.e. 750 mm and, in the way of openings, 600 mm specified in 11.6.5.5, should be measured perpendicular to the face of the ladder.

Detailed interpretations of the requirements in Table 11.6.5.15 are contained in an IACS UI SC 191/Rev.8.

**Table 11.7.5.15**  
**Means of access for ballast and cargo tanks of oil tankers<sup>\*) \*\*)</sup>**

1 Water ballast tanks, except those specified in the right column, and cargo oil tanks	2 Water ballast wing tanks of less than 5 m width forming double side spaces and their bilge hopper sections
Access to the underdeck and vertical structure	
<p><b>1.1</b> For tanks of which the height is 6 m and over containing internal structures, permanent means of access shall be provided in accordance with .1 to .6<sup>1</sup>:</p> <p><b>.1</b> continuous athwartship permanent access arranged at each transverse bulkhead on the stiffened surface, at a minimum of 1.6 m to a maximum of 3 m below the deck head;</p> <p><b>.2</b> at least one continuous longitudinal permanent means of access at each side of the tank. One of these accesses shall be at a minimum of 1.6 m to a maximum of 6 m below the deck head and the other shall be at a minimum of 1.6 m to a maximum of 3 m below the deck head; there is a need to provide a continuous longitudinal permanent means of access when the deck longitudinals and deck transverses are fitted on deck but supporting brackets are fitted under the deck;</p>	<p><b>2.1</b> For double side spaces above the upper knuckle point of the bilge hopper sections, permanent means of access shall be provided in accordance with .1 to .3<sup>2</sup>:</p> <p><b>.1</b> where the vertical distance between horizontal uppermost stringer and deck head is 6 m or more, one continuous longitudinal permanent means of access shall be provided for the full length of the tank with a means to allow passing through transverse webs installed at a minimum of 1.6 m to a maximum of 3 m below the deck head with a vertical access ladder at each end of the tank; For a tank, the vertical distance between horizontal upper stringer and deck head of which varies at different sections, paragraph 2.1.1 should be applied to such sections that fall under the criteria. The continuous permanent means of access may be a wide longitudinal, which provides access to critical details on the</p>

<sup>1</sup> Subparagraphs .1 to .3 define access to under-deck structures, access to uppermost sections of transverse webs and connection between these structures.

Subparagraphs .4 to .6 define access to vertical structures only and are linked to the presence of transverse webs on longitudinal bulkheads.

If there are no under-deck structures (deck longitudinals and deck transverses) but there are vertical structures in the cargo tank supporting transverse and longitudinal bulkheads, access in accordance with subparagraphs .1 to .6 should be provided for inspection of the upper parts of vertical structure on transverse and longitudinal bulkheads.

If there is no structure in cargo tank, section 1.1 of table 11.6.5.15 should not be applied.

Section 1 of table 11.6.5.15 should also be applied to void spaces in the cargo area, comparable in volume to spaces covered by SOLAS regulation II-1/3-6, except those spaces covered by section 2.

The vertical distance below the overhead structure should be measured from the underside of the main deck plating to the top of the platform of the means of access at a given location.

The height of the tank should be measured at each tank. For a tank the height of which varies at different bays, item 1.1 should be applied to such bays of a tank that have a height of 6 m and over.

<sup>2</sup> Section 2 of table 11.6.5.15 should also be applied to wing tanks designed as void spaces. Paragraph 2.1.1 represents requirements for access to under-deck structures, while paragraph 2.1.2 is a requirement for access for survey and inspection of vertical structures on longitudinal bulkheads (transverse webs).

<p>1 Water ballast tanks, except those specified in the right column, and cargo oil tanks</p>	<p>2 Water ballast wing tanks of less than 5 m width forming double side spaces and their bilge hopper sections</p>
<p>.3 access between the arrangements specified in .1 and .2 and from the main deck to either .1 or .2; means of access to tanks may be used for access to the permanent means of access for inspection;</p> <p>.4 continuous longitudinal permanent means of access which are integrated in the structural member on the stiffened surface of a longitudinal bulkhead, in alignment, where possible, with horizontal girders of transverse bulkheads shall be provided for access to the transverse webs unless permanent fittings are installed at the uppermost platform for use of alternative means, as defined in paragraph 11.6.5.10, for inspection at intermediate heights. For water ballast tanks of 5 m or more in width, side shell plating shall be considered in this context in the same way as “longitudinal bulkhead”. The permanent fittings required to serve alternative means of access such as wire lift platform, that should be used by crew and surveyors for inspection should be provide at least an equal level of safety as the permanent means of access stated by the same paragraph. These means of access should be carried on board the ship and be readily available for use without filling of water in tank. Therefore, rafting should not be acceptable under this provision. Alternative means of access should be part of the Ship Structure Access Manual which should be approved on behalf of the flag State;</p> <p>.5 for ships having cross-ties which are 6 m or more above tank bottom, a transverse permanent means of access on the cross-ties providing inspection of the tie flaring brackets at both sides of the tank, with access from one of the longitudinal permanent means of access in .4; and</p> <p>.6 alternative means as defined in paragraph 11.6.5.10 may be provided for small ships as an alternative to .4 for cargo oil tanks of which the height is less than 17 m.</p> <p>1.2 For tanks of which the height is less than 6 m, alternative means as defined in paragraph 11.6.5.10 or portable means may be utilized instead of the permanent means of access.</p> <p><b>Fore peak tanks</b></p> <p>1.3 For fore peak tanks with a depth of 6 m or more at the centre line of the collision bulkhead, a suitable means of access shall be provided for access to critical areas such as the underdeck structure, stringers, collision bulkhead and side shell structure.</p> <p>.1 Stringers of less than 6 m in vertical distance from the deck head or a stringer immediately</p>	<p>opposite side by means of platforms as necessary on web frames. In case the vertical opening of the web frame is located in the way of the open part between the wide longitudinal and the longitudinal on the opposite side, platforms should be provided on both sides of the web frames to allow safe passage through the web frame. Where two access hatches are required by SOLAS regulation II-1/3-6.3.2, access ladders at each end of the tank should lead to the deck;</p> <p>.2 continuous longitudinal permanent means of access, which are integrated in the structure, at a vertical distance not exceeding 6 m apart; the continuous permanent means of access may be a wide longitudinal, which provides access to critical details on the opposite side by means of platforms as necessary on web frames. In case the vertical opening of the web is located in the way of the open part between the wide longitudinal and the longitudinal on the opposite side, platforms should be provided on both sides of the web to allow safe passage through the web. A “reasonable deviation”, as noted in paragraph 1.4 of the Technical provisions, of not more than 10% may be applied where the permanent means of access is integral with the structure itself and</p> <p>.3 plated stringers shall, as far as possible, be in alignment with horizontal girders of transverse bulkheads.</p> <p>2.2 For bilge hopper sections of which the vertical distance from the tank bottom to the upper knuckle point is 6 m and over, one longitudinal permanent means of access shall be provided for the full length of the tank. It shall be accessible by vertical permanent means of access at each end of the tank. Permanent means of access between the longitudinal continuous permanent means of access and the bottom of the space should be provided. The height of bilge hopper tank located outside of the parallel part of the ship should be taken as the maximum of the clear vertical distance measured from the bottom plating to the hopper plating of the tank. The foremost and aftmost bilge hopper ballast tanks with raised bottom, of which the height is 6 m and over, a combination of transverse and vertical means of access to the upper knuckle point for each transverse web, should be accepted in place of the longitudinal permanent means of access.</p> <p>.1 The longitudinal continuous permanent means of access may be installed at a minimum 1.6 m to maximum 3 m from the top of the bilge hopper section. In this case, a platform extending the longitudinal continuous permanent means of</p>



<p>1 Water ballast tanks, except those specified in the right column, and cargo oil tanks</p>	<p>2 Water ballast wing tanks of less than 5 m width forming double side spaces and their bilge hopper sections</p>
<p>above are considered to provide suitable access in combination with portable means of access.</p> <p>.2 In case the vertical distance between the deck head and stringers, stringers or the lowest stringer and the tank bottom is 6 m or more, alternative means of access as defined in paragraph 11.6.5.10 shall be provided.</p>	<p>access in way of the webframe may be used to access the identified structural critical areas.</p> <p>.2 Alternatively, the continuous longitudinal permanent means of access may be installed at a minimum of 1.2 m below the top of the clear opening of the web ring allowing a use of portable means of access to reach identified structural critical areas.</p> <p>2.3 Where the vertical distance referred to in 2.2 is less than 6 m, alternative means as defined in paragraph 11.6.5.10 or portable means of access may be utilised in lieu of the permanent means of access. To facilitate the operation of the alternative means of access, in-line openings in horizontal stringers shall be provided.</p> <p>The openings shall be of an adequate diameter and shall have suitable protective railings.</p>

\*j) For oil/ore carriers, permanent means of access shall be provided in accordance with the applicable sections of Table 11.6.5.15 and table 12.3.5.2.

\*\*j) Double hull spaces designed as void spaces shall fulfil the requirements of Section 2 of Table 11.6.5.15.



## 12 BULK CARRIERS, ORE CARRIERS AND COMBINATION CARRIERS

### 12.1 General

#### 12.1.1 Application

The requirements of the present Chapter 12 apply to ships assigned the additional marks: **BULK CARRIER** or **ORE CARRIER** in the symbol of class or a combination of additional marks in the case of combination carriers affixed to the symbol of class in accordance with para. 3.4.2.3, *Part I – Classification Regulations*.

#### 12.1.2 Steering Gear

Ships shall fulfil the requirements of 11.3.

This requirement does not apply to those bulk carriers which the requirements of the *CSR Rules* refer to.

#### 12.1.3 Deck Equipment

Ships shall fulfil the requirements of 11.4.

### 12.2 Cargo Hatchways in Combination Carriers intended for Alternate Carriage of Dry Bulk Cargoes and Liquid Cargoes

#### 12.2.1 General

**12.2.1.1** The requirements of the present sub-chapter refer to the cargo hatches of cargo holds provided for alternate carriage of liquid bulk cargoes of density not exceeding 1.025 t/m<sup>3</sup>, as well as dry cargoes, and are applicable when the liquid bulk cargo fills up at least 90% of the cargo hold volume.

When the cargo hold is filled up by liquid bulk cargo in less percentage than that given above, cargo hatchways will be specially considered by PRS.

**12.2.1.2** Cargo hatchways of holds intended for alternate carriage of dry bulk cargoes and liquid bulk cargoes shall also fulfil the requirements of 7.10.1, 7.10.2, 7.10.3, 7.10.4, 7.10.6, 7.10.8, 11.2.4 and 11.2.5.

**12.2.1.3** Hatch covers shall be made of steel. The use of other materials will be specially considered by PRS.

**12.2.1.4** Where manholes to the hold, cleaning openings, openings for taking the cargo samples or other similar openings are provided in the cargo hatch cover, the closures of these openings shall fulfil the requirements of 11.2.

**12.2.1.5** When closed and secured, the hatch covers of holds intended for the carriage of inflammable liquids shall be earthed (see Chapters 1 and 2, *Part VIII – Electrical Installations and Control Systems*).

When, in the above condition, a sufficient electric contact between the hatch covers and ship's hull is ensured, special earthing of covers is not required.

#### 12.2.2 Design Loads

**12.2.2.1** Hatch covers, except cases specified in 12.2.2.2, shall be calculated for pressure of liquid carried in the cargo hold; the inside design load shall be taken depending on the system of framing in accordance with the following requirements:



- for transverse framing system (stiffenings perpendicular to the ship's centre plane), the design pressure acting on the whole surface of the cover shall be taken as evenly distributed pressure  $p$ , determined from the formula:

$$p = 0.7 p_0 + 1.275 (b + 2r) + 0.245l + 2.55K \quad [\text{kPa}] \quad (12.2.2.1-1)$$

- for longitudinal framing system (the stiffenings parallel to the ship's centre plane), as well as for mixed framing system, the design pressure acting on the entire surface of the cover, shall be taken as variable pressure  $p$ , with the variability rule determined from the formula:

$$p = 0.7 p_0 + 1.275 (b + 2r + 2y) + 2.55K \quad [\text{kPa}] \quad (12.2.2.1-2)$$

- $b$  – inner width of hatchway [m];
- $l$  – inner length of hatchway [m];
- $r$  – a value, [m], determined in the following way:
  - in the case of even hatches located symmetrically on both sides of the centre plane if no longitudinal tight swash bulkhead has been applied in the hold –  $r$  is equal to the distance between longitudinal symmetry axes of hatches parallel to the ship's centre plane;
  - in the case of hatches located in the ship's centre plane, as well as in the case of even hatches if a longitudinal tight swash bulkhead has not been applied in the hold –  $r$  is equal to zero;
- $y$  – distance from the longitudinal symmetry axis of hatch, parallel to the ship's centre plane, to the considered point of the hatch cover, [m];
  - for  $r > 0$ , the value of  $y$  shall be assumed positive for the direction from the hatch symmetry axis to the nearest ship's side and negative – for the opposite direction;
  - for  $r = 0$ , the following two variants of design load shall be considered:
    - for the positive value of  $y$  for one direction from the hatch symmetry axis and negative in another direction, and
    - for the value of  $y$  with opposite signs in relation to the first variant;
- $p_0$  – maximum opening pressure of the breathing valve, [MPa];
- $K$  – a value determined from the formula:

$$K = C - 2.4h \quad (12.2.2.1-3)$$

- $C$  – a value, [m], determined as follows:
  - for hatches located in the ship's centre plane and for even hatches if no longitudinal tight wash bulkhead has been applied in the hold –  $C$  is a distance measured on the deck level from the longitudinal hatch coaming at the ship's side to the outer plating of the hull or to the inner longitudinal bulkhead of the wing tank, if applied;
  - for even hatches if a longitudinal tight swash bulkhead has been applied in the hold –  $C$  is the greater of the two distances measured on the deck level:
    - from the longitudinal hatch coaming at the ship's side to the outer plating of the hull or to the inner longitudinal bulkhead of the wing tank, if applied,
    - from the longitudinal hatch coaming at the ship's centre plane to the tight swash bulkhead or to the nearest longitudinal bulkhead of the centre tank, if applied;
- $h$  – distance between the outer edges of deck plating and the hatch cover plating, [m].

If a negative value of  $K$  is obtained from formula 12.2.2.1-3,  $K = 0$  shall be taken for calculations.

**12.2.2.2** In the case of structure with two or more hatches located one by one along the hold, the design loads of hatch covers will be specially considered by PRS.

**12.2.2.3** The stresses in the hatch cover structural members under the design load shall not exceed 0.7 times the yield stress of the material used.

**12.2.2.4** When closed, hatch cover sealing shall withstand the inner pressure of the liquid carried in the hold equal to at least 24.5 kPa or to double value of  $p$  determined from formula 12.2.2.1-2 – whichever is the greater. The closure tightness shall be ensured by gaskets made of rubber or other suitable material, resistant to the action of liquid carried in the hold. Closing devices shall be, as far as possible, arranged at equal distances from each other.

### 12.2.3 Scantlings

**12.2.3.1** Each closing device of hatch cover shall be designed for greater of the following forces:

$$F_1 = \frac{l}{n} [4.4G + 294bl(b + 2r + 2K_l)] 10^{-2} \text{ [kN]} \quad (12.2.3.1-1)$$

$$F_2 = \frac{34.3bl}{n} + 44 \text{ [kN]} \quad (12.2.3.1-2)$$

$G$  – total mass of covers of the considered hatch, [kg];

$n$  – total number of closing devices at the circumference of the hatch in question;

$K_l$  – a value determined from the formula:

$$K_l = C - 0.75h \quad (12.2.3.1-3)$$

If a negative value of  $K_l$  is obtained from the above formula,  $K_l = 0$  shall be taken.

$b, l, r, C$  and  $h$  – see 12.2.2.1.

**12.2.3.2** Each closing device located on the longitudinal hatch coaming, in addition to compliance with the requirements of 12.2.3.1 – shall be designed for the action of force determined from the formula:

$$F_3 = ab (1.13b + 1.72r + 1.72K_2) + 35.3 \text{ [kN]} \quad (12.2.3.2-1)$$

$a$  – spacing between the closing devices, [m];

$K_2$  – a value determined from the formula:

$$K_2 = C - 2.14h \quad (12.2.3.2-2)$$

If a negative value of  $K_2$  is obtained from formula 12.2.3.2-2,  $K_2 = 0$  shall be taken.

$b, r, C$  and  $h$  – see 12.2.2.1.

**12.2.3.3** When forces determined in 12.2.3.1 and 12.2.3.2 are acting on the closing device, stresses in the structural elements shall not exceed 0.7 times the yield stress of the material used.

**12.2.3.4** Irrespective of compliance with the requirements of 7.10.8.2 and 12.2.2.3, the thickness of steel hatch covers shall not be less than 8 mm or  $s$  value determined from the following formula, whichever is the greater:

$$s = 25a_1 \sqrt{\frac{p}{R_e}} \text{ [mm]} \quad (12.2.3.4)$$

$p$  – pressure determined from formula 12.2.2.1-2, [kPa];  $y$  shall be taken as the distance from the longitudinal symmetry axis of the hatch, parallel to the ship's centre plane, to the furthest, from that axis, edge of the considered plate;

$a_1$  – spacing between the main stiffeners of the hatch cover, [m];

$R_e$  – yield stress of the hatch cover plating material, [MPa].

## 12.3 Access to and Within Spaces in, and Forward of, the Cargo Area of Bulk Carriers

### 12.3.1 Application

This requirement applies to bulk carriers of 20000 gross tonnage and over.

### 12.3.2 Means of Access to Cargo and Other Spaces

Each space shall be provided with means of access to enable, throughout the life of a ship, overall and close-up inspections and thickness measurements of the ship's structures to be carried out. Such means of access shall comply with the requirements of subparagraphs 12.3.3 and 12.3.5.

Each space for which close-up inspection is not required such as fuel oil tanks and void spaces forward of cargo area, may be provided with a means of access necessary for overall survey intended to report on the overall conditions of the hull structure.

Where a permanent means of access may be susceptible to damage during normal cargo loading and unloading operations or where it is impracticable to fit permanent means of access, PRS may allow, instead thereof, the provision of movable or portable means of access, as specified in the subparagraph 12.3.5, provided that the means of attaching, rigging, suspending or supporting the portable means of access forms a permanent part of the ship's structure. All portable equipment shall be capable of being readily erected or deployed by ship's personnel.

Some possible alternative means of access are listed in the paragraph 12.3.5.10. Always subject to acceptance as equivalent by the Administration, alternative means such as an unmanned root arm, ROVs and dirigibles with necessary equipment of the permanent means of access for overall and close-up inspections and thickness measurements of the deck head structure such as deck transverses and deck longitudinals of cargo oil tanks and ballast tanks, should be capable of:

- safe operation in ullage space in gas-free environment; and
- introduction into the place directly from a deck access.

The construction and materials of all means of access and their attachment to the ship's structure shall fulfil PRS rules. The means of access are subject to survey prior to, or in conjunction with, its use in carrying out surveys.

**The means of access arrangements, including portable equipment and attachments, should be annually inspected by the crew or competent inspectors and the inspections should be recorded in Part 2 of the Ship Structure Access Manual . In addition, prior to any space examinations that utilized the permanent means of access, an inspection to confirm the condition of the permanent means of access should be recorded for each space. (MSC.1/Circ/1572/Rev.2)**

Procedures:

- a) Any Company authorized person using the means of access should assume the role of inspector and check for obvious damage prior to using the access arrangements. Whilst using the means of access, the inspector should verify the condition of the sections used by close-up examination of those sections and note any deterioration in the provisions. Should any damage or deterioration be ascertained, it should be assessed if it affects the safety for continued use of the means of access. Deterioration found that is considered to affect safe use should be determined as "substantial damage" and measures should be put in place to ensure that the affected section(s) are not to be further used prior to effective repair. **Substantial damage should be reported in Part 2 of the Ship Structure Access Manual. (MSC.1/Circ/1572/Rev.2).**
- b) Statutory survey of any space that contains means of access should include verification of the continued effectiveness of the means of access in that space. Survey of the means of access should not be expected to exceed the scope and extent of the survey being undertaken. If the means of access is found deficient the scope of survey should be extended if this is considered appropriate.
- c) Records of all inspections should be established based on the requirements detailed in the ship's Safety Management System. The records should be readily available to persons using the means of access and a copy attached to the Ship Structure Access Manual. The latest record for the portion of the means of access inspected should include as a minimum the date of the inspection, the name and title of the inspector, a confirmation signature, the sections of means

of access inspected, verification of continued serviceable condition or details of any deterioration or substantial damage found. A file of permits issued should be maintained for verification. **Inspection records of permanent means of access should be made available to classification society surveyors priori to survey. (MSC.1/Circ/1572/Rev.2).**

### 12.3.3 Safe Access to Cargo Holds, Ballast Tanks and Other Spaces

**12.3.3.1** Safe access<sup>1</sup> to cargo holds, cofferdams, ballast tanks and other spaces in the cargo area shall be direct from the open deck and such as to ensure their complete inspection. Safe access<sup>1</sup> to double bottom spaces or to forward ballast tanks may be from a pump-room, deep cofferdam, pipe tunnel, cargo hold, double hull space or similar compartment not intended for the carriage of oil or hazardous cargoes.

