Polski Rejestr Statków

RULES
FOR THE CLASSIFICATION AND CONSTRUCTION OF NAVAL SHIPS

PART III

HULL EQUIPMENT

2008

GDAŃSK

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF NAVAL SHIPS prepared and issued by Polski Rejestr Statków S.A., 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 – Machinery Installations and Refrigerating Plants
Part VII – Machinery, Boilers and Pressure Vessels
Part VIII – Electrical Installations and Control Systems
Part X – Statutory Equipment.

with regard to materials and welding, the requirements of *Part IX – Materials and Welding* of the *Rules for the Classification and Construction of Sea-going Ships,* apply.

Part III – Hull Equipment, 2008, was approved by the PRS Board on 24 June 2008 and enters into force on 1 August 2008.

From the entry into force of the present *Part III*, its requirements apply to:

- with respect to new naval ships, for which the contract is signed on 1 August 2008, or after that date – in full scope,
- for existing naval ships – on the principles specified in *Part I – Classification Regulations.*

The requirements of the present *Rules* are extended and supplemented by documents referred to in particular *Parts,* and particularly standard NATO agreements, national standards and the PRS Publications.

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1 GENERAL

1.1 Application

1.1.1 The present Part of the *Rules* applies to naval ships specified in 1.1, *Part I – Classification Regulations.*

1.1.2 Non-typical and special hull equipment is subject to special consideration by PRS.

1.1.3 The present Part of the *Rules* contains both basic and additional requirements. Compliance with the basic requirements (Chapters 1÷10), as applicable, is necessary for assignment of the main symbol of class.

Additional marks in the symbol of the ship class will be affixed, provided the additional provisions, as applicable, are complied with.

1.2 Definitions and Descriptions

1.2.1 Descriptions concerning general terminology applied in *the Rules for the-Classification and Construction of Naval Ships* (further referred to as the Rules) are contained in *Part I – Classification Regulations*. In the present sub-chapter are given definitions, descriptions and abbreviations specific to the Part III.

1.2.2 Symbols

FP – forward perpendicular – the perpendicular at the intersection of the summer load waterline corresponding to design draught with the fore side of the stem. For ships with unconventional stem curvature, the position of the forward perpendicular will be specially considered by PRS.

BP – baseplane – 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.

AP – after perpendicular – the perpendicular at the intersection of the waterline corresponding to design draught with the axis of the rudderstock or with transom line (in case of ships without classic rudders).

PS – the ship's plane of symmetry.

L – length of the ship – 96% of the total length of the ship measured on a waterline at 85% of the moulded depth, measured from the base plane, or the length from the fore side of the stem to the axis of the rudder stock on that waterline, if that be greater. In ships designed with a rake of keel, the waterline on which this length is measured is to be parallel to the design waterline. In ships with unusual stern and bow arrangement, the length *L* is to be agreed with PRS.

L_o – design length of the ship, [m] – the length of the ship measured on a waterline plane corresponding to design draught from the fore edge of the stem to the axis of the rudderstock (to the transom – for ships without classic rudders). The assumed value of L_o is not to be less than 96% of the total length of the hull measured on a waterline plane as above, and must not be greater than 97% of that length. If a shape of the ships' bow or stern differs from usually applied, the length L_o will be specially considered by PRS.

L_w – length of the ship measured on a waterline corresponding to design draught, [m] - the distance measured on this waterline from the fore edge of the stem to the point of intersection of the waterline with the after edge of the stern (transom).

L_{BP} – length between perpendiculars, [m] – the distance between the fore and aft perpendicular.

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

T – design draught, [m] – the vertical distance measured amidship from the baseline to the waterline at the maximum anticipated draught of the ship in normal service conditions.

H – moulded depth, [m] – the vertical distance measured amidship from the baseline to the upper edge of the uppermost deck's beam. For the ships with the rounded connection of the deck stringer and the shear strake, the moulded depth is to be measured to the intersection point of the deck line and side line extensions. Where the upper deck is stepped, and through the point, in which the depth is to be assumed, passes upper part of the deck, the moulded depth is to be measured from the reference line constituting extension of the lower part parallel to the upper part of the deck.

D – moulded displacement, [t] – the weight of the ship, in tonnes, as the weight of water of capacity equal to the capacity of the submerged part of a hull. If not defined otherwise, salt water density of 1.025 t/m^3 is to be assumed.

D_p – full displacement, [t] – displacement of fully equipped ship, with the crew, cargo, full supply of munitions, provisions, fuel, lubricants and boiler water.

D_{max} – maximum displacement, [t] – displacement of the most loaded ship, at maintained stability, with possible limitation of speed or service range.

V – volume of the moulded displacement, [m^3] – the volume of a body defined by the external edges of frames at draught T.

v – speed of the ship, [knots] – speed of the ship reached, if not assumed otherwise, under full displacement and good weather conditions.

v_m – maximum momentary speed, [knots] – the upmost speed of the ship, achievable for certain period of time, under permissible overload of the propulsion system.

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

R_e – material yield point, [MPa] – see *Part IX – Materials and Welding.*

1.2.3 Co-ordinate System

1.2.3.1 In the present part of the *Rules*, the co-ordinate system, as can be seen on Fig. 1.2.2.1, has been assumed for ships. The following reference planes have been assumed for the system: baseline, centreline and midship section.

The intersection of the centreline and the baseline forms the *x* axis of the positive sense forward.

The intersection of the baseline and midship section forms the *y* axis of the positive sense towards port side.

The intersection of the centreline and midship section forms the *z* axis of the positive sense towards upward.