Access to double side skin space of bulk carriers may be either from a topside tank or double bottom tank or from both.

The wording “not intended for the carriage of oil or hazardous cargoes” applies only to “similar compartments”, i.e. safe access can be through a pump-room, deep cofferdam, pipe tunnel, cargo hold or double-hull space.

**12.3.3.2** Tanks, and subdivisions of tanks, having a length of 35 m or more, shall be fitted with at least two access hatchways and ladders, as far apart as practicable. Tanks less than 35 m in length shall be served by at least one access hatchway and ladder. When a tank is subdivided by one or more swash bulkheads or similar obstructions which do not allow ready means of access to the other parts of the tank, at least two hatchways and ladders shall be fitted.

A cargo oil tank of less than 35 m length without a swash bulkhead requires only one access hatch.

Where rafting is indicated in the ship structures access manual as the means to gain ready access to the under-deck structure, the term “similar obstructions” referred to in the regulation includes internal structures (e.g. webs > 1.5 m deep) which restrict the ability to raft (at the maximum water level needed for rafting of under-deck structure) directly to the nearest access ladder and hatchway to deck. When rafts or boats alone, as an alternative means of access, are allowed under the conditions specified in the 2011 *ESP Code*, as amended permanent means of access are to be provided to allow safe entry and exit. This means:

- a) access direct from the deck via a vertical ladder and small platform fitted approximately 2 m below the deck in each bay; or
- b) access to the deck from a longitudinal permanent platform having ladders to the deck in each end of the tank. The platform should, for the full length of the tank, be arranged in level with, or above, the maximum water level needed for rafting of the under-deck structure. For this purpose, the ullage corresponding to the maximum water level should not be assumed more than 3 m from the deck plate measured at the midspan of deck transverses and in the middle length of the tank (see figure below). A permanent means of access from the longitudinal permanent platform to the water level indicated above should be fitted in each bay (e.g. permanent rungs on one of the deck webs inboard of the longitudinal permanent platform).

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<sup>1</sup> IMO Res. A1050(27).

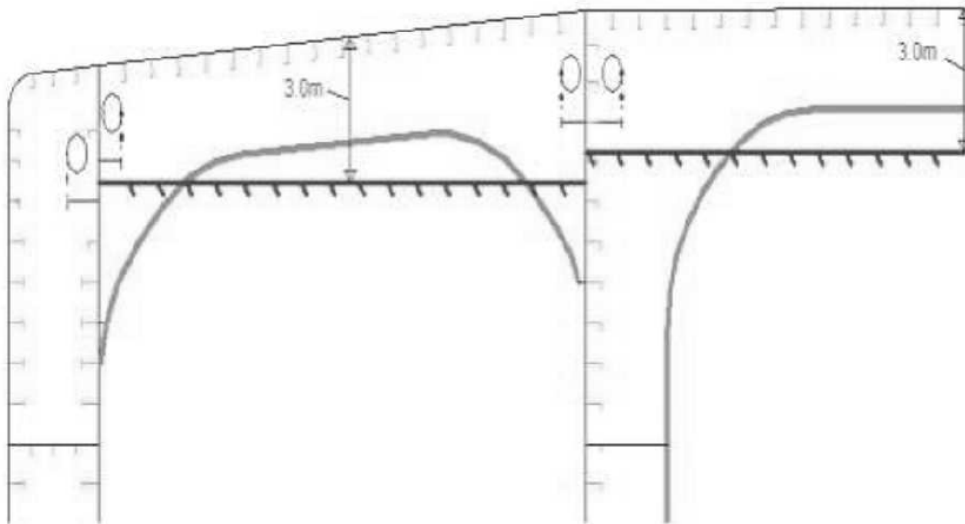


Fig. 12.3.3.2. Interpretation

**12.3.3.3** Each cargo hold should be provided with at least two ladders as far apart as practicable longitudinally. If possible, these ladders should be arranged diagonally, e.g. one ladder near the forward bulkhead on the port side, the other one near the aft bulkhead on the starboard side, from the ship's centerline. Ladders should be so designed and arranged that the risk of damage from the cargo handling gear is minimized.

#### 12.3.4 Ship Structure Access Manual

**12.3.4.1** A ship's means of access to carry out overall and close-up inspections and thickness measurements shall be described in a *Ship Structure Access Manual* approved by PRS on behalf of the administration, an updated copy of which shall be kept on board. The *Ship Structure Access Manual* shall include the following for each space:

- .1 plans showing the means of access to the space, with appropriate technical specifications and dimensions;
- .2 plans showing the means of access within each space to enable an overall inspection to be carried out, with appropriate technical specifications and dimensions. The plans shall indicate from where each area in the space can be inspected;
- .3 plans showing the means of access within the space to enable close-up inspections to be carried out with appropriate technical specifications and dimensions. The plans shall indicate the positions of critical structural areas, whether the means of access is permanent or portable and from where each area can be inspected;
- .4 instructions for inspecting and maintaining the structural strength of all means or access and means of attachment, taking into account any corrosive atmosphere that may be within the space;
- .5 instructions for safety guidance when rafting is used for close-up inspections and thickness measurements;
- .6 instructions for the rigging and use of any portable means of access in a safe manner;
- .7 an inventory of all portable means of access; and
- .8 records of periodical inspections and maintenance of the ship's means of access.



For the purpose of this requirement “critical structural areas”<sup>1</sup> are locations which have been identified from calculations (i.e. advanced calculation techniques for structural strength and fatigue performance, if available) to require monitoring or from the service history of, similar or sister ships to be sensitive to cracking, buckling, deformation or corrosion which would impair the structural integrity of the ship.

**12.3.4.2** *The Ship Structure Access Manual*<sup>2</sup> shall contain at least the following two parts:

- Part 1: Plans, instructions and inventory required by paragraphs 12.3.4.1.1 to 12.3.4.1.7. This part shall be approved by PRS;
- Part 2: Form of record of inspections and maintenance, and change of inventory of portable equipment due to additions or replacement after construction. This part shall be approved only at new building.

The following matters shall be addressed in the ship structure access manual:

- a) the *Access Manual* shall clearly cover scopes specified in the regulations for use by crews, surveyors and Port State Control officers;
- b) approval/re-approval procedure for the manual, i.e. any changes of the permanent, portable, movable or alternative means of access within the scope of the regulation and the Technical provisions are subject to review and approval by PRS;
- c) verification of means of access shall be part of safety construction survey for continued effectiveness of the means of access in that space which is subject to the statutory survey;
- d) inspection of means of access by the crew and/or a competent inspector of the company as a part of regular inspection and maintenance (see paragraph 2.3 of *SOLAS* regulation II-1/3-6);
- e) actions to be taken if means of access is found unsafe to use;
- f) in case of use of portable equipment, plans showing the means of access within each space with indication from where and how each area in the space can be inspected.

See also IACS Recommendation No. 90 “Ship Structural Access Manual.”

### 12.3.5 Technical Provisions for Means of Access

#### 12.3.5.1 Definitions

*Cross deck* – the transverse area of the main deck which is located inboard and between hatch coamings.

*Distance below deck head* – the distance below the plating.

*Flight of an inclined ladder* – the actual stringer length of an inclined ladder. For vertical ladders, it is the distance between the platforms.

*Inclined ladder* – a ladder of which the inclined angle is less than 70°.

*Overhead obstructions* – the deck or stringer structure including stiffeners above the means of access.

*Rung* – the step of a vertical ladder or step on the vertical surface, made as a single bar.

*Stringer:*

- the frame of a ladder; or

<sup>1</sup> Reference shall be made to the following publications for critical structural areas, where applicable:

- bulk carriers: Guidelines for Surveys, Assessment and Repair of Hull Structure by IACS;
- bulk carriers: resolution A.1049(27), as amended.

<sup>2</sup> The *Manual* shall address spaces listed in 12.3.3. As a minimum the English version shall be provided.



- the stiffened horizontal plating structure fitted on the side shell, transverse bulkheads and/or longitudinal bulkheads in the space.

For the purpose of ballast tanks of less than 5 m width forming double side spaces, the horizontal plating structure is credited as a stringer and a longitudinal permanent means of access, if it provides a continuous passage of 600 mm or more in width past frames or stiffeners on the side shell or longitudinal bulkhead. Openings in stringer plating utilized as permanent means of access shall be arranged with guard rails or grid covers to provide safe passage on the stringer or safe access to each transverse web.

*Tread* – the step of an inclined ladder or horizontal step for the vertical access opening.

*Vertical ladder* – a ladder of which the inclined angle is 70° and over up to 90°. A vertical ladder shall not be skewed by more than 2°.

**12.3.5.2** Structural members subject to the close-up inspections and thickness measurements of the ships structure except those in double bottom spaces, shall be provided with a permanent means of access to the extent as specified in table 12.3.5.2, as applicable. The permanent means of access to a space can be credited for the permanent means of access for inspection. For wing ballast tanks of ore carriers approved by PRS, alternative methods may be used in combination with the fitted permanent means of access approved by PRS, provided that the structure allows for its safe and effective use.

Detailed interpretations of the requirements in Table 12.3.5.2 are contained in an IACS UI SC 191/Rev.8.

**12.3.5.3** Permanent means of access shall as far as possible be integral to the structure of the ships.

**Table 12.3.5.2**  
**Means of access for bulk carriers\*)**

1 Cargo holds	2 Ballast tanks
<p><b>Access to underdeck structure</b></p> <p><b>1.1</b> Permanent means of access shall be fitted to provide access to the overhead structure at both sides of the cross deck and in the vicinity of the centreline. Each means of access shall be accessible from the cargo hold or directly from the main deck and installed at a minimum of 1.6 m to a maximum of 3 m below the deck. Means of access should be provided to the cross-deck structures of the foremost and aftmost part of each cargo hold. Interconnected means of access under the cross deck for access to three locations at both sides and in the vicinity of the centerline should be acceptable as the three means of access. Permanent means of access fitted at three separate locations accessible independently, one at each side and one in the vicinity of the centerline, should be acceptable. Special attention should be paid to the structural strength where any access opening is provided in the main deck or cross deck. The requirements for bulk carrier cross-deck structure should also be considered applicable to ore carriers.</p>	<p><b>Top side tanks</b></p> <p><b>2.1</b> For each topside tank of which the height is 6 m and over, one longitudinal continuous permanent means of access shall be provided along the side shell webs and installed at a minimum of 1.6 m to a maximum of 3 m below deck with a vertical access ladder in the vicinity of each access to that tank.</p> <p><b>2.2</b> If no access holes are provided through the transverse webs within 600 mm of the tank base and the web frame rings have a web height greater than 1 m in way of side shell and sloping plating, then step rungs/grab rails shall be provided to allow safe access over each transverse web frame ring.</p> <p><b>2.3</b> Three permanent means of access, fitted at the end bays and middle bay of each tank, shall be provided spanning from tank base up to the intersection of the sloping plate with the hatch side girder. The existing longitudinal structure, if fitted on the sloping plate in the space may be used as part of this means of access. If the longitudinal structures on the sloping plate are fitted outside of the tank, a means of access should be provided.</p>

1 Cargo holds	2 Ballast tanks
<p><b>1.2</b> An athwartship permanent means of access fitted on the transverse bulkhead at a minimum 1.6 m to a maximum 3 m below the cross-deck head is accepted as equivalent to 1.1.</p> <p><b>1.3</b> Access to the permanent means of access to overhead structure of the cross deck may also be via the upper stool. Particular attention should be paid to preserve the structural strength in way of access opening provided in the main deck or cross deck.</p> <p><b>1.4</b> Ships having transverse bulkheads with full upper stools with access from the main deck which allows monitoring of all framing and plates from inside do not require permanent means of access to the cross deck. “Full upper stools” are understood to be stools with a full extension between topside tanks and between hatch end beams.</p> <p><b>1.5</b> Alternatively, movable means of access may be utilized for access to the overhead structure of the cross deck if its vertical distance is 17 m or less above the tank top. The movable means of access to the under-deck structure of cross deck need not necessarily be carried on board the ship. It should be sufficient if it is made available when needed.</p>	<p><b>2.4</b> For topside tanks of which the height is less than 6 m, alternative means as defined in paragraph 12.3.5.10 or portable means may be utilized instead of the permanent means of access.</p> <p><b>Bilge hopper tanks</b></p> <p><b>2.5</b> For each bilge hopper tank of which the height is 6 m and over, one longitudinal continuous permanent means of access shall be provided along the side shell webs and installed at a minimum of 1.2 m below the top of the clear opening of the web ring with a vertical access ladder in the vicinity of each access to the tank. The height of a bilge hopper tank located outside of the parallel part of the vessel should be taken as the maximum of the clear vertical height measured from the bottom plating to the hopper plating of the tank. It should be demonstrated that portable means for inspection can be deployed and made readily available in the areas where needed.</p> <p><b>2.5.1</b> An access ladder between the longitudinal continuous permanent means of access and the bottom of the space shall be provided at each end of the tank.</p>
<p>The requirements for a bulk carrier cross-deck structure should also be considered applicable to ore carriers.</p> <p><b>Access to vertical structures</b></p> <p><b>1.6</b> Permanent means of vertical access shall be provided in all cargo holds and built into the structure to allow for an inspection of a minimum of 25 % of the total number of hold frames port and starboard equally distributed throughout the hold including at each end in way of transverse bulkheads. But in no circumstance is this arrangement to be less than 3 permanent means of vertical access fitted to each side (fore and aft ends of hold and mid-span). Permanent means of vertical access fitted between two adjacent hold frames is counted for an access for the inspection of both hold frames. A means of portable access may be used to gain access over the sloping plating of lower hopper ballast tanks. The maximum vertical distance of the rungs of vertical ladders for access to hold frames should be 350 mm. If a safety harness is to be used, means should be provided for connecting the safety harness in suitable places in a practical way.</p> <p><b>1.7</b> In addition, portable or movable means of access shall be utilized for access to the remaining hold frames up to their upper brackets and transverse bulkheads. Portable, movable or alternative means of access should also be applied to corrugated bulkheads.</p>	<p><b>2.5.2</b> Alternatively, the longitudinal continuous permanent means of access can be located through the upper web plating above the clear opening of the web ring, at a minimum of 1.6 m below the deck head, when this arrangement facilitates more suitable inspection of identified structurally critical areas. A wide longitudinal frame (of at least 600 mm clear width) may be used for the purpose of the longitudinal continuous permanent means of access. For the foremost and aftermost bilge hopper ballast tanks with raised bottom, of which the height is 6 m and over, a combination of transverse and vertical means of access to the sloping plate of hopper tank construction with side shell plating for each transverse web can be accepted in place of the longitudinal permanent means of access. A wide longitudinal frame of at least 600 mm clear width may be used for the purpose of the longitudinal continuous permanent means of access. The foremost and aftermost bilge hopper ballast tanks with raised bottom, of which the height is 6 m and over, a combination of transverse and vertical means of access to the sloping plate of hopper tank connection with side shell plating for each transverse web can be</p>

1 Cargo holds	2 Ballast tanks
<p><b>1.8</b> Portable or movable means of access may be utilized for access to hold frames up to their upper bracket in place of the permanent means required in 1.6. Such means of access shall be carried on board and readily available for use, i.e. able to be transported to location in cargo hold and safely erected by ship's staff.</p> <p><b>1.9</b> The width of vertical ladders for access to hold frames shall be at least 300 mm, measured between stringers.</p> <p><b>1.10</b> A single vertical ladder over 6 m in length is acceptable for the inspection of the hold side frames in a single skin construction.</p> <p><b>1.11</b> For double-side skin construction no vertical ladders for the inspection of the cargo hold surfaces are required. Inspection of this structure shall be provided from within the double hull space.</p>	<p>accepted in place of the longitudinal permanent means of access.</p> <p><b>2.5.3</b> For double-side skin bulk carriers, the longitudinal continuous permanent means of access may be installed within 6 m from the knuckle point of the bilge, if used in combination with alternative methods to gain access to the knuckle point.</p> <p><b>2.6</b> If no access holes are provided through the transverse ring webs within 600 mm of the tank base and the web frame rings have a web height greater than 1 m in way of side shell and bottom plating, then step rungs/grab rails shall be provided to allow safe access over each transverse web frame ring. The height of web frame rings should be measured in way of side shell and tank base.</p> <p><b>2.7</b> For bilge hopper tanks of which the height is less than 6 m, alternative means as defined in 12.3.5.10 or portable means may be utilized instead of the permanent means of access. Such means of access shall be demonstrated that they can be deployed and made readily available in the areas where needed.</p> <p><b>Double-skin side tanks</b></p> <p><b>2.8</b> Permanent means of access shall be provided in accordance with the applicable sections of table 11.6.5.</p> <p><b>Fore peak tanks</b></p> <p><b>2.9</b> For fore peak tanks with a depth of 6 m or more at the centreline of the collision bulkhead, a suitable means of access shall be provided for access to critical areas such as the underdeck structure, stringers, collision bulkhead and side shell structure.</p> <p><b>2.9.1</b> Stringers of less than 6 m in vertical distance from the deck head or a stringer immediately above are considered to provide suitable access in combination with portable means of access.</p> <p><b>2.9.2</b> In case the vertical distance between the deck head and stringers, stringers or the lowest stringer and the tank bottom is 6 m or more, alternative means of access as defined in paragraph 12.3.5.10 shall be provided.</p>

<sup>\*)</sup> For oil/ore carriers, permanent means of access shall be provided in accordance with the applicable sections of table 11.6.5.15 and table 12.3.5.2.

**12.3.5.4** Elevated passageways forming sections of a permanent means of access, where fitted shall have a minimum clear width of 600 mm, except for going around vertical webs where the minimum clear width may be reduced to 450 mm, and have guard rails over the open side of their entire length (passageways which are not integrated with ship's construction shall have guard rails on both the sides).

Sloping structure<sup>1</sup> providing part of the access shall be of a non-skid construction. Non-skid construction is such that the surface on which personnel walks provides sufficient friction to the sole of boots even if the surface is wet and covered with thin sediment.

Guard rails should be fitted on the open side and should be at least 1000 mm in height and consist of a rail and intermediate rail 500 mm height and of substantial construction<sup>2</sup>. For stand-alone passageways guard rails should be fitted on both side these structures. The distance between the passageway and the intermediate rail and the distance between intermediate rail and the top rail shall not be more than 500 mm. Guard rail stanchions shall be attached to the permanent means of access and are be less than 3 m apart.

Discontinuous top handrails are allowed, provided the gap does not exceed 50 mm. The same maximum gap shall be considered between the top handrail and other structural members (i.e. bulkhead, web frame, etc.).

The maximum distance between the adjacent stanchions across the handrail gaps shall be 350 mm where the top and mid handrails are not connected together and 550 mm when they are connected together.

The maximum distance between the stanchion and other structural members shall not exceed 200 mm where the top and mid handrails are not connected together and 300 mm when they are connected together.

When the top handrail is bent at its ends, the outside radius of the bent part shall not exceed 100 mm (see Fig. 12.3.5.4).

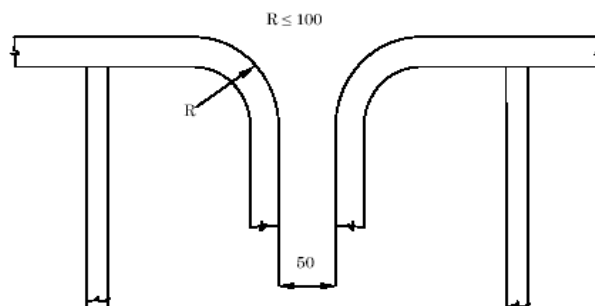


Fig. 12.3.5.4

**12.3.5.5** Access to permanent means of access and vertical openings from the ship's bottom shall be provided by means of easily accessible passageways, ladders or treads.

Treads shall be provided with lateral support for the foot. Where the rungs of ladders are fitted against a vertical surface, the distance from the centre of the rungs to the surface shall be at least 150 mm. Where vertical manholes are fitted higher than 600 mm above the walking level, access shall be facilitated by means of treads and hand grips with platform landings on both sides and should be demonstrated that an injured person can be easily evacuated.

<sup>1</sup> „Sloping structures” are structures that are sloped by 5 or more degrees from horizontal plane when a ship is in upright position at even-keel.

<sup>2</sup> “Substantial construction” is taken to refer to the as-designed strength as well as the residual strength during the service life of the vessel. Durability of passageways together with guard rails should be ensured by the initial corrosion protection and inspection and maintenance during services.

**12.3.5.6** Permanent inclined ladders should be at an angle of less than 70 degrees to the horizontal and should comprise one or more ladder linking platforms spaced not more than 6 m apart vertically and displaced to one side of the ladder. There shall be no obstruction within 750 mm of the face of the inclined ladder, except that in way of an opening this clearance may be reduced to 600 mm. Adjacent sections of ladder should be laterally offset from each other by at least the width of the ladder.

Ladders and handrails shall be constructed of steel or equivalent material<sup>1</sup> of adequate strength and stiffness and securely attached to the structure by stays. The method of support and length of stay shall be such that vibration is reduced to a practical minimum.

In cargo holds, ladders shall be designed and arranged so that cargo handling difficulties are not increased and the risk of damage from cargo handling gear is minimized.

Tunnels passing through cargo holds should be equipped with ladders or steps at each end of the hold so that personnel may easily get across such tunnels.

**12.3.5.7** The width between stringers of inclined ladders for access to a cargo hold shall not be less than 450 mm. The width of inclined ladders other than an access to cargo hold shall not be less than 400 mm.

The treads shall be equally spaced at a distance apart, measured vertically, of between 200 mm and 300 mm. When steel is used, the treads shall be formed of two square bars of not less than 22 mm by 22 mm in section, fitted to form a horizontal step with the edges pointing upward. The treads shall be carried through the side stringers and attached thereto by double continuous welding. All inclined ladders shall be provided with handrails of substantial construction on both sides. Vertical height of handrails shall not be less than 890 mm from the centre of the step and two course handrails shall be provided where the gap between the stringer and the top handrail is greater than 500 mm.

**12.3.5.8** For vertical ladders or spiral ladders, the width and construction shall fulfil international or national standards accepted by the Administration. PRS recommendations are as follows:

- for vertical ladders when steel is used, the rungs shall be formed of single square bars of not less than 22 mm by 22 mm;
- the minimum width of vertical ladders shall be 350 mm and the vertical distance between the rungs shall be equal and shall be between 250 mm and 350 mm;
- the vertical ladders shall be secured at intervals not exceeding 2.5 m apart to prevent vibration;
- a minimum climbing clearance in width shall be 600 mm for the ladder other than these placed between the hold frames.

**12.3.5.9** No free-standing portable ladder shall be more than 5 m long. Portable ladders more than 5 m long may only be utilized if fitted with a mechanical device to secure the upper end of the ladder. A mechanical device such as hooks for securing at the upper end of a ladder should be considered as an appropriate securing device if a movement fore/aft and sideways can be prevented at the upper end of the ladder.

Innovative design is to be accepted if it fits the functional requirement with due consideration for safe use.

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<sup>1</sup> For guard rails, use of alternative materials such as GRP, is to be subject to compatibility with the liquid carried in the tank. Non-fire resistant materials should not be used for means of access to a space with a view to securing an escape route at a high temperature.

**12.3.5.10** Alternative means of access include, but are not limited to, such devices as:

- hydraulic arm fitted with a stable base;
- wire lift platform;
- staging;
- rafting;
- robot arm or remotely operated vehicle (ROV);
- portable ladders more than 5 m long shall only be utilized if fitted with a mechanical device to secure the upper end of the ladder;
- other means of access, approved by, or acceptable to the Administration.

Means for safe operation and rigging of such equipment to and from and within the spaces shall be clearly described in the *Ship Structure Access Manual*.

Guidelines for approval or acceptance of the alternative means of access are contained in *Publication 27/I*.

**12.3.5.11** For access through horizontal openings, hatches and manholes, the minimum clear opening should be not less than 600 mm × 600 mm. Openings of 600 mm by 600 mm minimum clearance, or larger, should be provided in each horizontal girder in vertical alignment within the vertical wing space. The term minimum clear opening of not less than 600 mm by 600 mm means that such openings may have corner radii up to 100 mm maximum, due regard being given to stress concentration. When it is considered appropriate to take measures to reduce the stress in corners, the larger opening with increased radii eg. 600 mm × 800 mm with 300 mm radii, shall be provided.

Any opening or open hatchway larger than 200 mm diameter on bulkhead stringers and horizontal girders should be fitted with gratings or safety guide rails of adequate design and construction. The free edge of walkways, bulkhead stringers and horizontal girders should be fitted with two-tier guide rails and vertical plate at least 50 mm high around edge of platform except in way of ladder. Guide rails or fencing should be free from sharp edges and should consist of an upper rail area height of 900 mm and an intermediate rail at a height of 500 mm. The rails may, where necessary, consist of taut wire or taut chain. Step rungs and grip rails should be provided on inclined or curved surfaces to assist footing.

Access hatch coamings having a height greater than 450 mm should be fitted with steps or footholds inside the coaming and, if greater than 900 mm, should also have steps on the outside in conjunction with cargo hold ladders.

Guidelines for approval or acceptance of the alternative means of access are contained in *Publication 27/I*.

**12.3.5.12** If separate hatches are used to access the ladders required in each cargo hold, each hatch should have a clear opening of at least 600 mm by 600 mm. When access to a cargo hold is arranged through the cargo hatch, the top of the ladder shall be placed as close as possible to the hatch coaming.

The access hatch and associated ladders should, unless used solely for inspection and maintenance and not for operational access, be located such that a person using them will not enter the volume defined by the vertical projection upwards and downwards of the uppermost cargo hatchway. Accesses and ladders should be so arranged that personnel equipped with self-contained breathing apparatus may readily enter and leave the cargo hold.

Where the dimensions of the bottom panel may hinder the cut of an opening compliant with the above requirements, smaller dimensions of openings, particularly for the access within the double bottom, may be accepted by PRS, provided that it is demonstrated that an injured person can be removed from the space.



**12.3.5.13** For access through vertical openings, or manholes providing passage through the length and breadth of the space, the minimum clear opening should be not less than 600 mm by 800 mm, at a height of not more than 600 mm from the bottom shell plating or stringer unless gratings or other footholds are provided. Such openings should be provided with grab bars.

The term minimum clear opening of not less than 600 mm by 800 mm also includes an opening with corner radii of 300 mm. An opening of 600 mm in height × 800 mm in width may be accepted as access opening in vertical structures where it is not desirable to make large openings in the structural strength aspects, i.e. in girders and floors in double bottom tanks. For inspection purposes, an adequate number of vertical access openings should be provided.

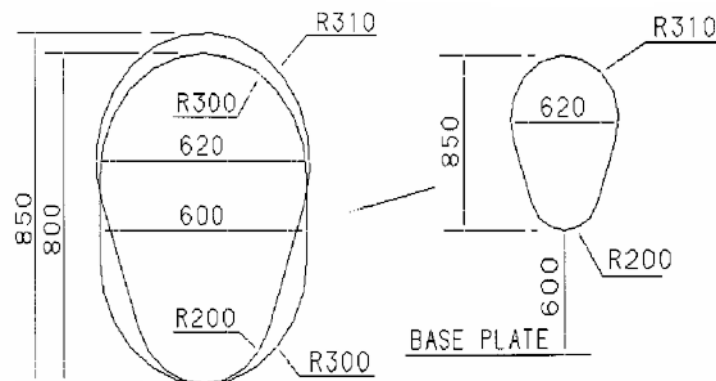


Fig. 12.3.5.13

Subject to verification of easy evacuation of injured person on a stretcher, the vertical opening 850 mm × 620 mm with upper half wider than 600 mm, while the lower half may be less than 600 mm with the overall height not less than 850 mm is considered an acceptable alternative to the traditional opening of 600 mm × 800 mm with corner radii of 300 mm.

If a vertical opening is at a height of more than 600 mm, steps and handgrips shall be provided. In such arrangements it shall be demonstrated that an injured person can be easily evacuated.

**12.3.5.14** For bulk carriers, access ladders to cargo holds and other spaces shall be:

- .1 Where the vertical distance between the upper surface of adjacent decks or between deck and the bottom of the cargo space is not more than 6 m, either a vertical ladder or an inclined ladder<sup>1</sup>.
- .2 Where the vertical distance between the upper surface of adjacent decks or between deck and the bottom of the cargo space is more than 6 m, an inclined ladder or series of inclined ladders at one end of the cargo hold, except the uppermost 2.5 m of a cargo space measured clear of overhead obstructions and the lowest 6 m may have vertical ladders, provided that the vertical extent of the inclined ladder or ladders connecting the vertical ladders is not less than 2.5 m.

The second means of access at the other end of the cargo hold may be formed of a series of staggered vertical ladders, which shall comprise one or more ladder linking platforms spaced not more than 6 m apart vertically and displaced to one side of the ladder. Adjacent sections of ladder shall be laterally offset from each other by at least the width of the ladder<sup>2</sup>.

<sup>1</sup> Either a vertical or an inclined ladder or a combination of them may be used for access to a cargo hold where the vertical distance is 6 m or less from the deck to the bottom of the cargo hold. Deck is defined as "weather deck".

<sup>2</sup> The minimum "lateral offset" between two adjacent sections of a vertical ladder is the distance between the sections, upper and lower, so that the adjacent stringers are spaced of at least 200 mm, measured from half thickness of each stringer.



The uppermost entrance section of the ladder directly exposed to a cargo hold shall be vertical for a distance of 2.5 m measured clear of overhead obstructions and connected to a ladder-linking platform. Adjacent sections of a vertical ladder shall be installed so that the upper end of the lower section is vertically overlapped, in respect to the lower end of the upper section, to a height of 1500 mm in order to permit a safe transfer between ladders. No section of the access ladder shall be terminated directly or partly above an access opening. For permitted designs see Fig.12.3.5.14 a) and b).

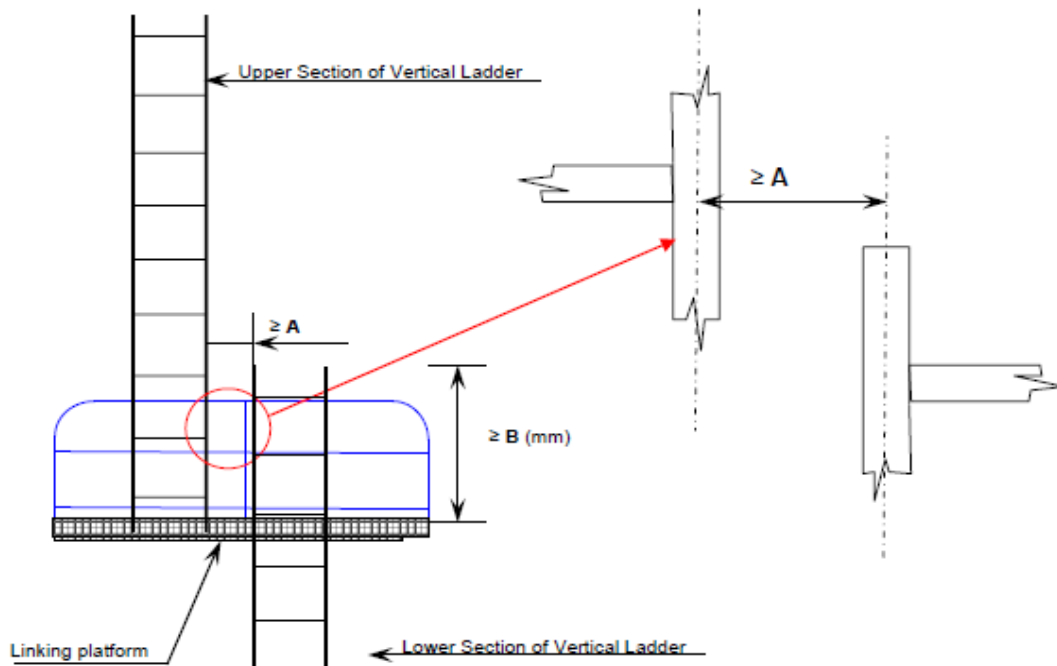
- .3 A vertical ladder may be used as a means of access to topside tanks, where the vertical distance is 6 m or less between the deck and the longitudinal means of access in the tank or the stringer or the bottom of the space immediately below the entrance. The uppermost entrance section from deck of the vertical ladder of the tank shall be vertical for a distance of 2.5 m measured clear of overhead obstructions and comprise a ladder linking platform, unless landing on the longitudinal means of access, the stringer or the bottom within the vertical distance of 2.5 m, displaced to one side of a vertical ladder.
- .4 Unless allowed in .3 above, an inclined ladder or combination of ladders shall be used for access to a tank or a space where the vertical distance is greater than 6 m between the deck and a stringer immediately below the entrance, between stringers, or between the deck or a stringer and the bottom of the space immediately below the entrance.
- .5 In case of .4 above, the uppermost entrance section from deck of the ladder shall be vertical for a distance of 2.5 m clear of overhead obstructions and connected to a landing platform and continued with an inclined ladder.

The flights of inclined ladders shall not be more than 9 m in actual length and the vertical height is normally to be no more than 6 m. The lowermost section of the ladders may be vertical for a distance of not exceeding 2.5 m.

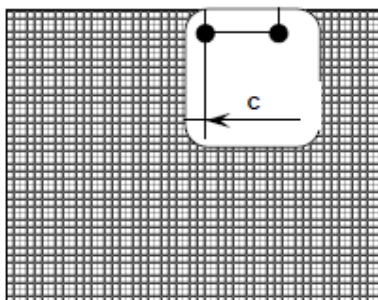
- .6 In double-side skin spaces of less than 2.5 m in width, the access to the space may be by means of vertical ladders that comprise one or more ladder linking platforms spaced not more than 6 m apart vertically and displaced to one side of the ladder. Adjacent sections of ladder shall be laterally offset from each other by at least the width of the ladder<sup>1</sup>. For permitted design see Fig. 12.3.5.14 b). No section of the access ladder shall be terminated directly or partly above an access opening.
- .7 A spiral ladder is considered acceptable as an alternative to inclined ladders. In this regard, the uppermost 2.5 m can continue to be consisted of the spiral ladder and need not change over to vertical ladders.

<sup>1</sup> The minimum "lateral offset" between two adjacent sections of a vertical ladder is the distance between the sections, upper and lower, so that the adjacent stringers are spaced of at least 200 mm, measured from half thickness of each stringer.

a) Ladder through linking platform



Dimension		
A	Horizontal separation between two vertical ladders, stringer to stringer	$\geq 200 \text{ mm}$
B	Stringer height above landing or intermediate platform	$\geq 1500^* \text{ mm}$
C	Horizontal separation between ladder and platform	$100 \text{ mm} \leq C < 300 \text{ mm}$
*Note: the minimum height of the handrail stanchions of resting platform is of 1000 mm (Technical Provision, resolution MSC.158(78), paragraph 3.3)		



b) Side mount

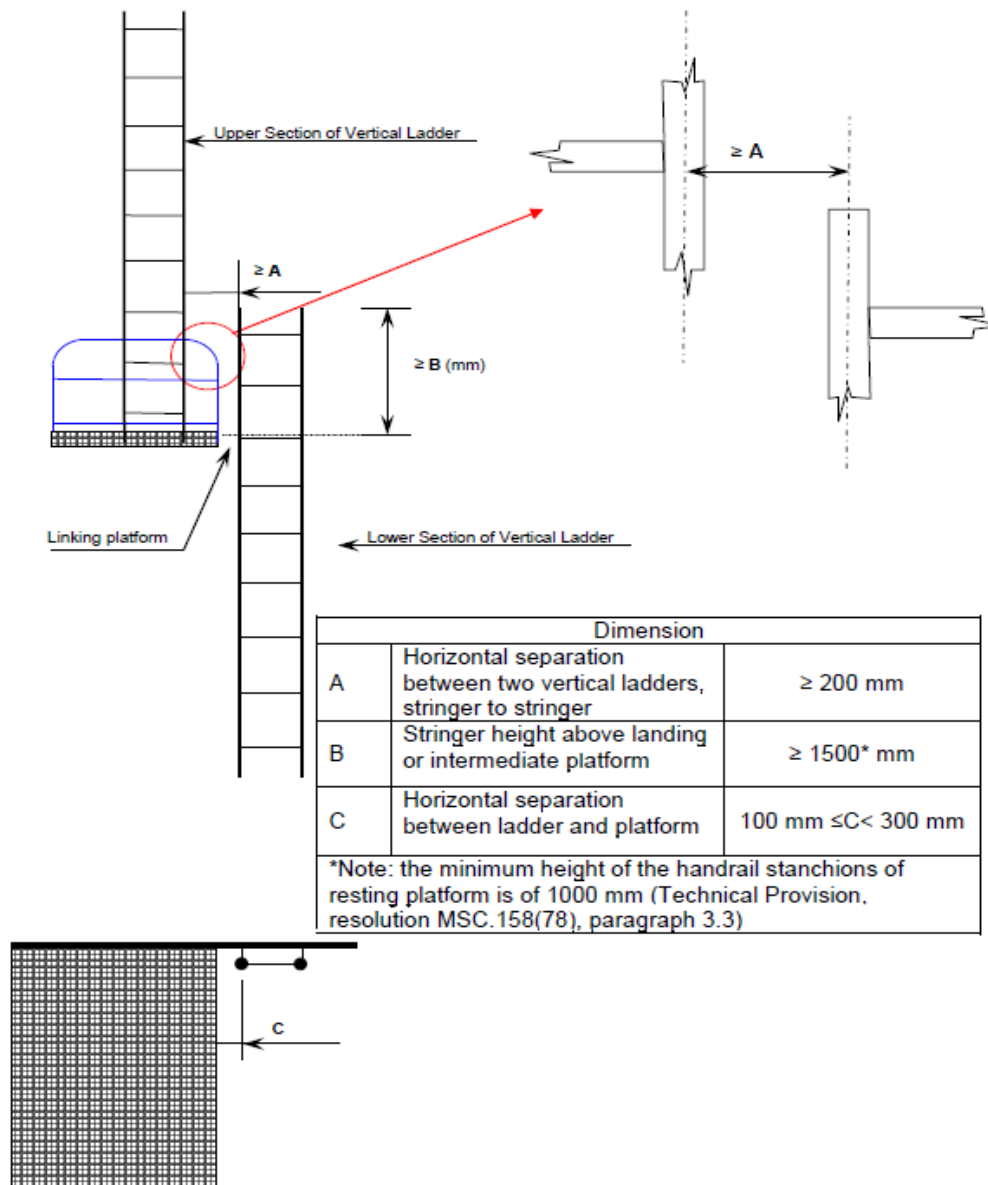


Fig. 12.3.5.14. Arrangement of vertical ladders and platforms

**12.3.5.15** The uppermost entrance section from deck of the vertical ladder providing access to a tank shall be vertical for a distance of 2.5 m measured clear of overhead obstructions and comprise a ladder linking platform, displaced to one side of a vertical ladder. The vertical ladder can be between 1.6 m and 3 m below deck structure if it lands on a longitudinal or athwartship permanent means of access fitted within that range.

**12.4 Flooding detection systems on bulk carriers**

Bulk carriers subject to SOLAS Convention shall be provided with water level detection systems in accordance with the requirements specified in subchapter 22.8.1 of *Part VIII* of the Rules. (SOLAS XII/12)

## 13 PASSENGER SHIPS AND SPECIAL PURPOSE SHIPS

### 13.1 General

#### 13.1.1 Application

**13.1.1.1** The requirements of the present Chapter 13 apply to ships assigned additional marks: **PASSANGER SHIP** or **SPECIAL PURPOSE SHIP** in the symbol of class.

**13.1.1.2** Passenger ships engaged on domestic voyages and assigned in the symbol of class, in addition to the mark **PASSENGER SHIP**, one of the following additional marks: **Class A**, **Class B**, **Class C** or **Class D**, shall comply with the general requirements and the requirements of Chapter 13 (with the exception of 13.3, 13.4, 13.5, 13.7, 13.8) of this *Part III* and the requirements of *Publication 100/P*.

**13.1.1.3** Designs of passenger ships shall reflect the safety guidelines referring to passengers with restricted mobility as per MSC/Circ.735.

**13.1.1.4** Taking into account paragraph 1.8.3, in **class B, C or D** passenger ships of gross tonnage less than 1,600, measures shall be taken to reduce machinery noise in machinery spaces to acceptable levels as determined by the Administration. If this noise cannot be sufficiently reduced, the source of excessive noise shall be suitably insulated or isolated or a refuge from noise shall be provided if the space is required to be manned.

### 13.2 Closing Appliances of Openings

#### 13.2.1 Side Scuttles

**13.2.1.1** Side scuttles of opening type fitted in the shell plating below the bulkhead deck shall have, instead of one of the earnuts securing their frame, a nut being screwed off with a special wrench only.