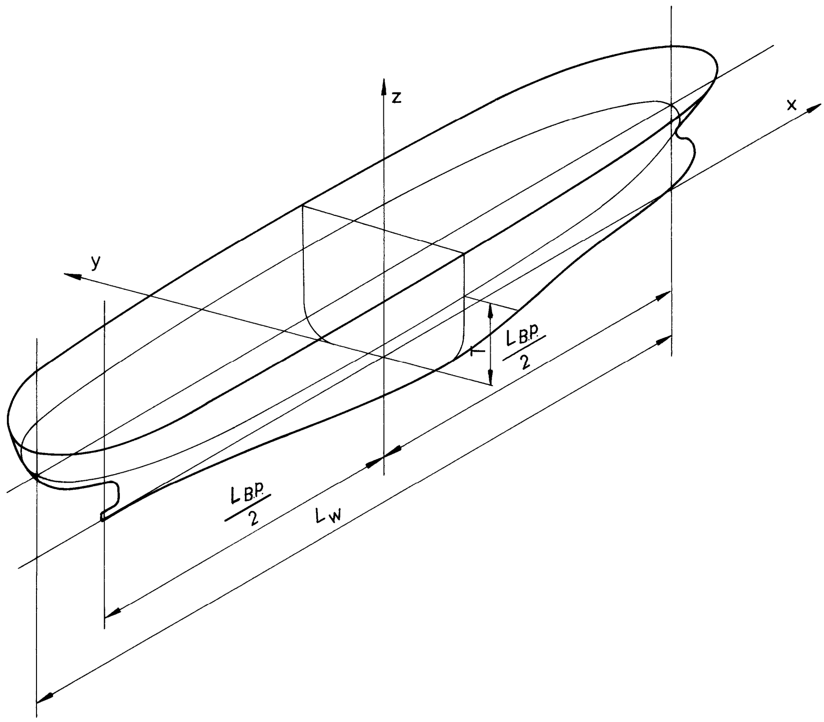


Fig. 1.2.2.1 Ship co-ordinate system

1.2.4 Definitions

Damage waterline – see *Part IV – Stability and Subdivision.*

Margin line – the line drawn on the ship's side, at least 76 mm below the upper surface of the bulkhead deck.

PAWMD – Protection Against Weapons of Mass Destruction. Requirements for this protection are specified in tactical and technical data by the Purchaser.

Midship section – hull cross-section at the middle of the distance between the fore perpendicular and aft perpendicular.

Upper deck – the uppermost continuous deck extending over the full length of the ship.

Bulkhead deck – the uppermost deck to which the main watertight bulkheads, subdividing the ship into watertight compartments, are carried.

Open deck – the lowest continuous deck, which may be exposed to the effects of sea and weather. Open deck shall be determined, upon PRS agreement, at a design stage.

Weather deck – each deck or part thereof, which may be exposed to the effects of sea and weather.

Lower deck, 'tween deck – the deck situated below the upper deck. Where there are several lower decks, they are named: the second deck, the third deck, etc., counting from the upper deck.

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 from the upper deck.

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 0.04 B.

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 0.04 B.

Trunk – a decked structure on the freeboard deck with the side wall being inboard of any ship's side more than 0.04 B and having no doors, windows or other similar openings in the outer bulkheads.

Gastightness – the term pertaining to closing appliances of openings, which means that under defined gas pressure it will not penetrate through these openings. The closing appliances shall fulfil following criterion – in compartments, where pressure has been risen to 0.015kg/cm^2 (1500 Pa), pressure drop after 10 min. shall not exceed 0.0013 kg/cm^2 (130 Pa).

Watertightness – the term pertaining to closing appliances of openings which means that under specified pressure the liquid will not penetrate through these openings.

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 are to 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 is to be not more than 3 metres).

Cycloidal propeller – a propeller with vertical axis consisting of wings, which, except for rotation around propeller's axis, exercise also swing movements around their own axis, enabling not only propulsion of the ship, but steering the ship as well.
Requirements concerning cycloidal propellers are given in *Part VII – Machinery, Boilers and Pressure Vessels.*

Azimuth propeller – an appliance powered by the main engine (usually electric motor) in which propeller rotating around vertical axis can provide a thrust in the specified range of angles, enabling steering the ship.
Requirements concerning azimuth propellers are given in *Part VII – Machinery, Boilers and Pressure Vessels.*

Active rudder – a self-propelled device exerting thrust under any angle to the longitudinal centre plane of the ship at zero or small speed, irrespective of the main engine operation.

Balanced rudder – a rudder with axis of rotation so selected that the centre of water pressure acting on the deflected rudder blade is positioned between the axis of rotation and the trailing edge of the rudder blade.

Rudder stock – a component of the rudder gear connecting the rudder blade with the tiller and transmitting the torque between these two parts.

Geometrical rudder axis – a geometrical axis of rotation of the rudder blade and rudder stock connected to it.

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.

Rudder pintle – a pin installed in the sternframe structure, the geometrical axis of which is in line with the rudder geometrical axis. Two rudder pintles, fitted in the lower and upper part of the sternframe, perform the task of the structural rudder axle.

Main steering gear – the steering arrangement provided for putting the rudder or the steering nozzle over and necessary for steering the ship under normal service conditions. The main steering gear consists of an actuator enabling the rudder or the steering nozzle to be put over, a steering gear power unit, if any, means of applying torque to the rudder stock (e.g. tiller or quadrant) and additional equipment.

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.

Steering gear power unit:

1. in the case of electric steering gear – an electric motor and its associated electrical equipment;

2. in the case of electro-hydraulic 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.

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. The power actuating systems may share common mechanical components, i.e. tiller, quadrant and rudder stock, or components serving the same purpose.

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.

Permanent fixed lashing materials – components dismountable or permanently attached to the hull structure, such as: guides, seatings, supports, sockets, lashing eyes and plates, etc.

1.3 Survey

1.3.1 Survey is carried out in accordance with the provisions set out in *Part I – Classification Regulations.*

1.3.2 The following items are subject to PRS' survey during manufacture:
- **.1** anchors;
- **.2** towing hooks;
- **.3** watertight and gastight doors and their closing appliances;
- **.4** hatch covers and cargo ports;
- **.5** side and flush scuttles, and windows;
- **.6** anchor and mooring stoppers;
- **.7** mooring and towing bollards, fairleads, etc.;
- **.8** watertight doors in subdivision bulkheads;
- **.9** active rudder systems (only in cases given in 2.1.4);
- **.10** fixed lashing equipment for containers and ro-ro cargo.

1.3.3 During ship construction, PRS' survey covers the whole hull equipment comprised in the present *Rules*, 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** arrangement and equipment of ship spaces;
- **.8** guard rails, bulwarks and gangways;

.9 active rudder systems (see 2.1.3);
.10 fixed lashing equipment for containers and ro-ro cargo;
.11 passive and active heeling stabilizers.

1.3.4 During the manufacture of products and ship construction, the 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 Rules within the scope not specified in the technical documentation,
– compliance with the requirements of *Part IX – Materials and Welding*.