**13.2.1.2** Efficient hinged inside deadlights so arranged that they can be easily and effectively closed and secured watertight, shall be fitted to all sidescuttles except that abaft  $0.125L$  from the forward perpendicular and above a line drawn parallel to the bulkhead deck at side and having its lowest point at a height of 3700 mm plus  $0.025B$  above the deepest subdivision draught, the deadlights may be portable in passenger accommodation, unless the deadlights are required by *the International Convention on Load Lines* in force to be permanently attached in their proper positions. Such portable deadlights shall be stowed adjacent to the sidescuttles they serve.

**13.2.1.3** No side scuttles shall be fitted in any spaces situated below the bulkhead deck and intended for the carriage of cargoes.

**13.2.1.4** Side scuttles may be fitted in spaces intended for the alternate carriage of cargo and passengers or cargo and special personnel. Where such side scuttles are of opening type, they shall have, instead of one of the earnuts securing their frame, a nut which can be screwed off with a special wrench only.

**13.2.1.5** No exhaust or supply ventilators shall be fitted in side scuttles.

#### 13.2.2 Discharge Openings

**13.2.2.1** Closures of discharge openings shall be closed and opened with the use of hydraulic pumps manually or mechanically operated, either individually or in groups from a place above a freeboard deck and also individually manually from a place in which they are located. The time necessary for closing shall be as short as possible.

**13.2.2.2** In ships with ro-ro spaces, the requirements of 7.4.7 and 7.5.6 shall be fulfilled for all openings through which, in PRS' opinion – when left open or improperly secured – a serious flooding of the ship's inside may occur.

**13.2.2.3** In special purpose ships, the number and size of discharge openings used for discharge of waste from the processing spaces, located below the freeboard deck, are to be reduced to the minimum necessary for normal ship operation. Closures of these openings shall be located as high as possible above the summer load line.

### **13.2.3 Integrity of the Hull and Superstructure, Damage Prevention and Control in Ro-ro Passenger Ships**

The requirements of this subchapter are fully applicable to ships subject to SOLAS Convention. Other ships shall meet these requirements as far as possible.

**13.2.3.1** All access from the ro-ro deck that leads to spaces below the bulkhead deck shall have a lowest point which is not less than 2.5 m above the bulkhead deck,\* unless the access is covered by the requirements of paragraphs 13.2.3.2 or 13.2.3.3. (SOLAS II-1/17-1.1.1)

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\* See Explanatory Note on SOLAS regulation II-1/17-1.1.1 (Res. MSC.429/Rev.2)

**13.2.3.2** Where vehicle ramps are installed to give access to spaces below the bulkhead deck, their openings shall be able to be closed weathertight to prevent ingress of water below and fitted with alarms and open/close indicators on the navigation bridge. The means of closure shall be watertight if the deck is intended as a watertight horizontal boundary under SOLAS regulation II-1/7-2.6. (SOLAS II-1/17-1.1.2)

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\* See Explanatory Note on SOLAS regulation II-1/17-1.1.2. (Res. MSC.429/Rev.2)

**13.2.3.3** Taking into account the need to close the entrances before the commencement of the voyage, in accordance with SOLAS II-1/23.3 and 23.6, the Administration, may permit the fitting of particular accesses from the ro-ro deck to spaces below the bulkhead deck, provided they are necessary for the essential working of the ship, e.g. the movement of machinery and stores, subject to such accesses being made watertight, fitted with alarms and open/close indicators on the navigation bridge. (SOLAS II-1/17-1.1.3)

**13.2.3.4** Indicators shall be provided on the navigation bridge for all shell doors, loading doors and other closing appliances which, if left open or not properly secured, could, in the opinion of the Administration, lead to flooding of a special category space or ro-ro space. The indicator system shall be designed on the fail-safe principle and shall show by visual alarms if the door is not fully closed or if any of the securing arrangements are not in place and fully locked and by audible alarms if such door or closing appliances become open or the securing arrangements become unsecured. The indicator panel on the navigation bridge shall be equipped with a mode selection function "harbour/sea voyage" so arranged that an audible alarm is given on the navigation bridge if the ship leaves harbour with the bow doors, inner doors, stern ramp or any other side shell doors not closed or any closing device not in the correct position. The power supply for the indicator system shall be independent of the power supply for operating and securing the doors. (SOLAS II-1/17-1.2)

**13.2.3.5** Television surveillance and a water leakage detection system shall be arranged to provide an indication to the navigation bridge and to the engine control station of any leakage through inner and outer bow doors, stern doors or any other shell doors which could lead to flooding of special category spaces or ro-ro spaces. (SOLAS II-1/17-1.3)

### 13.3 Means of Escape

Means of escape shall comply with the applicable requirements of *Part V* of the Rules.

### 13.4 Doors

#### 13.4.1 General

**13.4.1.1** The requirements of 7.3 shall be applicable but doors in watertight bulkheads shall fulfil the requirements of sub-chapter 21.2.1.

**13.4.1.2** Watertight doors permitted to remain open during navigation shall be clearly indicated in the ship's *Stability booklet*.

**13.4.1.3** For passenger and special purpose ships, portable plates on bulkheads shall not be permitted except in machinery spaces.

### 13.5 Steering Gear

#### 13.5.1 Requirements for Passenger Ships

**13.5.1.1** Where the main steering gear comprises two or more identical power units, an auxiliary steering gear need not be fitted provided that if the main steering gear is capable of operating the rudder as required by 2.6.1.2 while any one of the power units is out of operation.

**13.5.1.2** For a ship fitted with multiple steering propulsion units, where each main steering system comprises two or more identical steering actuating systems, an auxiliary steering gear need not be fitted, provided that each steering gear is capable of satisfying the requirements of 2.6.1.2 while any one of the steering gear steering actuating systems is out of operation.

**13.5.1.3** For a ship fitted with a single steering-propulsion unit where the main steering gear comprises two or more identical power units and two or more identical steering actuators, an auxiliary steering gear need not be fitted provided that the steering gear is capable of satisfying the requirements of 2.6.1.2 while any one of the power units is out of operation.

#### 13.5.2 Requirements for Special Purpose Ships

Where the main steering gear is fitted with at least two identical power units, an auxiliary steering gear need not be fitted if the steering gear may operate in compliance with the requirements of 2.6.1.2:

- with any power unit inoperative – in ships having on board over 240 persons of special personnel;
- with all power units operative – in ships having on board not more than 240 persons of special personnel.

### 13.6 Ventilation Trunks on Passenger Ships

**13.6.1** In passenger ships, where a ventilation trunk passing through a structure penetrates a watertight area of 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 during flooding, in accordance with SOLAS II-1/7-2. (SOLAS II-11/16-1.2)

**13.6.2** In ro-ro passenger ships where all or part of the penetration of the bulkhead deck is on the main ro-ro deck, the trunk shall be capable of withstanding impact pressure due to internal water motions (sloshing) of water trapped on the ro-ro deck. (SOLAS II-1/16-1.3)



### 13.7 Patrolling or Monitoring of Spaces in Ro-ro Passenger Ships

**13.7.1** Special category spaces and ro-ro spaces shall be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorized access by passengers thereto can be detected during navigation. (SOLAS II-1/23.1)

**13.7.2** Documented operating procedures for closing and securing all shell doors, loading doors and other closing appliances which, if left open or not properly secured, could, in the opinion of the PRS or Administration, lead to flooding of a special category space or ro-ro space, shall be kept on board and posted at an appropriate place. (SOLAS II-1/23.2)

**13.7.3** On ships subject to SOLAS Convention the operating procedures required in par. 13.7.2 shall include the following information:

- .1 All accesses from the ro-ro deck and vehicle ramps that lead to spaces below the bulkhead deck shall be closed before the voyage commences and shall remain closed until the ship is at its next berth.
- .2 The master shall ensure that an effective system of supervision and reporting of the closing and opening of such accesses referred to in par. 1 is implemented.
- .3 The master shall ensure, before the voyage commences, that an entry in the log-book is made of the time of the last closing of the accesses referred to in par. 1.
- .4 Notwithstanding the requirements of par. 1, the Administration may permit some accesses to be opened during the voyage, but only for a period sufficient to permit through passage and, if required, for the essential working of the ship\*.
- .5 All transverse or longitudinal bulkheads which are taken into account as effective to confine the seawater accumulated on the ro-ro deck shall be in place and secured before the voyage commences and remain in place and secured until the ship is at its next berth.
- .6 Notwithstanding the requirements of par. 5, the Administration may permit some accesses within such bulkheads to be opened during the voyage but only for sufficient time to permit through passage and, if required, for the essential working of the ship.
- .7 In all ro-ro passenger ships, the master or the designated officer shall ensure that, without the expressed consent of the master or the designated officer, no passengers are allowed access to an enclosed ro-ro deck during navigation. (SOLAS II-1/23.3 to 9)

\* See Explanatory Note on SOLAS regulation II-1/23.6. (Res. MSC.429/Rev.2)

### 13.8 Flooding Detection Systems on Passenger Ships

**13.8.1** All passenger ships carrying 36 or more passengers shall be provided with flooding detection systems for watertight spaces below the bulkhead deck. (SOLAS II-1/22-1)

**13.8.2** A flooding detection system shall be fitted in all watertight spaces below the bulkhead deck which have a volume, in m<sup>3</sup>, that is more than:

- a) ship's moulded displacement per centimetre immersion at deepest subdivision draught; or
- b) 30 m<sup>3</sup>,

whichever is the greater.

**13.8.3** The requirements in sub-chapter 13.8 do not apply to any watertight spaces that are separately equipped with a liquid level monitoring system (such as fresh water, ballast water, fuel, etc.) with an indicator panel or other means of monitoring at the navigation bridge (and the safety centre if located in a separate space from the navigation bridge).



**13.8.4** The flooding detection system shall be designed so that it complies with the guidelines in IMO MSC.1/Circ.1291.

### **13.9 Openings in Watertight Boundaries\* below the Bulkhead Deck in Passenger Ships**

The requirements of this subchapter are fully applicable to ships subject to SOLAS Convention. Other ships shall meet these requirements as far as possible.

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\* See Explanatory Note on SOLAS regulation II-1/13. (Res. MSC.429/Rev.2)

**13.9.1** No doors, manholes or access openings are permitted in watertight transverse bulkheads dividing a cargo space from an adjoining cargo space, except as provided in par. 13.9.11 and subchapter 13.10 (SOLAS II-1/13.8.1 and II-1/14). (SOLAS II-1/13.3)

**13.9.2** Subject to par. 13.9.13 (SOLAS II-1/13.9), not more than one door, apart from the doors to shaft tunnels, may be fitted in each watertight bulkhead\* within spaces containing the main and auxiliary propulsion machinery including boilers serving the needs of propulsion. Where two or more shafts are fitted, the tunnels shall be connected by an intercommunicating passage. There shall be only one door between the machinery space and the tunnel spaces where two shafts are fitted and only two doors where there are more than two shafts. All these doors shall be of the sliding type and shall be so located as to have their sills as high as practicable. The hand gear for operating these doors from above the bulkhead deck shall be situated outside the spaces containing the machinery. (SOLAS II-1/13.4)

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\* See Explanatory Note on SOLAS regulation II-1/13.4. (Res. MSC.429/Rev.2)

**13.9.3** Watertight doors\*, except as provided in par. 13.9.11 and subchapter 13.10 (SOLAS II-1/13.8.1 and II-1/14), shall be power-operated sliding doors complying with the requirements of this subchapter 13.9. (SOLAS II-1/13.5.1)

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\* See interpretation given in MSC.1/Circ.1362/rev.2 and IACS UI SC156/Rev.2

**13.9.4** The means of operation whether by power or by hand of any power-operated sliding watertight door shall be capable of closing the door with the ship listed to 15° either way. Consideration shall also be given to the forces which may act on either side of the door as may be experienced when water is flowing through the opening applying a static head equivalent to a water height of at least 1 m above the sill on the centreline of the door. (SOLAS II-1/13.5.2)

**13.9.5** Watertight door controls, including hydraulic piping and electric cables, shall be kept as close as practicable to the bulkhead in which the doors are fitted, in order to minimize the likelihood of them being involved in any damage which the ship may sustain. The positioning of watertight doors and their controls shall be such that if the ship sustains damage within one fifth of the breadth of the ship, as defined in SOLAS regulation II-1/2, such distance being measured at right angles to the centreline at the level of the deepest subdivision draught, the operation of the watertight doors clear of the damaged portion of the ship is not impaired. (SOLAS II-1/13.5.3)

**13.9.6** Each power-operated sliding watertight door shall comply with the following requirements:

- .1** shall have a vertical or horizontal motion;
- .2** shall, subject to paragraph 9, be normally limited to a maximum clear opening width of 1.2 m. The Administration may permit larger doors only to the extent considered necessary for the effective operation of the ship provided that other safety measures, including the following, are taken into consideration:
  - .1** special consideration shall be given to the strength of the door and its closing appliances in order to prevent leakages; and

- .2 the door shall be located inboard the damage zone B/5;
- .3 shall be fitted with the necessary equipment to open and close the door using electric power, hydraulic power or any other form of power that is acceptable to the Administration;
- .4 shall be provided with an individual hand-operated mechanism. It shall be possible to open and close the door by hand at the door itself from either side and, in addition, close the door from an accessible position above the bulkhead deck with an all-round crank motion or some other movement providing the same degree of safety acceptable to the Administration. Direction of rotation or other movement is to be clearly indicated at all operating positions. The time necessary for the complete closure of the door, when operating by hand gear, shall not exceed 90 s with the ship in the upright position. Visual indicators to show whether the door is open or closed shall be provided at the accessible position above the bulkhead deck;
- .5 shall be provided with controls for opening and closing the door by power from both sides of the door and also for closing the door by power from the central operating console(s) required by subchapter 22.1.3 of *Part VIII* of the Rules;
- .6 shall be provided with an audible alarm, distinct from any other alarm in the area, which will sound whenever the door is closed remotely by power and which shall sound for at least 5 s but no more than 10 s before the door begins to move and shall continue sounding until the door is completely closed. In the case of remote hand operation it is sufficient for the audible alarm to sound only when the door is moving. Additionally, in passenger areas and areas of high ambient noise the Administration may require the audible alarm to be supplemented by an intermittent visual signal at the door; and
- .7 shall have an approximately uniform rate of closure under power. The closure time, from the time the door begins to move to the time it reaches the completely closed position, shall in no case be less than 20 s or more than 40 s with the ship in the upright position. (SOLAS II-1/13.6.1)

**13.9.7** The mechanical drive of watertight sliding doors shall meet the requirements specified in sub-chapter 22.1.3 of *Part VIII* of the Rules. (SOLAS II-1/13.6.2 and 13.6.3)

**13.9.8** Control handles shall be provided at each side of the bulkhead at a minimum height of 1.6 m above the floor and shall be so arranged as to enable persons passing through the doorway to hold both handles in the open position without being able to set the power closing mechanism in operation accidentally. The direction of movement of the handles in opening and closing the door shall be in the direction of door movement and shall be clearly indicated. (SOLAS II-1/13.6.4)

**13.9.9** As far as practicable, electrical equipment and components for watertight doors shall be situated above the bulkhead deck and outside hazardous areas and spaces. (SOLAS II-1/13.6.5)

**13.9.10** The electrical power supply, control and signaling systems of watertight sliding doors shall meet the requirements specified in subchapter 22.1.3 of *Part VIII* of the Rules. (SOLAS II-1/13.6 and 13.7)

**13.9.11** If the Administration is satisfied that such doors are essential, watertight doors of satisfactory construction may be fitted in watertight bulkheads dividing cargo spaces on 'tween decks. Such doors may be hinged, rolling or sliding doors but shall not be remotely controlled. They shall be fitted at the highest level and as far from the shell plating as practicable, but in no case shall the outboard vertical edges be situated at a distance from the shell plating which is less than one fifth of the breadth of the ship, as defined in SOLAS regulation II-1/2, such distance being measured at right angles to the centreline at the level of the deepest subdivision draught. (SOLAS II-1/13.8.1)

**13.9.12** Should any such doors referred to in par. 13.9.11 be accessible during the voyage, they shall be fitted with a device which prevents unauthorized opening. When it is proposed to fit such doors, the number and arrangements shall receive the special consideration of the Administration. (SOLAS II-1/13.8.2)

**13.9.13** Portable plates on bulkheads shall not be permitted except in machinery spaces. The Administration may permit not more than one power-operated sliding watertight door larger than those specified in paragraph 13.9.6.2 (SOLAS II-1/13.6.1.2) to be substituted for these portable plates in each watertight bulkhead, provided these doors are intended to remain closed during navigation except in case of urgent necessity at the discretion of the master. These doors need not meet the requirements of paragraph 13.9.6.4 (SOLAS II-2/6.1.4) regarding complete closure by hand-operated gear in 90 s. (SOLAS II-1/13.9)

**13.9.14** Where trunkways or tunnels for access from crew accommodation to the machinery spaces, for piping, or for any other purpose are carried through watertight bulkheads, they shall be watertight and in accordance with the requirements of subchapter 7.7 (SOLAS II-1/16-1). The access to at least one end of each such tunnel or trunkway, if used as a passage at sea, shall be through a trunk extending watertight to a height sufficient to permit access above the bulkhead deck. The access to the other end of the trunkway or tunnel may be through a watertight door. Such trunkways or tunnels shall not extend through the first subdivision bulkhead abaft the collision bulkhead. (SOLAS II-1/13.10.1)

**13.9.15** Where it is proposed to fit tunnels piercing watertight bulkheads, these shall receive the special consideration of the Administration. (SOLAS II-1/13.10.2)

**13.9.16** Where trunkways in connection with refrigerated cargo and ventilation or forced draught trunks are carried through more than one watertight bulkhead, the means of closure at such openings shall be operated by power and be capable of being closed from a central position situated above the bulkhead deck. (SOLAS II-1/13.10.3)

### **13.10 Passenger Ships Carrying Goods Vehicles and Accompanying Personnel**

**13.10.1** This subchapter applies to passenger ships subject to SOLAS Convention designed or adapted for the carriage of goods vehicles and accompanying personnel. (SOLAS II-1/14.1)

**13.10.2** If in such a ship the total number of passengers which include personnel accompanying vehicles does not exceed  $12 + Ad/25$ , where  $Ad$  = total deck area (square metres) of spaces available for the stowage of goods vehicles and where the clear height at the stowage position and at the entrance to such spaces is not less than 4 m, the requirements of par. 13.9.13 (SOLAS II-1/13.9) in respect of watertight doors apply except that the doors may be fitted at any level in watertight bulkheads dividing cargo spaces. Additionally, indicators are required on the navigation bridge to show automatically when each door is closed and all door fastenings are secured. (SOLAS II-1/14.2)

**13.10.3** The ship may not be certified for a higher number of passengers than assumed in paragraph 13.10.2, if a watertight door has been fitted in accordance with this regulation. (SOLAS II-1/14.3)

### **13.11 Internal Watertight Integrity of Passenger Ships above the Bulkhead Deck**

The requirements of this subchapter are fully applicable to ships subject to SOLAS Convention. Other ships shall meet these requirements as far as possible.

**13.11.1** The internal watertight subdivision arrangements to limit the entry and spread of water above the bulkhead deck\* shall be in accordance with the design arrangements necessary for compliance with the stability requirements in part B-1, and part B-2, of SOLAS Convention, chapter II-1, if applicable. (SOLAS II-1/17.2)

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\* See Explanatory Note on SOLAS regulation II-1/17.2. (Res. MSC.429/Rev.2)

**13.11.2** Doors in internal watertight subdivision arrangements above the bulkhead deck\*, and also above the worst intermediate or final stage of flooding waterlines, shall be capable of preventing the passage of water when immersed in the required range of positive stability for any damage cases contributing to the attained subdivision index A. These doors may remain open provided they can be remotely closed from the navigation bridge. They shall always be ready to be immediately closed. (SOLAS II-1/17.3)

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\* See Explanatory Note on SOLAS regulation II-1/17.3. (Res. MSC.429/Rev.2)

**13.11.3** All openings in the exposed weather deck shall have coamings of ample height and strength and shall be provided with efficient means for expeditiously closing them weathertight. Freeing ports, open rails and scuppers shall be fitted as necessary for rapidly clearing the weather deck of water under all weather conditions. (SOLAS II-1/17.4)

**13.11.4** Sidescuttles, gangway, cargo and fuelling ports and other means for closing openings in the shell plating above the bulkhead deck shall be of efficient design and construction and of sufficient strength having regard to the spaces in which they are fitted and their positions relative to the deepest subdivision draught. \*(SOLAS II-1/17.6)

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\* Refer to the *Recommendation on strength and security and locking arrangements of shell doors on ro-ro passenger ships*, adopted by IMO by resolution A.793(19).

**13.11.5** Efficient inside deadlights, so arranged that they can be easily and effectively closed and secured watertight, shall be provided for all sidescuttles to spaces below the first deck above the bulkhead deck. (SOLAS II-1/17.7)

## **13.12 Periodical Operation and Inspection of Watertight Doors, etc. in Passenger Ships**

**13.12.1** Ships subject to SOLAS Convention shall have operational procedures for carrying out periodic tests and inspections of equipment and closures in watertight divisions, containing the following information:

- .1 Operational tests of watertight doors, sidescuttles, valves and closing mechanisms of scuppers shall take place weekly. In ships in which the voyage exceeds one week in duration a complete set of operational tests shall be held before the voyage commences, and others thereafter at least once a week during the voyage.
- .2 All watertight doors, both hinged and power operated, in watertight bulkheads, in use at sea, shall be operated daily.
- .3 The watertight doors and all mechanisms and indicators connected therewith, all valves, the closing of which is necessary to make a compartment watertight, and all valves the operation of which is necessary for damage control cross connections shall be periodically inspected at sea at least once a week.
- .4 A record of all operational tests and inspections required by this regulation shall be recorded in the logbook with an explicit record of any defects which may be disclosed. . (SOLAS II-1/21).

## 14 FISHING VESSELS

### 14.1 General

#### 14.1.1 Application

**14.1.1.1** The requirements of the present Chapter 14 apply to ships assigned the additional mark: **FISHING VESSEL** in the symbol of class.

**14.1.1.2** The deck equipment of fishing vessels shall meet the recommendations of the *Torremolinos International Convention for the Safety of Fishing Vessels, 1977*, with 1993 Protocol, as well as the recommendations of Council Directive 97/70/EC of 11 December 1997, as amended by Commission Directive 1999/19/EC of 18 March 1999 and Commission Directive 2002/35/EC of 25 April 2002.

**14.1.1.3** The rules, specified in the present Chapter, are applicable to new fishing vessels exceeding 24 m in length, including ships additionally engaged in fish processing.

**14.1.1.4** The requirement, specified in 14.3.8, is applicable only to ships assigned additional mark **MS** in their symbol of class adapted for mooring to other ships at sea.

### 14.2 Steering Gear

**14.2.1** The main steering gear shall be of adequate strength and capable of steering the ship at maximum service speed. The main steering gear and rudder stock shall be so designed that they will not be damaged at maximum astern speed or during manoeuvres associated with fishing operations.

**14.2.2** The auxiliary steering gear shall be of adequate strength and capable of steering the ship at its navigational speed. Provision shall be made for quick starting the auxiliary steering gear in case of failure.

### 14.3 Anchoring and Mooring Equipment

**14.3.1** Anchoring equipment shall be chosen in accordance with the equipment number determined in 1.7, Table 14.3.1. The Table specifies the diameters of chains with stud links.

**Table 14.3.1**  
**Fishing vessels equipment\*)**

Equipment number	Stockless bower anchors		Stud link chain cables for bower anchors			Mooring lines			
	number	mass per anchor [kg]	total length of both chains [m]	Min. diameter		number	Min. length of each line [m]	Ship design minimum breaking load [kN]	
				normal strength steel (grade 1)***) [mm]	higher strength steel (grade 2)***) [mm]				
Exceeding 1	2	3	4	5	6	7	8	9	
Not exceeding									
30	40	2	80	165	11**)	-	2	50	29
40	50	2	100	192.5	11**)	-	2	60	29
50	60	2	120	192.5	12.5**)	-	2	60	29
60	70	2	140	192.5	12.5**)	-	2	80	29
70	80	2	160	220	14**)	12.5	2	100	34
80	90	2	180	220	14**)	12.5	2	100	36.8

Equipment number	Stockless bower anchors		Stud link chain cables for bower anchors			Mooring lines		
	number	mass per anchor [kg]	total length of both chains [m]	Min. diameter		number	Min. length of each line [m]	Ship design minimum breaking load [kN]
				normal strength steel (grade 1)*** [mm]	higher strength steel (grade 2)*** [mm]			
1 Exceeding	2	3	4	5	6	7	8	9
100	100	210	220	16**)	14	2	110	36.8
100	110	240	220	16**)	14	2	110	39
110	120	270	247.5	17.5	16	2	110	39
120	130	300	247.5	17.5	16	2	110	44
130	140	340	275	19	17.5	2	120	44
140	150	390	275	19	17.5	2	120	49
150	175	480	275	22	19	2	120	54
175	205	570	302.5	24	20.5	2	120	59
205	240	660	302.5	26	22	2	120	64
240	280	780	330	28	24	3	120	71
280	320	900	357.5	30	26	3	140	78
320	360	1020	357.5	32	28	3	140	85.8
360	400	1140	385	34	30	3	140	93
400	450	1290	385	36	32	3	140	101
450	500	1400	412.5	38	34	3	140	108
500	550	1590	412.5	40	34	4	160	113
550	600	1740	440	42	36	4	160	118
600	660	1920	440	44	38	4	160	123
660	720	2100	440	46	40	4	160	127

\*) **Note:** PRS may increase the above requirements for ships fishing in very rough waters.

\*\*) Alternative to stud link chain cables, short link chain cables may be considered.

\*\*\*) The steel grades of the chain cables are covered by UR A1, A1.5.2.

**14.3.2** The number, length and breaking strength of the mooring ropes shall be determined from Table 14.3.1 according to the equipment number calculated in compliance with 1.7, where:

*D* – moulded displacement of ship at draught to the maximum design waterline, [t];

*B* – greatest moulded ship's breadth, [m];

*h* – effective height measured from the maximum design waterline to the top of the uppermost house, [m], and:

$$h = a + \sum_{i=1}^{i=n} h_i \quad (14.3.2)$$

*a* – distance from the maximum design waterline to the upper edge of the uppermost complete deck at the side amidship, [m];

*h<sub>i</sub>* – height on the centreline of each tier of houses having breadth greater than 0.25*B*, [m]; For the lowest tier *h* is measured at centerline from the upper deck or from a notional deck line where there is local discontinuity in the upper deck. When calculating *h*, sheer and trim can be ignored;



- $A$  – side-projected area of the hull, within the length of the ship between perpendiculars, and of superstructures and houses above the maximum design waterline having a width greater than  $0.25B$ , [m<sup>2</sup>];
- $n$  – number of tiers described in the above definition of  $h_i$ .

Screens and bulwarks more than 1.5 m in height should be regarded as parts of houses when determining  $h$  and  $A$ .

**14.3.3** The length of individual mooring ropes may be reduced by 7% as compared with that required by the Equipment Table, provided that the total length of mooring ropes is not less than that resulting from the Table 14.3.1.

**14.3.4** For mooring ropes, steel wire cables, as well as fibre ropes made of natural or synthetic fibres may be used. Natural and synthetic fibre mooring ropes shall have diameter not less than 20 mm, irrespective of their breaking strength derived from Table 14.3.1.

**14.3.5** For ships of less than 40 m in length, the anchor chain may be replaced with wire ropes of equal strength of the tabular anchor cables of Grade 1. These ropes shall fulfil the requirements of 3.3.3.

**14.3.6** Wire ropes of trawl winches complying with the requirements of 3.3.3 may be used as anchor chain cables.

**14.3.7** Vessels intended for mooring at sea shall be provided with pneumatic fenders or other hull protection devices equivalent with regard to impact absorption.

The requirement of the present paragraph applies to vessels intended for mooring at sea state not exceeding 5.

## **14.4 Hatchways and Hatch Covers**

### **14.4.1 Hatchways with Wooden Hatch Covers**

**14.4.1.1** For hatchways closed by wooden hatch covers, the height of coamings above deck shall be at least 600 mm on exposed parts of working deck and at least 300 mm on the superstructure deck.

**14.4.1.2** The finished thickness of wood hatchway covers shall include allowance for abrasion due to rough handling. In any case, the finished thickness of these covers shall be at least 4 mm for each 100 mm of unsupported span, but not less than 40 mm, and the width of their bearing surfaces shall be at least 65 mm.

**14.4.1.3** Wooden hatch covers shall be fitted with weathertightness securing arrangements.

### **14.4.2 Hatchways with Hatch Covers Made of Material other than Wood**

**14.4.2.1** For hatchways closed with hatch covers made of material other than wood, the height of coamings above deck shall be in accordance with the requirements of 14.4.1.1. In justified cases, at PRS' consent, the height of these coamings may be reduced, or the coamings omitted entirely, provided that the safety of ship is not thereby impaired. In such a case, the hatchway openings shall be as small as possible and the hatch covers shall be permanently attached by hinges and shall be capable of being rapidly closed and battened down.

**14.4.2.2** For the purpose of strength calculations, it shall be assumed that hatch covers are subjected to load of the cargo stowed on them or to the following static loads, whichever is the greater:

- 10.0 kN/m – for ships of 24 m in length,
- 17.0 kN/m – for ships of 100 m in length and over.



For intermediate lengths, the load shall be determined by linear interpolation. In justified cases, PRS may give consent to reduction of the loads to not less than 75% of the above values for covers of hatchways situated on the superstructure deck in a position abaft a point located  $0.25L$  from the forward perpendicular.

**14.4.2.3** Where hatch covers are made of low-carbon steel, the maximum stress determined for loads specified in 14.4.2.2 and multiplied by 4.25 shall not exceed the minimum strength of the material. The deflection imposed by such load shall not exceed 0.0028 times the span.

**14.4.2.4** Covers made of materials other than low-carbon structural steel shall be of strength equivalent to those made of low-carbon steel and their construction shall be of sufficient stiffness ensuring weathertightness under the loads specified in 14.4.2.2.

**14.4.2.5** Hatch covers shall be provided with clamping devices and gaskets sufficient to ensure weathertightness.

### **14.4.3 Closing Devices**

**14.4.3.1** Where it is essential for fishing operations, flush deck scuttles of the screw, bayonet or equivalent type and manholes may be fitted, provided that these are capable of being closed watertight. Closing devices shall be permanently attached to the adjacent structure.

**14.4.3.2** Hinged covers of hatchways, manholes and other openings shall be protected against accidental closing. This applies particularly to heavy covers on casings of emergency exits which should be provided with counterweights and so designed that their opening is possible from any side of the cover. The dimensions of entrance hatches shall not be less than  $600 \times 600$  mm or their diameter shall be at least 600 mm.

**14.4.3.3** Hand grips above the deck level over the emergency exit openings shall be provided, where practicable.

## **14.5 Opening Closures**

### **14.5.1 General**

**14.5.1.1** The number of openings in watertight bulkheads shall be limited to the minimum. The openings shall be fitted with watertight closing appliances.

**14.5.1.2** Deck openings, which can be open during fishing operations shall, as a rule, be situated close to the ship's centre plane. Other solutions may be applied upon agreement with PRS, provided that the ship safety is not thereby impaired.

**14.5.1.3** Fish flaps on stern trawlers shall be watertight, power-operated and capable of being controlled from any position which provides an unobstructed view of the operation of the flaps.

**14.5.1.4** All access openings in bulkheads of enclosed superstructures and other external structures through which water may enter and endanger the vessel shall be fitted with weathertight doors. The strength of these doors shall be equivalent to that of the surrounding structure. The doors shall be capable of being operated from both sides.

**14.5.1.5** Openings in machinery space shall be enclosed with casings of a strength equivalent to that of the adjacent superstructure.

Openings other than access openings shall be fitted with weathertight covers of strength equivalent to that of the surrounding structure and permanently attached thereto.

**14.5.1.6** Openings other than hatchways, machinery space openings, manholes or flush scuttles on the working or superstructure deck shall be fitted with weathertight doors. Companionways shall be situated as close as practicable to the ship's centre plane.

**14.5.1.7** Discharge openings shall fulfil the requirements of 13.2.2.

## **14.5.2 Doors**

**14.5.2.1** The strength of watertight doors shall be equal to that of the surrounding structure.

**14.5.2.2** For vessels of less than 45 m in length, watertight doors may be of the hinged type, capable of being operated from each side of the door.

**14.5.2.3** For vessels of 45 m in length and over, watertight doors shall be of sliding type in:

- .1 spaces to which access is provided at sea and the sills of which are situated below the deepest service waterline. Other solutions are subject to special consideration by PRS;
- .2 the lower part of machinery space, from which access to shaft tunnel is provided.

In other cases, watertight doors may be of the hinged type.

**14.5.2.4** Sliding watertight doors shall be capable of being operated at ship's list to 15°.

**14.5.2.5** Sliding watertight doors, operated manually or otherwise, shall be capable of being operated from both sides near the door. For vessels of 45 m in length and over, such doors, except doors fitted in crew accommodation spaces, shall be closed from an accessible position above the working deck.

**14.5.2.6** Means shall be provided at remote operating positions to indicate when a sliding door is open or closed.

**14.5.2.7** The height above deck of sills in weathertight doors and the height of sills of companionways in structures and machinery casings, which enable the direct access to the exposed parts of the deck, shall be at least 600 mm on the working deck and at least 300 mm on the superstructure deck.

In justified cases, PRS may give consent to the reduction of sills height, but to not less than 380 mm and 150 mm, respectively. This does not apply to doors giving direct access to machinery spaces.

## **14.5.3 Side Scuttles and Windows**

**14.5.3.1** Side scuttles in spaces above the working deck and in enclosed superstructures on this deck shall be provided with hinged watertight deadlights.

**14.5.3.2** The lower edges of side scuttles cannot be situated less than 500 mm above the deepest service waterline. If they are situated less than 1000 mm above this waterline, they shall be of heavy non-opening type, according to 7.2.

**14.5.3.3** Side scuttles, including their glasses and deadlights shall meet the requirements specified in 7.2.

**14.5.3.4** Only toughened safety glass or its equivalent may be used for the wheelhouse windows, according to 7.2.

**14.5.3.5** The application of side scuttles and windows without deadlights in side and aft bulkheads of deckhouses, located on or above the working deck, will be subject to special consideration by PRS. Such solution cannot impair the ship's safety.

#### 14.5.4 Ventilators and Ventilating Ducts

**14.5.4.1** For vessels of 45 m in length and over, the height above deck of ventilator coamings other than the coamings of machinery space ventilators shall be at least 900 mm on the working deck and at least 760 mm on the superstructure deck. For vessels of less than 45 m in length, the heights of these coamings shall be 760 mm and 450 mm, respectively.

**14.5.4.2** The construction of ventilator coamings shall fulfil the requirements of sub-chapter 8.6 in *Part II – Hull* and their strength shall be equivalent to that of the adjacent structure. Where the coaming of ventilator exceeds 900 mm in height, it shall be additionally supported.

**14.5.4.3** For vessels of 45 m in length and over, closing devices need not be applied to ventilators, the coamings of which extend to more than 4500 mm above the working deck or more than 2300 mm above the superstructure deck.

For vessels of less than 45 m in length, closing devices need not be applied to ventilators, the coamings of which extend to more than 3400 mm above the working deck or more than 1700 mm above the superstructure deck.

**14.5.4.4** In all cases, except those specified in 14.5.4.3, ventilating ducts shall be provided with weathertight closing devices permanently attached to the ventilator or to the adjacent structure.

#### 14.6 Guard Rails and other Protection Means

**14.6.1** Effective bulwarks or guard rails of at least 1 m in height above deck shall be fitted in all exposed parts of the working and superstructure decks if they are working platforms. The distance between the lowermost bar of the guard rail and the deck shall not exceed 230 mm, while the distance between the remaining bars shall be at least 380 mm. The spacing between stanchions shall not exceed 1.5 m. In ships with a rounded sheerstrake, the guard rail stanchions shall be fastened to the flat part of the deck.

**14.6.2** It is required that storm rails shall be fitted at the outer side of all deckhouses and trunks.

**14.6.3** Stern trawlers shall be provided with suitable protecting devices in the upper part of the stern ramp, such as: doors, ports or nets – at the same height as the adjacent bulwarks or guard rails. A chain or other protective arrangements shall be provided across the ramp when the stern ramp is open.

**14.6.4** Coamings and sills of deck openings, if less than 600 mm in height, shall be fitted with protection means, such as hinged or portable barriers or nets.

**14.6.5** Skylights and other similar openings shall be fitted with protective bars spaced not more than 350 mm apart.

**14.6.6** In the case of small openings, upon agreement with PRS, the requirements specified in 14.6.4 and 14.6.5 may be waived.

**14.6.7** All deck surfaces shall be so designed as to protect the working personnel from slipping. Particularly within working areas, e.g. in machinery spaces, galleys, in vicinity of winches, in the fish handling area, under and over the ladders, as well as in front of doors non-slip deck surfaces shall be provided.

## 15 CONTAINER CARRIERS

### 15.1 General

#### 15.1.1 Application

**15.1.1.1** The requirements of the present Chapter 15 apply to ships assigned additional marks: **CONTAINER SHIP** or **ACC** in the symbol of class.

**15.1.1.2** The requirements for fixed outfit and lashing of containers are given in *Publication 32/P – The Requirements Concerning Stowage and Lashing of Cargoes on Sea-going Ships*.

#### 15.1.2 Scope of Survey

The general principles of classification procedure and survey, as well as requirements concerning technical documentation are given in Chapter 1.

### 15.2 Stowage of Containers on Board Ships

**15.2.1** Containers may be stowed longitudinally or transversely and shall be so lashed as to prevent shifting, sliding, tearing off or overturning. Guidelines contained in MSC.1/Circ.1353/Rev.2, to be the base for Administration approved Cargo Securing Manual (CSM), shall be taken into account.

**15.2.2** Containers shall be so stowed as to leave passage enabling easy access to compartments and equipment for essential services, as well as to enable access to container lashing equipment for easy control and maintenance. The Cargo Safe Access Plan (CSAP), prepared in accordance with MSC.1/Circ.1352/Rev.1 and MSC.1/Circ.1353 /Rev.2 (see *Publication 32/P*) and approved by Administration, shall be submitted to PRS for verification.

**15.2.3** All container lashing sockets, brackets, cell guides and other devices shall be fastened to decks and other elements of the hull structure or equipment, properly reinforced and not subjected to permanent deformations in service.

**15.2.4** The structure of the inner bottom in holds shall have sufficient strength and shall be properly reinforced in the area of container sockets transmitting concentrated loads from the container corners.

**15.2.5** When the corner fittings of one side wall of a container rest on the hatch cover that changes its position during the motion of a ship and the corner fittings of the other side wall rest on special supports – such container shall be suitably protected against forces due to possible movement of the hatch cover.

### 15.3 Lashing of Containers

#### 15.3.1 General

**15.3.1.1** Portable equipment or fixed special structures, as well as their connections with the hull shall fulfil the requirements of Chapter 18, *Part II – Hull*.

#### 15.3.2 Container Cell Guides

**15.3.2.1** Containers stowed in six tiers and more shall be stowed in cell guides forming container cells.

**15.3.2.2** Cell guides shall have sufficient strength for bearing the static and dynamic loads. Cell guides cannot yield to distortions and shall prevent permanent deformations of containers.

**15.3.2.3** Cell guides on decks and in holds may be fastened permanently or be detachable – secured by bolts, suspended, etc.

**15.3.2.4** The thickness of profiles used as cell guides shall take into account their wear due to grinding caused by repeated stowage of containers.

**15.3.2.5** Any strengthenings and connecting members of cell guides shall be in line with the corner fittings of containers stowed in cell guides.

**15.3.2.6** Cell guides should be fitted with entry guide devices enabling to direct containers into the cell.

**15.3.2.7** The clearance between the guiding members and containers of nominal sizes shall not exceed 25 mm along the breadth and 40 mm along the length of the cell.

**15.3.2.8** Longitudinal and transverse strengthenings of guiding members shall be such as not to obstruct loading and unloading of containers and to ensure that the adjacent containers are not damaged during voyage.

**15.3.2.9** The upper and lower attachments of vertical guiding members shall be calculated to withstand the horizontal force determined by the formula:

$$T = (20.4 - 0.021L_0) nK_1R10^{-4} \text{ [kN]} \quad (15.3.2.9)$$

$K_1 = 2$  – if guiding member supports two stacks of containers;

$K_1 = 1$  – if guiding member supports one stack of containers;

$n$  – number of containers in a stack;

$R$  – maximum gross mass of container in accordance with international standards, [kg];

$L_0$  – design length of ship, [m], but not more than 180 m;  $L_0 = 180$  shall be taken for barges of barge carrier.

Where intermediate supports (horizontal beams) are provided for guiding members, the force  $T$  may be reduced accordingly.

The permissible equivalent stresses shall not exceed  $0.7R_e$ .