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

1.4 Technical Documentation

1.4.1 Classification Documentation of Ship under Construction

1.4.1.1 General principles covering the scope of technical documentation and approval procedure are given in *Part I – Classification Regulations.*

1.4.1.2 Prior to the commencement of construction of the ship's hull, the documentation, specified in 1.4.2, is to be submitted to PRS for consideration within the applicable scope, taking into account its arrangements and equipment. PRS may extend the scope of documentation upon examination of 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 Plans of rudder gear, as well as drawings of rudder stock, rudder blade, rudder axle, pintles, bearings, glands, including the calculations of steering gear.
.3 Plans and calculations of anchor equipment,
.4 Plan and calculations of mooring and towing equipment (p. 4.2.5 and 5.2.3).
.5 Drawings of signal masts, as well as the masts of special construction, including calculations of their structure and rigging.
.6 Arrangement of openings and their closing appliances in hull, superstructures, deckhouses and watertight bulkheads, including their dimensions, the height of coamings, thresholds, etc., as well as structural details of coamings and closing appliances.
.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 the hold panelling.

.8 Plan of the hold equipment, including drawings of supports and cargo racks dimensions.

Additionally the following is to be submitted:

.9 For tugs:
- arrangement of towing equipment, including SWL for elements of anchoring equipment;
- drawings of towing hooks, bollards and chocks, their seating and supporting;
- list and characteristics of towing equipment, including information concerning tow rope breaking force;
- calculation of towing equipment.

.10 Documentation concerning horizontal and vertical loading, including appliances for special cargos loading (munitions, armament, etc.), appliances for at sea loading (RAS), as well as on-deck transport appliances:
- arrangement of horizontal and vertical loading appliances,
- drawings of seating and supporting loading appliances,
- drawings of masts and columns together with their structural calculations and rigging,
- remaining documentation according to PRS requirements.

.11 For ships carrying ro-ro cargo 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 ship structure strengthening under the fixed outfit and equipment;
- drawings of movable ramps for loading vehicles including calculations containing data on:
  - the maximum number of vehicles 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 proposed programme of strength and operation tests;
- arrangement plan of movable deck structures;
- drawings and calculations of movable decks structure, 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;

.12 For ships intended for the carriage of containers:
- arrangement of sockets, securing pads, cellular guides, etc. for fixing and fastening containers;
- details of cellular guides structure and strengthenings under the fixed lashing equipment.;

.13 For ships intended to be moored at sea:
- information on means absorbing hulls' impacts during mooring.

.14 For ships 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.

.15 For ships adapted for loading at sea (RAS) additionally to 1.4.2.10:
- instructions for loading operations during ship's movement and during her stay in port and at sea.

1.4.3 Workshop Documentation

Upon approval of documentation specified in 1.4.2, the following workshop documentation is to be submitted to the PRS for consideration and agreement:
- program of mooring and sea trials,
- drawings of local strengthening under gear and machinery not shown in documentation specified in 1.4.2.

1.4.4 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, is to be submitted to the PRS for consideration.

When new machinery or arrangements, covered by the requirements of *the Rules*, are installed, 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, is to be submitted to the PRS.

1.4.5 Documentation of Products

Prior to the commencement of manufacture of products, mentioned in 1.3.2, the following documentation is to be submitted to PRS:
- assembly drawing,
- calculations,
- drawings of assemblies and parts if they are not to be 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 of *the Rules* are to comply with the requirements of *Part IX – Materials and Welding*.

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

1.5.3 Unless otherwise specified in the relevant Parts of *the Rules*, the materials intended for other items of machinery and equipment are to comply with the requirements set forth in technical documentation approved by PRS.

Table 1.5.2[1]

Item	Specification	Material
1	2	3
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
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 [2), 3)]	Rolled steel, wrought aluminium alloys
8	Watertight sliding doors [2), 3)]	Steel forgings, steel castings, rolled steel
9	Anchors	Steel forgings, steel castings
10	Anchor chains	Rolled steel, steel forgings, steel castings

[1)] For ships of special magnetic parameters, or constructed with materials other than steel, application of materials other that given in Table 1.5.2, but complying with requirements of *Part IX – Materials and welding,* may be considered.

[2)] The grade of rolled steel plates and profiles is to be selected in accordance with *Part II – Hull* for group II; for ships with ice strengthening L1 and L1A (except closures of cargo hatches located outside positions 1 and 2 – not below category B.

[3)] Welded structures and welding procedure are also to comply with the relevant requirements of *Part II – Hul.*

1.6 Working and Permissible Stresses

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

$$\sigma_{zr} = \sqrt{\sigma^2 + 3\tau^2}, \text{ [MPa]} \tag{1.6.1}$$

σ – normal stress in the considered cross-section, [MPa];
τ – shear stress in the considered cross-section, [MPa].

The strength is to be checked for equivalent stress σ_{zr}.

The equivalent stresses may be also calculated by other method agreed with PRS.

1.6.2 Permissible stresses, with which equivalent stresses are compared at strength checking, are expressed in the present Part of the Rules as a fraction of the material yield stress.

Unless stated otherwise, the yield stress is to be taken not 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 is to be determined from the following formula:

$$N_c = D^{2/3} + 2Bh + 0.1A \tag{1.7.2-1}$$

D – displacement of ship at maximum draught in normal service conditions, [t];
B – ship's breadth, [m];
h – effective height measured from the maximum draught waterline to the top of the uppermost erection, [m], and:

$$h = a + \sum h_i \tag{1.7.2-2}$$

a – distance from the maximum draught waterline in normal service conditions amidship to the upper deck at side, [m];
h_i – height (measured at the centerline) of each tier of the superstructure of deckhouse exceeding 0.25 B in breadth; where there are two or more superstructures or deckhouses along the ship's length, only the widest one is to be taken into account; for the lowest tier, h_i is to be measured at the centerline from the upper deck or from a conventional deck line where a deck is discontinued; if an erection having a breadth greater than 0.25 B is above an erection of a breadth of 0.25 B or less, then the wide erection is to be included in calculations, while the narrow may be neglected;

A – lateral windage area of the hull above the maximum draught waterline in normal service conditions, as well as of superstructures and deckhouses having a breadth greater than 0.25 *B*, within the length L_0, [m^2].

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 are to be included in calculations and treated as erections, while hatch coamings and deck cargo, such as containers, may be disregarded.

In case where bulwark height exceeds 1,5 m, as shown on Fig. 1.7.3, area A_2 is to be included in *A*.