**15.3.2.10** The transverse section modulus of a guiding member shall not be less than that determined by the formula:

$$W_p = (0.82 - 83L_010^{-4}) Rh_p K_210^{-3} \text{ [cm}^3\text{]} \quad (15.3.2.10-1)$$

$$W_w = 0.17K_2Rh_w10^{-3} \text{ [cm}^3\text{]} \quad (15.3.2.10-2)$$

$W_p$  – section modulus perpendicular to the ship's centre plane;

$W_w$  – section modulus parallel to the ship's centre plane;

$L_0, R$  – see 15.3.2.9;

$h_p$  – span of a guiding member between the supports transverse to the ship's centre plane, [m];

$h_w$  – span of a guiding member between the supports alongside the ship's centre plane, [m];

$K_2 = 16 C$  – for  $h_p \leq 3.8$  m,

$K_2 = 4.2 C - h_p$  – for  $h_p > 3.8$  m;

$C = 1$  for two stacks of containers,

$C = 2$  for one stack of containers.

Consideration shall be given to the fact that the vertical guiding member may be a support for one stack of containers within one plane and for two stacks of containers – within another plane.

**15.3.2.11** The cross-sectional area of a horizontal beam shall not be less than that determined by the formula:

$$S = \frac{(80.4 - 0.081L_0)mhR}{(1000 - 4.4\frac{l}{l})R_e} \quad [\text{cm}^2] \quad (15.3.2.11)$$

$m$  – number of container stacks along the hold breadth;

$h$  – mean distance between two adjacent horizontal beams, [m];

$l$  – length of the horizontal beam under consideration, [m];

$$i = 0.01 \sqrt{\frac{I}{S}};$$

$I$  – minimum moment of inertia of cross-sectional area of the horizontal beam under consideration, [cm<sup>4</sup>];

$L_0, R$  – see 15.3.2.9.

## 16 TIMBER CARRIERS

### 16.1 General

#### 16.1.1 Application

**16.1.1.1** The requirements of the present Chapter 16 apply to ships assigned additional mark **TIMBER** in the symbol of class, as well as to ships provided with the entry “ship adapted to the carriage of timber cargo on deck” in the Certificate of Class.

**16.1.1.2** It is assumed that “timber deck cargo” means a cargo of timber carried on an uncovered part of a freeboard deck or superstructure deck.

#### 16.1.2 General

**16.1.2.1** Unless stated otherwise in the present Chapter, the arrangement and lashing of the timber deck cargo shall fulfil at least the requirements of the *Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 2011* (IMO Resolution A.1048(27)).

**16.1.2.2** The arrangements, outfit and other deck equipment used for lashing and securing the timber deck cargo are subject to PRS’ survey and classification if any part of the timber volume on the deck has been included in calculations of the ship’s cross curves of stability.

**16.1.2.3** The fixed outfit provided for lashing the timber deck cargo shall meet the requirements of the *Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 2011*.

**16.1.2.4** The hull equipment of ships carrying timber deck cargo is subject to PRS’ survey according to the requirements of the present *Part III*, taking into account the relevant requirements of the *General Survey Regulations*.

**16.1.2.5** Ships shall be fitted either with permanent bulwarks at least 1 m 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 with efficient rails of the same height and of specially strong construction.

#### 16.1.3 Arrangement of Timber Deck Cargo

**16.1.3.1** The timber deck cargo shall be so arranged as to meet the following conditions:

- .1 provision shall be made for safe and satisfactory access to crew compartments, machinery spaces and all other spaces normally used during the ship service, as well as the possibility for pilot embarkation; in the vicinity of openings giving access to such places, the cargo shall be arranged in a way enabling proper closing these openings and protecting them against penetration of water;
- .2 access shall be provided to the equipment connected with ship’s safety, remote control arrangements of pipelines, etc.

#### 16.1.4 Visibility

**16.1.4.1** Bridge visibility of ships with timber deck cargo cannot be worse than that described in 7.2.1.7.

**16.1.4.2** For calculating the bridge visibility, the following formula can be used (see Fig. 6.1.4.2, as well):

$$V = \frac{K_C K_S \cdot A_S}{A_C - A_S} - K_S K_P \quad (6.1.4.2)$$



where:

$K_c K_s$  – horizontal distance from conning position to position 'S';

$K_s K_p$  – horizontal distance from position 'S' to position 'P';

$A_c$  – airdraft of conning position;

$A_s$  – airdraft of position 'S'.

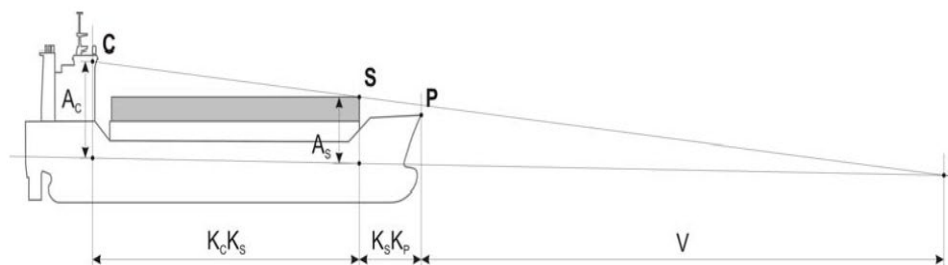


Fig. 6.1.4.2. Distances used for calculating the bridge visibility

## 16.2 Crew Protection Means

**16.2.1** Guard lines or rails shall be installed on the cargo deck if there is no convenient passage on the deck or below it.

**16.2.2** Guard lines or rails, not more than 330 mm apart vertically, shall be provided on each side of the deck cargo to a height of at least 1 m above the cargo. In addition, a lifeline, preferably wire rope, set up taut with a tightening device shall be provided as near as practicable to the centre plane of the ship. The stanchion supports to all guard rails or lifelines shall be so spaced as to prevent undue sagging.

**16.2.3** Where the cargo is uneven, a safe walking surface of not less than 600 mm in width shall be fitted over the cargo and effectively secured beneath, or adjacent to, the lifeline.

**16.2.4** Where uprights are not fitted, a walkway of substantial construction shall be provided having an even walking surface fitted with a set of guard lines or rails about 1 m apart, each having a minimum of three courses of guard lines or rails to a height of not less than 1 m above the walking surface. Such guard lines or rails shall be supported by rigid stanchions spaced not more than 3 m apart and lines shall be set up taut by tightening devices.

**16.2.5** As an alternative to 16.2.1 and 16.2.2, a lifeline, preferably wire rope, may be erected above the timber deck cargo such that a crew member equipped with a fall protection system can hook on to it and work about the timber deck cargo.

The lifeline shall be:

- .1 erected about 2 m above the timber deck cargo as near as practicable to the centre plane of the ship;
- .2 stretched sufficiently taut with a tightening device to support a fallen crew member without collapse or failure.

**16.2.6** Properly constructed ladders, steps or ramps fitted with guard lines or handrails shall be provided from the top of the cargo to the deck, and in other cases where the cargo is stepped by more than 68 cm, in order to provide reasonable access.

**16.2.7** Fencing or means of closing shall be provided for all openings in the stow such as masts, winches, etc.

### **16.3 Steering Gear**

Components of steering gear shall be effectively protected against damage. In the case of failure of the main steering gear, the emergency steering cannot be obstructed by the deck cargo.

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## 17 TUGS, RESCUE VESSELS AND SUPPLY VESSELS

### 17.1 General

#### 17.1.1 Application

The requirements of the presented Chapter 17 apply to ships assigned additional marks: **TUG**, **RESCUE VESSEL** or **SUPPLY VESSEL** in the symbol of class.

#### 17.1.2 General

**17.1.2.1** Unless stated otherwise, the requirements specified in the following sub-chapter shall be taken into account when the relevant function is provided in the vessel service specification.

### 17.2 Towing Equipment

#### 17.2.1 Selection of Towing Equipment

**17.2.1.1** The equipment and outfit necessary for carrying out towing operations are specified by the Shipowner; they are, however, to comply with the requirements set forth in the present sub-chapter 17.2.

**17.2.1.2** Towing equipment shall be chosen depending on the rated towing force determined by calculations or during the prototype tests. If such calculations are not carried out and the prototype tests results are not available, the towing force shall be taken not less than:

$$F = 0.133CP_e \quad [\text{kN}] \quad (17.2.1.2)$$

$F$  – towing force;

$P_e$  – total rated output of tug's main engines (at propeller cone), [kW];

$C = 1.25$  for tugs with fixed pitch propellers,

$C = 1.40$  for tugs with Voith-Schneider propellers,

$C = 1.65$  for tugs with controllable pitch propellers,

$C = 1.80$  for tugs with fixed pitch propellers and nozzles,

$C = 2.10$  for tugs with controllable pitch propellers and nozzles.

However, if during mooring and sea trials the towing force is found greater than that determined from calculations or the prototype tests, PRS may require strengthening of the towing equipment components or power reduction during towing operations.

**17.2.1.3** The actual breaking strength of the towing rope shall be as follows:

$3F$  – for  $F < 150$ , [kN],

$2F$  – for  $F \geq 300$ , [kN].

The intermediate values shall be determined by linear interpolation.

The length of the towing rope shall be at least 150 m.

**17.2.1.4** All components of the towing equipment carrying loads (such as the towing hook, towing rail, etc.), as well as their fastening to the ship's hull shall be so designed as to overtake the breaking strength of the towing rope. The equivalent stresses in these components shall not exceed 0.95 times the yield stress of the material used.

**17.2.1.5** No part of the towing equipment subjected to tension or bending under the pull of the towing rope shall be made of cast iron.

**17.2.1.6** The towing rope stopper and components of its fastening are to be so selected that their breaking force is equal to at least 1.5 times the rated towing force.

**17.2.1.7** The requirements of *Part IV – Stability and Subdivision* shall be taken into consideration when choosing the location of the towing hook and the towing winch.

## **17.2.2 Towing Hook**

**17.2.2.1** Towing hooks shall be of a slip-type and shall have a device releasing the towing rope, operating efficiently within the range of loads on the towing hook from zero to three times the rated towing force and at any possible deflection of the towing rope from the centre plane of the ship.

**17.2.2.2** The device shall be controlled both from a place located in the vicinity of the towing hook and from the navigation bridge.

**17.2.2.3** Where the ship is fitted with a spare towing hook, in addition to the main one, the spare hook need not be of a slip-type and need not have a device releasing the towing rope.

**17.2.2.4** It is recommended to calculate the towing hook as a curvilinear bar. Where formulae for rectilinear bars are used, the permissible stresses shall be reduced by 35%.

**17.2.2.5** The towing hook shall be made as a solid forged piece (with use of open die or drop forging). Elongation of the hook material shall not be less than 18% for  $A_5$  sample. Hooks made of hardened and tempered alloy steel with elongation less than 18% need special consent of PRS.

**17.2.2.6** If the towing hook is provided with shock absorbers, their ultimate load is to be not less than 1.3 times the rated towing force.

**17.2.2.7** The arrangement protecting the towing hook against overloading shall be calculated for a breaking load not exceeding three times the rated towing force.

**17.2.2.8** Prior to installation on board the ship, the towing hook shall be tested with a proof load equal to twice the rated towing force.

**17.2.2.9** In ships with main engines power output below 220 kW, navigating in restricted area III, towing hook shock absorbers may be dispensed with.

## **17.2.3 Towing Arch**

**17.2.3.1** The shape of towing arches shall be similar to a parabola. The towing arches shall be made of tubes or other similar sections. Wide and high arches shall be supported by trestle shaped tubular supports arranged in the centre plane of the ship or symmetrically to it.

**17.2.3.2** Towing Arch shall be modelled as a single or multi-span beam adequately supported and loaded by the vertical force  $P$  at the middle of the longest span.

The vertical force  $P$  acting on Towing Arch is to be computed applying the formulae:

$$P = 1.3 \cdot a \cdot F + 0.5 \cdot (g + 0.5 \cdot a_v) \cdot m \quad [\text{kN}] \quad (17.2.3.2.1)$$

where:

$a$  – the coefficient, not less than  $\sin\theta$ , where  $\theta$  is the pitch amplitude determining applying the requirements of p.17.3.2 *Part II – Hull*, but not less than 0.32 rad (18 degrees),

$F$  – the towing force, [kN],

$g$  – standard acceleration of gravity, [m/s<sup>2</sup>],

- $a_v$  – vertical acceleration, at the position of the towing arch force  $P$  application, determined applying the requirements of p. 17.4.1 *Part II – Hull*, [m/s<sup>2</sup>],  
 $m$  – mass of the towing line (length of the line applied to compute the mass  $m$  value is not to be less than 300 m).

The allowable equivalent stress von Mises for construction of the towing arch is:

$$\sigma_{zr} = R_e \text{ [MPa]},$$

where  $R_e$  – yield point of the towing arch material, [MPa].

The section modulus of the towing arch transverse cross-section shall not be less than that determined by the formula:

$$W = 0.0343 \frac{d^2 l_o l}{R_e} \text{ [cm}^3\text{]} \quad (17.2.3.2.2)$$

- $d$  – diameter of the towing wire rope, [mm];  
 $l_o$  – length of the towing rope, [m], but not less than 300;  
 $l$  – maximum distance between supports of the towing arch or between a support and the bulwark, [m];  
 $R_e$  – yield point of the arch material, [MPa].

**17.2.3.3** Each support should be able to withstand the vertical force  $P$  and the horizontal force  $P_1 = 0.17P$  acting parallel to the ship's X axis. Buckling capacity of the support structures should be checked according to p. 13.7 *Part II – Hull*.

The cross-sectional area of each branch of trestle type strut shall not be less than:

$$f = 0.003 \frac{d^2 l_o}{R_e} \text{ [cm}^2\text{]} \quad (17.2.3.3)$$

$R_e$  – yield stress of the support material, [MPa].

It is recommended to apply dismountable supports.

Strength criteria for ship hull construction under the supports are the same as in p. 14.5.3 *Part II – Hull*.

## 17.2.4 Towing Winches

**17.2.4.1** The requirements regarding the strength and design of towing winches are specified in sub-chapter 6.5, *Part VII – Machinery, Boilers and Pressure Vessels*.

**17.2.4.2** Provision shall be made for operating the towing winch from a place near the winch; it is recommended to provide a possibility to operate the towing winch from the wheelhouse.

**17.2.4.3** Where the towing operations are made with the use of towing winch, without using the hook, the winch shall be controlled both from the local control post and from the wheelhouse.

## 17.2.5 Towing Winch Rope

**17.2.5.1** The length of the towing winch rope shall not be less than 400 m.

**17.2.5.2** In all other respects, the towing winch rope shall fulfil the requirements for mooring ropes.

**17.2.5.3** Where towing operations are carried out by means of the towing winch instead of the hook, the towing winch rope shall also fulfil the requirements of 17.2.1.2.

## 17.3 Anchoring and Mooring Equipment

### 17.3.1 Equipment for Tugs

The anchor and mooring equipment for tugs shall be selected according to the equipment number determined in accordance with 1.7. However, for tugs of unrestricted service, this equipment may be selected according to the equipment number determined from the following formula:

$$N_c = D^{2/3} + 2(aB + \sum h_i \cdot b_i) + 0.1A \quad (17.3.1)$$

$D, B, a, h_i, A$  – see formulae 1.7.2-1 and 1.7.2-2;

$b_i$  – width of the widest superstructure or deckhouse at the level of the considered tier, taking into account only structures with the width exceeding  $B/4$ , [m].

For tugs under 45 m in length intended for towing service only, one anchor may be used onboard provided that the second anchor and its relevant chain cable holds readily available to be installed. In case of loss of anchor, the tug is to remain in port until replace anchor equipment is installed onboard.

### 17.3.2 Supply Vessels Equipment

It is recommended that the total length of both chains for bower anchors shall be taken by at least 165 m greater than that determined from Table 3.1.3 and the diameter of these chains – by at least 15% greater, with due regard paid to the requirements specified in 10.2.1.

## 17.4 Closing Appliances of Openings

**17.4.1** Exits to the upper deck shall be provided with weathertight doors with sills of at least 600 mm in height. Exits from the machinery space shall lead, as far as practicable, to a deck situated above the upper deck.

The lowermost point of the line, determined in 7.2.1.2, shall be situated above the summer load waterline at a distance equal to  $0.025B$ , or 750 mm, whichever is the greater.

**17.4.2** Skylights on the uppermost continuous deck shall be fitted on coamings of at least 900 mm in height.

**17.4.3** Companionways leading to spaces below the deck shall be provided with coamings of at least 600 mm in height, as well as with weathertight closures opened and closed from both the inside and outside.

## 17.5 Emergency Exits and Corridors

**17.5.1** The machinery space shall be provided with an emergency exit leading to the weather deck.

**17.5.2** The hatch of the emergency exit on the deck shall be provided with coamings of at least 600 mm in height. The hatch cover shall be provided with hinges arranged transversely to the ship's centre plane. The hatch cover shall be weathertight and capable of being opened and closed from both the inside and outside. The emergency exits shall be capable of being opened at any heel angle of ship.

**17.5.3** In ships with main engines power output below 370 kW, the width of the main corridors may be reduced to 0.8 m and the width of side corridors – to 0.6 m.

## 18 DREDGERS, HOPPER BARGES AND FLOATING CRANES

### 18.1 General

#### 18.1.1 Application

The requirements of the present Chapter 18 apply to ships assigned additional marks: **DREDGER**, **HOPPER BARGE** or **FLOATING CRANE** in the symbol of class.

### 18.2 Steering Gear

In the case of non-propelled ships, PRS may allow to omit devices ensuring ship steerability or to provide course stabilizers only. The area of navigation and operational conditions in such case are subject to special consideration of PRS.

### 18.3 Equipment Number

The equipment number  $N_c$  shall be determined from the formula:

$$N_c = 1.5D^{2/3} + 2Bh + 2S + 0.1A \quad (18.3)$$

$S$  – projection on the midship plane of the windage area of crane structure (in "stowed for sea" position) or other essential structures situated above the deck plating of the uppermost superstructure taken into account when determining  $h$ ; the windage area shall be determined as the area limited by the structure contour, [m<sup>2</sup>];

$D, B, h, A$  – according to 1.7; when determining windage area  $A$ , the lateral windage area of the structure limited by the structure contour shall be taken into account.

When calculating the equipment number bucket ladders and gallows are not to be included.

When calculating  $h$  value for the equipment number, central gantries and other towers of frame structures in dredges need not be taken into account.

The equipment number for dredgers with a typical shape of the underwater part of hull, operating in unrestricted area, may be determined according to 17.3 or 1.7.

### 18.4 Anchoring Equipment

For hopper barges and dredgers without holds for dredging spoil, the diameter of bower anchor chain cables, determined from Table 3.1.3, shall be increased by at least 15%. For hopper dredgers, the diameter of bower anchor chain cable shall be increased by at least 5%.

### 18.5 Side Scuttles

Side scuttles of floating cranes shall be of heavy and non-opening type if the distance of their lower edges to the waterline is less than 300 m at maximum heel with the load suspended on the crane hook.



## 19 SHIPS WITH MOVABLE DECKS

### 19.1 General

#### 19.1.1 Application

**19.1.1.1** The requirements of the present Chapter 19 apply to ships assigned additional mark **MD** in the symbol of class.

**19.1.1.2** The requirements apply to movable decks, ramps and similar structures, which may be arranged in two positions:

- operational position, enabling to carry vehicles or other cargoes on these structures, as well as to perform loading and discharging operations with these vehicles and cargoes,
- non-operational position, in which they are not used for the carriage or for loading/discharging vehicles or other cargoes.

#### 19.1.2 General

**19.1.2.1** The requirements concerning movable ramps enabling loading or discharging from decks are given in 9.7.

**19.1.2.2** The arrangements for raising, lowering and fixing these structures shall fulfil the requirements specified in *Part VI – Lifting Appliances of the Rules for Statutory Survey of Sea-going Ships*.

**19.1.2.3** The supporting structures at sides, decks and bulkheads, pillars or tie rods ensuring reliable securing the movable structures in an operational position shall fulfil the general requirements of *Part II – Hull*.

### 19.2 Scantlings

**19.2.1** Arrangements shall be provided for a reliable fastening of movable structures in a non-operational position.

**19.2.2** When a movable structure is in a non-operational position, the raising arrangements and parts of the structure shall not be under load.

Ropes shall not be used for suspension of movable structures.

**19.2.3** Movable car decks shall be built as pontoons consisting of a grillage system of girders and stiffeners with plating welded to them. pontoons may be made of steel or aluminium alloys complying with the requirements of Chapter 2, *Part II – Hull*.

**19.2.4** The scantlings of structural members, particularly the scantlings of plating, stiffeners and girders of movable car decks shall fulfil the requirements of sub-chapter 19.5, *Part II – Hull* assuming that the girders and stiffeners are simply supported at both ends. The values of allowable stresses for longitudinal girders of movable decks shall be taken as equal to allowable stresses for transverse girders specified in sub-chapter 14.4, *Part II – Hull*.

**19.2.5** The scantlings of supports and suspensions shall be calculated with the use of direct stress analysis. The following shall be taken into account in the calculations:

- the total load of movable deck section, including the mass of the sections,
- all tiers of movable decks fastened by the considered supports or suspensions and loaded as above.

The permissible stresses in supports shall be assumed as follows:

normal stresses  $\sigma = 110/k$  [MPa];

shear stresses  $\tau = 65/k$  [MPa];

equivalent stresses  $\sigma_{zr} = \sqrt{\sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2 + 3\tau^2} = 120/k$  [MPa];

$k$  – material factor, equal to:

$k = 1.00$  for  $R_e = 235$  MPa (for NS steel),

$k = 0.78$  for  $R_e = 315$  MPa (for HS32 steel),

$k = 0.72$  for  $R_e = 355$  MPa (for HS36 steel).

The value of  $k$  for steel with  $R_e$  other than defined above is subject to PRS agreement in each particular case.

In stress analysis, particular attention shall be paid to stress concentrations. For slender supports subject to compression, determining the permissible stresses may require special consideration of PRS.

**19.2.6** Steel wire ropes used in the arrangements mentioned in 19.2.1 shall fulfil the requirements of Chapter 21, *Part IX – Materials and Welding*, while the chains – with the requirements of Chapter 20 of the said Part.

## **20 SHIPS WITH ICE STRENGTHENING**

### **20.1 General**

#### **20.1.1 Application**

The requirements for hull equipment for Baltic Ice class and Polar class are given in *Publication 122/P – Requirements for ice Baltic class and Polar class for ships under PRS supervision*.

#### **20.2 Side Scuttles**

Side scuttles shall not be fitted in way of the ice strengthening belt of the shell plating, determined in Chapter 26, *Part II – Hull*.

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## 21 SHIPS WITH SUBDIVISION MARKS

### 21.1 General

#### 21.1.1 Application

**21.1.1.1** The requirements of this Chapter 21 apply to ships assigned additional subdivision marks affixed to the symbol of class.

**21.1.1.2** In ro-ro ships, the watertight door fitted in subdivision bulkheads separating two adjacent cargo spaces need not comply with the requirements of sub-chapter 21.2.1, provided they meet the requirements of sub-chapter 21.2.2.

#### 21.1.2 General

**21.1.2.1** The number of openings in watertight boundaries shall be reduced to the minimum compatible with the design and proper working of the ship. Satisfactory devices shall be provided for closing these openings.

**21.1.2.2** Where pipelines, ventilation ducts, electric cables, etc., are carried through watertight boundaries, arrangements shall be made to ensure the watertight integrity of the boundaries, complying with requirements of *Part VI – Ship and Machinery Piping Systems* and *Part VIII – Electrical Installations and Control Systems*.

**21.1.2.3** The design, materials and construction of all watertight closures of openings such as doors, hatches, sidescuttles, gangway and cargo ports shall comply with requirements of PRS Rules. The closures of openings shall be of a strength equivalent to that of the bulkhead in which they are fitted.

**21.1.2.4** Watertight doors in passenger ships permitted to remain open during navigation shall be clearly indicated in the ship's *Stability booklet*.

### 21.2 Closures of Openings

#### 21.2.1 Doors in Watertight Subdivision Bulkheads

##### 21.2.1.1 Application

The requirements of subchapter 21.2.1 are applicable to doors fitted in watertight subdivision bulkheads and external watertight boundaries, necessary to ensure compliance with the relevant subdivision and damage stability regulations. This does not apply to doors located in external boundaries above the equilibrium or intermediate waterline. The design and testing requirements for watertight doors vary according to their location relative to the equilibrium waterplane or intermediate waterplane at any stage of assumed flooding and or bulkhead deck or freeboard deck.

The requirement of subchapter 21.2.1 applies to ships subject to classification under SOLAS, MARPOL, ICLL Conventions, the IBC Code and the IGC Code in accordance with SOLAS II-1/Reg. 4.1 and Reg. 4.2, as amended.

Small cargo vessels not subject to damage stability requirements are not required to comply with the full scheme\*.

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\* Doors in watertight bulkheads of small cargo ships, not subject to any statutory subdivision and damage stability requirements, may be hinged single action doors arranged to open out of the major space protected. They shall be constructed in accordance with the requirements of the classing society and have notices affixed to each side stating, "To be kept closed at sea".

### 21.2.1.2 Structural Design

Watertight doors shall be of approved design and substantial construction in accordance with the requirements of the classing society and shall be of a strength equivalent to that of the subdivision bulkheads in which they are fitted. (IACS UI SC156/Rev.2, par. 2)

Watertight doors shall be made of steel. The use of other materials is subject to special consideration of PRS.

The doors shall withstand the design head pressure (see definition in par. 1.2.3 – watertightness). The applied pressure, measured from the lower edge of the doorway, cannot be less than 49 kPa. The reduced stresses in the door frame and door plate shall not exceed 0.6 times the yield stress of their material.

The thickness of steel watertight door plating shall not be less than that determined from the following formula:

$$t = 28.5a_1\sqrt{\frac{p}{R_e}} \text{ [mm]} \quad (21.2.1.2-1)$$

- $p$  – design pressure induced by the flooding head, [kPa];  
 $a_1$  – spacing of main supporting members of door plating, [m];  
 $R_e$  – yield point of door plating material, [MPa].

This thickness shall not be less than that required for the bulkhead plating thickness in this place.

The arrangement of watertight door main supporting members and the adjacent structure of bulkhead shall have adequate stiffness to ensure watertightness along the whole circumference of the door leaf.

Scanlings of supporting members shall be in principle based on the results of direct calculations. Usually, in order to determine the bending stresses, formulae coming from the simple beam theory may be applied, assuming that the supporting members ends are simply supported.

Edge stiffeners of the door leaf shall have a stiffness not less than that determined from the following formula:

$$I = 8pa^4 \text{ [cm}^4\text{]} \quad (21.2.1.2-2)$$

- $p$  – pressure exerted on sealing, not lesser than 5 kN/m [kN/m];  
 $a$  – spacing of securing devices (eg. wedge-shaped closures), [m].

### 21.2.1.3 Operation Mode, Location and Outfitting

Doors shall be fitted in accordance with all requirements regarding their operation mode, location and outfitting, i.e. provision of controls, means of indication, etc., as shown in Tables 21.2.1-1 21.2.1-2 below. This tables is to be read in conjunction with the following general notes: For passenger ships the watertight doors and their controls are to be located in compliance with SOLAS II-1/13.5.3 and II-1/13.7.1.2.2. (IACS UI SC156/Rev.2, par. 3)

### 21.2.1.4 Frequency of Use whilst at sea

Due to the frequency of use doors whilst at sea, the following are distinguished:

- **Normally Closed:** kept closed at sea but may be used if authorised. To be closed again after use.
- **Permanently Closed:** the time of opening such doors in port and of closing them before the ship leaves port shall be entered in the log-book. Should such doors be accessible during the voyage, they shall be fitted with a device to prevent unauthorised opening.

- **Used:** kept closed, but may be opened during navigation when authorized by the Administration to permit the passage of passengers or crew, or when work in the immediate vicinity of the door necessitates it being opened. The door shall be immediately closed after use. (IACS UI SC156/Rev.2, par. 3.1)

#### 21.2.1.5 Type

There are the following types of doors:

- **POS** Power operated, sliding or rolling
- **POH** Power operated, hinged
- **S** Sliding or Rolling
- **H** Hinged

#### 21.2.1.6 Local Control

All doors, except those which are to be permanently closed at sea, are to be capable of being opened and closed by hand (and by power, where applicable<sup>3</sup>) locally from both sides of the doors, with the ship listed to either side.

For passenger ships, the angle of list at which operation by hand is to be possible is 15 degrees.

For cargo ships, the angle of list at which operation by hand is to be possible is 30 degrees. (IACS UI SC156/Rev.2, par. 3.3.1)

#### 21.2.1.7 Remote Control

Where indicated in Tables 21.2.1-1 21.2.1-2, doors are to be capable of being remotely closed by power from the bridge <sup>4</sup> for all ships, and by hand also from a position above the bulkhead deck for passenger ships as required by SOLAS II-1/13.7.1.4. Where it is necessary to start the power unit for operation of the watertight door, means to start the power unit is also to be provided at remote control stations. The operation of such remote control is to be in accordance with SOLAS II-1/13.8.1 to 13.8.3. For tankers, where there is a permanent access from a pipe tunnel to the main pump room, in accordance with regulation II-2/4.5.2.4 the watertight door shall be capable of being manually closed from outside the main pump room entrance in addition to the requirements above. (IACS UI SC156/Rev.2, par. 3.3.2)

#### 21.2.1.8 Indication of Door Position\*

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\* See *International Code on Alarms and Indicators*.

**21.2.1.8.1** Where shown in Tables 21.2.1-1 21.2.1-2, position indicators are to be provided at all remote operating positions for all ships and provided locally on both sides of the internal doors for cargo ships, to show whether the doors are open or closed and, if applicable, with all dogs/cleats fully and properly engaged. (IACS UI SC156/Rev.2, par. 3.4.1)

**21.2.1.8.2** The door position indicating system is to be of self-monitoring type and the means for testing of the indicating system are to be provided at the position where the indicators are fitted. (IACS UI SC156/Rev.2, par. 3.4.2)

**21.2.1.8.3** A diagram showing the location of the door and an indication to show its position shall be provided at the central operating console located at the navigating bridge. A red light shall indicate the door is in the open position and a green light shall indicate the door is in the closed position. When the door is closed from this remote position, the red light shall flash when the door is in an intermediate position. This applies to passenger ships and cargo ships. (IACS UI SC156/Rev.2, par. 3.4.3)

**21.2.1.8.4** Signboard/ instructions shall be placed in way of the door advising how to act when the door is in "doors closed" mode. (IACS UI SC156/Rev.2, par. 3.4.4)

#### **21.2.1.9 Alarms**

**21.2.1.9.1** For passenger ships, failure of the normal power supply of the required alarms shall be indicated by an audible and visual alarm at the central operating console at the navigation bridge. For cargo ships, failure of the normal power supply of the required alarms shall be indicated by an audible and visual alarm at the navigation bridge. (IACS UI SC156/Rev.2, par. 3.5.1)

**21.2.1.9.1** All door types, including power-operated sliding watertight doors which are to be capable of being remotely closed are to be provided with an audible alarm, distinct from any other alarm in the area, which will sound whenever such a door is remotely closed.

For passenger ships the alarm shall sound for at least 5 s but not more than 10 s before the door begins to move and shall continue sounding until the door is completely closed. In the case of remote closure by hand operation, an alarm is required to sound only while the door is actually moving. In passenger areas and areas of high ambient noise, the audible alarms are to be supplemented by visual signals at both sides of the doors. (IACS UI SC156/Rev.2, par. 3.5.2)

**21.2.1.9.1** All watertight doors, including sliding doors, operated by hydraulic door actuators, either a central hydraulic unit or an independent hydraulic unit for each door is to be provided with a low fluid level alarm or low gas pressure alarm, as applicable or some other means of monitoring loss of stored energy in the hydraulic accumulators. For passenger ships this alarm is to be both audible and visible and shall be located on the central operating console at the navigation bridge. For cargo ships, this alarm shall be both audible and visible and should be located at the navigation bridge. (IACS UI SC156/Rev.2, par. 3.5.3)

#### **21.2.1.10 Notices on Doors**

As shown in Tables 21.2.1-1 21.2.1-2, doors which are normally closed at sea but not provided with means of remote closure, are to have notices fixed to both sides of the doors stating, "To be kept closed at sea". Doors which are to be permanently closed at sea are to have notices fixed to both sides stating, "Not to be opened at sea". (IACS UI SC156/Rev.2, par. 3.6)

#### **21.2.1.11 Location of Doors**

**21.2.1.11.1** In passenger ships, arrangement of watertight doors and their controls shall comply with the requirements specified in subchapter 13.9 (SOLAS II-1/13).

**21.2.1.11.2** In cargo ships, watertight doors shall comply with the requirements specified in subchapter 7.13 (SOLAS II-1/13-1).



**Table 21.2.1-1**  
**Doors in Internal Watertight Bulkheads in Cargo Ships and Passenger Ships**

Position relative to bulkhead or freeboard deck	1. Regulation	2. Frequency of Use while at sea	3. Type	4. Remote Closure	5. Remote Indication	6. Audible or Visual Alarm	7. Notice	8. Comments
<b>I. Passenger Ships</b>								
(1) Below	SOLAS II-1/10, 13.4, 13.5.1, 13.5.2, 13.6, 13.7.1, 13.8.1, 13.8.2, 16.2, 22.1, 22.3 and 22.4	Used	POS	Yes	Yes	Yes (local)	No	For doors that are used, see SOLAS II-1/22.3 and IMO MSC.1/Circ.1564
	SOLAS II-1/10, 13.9.1, 13.9.2, 14.2, 16.2, 22.2 and 22.5	Permanently closed	S, H	No	No	No	Yes	See Notes 3 + 4 + 6
(2) At or above	SOLAS II-1/10, 16.2, 17.1 and 22.3	Used	POS, POH	Yes	Yes	Yes (local)	No	See Note 7
			S, H	No	Yes	No	Yes	See Note 1
	SOLAS II-1/17-1.1.1, 17-1.1.2, 17-1.1.3, 23.6 and 23.8	Permanently closed	S, H	No	Yes	Yes (remote)	Yes	Doors giving access to below Ro-Ro deck
	SOLAS II-1/17-1.1.1, 17-1.1.2, 17-1.1.3, 22.7 and 23.3 to 23.5		S, H	No	Yes	Yes (remote)	Yes	See Notes 1 + 3 + 4
<b>II. Cargo Ships</b>								
(1) Below	SOLAS II-1/10, 13-1.2, 16.2 and 22.3 MARPOL I/28.3, ICLL66 + A.320 1988 Protocol to ICLL66, IBC and IGC	Used	POS	Yes	Yes	Yes (local)	No	
	SOLAS II-1/10, 13-1.3, 16.2, 22.3 and 24.4	Normally closed	S, H	No	Yes	No	Yes	See Note 1
	SOLAS II-1/10, 13-1.4, 16.2, 24.3 and 24.4	Permanently closed	S, H	No	No	No	Yes	See Notes 3 + 4
SOLAS II-1/10, 13-1.4, 13-1.5, 16.2, 22.2, 24.3 and 24.4								
(2) At or above	SOLAS II-1/10, 13-1.2, 16.2 and 22.3 MARPOL I/28.3, ICLL66 + A.320 1988 Protocol to ICLL66, IBC and IGC	Used	POS	Yes	Yes	Yes (local)	No	See Notes 2 + 5
	SOLAS II-1/10, 13-1.3, 16.2, 22.3 and 24.4	Normally closed	S, H	No	Yes	No	Yes	See Note 1
	SOLAS II-1/10, 13-1.4, 13-1.5, 16.2, 24.3 and 24.4	Permanently closed	S, H	No	No	No	Yes	See Notes 3 + 4

**Notes:**

1. If hinged, this door shall be of single action type.

2. Under ICLL66, doors separating a main machinery space from a steering gear compartment may be hinged single action type provided the lower sill of such doors is above the Summer Load Line and the doors remain closed at sea whilst not in use.
3. The time of opening such doors in port and closing them before the ship leaves port shall be entered in the logbook, in case of doors in watertight bulkheads subdividing cargo spaces.
4. Doors shall be fitted with a device which prevents unauthorized opening.
5. Under MARPOL, hinged watertight doors may be acceptable in watertight bulkhead in the superstructure.
6. Passenger ships which have to comply with SOLAS II-1/14.2 require an indicator on the navigation bridge to show automatically when each door is closed and all door fastenings are secured.
7. Refer to the Explanatory Note to Regulation 17.1 of Res. MSC.429(98) regarding sliding watertight doors with a reduced pressure head and sliding semi-watertight doors.

**Table 21.2.1-2**

**Doors in External Watertight Bulkheads below equilibrium or intermediate waterplane in Cargo Ships and Passenger Ships**

Position relative to bulkhead or freeboard deck	1. Regulation	2. Frequency of Use while at sea	3. Type	4. Remote Closure	5. Remote Indication	6. Audible or Visual Alarm	7. Notice	8. Comments
<b>I. Passenger Ships</b>								
(1) Below	SOLAS II-1/15.9, 22.6 and 22.12	Permanently closed	S, H	No	No	No	Yes	See Notes 2 + 3
(2) At or above	SOLAS II-1/17.1 and 22.3 MSC. CIRC. 541	Normally closed	S, H	No	Yes	No	Yes	See Note 1
	SOLAS II-1/17-1.1.1, 17-1.1.2, 17-1.3, 23.6 and 23.8		S, H	No	Yes	Yes (remote)	Yes	Doors giving access to below Ro-Ro deck
	SOLAS II-1/17-1.1.1, 17-1.2, 17-1.3, 23.3 and 23.5	Permanently closed	S, H	No	Yes	Yes (remote)	Yes	See Notes 2 + 3
<b>II. Cargo Ships</b>								
(1) Below	SOLAS II-1/15.9, 15-1.2, 15-1.3, 15-1.4, 22.6, 22.12 and 24.1	Permanently closed	S, H	No	Yes	No	Yes	See Notes 2 + 3
(2) At or above	SOLAS II-1/15-1.2	Normally closed	S, H	No	Yes	No	Yes	See Note 1
	SOLAS II-1/15-1.2 and 15-1.4	Permanently closed	S, H	No	Yes	No	Yes	See Notes 2 + 3

**Notes:**

1. If hinged, this door shall be of single action type.
2. The time of opening such doors in port and closing them before the ship leaves port shall be entered in the logbook.
3. Doors shall be fitted with a device which prevents unauthorized opening.

## 21.2.2 Fire doors

If watertight doors are installed in fire resisting divisions, they shall also meet the requirements for fire doors specified in subchapter 2.2.7 - on cargo ships and 11.1.3 - on passenger ships, *Part V of the Rules* (SOLAS II-2/9.2.2.7 and 9.4).

Where a watertight door is located adjacent to a fire door, both doors shall be capable of independent operation, remotely if required by SOLAS II-1/13.8.1 to 13.8.3 and from both sides of each door. (IACS UI SC156/Rev.2, par. 4)

## 21.2.3 Watertight Doors in Bulkheads of Ro-ro Ships

**21.2.3.1** The requirements of the present sub-chapter apply to watertight doors fitted in watertight bulkheads of cargo holds intended for the carriage of vehicles. Such doors may be applied if the number of passengers on board is not greater than:

$$N = 12 + 0.04A \quad (21.2.3.1)$$

*A* – deck area of such spaces available for the stowage of vehicles where the clear height at the stowage position and entrances to such spaces is not less than 4 m, [m<sup>2</sup>].

**21.2.3.2** Watertight doors may be fitted at any level if, according to PRS, such doors are essential for the movement of the said vehicles in the ship.

The number and the arrangement of doors are subject to special consideration of PRS.

**21.2.3.3** Watertight doors shall be fitted as far from the shell plating as practicable, but in no case are the outboard vertical edges to be situated at a distance from the shell plating less than 0.2 of the ship breadth. Such a distance shall be measured at right angle to the centre plane of the ship at the level of the deepest subdivision loadline.

**21.2.3.4** Watertight doors shall be made of steel. The use of other materials is subject to special consideration of PRS.

Watertight doors may be hinged, rolling or sliding. Portable doors shall not be used. The doors shall be fitted with devices to ensure satisfactory tightness, securing and locking. If the sealing gasket material is not classed as non-combustible, the gasket shall be properly protected against the effect of fire to the satisfaction of PRS.

The doors shall be provided with devices preventing the door opening by unauthorized persons.

**21.2.3.5** The construction of watertight doors shall be such as to ensure their capability of closing or opening both with the cargo on decks or without it, the deck deflection due to mass of cargo being taken into account.

The construction of closing appliances of the doors shall take account of the deflection of decks due to mass of the cargo causing displacement of structural parts of bulkheads and door plating with respect to each other.