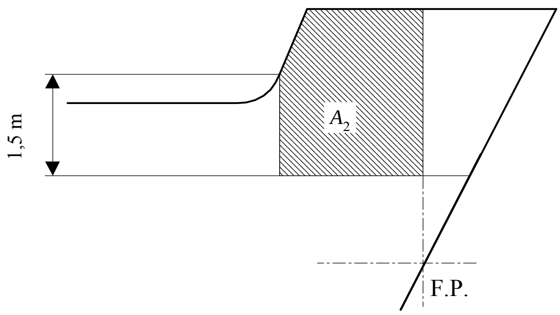


Fig. 1.7.3

1.7.4 Special anchoring and mooring systems, as well as anchoring and mooring systems for special purpose ships are subject of separate PRS consideration. PRS specifies requirements and scope of documentation to be submitted for approval. For calculations of the above systems, expected loads, which may occur during service, are to be assumed.

2 STEERING GEAR

2.1 General

2.1.1 Every ship is to be provided with an appropriate arrangement ensuring her manoeuvrability and course-keeping ability. Such arrangement may be: arrangement with a rudder blade, arrangement with a steering nozzle or other arrangements agreed with the PRS.

2.1.2 The present Chapter applies only to arrangements with ordinary rudders or streamlined steering nozzles with fixed stabilizers.

Steering arrangements of special design, as well as propulsion-steering arrangements are subject to special consideration of the PRS.

2.1.3 Arrangements of active rudder are supplementary to the arrangements referred to in 2.1.1 and are considered by PRS in respect to influence of their construction, installation, etc. on the ship's general safety.

2.1.4 In particular cases – taking into account the purpose, characteristics and assumed operating conditions of the ship – PRS may agree 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, rudder arms of single-plated rudders, pintles, keys and coupling bolts are to be made of forged or rolled steel, while cast components – of carbon-manganese steel according to the requirements specified in *Part IX – Materials and Welding*. Where other materials are proposed dimensions of elements will be considered separately by the PRS.

The yield stress of materials used for the above-mentioned items is to be not less than 200 MPa.

The requirements of the present Part of the *Rules* are based on material yield stress 235 MPa. If the material used has a yield stress different than 235 MPa, the material factor is to be determined from the formula:

$$k = \left(\frac{235}{R_e}\right)^e \qquad (2.1.3)$$

e = 0.75 for $R_e > 235$ MPa;
e = 1.0 for $R_e \le 235$ MPa;
R_e – yield stress of the material used, [MPa]; and is to be taken not greater than 0.7 R_m or 450 MPa, whichever is the lesser;
R_m – tensile strength of the material used, [MPa].

2.1.6 Welded components of rudders are to be made of ship hull structural steel.

Where higher strength steel is applied, the component scantlings, determined from the relevant requirements of the present Part of the *Rules*, may be reduced by applying the material factor k given below:
$k = 0.78$ for $R_e = 315$ MPa,
$k = 0.72$ for $R_e = 355$ MPa.

The use of steel with R_e exceeding 355 MPa shall be separately accepted by the PRS.

2.1.7 Where steel of tensile strength higher than 235 MPa is applied, excessive reduction of rudder stock diameter is to be avoided. The PRS may require rudder stock deformations calculations.

2.2 Steering Gear Loads

2.2.1 Scope of Application

The parameters calculated in sub-chapter 2.2 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.

Where the rudder is of innovative feature, of high elongation or the ship speed exceeds 42 knots, scantlings of the rudder and rudder stock are to be determined by the direct calculations and, if considered necessary by the PRS, utilizing model tests results.

2.2.2 Force Acting on the Rudder Blade

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

$$F = 132 K_1 K_2 K_3 K_4 A v^2_{\mathrm{m}}, \quad [\mathrm{N}] \qquad (2.2.2.1\text{-}1)$$

A – rudder blade area, [m^2];
v_m – maximum service speed, [knots].

When the ship's speed is less than 10 knots, v_{m} is to be determined from the formula:

$$v_m = \frac{v+20}{3} \qquad (2.2.2.1\text{-}2)$$

For the astern running, the maximum astern speed is to be used. However, in no case is this speed to be less than 0.5 v_{m}.

K_1 – factor depending on the rudder blade dimensions,

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

$a_1 = \frac{b}{A_1}$, but not to be taken greater than 2.0; (2.2.2.1-4)

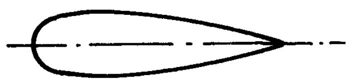
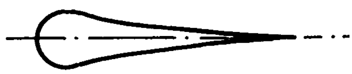
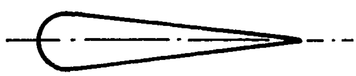
b – mean height of the rudder blade, [m];

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

The mean height and mean breadth of rudder blade are to be calculated according to the co-ordinate 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^2];

Table 2.2.2.1

Profile type	K_2	
	Ahead condition	Astern condition
NACA – 00, Göttingen profiles 	1.1	0.80
Hollow profiles 	1.35	0.90
Flat side profiles 	1.1	0.90

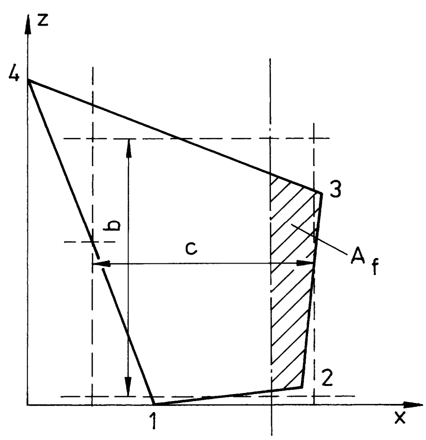


Fig. 2.2.2.1

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,
K_3 = 1.15 for rudders behind a fixed propeller nozzle,
K_3 = 1.0 otherwise;
K_4 – factor depending on the propeller thrust coefficient (w). For rudders behind propeller, K_4 = 1.0 is to be taken. If w exceeds 1.0, the value of K_4 coefficient is to be agreed with the PRS.

K_5 – factor depending on the value $\frac{v_m}{\sqrt{L_w}}$, where L_w as defined in 1.2.1.

for $\frac{v_m}{\sqrt{L_w}} < 3.0$ $K_5 = 1$

for $\frac{v_m}{\sqrt{L_w}} \geq 3.0$ $K_5 = (1.12 - 0.005v)^3$,

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

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

2.2.3 Rudder Torque

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

$$M_s = F\,r\,,\ [\text{Nm}] \qquad (2.2.3.1\text{-}1)$$

$$r = c\left(\alpha - k\right),\ [\text{m}] \qquad (2.2.3.1\text{-}2)$$

F – rudder blade force, [N], according to 2.2.2.1;
c – mean breadth of rudder blade, [m], according to Fig. 2.2.2.1;
α = 0.33 for ahead condition,
α = 0.66 for astern condition;
k – rudder blade balance factor determined from the formula:

$$k = \frac{A_f}{A} \qquad (2.2.3.1\text{-}3)$$

A_f – portion of the rudder blade area situated ahead of the rudder stock centerline;
r_{min} = 0.1 c, [m], for ahead condition.

2.2.3.2 For semi-spade rudders, the total value of torque applied to the steering gear is to be determined for ahead and astern condition from the following formula:

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

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

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

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

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

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

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

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
$A_1 + A_2 = A$, [m^2], according to Fig. 2.2.3.2;

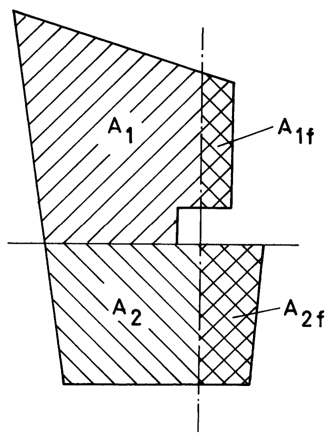


Fig. 2.2.3.2

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

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

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

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

k_1, k_2 – partial rudder blade balance factors determined from the formulae:

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

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

α = 0.33 for ahead condition,
α = 0.66 for astern condition;
for rudder blade parts behind a fixed structure, such as rudder horn:
α = 0.25 for ahead condition,
α = 0.55 for astern condition.

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

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

2.2.4 Bending Moment

2.2.4.1 Unless determined by direct calculation, bending moments for some, most common, rudder arrangements may be calculated according to formulae given in 2.2.4.2, 2.2.4.3 and 2.2.4.4.

Where the rudder blade is supported by sole piece or rudder horn, these structures are to be included in the calculation model to consider the elastic support of rudder blade.

2.2.4.2 The bending moments for supported rudder, shown in Fig. 2.2.4.2, are to be determined from formulae 2.2.4.2-1 and 2.2.4.2-2.

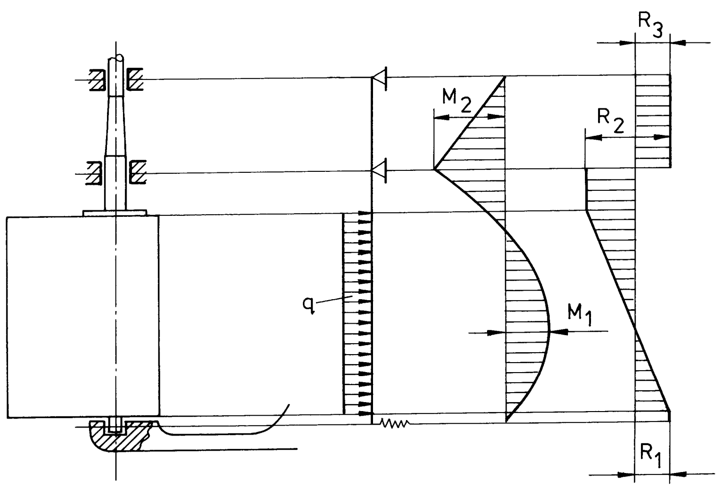


Fig. 2.2.4.2 Supported rudder

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

$$M_1 = 0.125 F b, \ [\text{Nm}] \qquad (2.2.4.2\text{-}1)$$

F – rudder blade force, [N], according to formula 2.2.2.1-1;
b – mean height of the rudder blade, [m], according to formula 2.2.2.1-6.

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

$$M_2 = \frac{F b}{7}, \ [\text{Nm}] \qquad (2.2.4.2\text{-}2)$$

2.2.4.3 For spade rudder, shown in Fig. 2.2.4.3, the bending moments are to be determined from formulae 2.2.4.3-1 and 2.2.4.3-2.

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

$$M_1 = \frac{F A_b h_1}{A}, \ [\text{Nm}] \qquad (2.2.4.3\text{-}1)$$

F – see 2.2.2.1-1;
A_b – rudder blade area below the section considered, [m^2];
h_1 – vertical distance from the centre of partial rudder blade area A_b to the section considered, [m^2];
A – rudder blade area, [m^2].

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

$$M_2 = F h_2, \ [\text{Nm}] \qquad (2.2.4.3\text{-}2)$$

h_2 – vertical distance from the centre of rudder area to the centre of the lower bearing, [m].

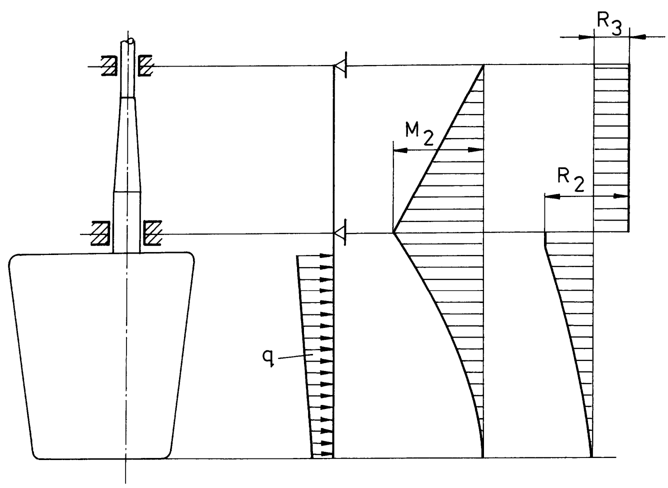


Fig. 2.2.4.3 Spade rudder

2.2.4.4 For semi-spade rudder, shown in Fig. 2.2.4.4, the bending moments are to be determined from formulae 2.2.4.4-1 and 2.2.4.4-2.