**21.2.3.6** If the watertightness of the doors is provided by a gasket made of rubber or other suitable material and by means of closing appliances, a closing appliance shall be provided at each corner of the door (or door section, when the doors consist of sections). Such a closing appliance shall be calculated for the force determined by the formula:

– for closing appliances fitted at the lower edge of the doors:

$$F_1 = \frac{9.81A}{n_1} \left( \frac{H_1}{2} - \frac{h}{6} \right) + 29.42 \text{ [kN]} \quad (21.2.3.6-1)$$

- for closing appliances fitted at the upper edge of the doors:

$$F_2 = \frac{9.81A}{n_2} \left( \frac{H_1}{2} - \frac{h_i}{3} \right) + 29.42 \text{ [kN]} \quad (21.2.3.6-2)$$

- for closing appliances fitted at the vertical edge of the doors:

$$F_3 = \frac{a}{A} [F_1 (n_1 - 1)h_i + F_2 (n_2 - 1)(h - h_i)] \text{ [kN]} \quad (21.2.3.6-3)$$

$A$  – clear area of watertight door, [m<sup>2</sup>];

$H_1$  – vertical distance from the lower edge of door opening to the lower edge of bulkhead deck plating, measured in the ship's centre plane, however, not less than 5 m, [m];

$h$  – height of the door opening, [m];

$h_i$  – vertical height between considered closing appliance and the upper edge of the watertight door, [m];

$a$  – arithmetic mean of the distances measured vertically between the considered closing appliance and adjacent (upper and lower) appliances, [m];

$n_1$  – number of closing appliances fitted at the lower edge of the door;

$n_2$  – number of closing appliances fitted at the upper edge of the door.

The stresses in the structural members of the closing appliance under design force  $F_1$ ,  $F_2$  or  $F_3$  shall not exceed 0.5 times the yield stress of the material used.

**21.2.3.7** The operation of such doors shall be possible by means of a local control only. Indicators shall be provided on the bridge to show automatically when each door is closed and all door fastenings are secured.

**21.2.3.8** The watertight doors shall also fulfil the requirements of 21.2.1.2.

## 21.2.4 Manholes in Watertight Subdivision Bulkheads

**21.2.4.1** The requirements of 7.8 relating to the manholes located on the freeboard deck, raised quarter deck or first tier of superstructures are, as a rule, applicable to the manholes fitted in the watertight subdivision bulkhead.

**21.2.4.2** Portable plates on bulkheads shall not be permitted in:

- collision bulkhead below the bulkhead deck;
- in watertight transverse bulkheads dividing the ship into compartments, if such bulkheads separate a cargo space from an adjoining cargo space or fuel tank, except cases when PRS deems the fitting of a portable plate necessary; then each portable plate shall be secured over the opening before the voyage commences.
- in passenger ship bulkheads except those within machinery spaces;

PRS may permit not more than one power-operated sliding watertight door in each watertight bulkhead larger than those specified in paragraph 21.2.1.5.2 to be substituted for these portable plates, provided these doors are intended to remain closed during navigation except in case of urgent necessity at the discretion of the master. These doors need not meet the requirements of paragraph 21.2.1.10 regarding complete closure by hand-operated gear in 90 s.

## 21.2.5 Side Scuttles

Side scuttles shall be of the non-opening type if calculations indicate that they would become immersed by any intermediate stage of flooding or the final equilibrium waterplane in any required damage case. The above requirement does not apply to side scuttles located within the considered damaged compartment.

### 21.3 Testing of Watertight Doors

**21.3.1** Doors which become immersed by an equilibrium or intermediate waterplane or are below the freeboard or bulkhead deck shall be subjected to a hydrostatic pressure test. (IACS UI SC156/Rev.2, par. 5.1)

**21.3.2** For large doors intended for use in the watertight subdivision boundaries of cargo spaces, structural analysis may be accepted in lieu of pressure testing. Where such doors utilize gasket seals, a prototype pressure test to confirm that the compression of the gasket material is capable of accommodating any deflection, revealed by the structural analysis, shall be carried out. (IACS UI SC156/Rev.2, par. 5.1.1)

**21.3.3** Doors above freeboard or bulkhead deck, which are not immersed by an equilibrium or intermediate waterplane but become intermittently immersed at angles of heel in the required range of positive stability beyond the equilibrium position, shall be hose tested. (IACS UI SC156/Rev.2, par. 5.2)

#### 21.3.4 Pressure testing

**21.3.4.1** The head of water used for the pressure test shall correspond at least to the head measured from the lower edge of the door opening, at the location in which the door shall be fitted in the ship, to the bulkhead deck or freeboard deck, as applicable, or to the most unfavourable damage waterplane, if that be greater. Testing may be carried out at the factory or other shore-based testing facility prior to installation in the ship. (IACS UI SC156/Rev.2, par. 5.3.1)

#### 21.3.4.2 Leakage criteria

**21.3.4.2.1** The following acceptable leakage criteria shall apply:

Doors with gaskets:	No leakage
Doors with metallic sealing:	Maximum leakage 1litre/min

**21.3.4.2.2** Limited leakage may be accepted for pressure tests on large doors located in cargo spaces employing gasket seals or guillotine doors located in conveyor tunnels, in accordance with the following formula\*:

$$\text{Leakage rate [l/min]} = (P+4.572)h^3/6568 \quad (21.3.4.2.2)$$

where:

$P$  – perimeter of door opening, in [m],

$h$  – test head of water, in [m].

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\* Published in the ATM F 1196, Standard Specification for Sliding Watertight Door Assemblies and referenced in the Title 46 US Code of Federal Regulations 170.270 Door design, operation installation and testing.

**21.3.4.2.3** However, in the case of doors where the water head taken for the determination of the scantling does not exceed 6.1 m, the leakage rate may be taken equal to 0.375 l/min if this value is greater than the calculated by the above-mentioned formula.

**21.3.4.2.4** For doors of passenger ships which are used at sea or which become submerged by the equilibrium or intermediate waterplane, a prototype test shall be conducted, on each side of the door, to check the satisfactory closing of the door against a force equivalent to a water height of at least 1 m above the sill on the centre line of the door\*. (IACS UI SC156/Rev.2, par. 5.3.2)

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\* Arrangements for passenger ships shall be in accordance with regulation of SOLAS II-1/13.5.2).

### **21.3.5 Hose testing**

**21.3.5.1** All watertight doors shall be subject to a hose test (refer to IACS UR S14/ Rev.7) after installation in a ship. Hose testing shall be carried out from each side of a door unless, for a specific application, exposure to floodwater is anticipated only from one side. Where a hose test is not practicable because of possible damage to machinery, electric equipment insulation, or outfitting items, it may be replaced by means such as an ultrasonic leak test or equivalent test. (IACS UI SC156/Rev.2, par. 5.4)

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## 22 CHEMICAL RECOVERY VESSELS

### 22.1 General

#### 22.1.1 Application

**22.1.1.1** The requirements of this Chapter 22 apply to vessels assigned an additional mark **OIL RECOVERY VESSEL** or **CHEMICAL RECOVERY VESSEL** in the symbol of class.

#### 22.1.2 Definitions

**22.1.2.1** Definitions of terms related to this Chapter are covered by Chapter 1, *Part I – Classification Regulations* and Chapter 29 of *Part II – Hull*.

### 22.2 Closings of Openings in Hull and Superstructures

#### 22.2.1 Location of Openings

**22.2.1.1** Entrances, air inlets and openings to accommodation, service and machinery spaces and control stations shall not face the cargo area nor shore connection for unloading equipment. They may be located in the end bulkhead not facing the cargo area and/or on the outboard side of the superstructure or deck-house at a distance of at least 4% of the length of the ship but not less than 3 m from the end of the superstructure or deck-house facing the cargo area. The distance, however, need not exceed 5 m.

**22.2.1.2** Except the region described in 22.2.1.1, no doors are permitted, except the doors to those spaces not having access to accommodation and service spaces, and control stations. Wheelhouse doors may be located within the area specified above, provided they are so designed that a rapid and efficient gas tightness of the wheelhouse can be ensured.

#### 22.2.2 Windows and Sidescuttles

**22.2.2.1** Windows and sidescuttles shall be of non-opening type and be of structure fulfilling the standards ISO 3903 and ISO 1751, respectively, or a specifically designed one.

**22.2.2.2** Windows and sidescuttles shall be generally of laminated type. The panes shall consist of at least two layers of thermally toughened safety glass, complying with ISO 21005 Standard, bonded by a foil.

**22.2.2.3** In addition to resistance to local design pressure, the windows and sidescuttles shall be designed to withstand a shock wave with a positive pressure of 0.3 bar for at least 200 ms.

**22.2.2.4** Sidescuttles in the first tier of superstructure over the main deck, located in a wall that faces the cargo area and on the sides of the superstructures within 3 m of the mentioned wall, shall be fitted with inside covers of steel or equivalent material.

### 22.3 Protection of Access to Rooms and Tanks

**22.3.1** All openings to rooms and tanks, except those which are in use during removal of pollution, must be designed to be capable of being closed gastight when the ship operates in a hazardous atmosphere.

**22.3.2** Openings and accesses into the citadel which during the service in a hazardous atmosphere are not in use, shall be capable of being closed gastight. For other openings and accesses, suitable measures shall be provided to prevent the entry of hazardous substances/loss of overpressure in the region of the citadel.



**22.3.3** The accesses to the citadel shall be provided with air locks which ensure the maintenance of overpressure inside. An air lock must comprise two doors not less than 1.5 m apart. The doors must be self-closing and may not have any fixing devices. An alarm shall be provided which indicates that more than one of the doors is not fully closed. The air system shall ensure at least 20 air changes per hour with air flushed from inside of the citadel outwards.

## **22.4 Access to Spaces in the Cargo Area**

**22.4.1** Direct and full access shall be ensured from the open deck to cofferdams, ballast tanks, cargo tanks and other spaces in the cargo area. Access to double-bottom spaces may be ensured through a cargo pump-room, pump room, deep cofferdam, pipe tunnel or similar spaces, subject to consideration of ventilation aspects.

**22.4.2** For access through horizontal openings, hatches or manholes, the dimensions shall be sufficient to allow a person wearing a self-contained air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and shall also provide a clear opening to facilitate the hoisting of an injured person from the bottom of the space. The minimum clear opening shall not be less than 600 mm by 600 mm.

**22.4.3** For access through vertical openings, or manholes providing passage through the length and breadth of the space, the minimum clear opening shall be not less than 600 mm by 800 mm at a height of not more than 600 mm from the bottom shell plating, unless gratings or other footholds are provided.

**22.4.4** Smaller dimensions, than those of 22.4.2 and 22.4.3, may be approved by the Administration in special circumstances, if the ability to traverse such openings or to transfer an injured person can be proved to the satisfaction of the Administration.

## **22.5 Cargo Pump-rooms**

**22.5.1** Cargo pump-rooms shall be so arranged as to ensure:

- a) unrestricted passage at all times from any ladder, platform and from the floor;
- b) unrestricted access to all valves for a person wearing the required personnel protective equipment.

**22.5.2** Guard railings shall be installed on all ladders and platforms.

**22.5.3** Access ladders shall not be fitted vertically.

## SUPPLEMENT RETROACTIVE REQUIREMENTS

### 1 GENERAL

**1.1** The requirements set forth in the present Supplement apply to ships in service classed with PRS.

**1.2** The scope of retroactive requirements and implementation dates are specified separately for each of the requirements given below.

**1.3** The scope of technical documentation subject to PRS' consideration and approval covers the required calculations, drawings of introduced structural changes, as well as *Operating and Maintenance Manuals for the bow and inner doors*.

**1.4** It is the responsibility of the Owner to execute the applicable retroactive requirements according to the implementation schedule. Retroactive requirements execution is confirmed by PRS' surveyor in the report from the nearest Periodical Survey.

### 2 REQUIREMENTS

#### 2.1 Bow Doors and Inner Doors

##### 2.1.1 Application

The present requirements apply to all existing ro-ro passenger ships constructed before 30 June 1996, including, when not differently deliberated by the competent flag Administration, ships only engaged on domestic sea voyages.

##### 2.1.2 Detailed Requirements<sup>1</sup>

**2.1.2.1** The structural condition of bow doors and inner doors, especially the primary structure, the securing and supporting arrangements and the hull structure alongside and above the doors, shall be specially examined and any defects rectified.

**2.1.2.2** The requirements, set forth in 7.4.9 of this *Part III* concerning operating procedures for the bow and inner door shall be fulfilled.

**2.1.2.3** The location and arrangement of inner doors shall fulfil the relevant requirements of 7.4.1.6 of this *Part III*.

**2.1.2.4** Ships with visor door shall fulfil the requirements of 7.4.7.10, of this *Part III* requiring two securing devices to prevent the upward opening of the bow door.

In addition, where the visor door is not self-closing under external loads (i.e. the closing moment  $M_y$ , calculated in accordance with 7.4.3.3 of this *Part III*, is less than zero), the opening moment  $M_0$ , calculated in accordance with 7.4.7.10 of this *Part III*, shall be taken not less than  $M_y$ . If drainage arrangements in the space between the inner and bow doors are not fitted, the value of  $M_0$  is subject to PRS' agreement. Where available space above the tanktop does not enable the full application of 7.4.7.10 of this, equivalent measures shall be taken to ensure that the door has positive means for being kept closed during sea-going operation.

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<sup>1</sup> See also 2.8.

**2.1.2.5** Ships with visor door shall fulfil the requirements of 7.4.7.11 of this *Part III*, requiring securing and supporting devices, excluding hinges, to be capable of bearing the vertical design force ( $F_z - 10W$ , [kN], where  $W$  – the door mass, [t]) without exceeding the permissible stresses given in 7.4.2.1 of this *Part III*.

**2.1.2.6** For side-opening doors, the structural arrangements for supporting vertical loads, including securing devices, supporting devices and, where applicable, hull structure above the door, shall be re-assessed in accordance with the applicable requirements of 7.4.7 of this *Part III* and modified accordingly.

**2.1.2.7** The securing and locking arrangements for bow doors and inner doors which may lead to the flooding of a special category space or ro-ro space as defined in SOLAS II-2/3 shall fulfil the requirements: specified in *Part VIII – Electrical installations and control system*.

## **2.2 Side Shell Doors and Stern Doors**

### **2.2.1 Application**

The present requirements apply to all existing ro-ro passenger ships constructed before 30 June 1996, including, when not differently deliberated by the competent flag Administrations, ships only engaged on domestic sea voyages.

### **2.2.2 Detailed Requirements<sup>1</sup>**

**2.2.2.1** The structural condition of side shell doors and stern doors, especially the primary structure, the securing and supporting arrangements and the hull structure alongside and above the doors, shall be specially examined and any defects rectified.

**2.2.2.2** The structural arrangement of securing devices and supporting devices of inwards opening doors and, where applicable, of the surrounding hull structure shall be re-assessed in accordance with the applicable requirements of 7.5.5 of this *Part III* and modified accordingly.

**2.2.2.3** The securing and locking arrangements for side shell doors and stern doors which may lead to the flooding of a special category space or ro-ro cargo space, as defined in SOLAS II-2/3 shall fulfil the requirements: specified in *Part VIII – Electrical installations and control system*.

**2.2.2.4** Documented operating procedures for closing and securing side shell and stern doors shall be kept on board and posted at the appropriate places.

## **2.3 Emergency Towing Arrangements**

**2.3.1** For existing tankers, constructed before 1 July 2002, the emergency towing arrangements, specified in sub-chapter 11.5, shall fulfil the requirements set forth in Guidelines for emergency towing arrangements on tankers, according to resolution MSC.35(63), as amended. The arrangement of the emergency towing equipment and its fastening on board are subject to PRS' approval. Towing equipment components shall be certified by PRS.

## **2.4 Small Hatches on the Exposed Fore Deck**

**2.4.1** For ships, specified in 2.4.2, small hatches on the exposed deck giving access to spaces forward of the collision bulkhead and to spaces which extend over this line aftwards shall fulfil the requirements of paragraph 7.6.4 of this *Part III* according to the schedule given in 2.4.3.

<sup>1</sup> See also 2.8.

Hatches designed for use as emergency escape shall fulfil the requirements of 7.6.4 of this *Part III* except the requirements given in 7.6.4.3.1 a) and b), 7.6.4.4.3 and 7.6.4.5.

Securing devices of hatches designed for emergency escape shall be of a quick-acting type (e.g., one action wheel handles are provided as central locking devices for latching/unlatching of hatch cover) operable from both sides of the hatch cover.

**2.4.2** The requirements of 2.4.1 are applicable to bulk carriers, ore carriers, combination carriers (as defined in IACS UR Z11) and general dry cargo ships (excluding container vessels, vehicle carriers, ro-ro ships and woodchip carriers), of length  $L_0 \geq 100\text{m}$ , contracted for construction prior to 1 August 2004.

## **2.5 Cargo Hatch Cover Securing Arrangements for Bulk Carriers not Built in Accordance with the Requirements of 12.3 of this *Part III***

**2.5.1** The requirements of sub-chapter 2.5 apply to all bulk carriers, which were not built in accordance with the requirements of sub-chapter 12.3 of this *Part III*.

**2.5.2** For ships, specified in 2.5.1, the steel hatch cover securing devices and stoppers for cargo hold hatchways No. 1 and No. 2 which are wholly or partially within  $0.25L_0$  of the fore perpendicular, except pontoon type hatch cover, shall fulfil the requirements of *IASC UR S30/Rev.1/Corr.1* according to the schedule given in 2.5.3.

**2.5.3** The requirements, given in 2.5.2, shall be fulfilled in compliance with the following schedule:

- a) for ships which were 15 years of age or more on 1 January 2005 by the due date of the first Intermediate or Class Renewal Survey after that date, whichever is earlier;
- b) for ships which were 10 years of age or more on 1 January 2005 by the due date of the first Class Renewal Survey after that date;
- c) for ships which were less than 10 years of age on 1 January 2005 by the date on which the ship reaches 10 years of age.

**2.5.4** The requirements of sub-chapter 2.5 are not applicable to self-unloading bulk carriers.

## **2.6 Access to and Within Spaces in, and Forward of the Cargo Area**

Oil tankers of 500 gross tonnage and over and bulk carriers of 20000 gross tonnage and over – constructed on or after 1 January 2005 – shall comply with the requirements respectively of subchapter 11.6, of this *Part III* (oil tankers of 500 gross tonnage and over) or 12.2 of this *Part III* (bulk carriers of 20 000 gross tonnage and over).

## **2.7 Steering Gear**

Passenger ships of **Class B** – constructed on 29 June 2011 or before that date – shall comply with the requirements of 2.6.1.2, 2.6.1.5 and 2.6.1.8 of this *Part III* (acc. to Dir. 2010/36/EU) by the due date of the first Class Renewal Survey after 29 June 2011.

## **2.8 Openings in Ro-Ro Passenger Ships**

In ro-ro passenger ships constructed before 1 July 1997: all access doors or hatchways to spaces below the ro-ro deck, which may be used at sea, shall have sills or coamings not less than 380 mm in height above the ro-ro deck, and shall be provided with doors or covers considered weathertight in relation to their position (refer to SOLAS regulation II-1/20-2) <sup>1</sup>.

<sup>1</sup> In SOLAS/CONF.3/46, Resolution 1.

In ro-ro passenger ships built after 1 July 1997: subject to the requirements of sub-paragraphs 13.2.3.2 and 13.2.3.3, all accesses that lead to spaces below the bulkhead deck shall have a lowest point which is not less than 2.5 m above the bulkhead deck (refer to SOLAS II-1/20-2<sup>1</sup> for ships constructed on or after 1 July 1997, but before 1 January 2009 and to SOLAS II-1/17-1.1 for ships constructed on 1 January 2009 or after that date).

The ro-ro deck, referred to above is the deck above which the stern, bow or side doors are fitted, or the first deck above the load waterline.

## 2.9 Safe Access to Cargo onboard Containerships

The design of containerships, the keel of which was laid, or which were at similar stage of construction before 1 January 2015, shall take into account the requirements contained in Chapter 8 of Annex 14 to MSC.1/Circ.1352 /Rev.1.

It is recommended to apply the guidelines given in Charter 6 of the above Annex, where it is not associated with the demand for ship size increase or significant modification of ship structure.

## 2.10 Preparation of the Cargo Securing Manual (CSM) for Containerships

For the containerships the keel of which was laid, or which were at a similar stage of construction before 1 January 2015, the Cargo Securing Manual, approved by Administration, shall be prepared taking into account Chapters 1 to 4 of the Revised Guidelines for the Preparation of the Cargo Securing Manual, contained in Annex to MSC.1/Circ.1353/Rev.2.

### List of amendments effective on 1 January 2025

<i>Item</i>	<i>Title/Topic</i>	<i>Source</i>
<a href="#">11.7.2</a>	Update of requirements	MSC.1/Circ/1572/Rev.2
<a href="#">12.2.3</a>	Update of requirements	MSC.1/Circ/1572/Rev.2
<a href="#">1.8.3</a>	Update of revision	MSC.1/Circ/1509/Rev.1
<a href="#">7.10.5.4</a>	Update of requirements	UR S35 corr.1