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

$$M_1 = \frac{F\,A_b\,h_2}{A}, \text{ [Nm]} \qquad (2.2.4.4\text{-}1)$$

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 is to be determined from the formula:

$$M_2 = \frac{F\,b}{17}, \text{ [Nm]} \qquad (2.2.4.4\text{-}2)$$

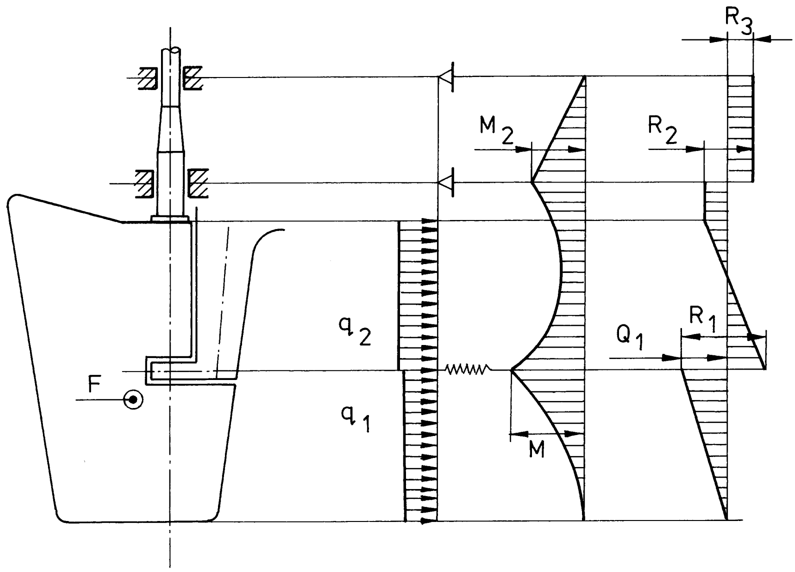


Fig. 2.2.4.4 Semi-spade rudder

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 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:
$R_1 = 0.6\,F$, [N] – at sole piece pintle bearing, (2.2.5.2-1)
$R_2 = 0.7\,F$, [N] – at stern pintle or the lower bearing, (2.2.5.2-2)
$R_3 = 0.1\,F$, [N] – at the upper bearing; (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 0.1 b below or above the centre of gravity of the rudder blade, (b – mean height of rudder blade, [m], see 2.2.2.1-6), and the reaction forces are as follows:

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

$R_2 = 0.4\ F$, [N] – at stern pintle or 0.3 F at the lower bearing, (2.2.5.3-2)

$R_3 = 0.1\ F$, [N] – at the upper bearing. (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:

$$R_2 = \frac{h_1 + h_2}{h_2} F, \text{ [N] – at the lower bearing of rudder stock,} \qquad (2.2.5.4\text{-}1)$$

$$R_3 = \frac{h_1}{h_2} F, \text{ [N] – at the upper bearing of rudder stock;} \qquad (2.2.5.4\text{-}2)$$

h_1 – vertical distance from the centre of gravity of the rudder blade to the centre of lower bearing, [m];

h_2 – vertical distance from the centre of the lower bearing to the centre of the upper bearing of the rudder stock, [m].

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, is to be applied.

2.3.1.3 When checking the steering nozzle pintles, as well as the nozzle stock bearings, pressures are not to 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 is to be taken not less than that determined by the formula:

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

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

$$F_d = 9.81 p D_d l_d v_p^2, \text{ [N]} \qquad (2.3.2.1\text{-}2)$$

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

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

D_d – nozzle inside diameter, [m];
l_d – nozzle length, [m];
A_{st} – nozzle stabilizer area, [m^2];
v_p – speed determined by the formula:

$$v_p = v_m (1 - w), \text{ [knots]} \qquad (2.3.2.1\text{-}4)$$

v_m – maximum ahead speed of the ship at a draught to the full displacement waterline, [knots], but not less than 10 knots;
w – mean wake factor; if reliable experimental data are not available, the w factor is to be determined by a formula agreed with the PRS;
p and q – factors determined from Table 2.3.2.1-1, depending on the value of propeller thrust load coefficient ξ_T and on the relative nozzle length λ_d;
ξ_T is to be determined by the formula:

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

T_s – propeller thrust at speed v, [N];
D – propeller diameter, [m];
λ_d – to be determined by the formula:

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

Table 2.3.2.1-1

ξ_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 ξ_T and λ_d, the values p and q are to be determined by linear interpolation.

m – coefficient determined from Table 2.3.2.1-2, depending on the relative aspect ratio λ_{st} of the stabilizer;
λ_{st} is to be determined by the formula:

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

h_{st} – nozzle stabilizer height, [m];
l_{st} – nozzle stabilizer length, [m].

Table 2.3.2.1-2

λ_{st}	m
1	2.1
2	3.1
3	3.8
4	4.2
5	4.5

For intermediate values of λ_{st}, the value m is to 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 is to be taken; this distance is to be not less than that determined by the formula:

$$r_d = l_d \left(b K + c \right), \text{ [m]} \qquad (2.3.2.2\text{-}1)$$

K – nozzle compensation factor determined by the formula:

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

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 ξ_T value.

Table 2.3.2.2

ξ_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 ξ_T, the values b and c are to 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 is to be taken; this distance is to be not less than that determined by the formula:

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

l_{st} – see 2.3.2.1.

2.3.3 Torque

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

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

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

$$M_d = F_d\left(l_{td} - r_d\right),\ \text{[Nm]} \qquad (2.3.3\text{-}2)$$

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

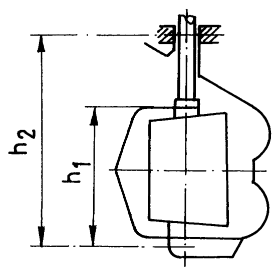
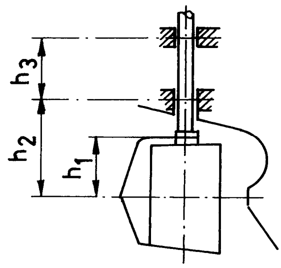
$$M_{st} = F_{st}\left(a + r_{st}\right),\ \text{[Nm]} \qquad (2.3.3\text{-}3)$$

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 are to be taken not less than those indicated in Table 2.3.4, depending on the type of the nozzle.

Table 2.3.4

Type of calculations	Type of steering nozzles	
	supported	spade
		
1	2	3
Design bending moment at the nozzle stock – on the stock bearing level, [Nm]	$M_2 = 0.13Fh_1 \times\left(1.17\frac{h_2}{h_1} - 1\right)$	$M_2 = 1.1Fh_2$
Design bending moment at the stock to nozzle connection, [Nm]	$M_3 = 0.21Fh_1 \times\left(1.05\frac{h_2}{h_1} - 1\right)$	$M_3 = 1.1Fh_1$
Design reaction force of supports at the lower bearing of the stock, [N]	$R_1 = F \times\left[0.53 – 0.24\left(\frac{h_2}{h_1} - 1.1\right)\right]$	$R_1 = 1.1F \times\left(1 + \frac{h_2}{h_3}\right)$

1	2	3
Design reaction force of supports at the pintle, [N]	$R_2=F \times\left[0.57–0.24\left(\frac{h_2}{h_1}-1.1\right)\right]$	–
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.

In the Table 2.3.4 formulae, all linear dimensions are to be given 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 the PRS.

2.4 Rudder Design

2.4.1 General

The section modulus and the web area of a horizontal section of the rudder blade made of normal hull structural steel are to be such that the following stress values are not exceeded:

– for supported and spade rudders (see Fig. 2.2.2.1):
bending stress σ = 110 MPa,
shear stress τ = 50 MPa,
equivalent stress σ_{zr} = 120 MPa;

– for semi-spade rudders (see Fig. 2.2.3.2):
bending stress σ = 75 MPa,
shear stress τ = 50 MPa in way of cut-outs,
equivalent stress σ_{zr} = 100 MPa.

2.4.2 Streamline Rudder Blade

2.4.2.1 The thickness of the rudder side, top and bottom plating made of normal hull structural steel is to be not less than:

$$s=5.5a_2\beta\sqrt{T+\frac{F\,10^{-4}}{A}}+2.5,\ \text{[mm]} \qquad (2.4.2.1\text{-}1)$$

T – draught of the ship to the full displacement waterline, [m];
F – rudder blade force, [N], according to 2.2.2.1;
A – rudder blade area, [m^2];

$$\beta=\sqrt{1.1–0.5\left(\frac{a_2}{a_2'}\right)} \qquad (2.4.2.1\text{-}2)$$

$$\beta_{max} = 1.0 \text{ when } \frac{a_2'}{a_2} \geq 2.5$$

a_2 – the minimum unsupported distance between the horizontal or vertical web plates, [m]; this value is not to 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].

2.4.2.2 The thickness of the nose plates of the rudder blade is to be not 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 is to be not 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 2.1.6, is to be applied.

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

2.4.2.5 The plating and stiffeners are to be welded together with fillet welding or plug weld with oblong cut-outs. Such connection is to 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 are to be provided with a rudder-piece extending over the full height of the rudder blade. The diameter of the rudder-piece is to 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 is to be not less than that determined from the formula:

$$s = 1.5 a_3 v_m + 2.5, \text{ [mm]} \quad (2.4.3.2)$$

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

v_m – ship maximum momentary speed, [knots] (see 2.2.2.1).

2.4.3.3 Horizontal stiffening arms are to 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 is not to exceed 1.0 m. For this purpose, intermediate arms are to be provided, where necessary. The arm thickness is to be not less than the rudder plate thickness.

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

$$W = 0.5 a_3 c_1^2 V^2 \text{, [cm}^3\text{]} \qquad (2.4.3.4)$$

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].

Where higher strength steel has been used, material factor k, given in 2.1.6, is to be applied.

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 is to be determined for shear stress not exceeding $\tau_t = \frac{68}{k_t}$, [MPa] and is to be not less than that determined by the formula:

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

M_s – rudder torque acting upon steering gear, [Nm], according to 2.2.3.1 or 2.2.3.2;
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, is to be not less than:

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

d_t – according to 2.4.4.1, [mm];
M – bending moment at the cross-section considered, [Nm], according to 2.2.4;
M_s – torque at the cross-section considered, [Nm], according to 2.2.3.

In the above formula, the following values of σ, τ and σ_{zr} have been assumed:

σ – bending stress:

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

τ – shear stress due to torsion:

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

σ_{zr} – equivalent stress:

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

but not more than $\sigma_{zr} = 118/k_t$; k_t – rudder stock material factor (see 2.1.5).

2.4.4.3 Prior to approving significant reductions in rudder stock diameter due to the application of steel with yield stress exceeding 235 MPa, the PRS may require to estimate the rudder stock deformations.

Large deformations, which cause excessive edge pressure in way of bearings, are to be avoided.

2.4.4.4 The transition of rudder stock diameter from d_t to d_c value is not to be abrupt. Where the transition is made stepped, the steps are to be provided with fillets having as large as practicable radius. The transition of the rudder stock into the flange is to 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 is to be not less than:

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

k – material factor for rudder axle, according to 2.1.5;
F – rudder force, [kN], determined according to 2.2.2.1;
a_o, b_o, l_o – see Fig. 2.4.5.1, [m];

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

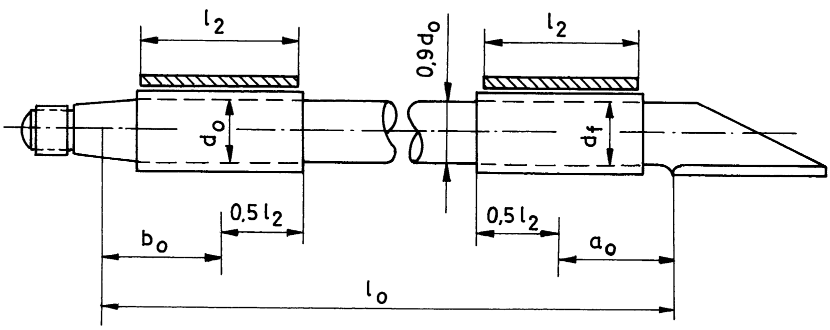


Fig. 2.4.5.1

The rudder axle diameter d_f between the lower edge of the coupling flange and the rudder bearing is to 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 is to 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., are to be determined according to 2.4.7 with the appropriate parameters of the rudder axle.

2.4.5.3 All bolts are to be fitted bolts. When a key is applied, the number of fitted bolts may be reduced to two. The nuts are to be of standard proportions and are to 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 are to be provided. A transition of the rudder axle into the flange is to be made with a fillet radius not less than 0.12 times the axle diameter.

2.4.5.5 The rudder axle nut is to be protected against self-loosening.

2.4.5.6 Rudder axle bearings located on the rudder blade and co-acting with the rudder axle are to comply with the requirements of 2.4.6.6 set forth for pintles.

2.4.6 Rudder Pintles

2.4.6.1 A pintle is to be connected with the bearing by means of a tapered part; the taper on the diameter is not to be greater than:

1:8 ÷ 1:12 – for keyed and other manually assembled pintles protected by securing nuts;
1:12 ÷ 1:20 – for pintles mounted with oil injection and hydraulic nut.

2.4.6.2 The pintle height within the bearing is to be not less than the pintle diameter determined by the formula:

$$d = 0.35\sqrt{R/k}\,, \text{ [mm]} \qquad (2.4.6.2)$$

R – bearing reaction force, [N], according to 2.2.5;
k – pintle material factor (see 2.1.5).

2.4.6.3 The minimum dimensions of threads and nuts are to be determined according to 2.4.8.7.

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

2.4.6.5 The pintle nut is to be reliably secured against loosening and the pintle is to be effectively clamped in its seating.

2.4.6.6 The selected dimensions of pintles are to be checked for surface pressure, taken as:

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

R – design reaction force at the pintle housing according to 2.2.5, [N];
d_e – pintle diameter, including the liner, if fitted, [mm];
h – height of the working part of the pintle, [mm].

The surface pressure is not to 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 the PRS.

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 of coupling bolts is to be not less than that determined by the formula:

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

d – rudder stock diameter, [mm]; for calculations, the greater of the values: d_t or d_c, determined in 2.4.4, is to be taken;
z – number of connecting bolts;
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 number of bolts in a horizontal flange coupling is to be not less than 6. The distance from the centre of any bolt to the centre of flange is to be not 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 is to be not 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 are to be fitted bolts. Only in the case when a key is applied, the number of fitted bolts may be reduced to two. The nuts are to be of standard proportions. The bolts and nuts are to be suitably protected against loosening.

2.4.7.4 The thickness of horizontal coupling flange is to be not less than that determined by the following formula:

$$s = d_b\sqrt{\frac{k_s}{k_k}}, \ [\text{mm}] \qquad (2.4.7.4)$$

In no case is the thickness to be less than: $s_{\min} = 0.9\, d_b$ (d_b determined for $z \le 8$).
d_b, k_s – see 2.4.7.6;
k_k – material factor for flange (see 2.1.5).

2.4.7.5 The width of material outside the bolt openings is to be not less than 0.67 d_b.

2.4.7.6 The diameter of bolts of vertical flange coupling is to be not less than that determined by the formula:

$$d_b = \frac{0.81d}{\sqrt{z}} \cdot \sqrt{\frac{k_t}{k_s}}, \text{ [mm]} \qquad (2.4.7.6\text{-}1)$$

d – rudder stock diameter, [mm]; for calculations, the greater of the values: d_t or d_c, determined in 2.4.4, is to be taken;
z – number of connecting bolts is to be not 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 static moment of the bolts cross-sectional area about the geometrical centre of the coupling is to be not less than that determined by the formula:

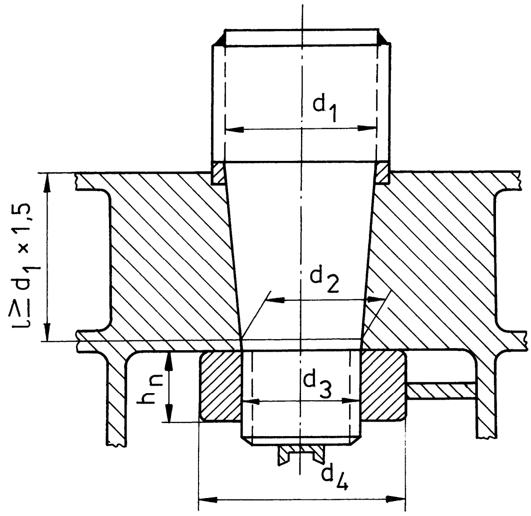
$$m = 0.00043d^3, \text{ [cm}^3\text{]} \qquad (2.4.7.6\text{-}2)$$

2.4.7.7 The thickness of vertical coupling flanges is to be at least equal to the diameter of bolts and the width of the material outside the bolt openings is to be not less than 0.67 d_b .

2.4.8 Cone Couplings

2.4.8.1 Keyed cone couplings without hydraulic arrangement for mounting and dismounting the coupling are to have a taper on diameter of 1:8 ÷ 1:12. The taper length of rudder stock, fitted into the rudder blade, is to be not less than 1.5 d_1 (see Fig. 2.4.8.1).

The taper is to pass into cylindrical portion without a step.



taper $= \dfrac{d_1 - d_2}{l}$

Fig. 2.4.8.1

2.4.8.2 A key is to be set on the cone generatrix. The key ends are to be suitably rounded.

2.4.8.3 Assuming that one half of the torque M_{sk} is transmitted by friction and the other half by the key, the working area of the key cross-section is to be not less than that determined by the formula:

$$A_s = \frac{16\, M_{sk}}{d_k\, R_e}, \ [\text{cm}^2] \qquad (2.4.8.3)$$

M_{sk} – yield torque of the rudder stock, [Nm] (see 2.4.8.5-1);
d_k – diameter of the taper cross-section in the middle of the key length, [mm];
R_e – yield stress of the key material, [MPa].

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

$$A_k = \frac{5\, M_{sk}}{d_k\, R_{ek}}, \ [\text{cm}^2] \qquad (2.4.8.4)$$

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

2.4.8.5 The yield torque of the rudder stock M_{sk} is to be determined by the formula:

$$M_{sk} = 0.02664\, d_t^3 / k_t, \ [\text{Nm}] \qquad (2.4.8.5\text{-}1)$$

k_t – material factor for rudder stock (see 2.1.5);
d_t – rudder stock diameter, [mm], according to 2.4.4.

Where the actual diameter is greater than the required d_t, to calculate M_{sk}, the actual diameter is to be taken.

2.4.8.6 The key height *h* is to be not less than 0.5 times its width b_s. The rudder stock key is not to extend beyond the conical connection.

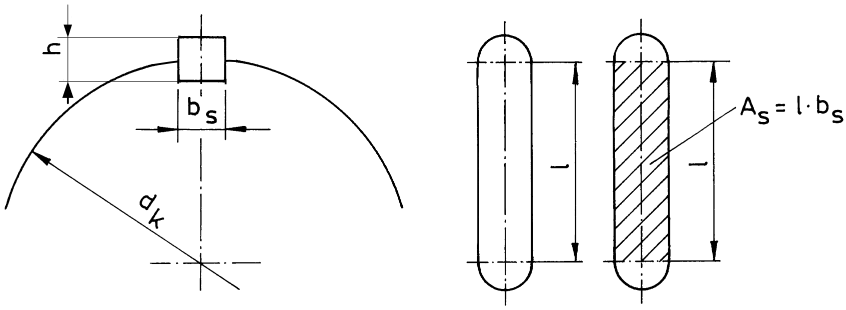


Fig. 2.4.8.6

2.4.8.7 The dimensions of the slugging nut are to be as follows (see Fig. 2.4.8.1):
- external thread diameter: $d_3 \geq 0.65\ d_1$;
- length of the nut: $h_n \geq 0.6\ d_3$;
- outer diameter of the nut: $d_4 \geq 1.2\ d_2$ or $1.5\ d_3$, whichever is the greater.

The thread is to be fine and the nut is to be reliably secured against self-loosing.

2.4.8.8 Cone couplings with hydraulic arrangements for mounting and dismounting the coupling are to have taper on diameter of 1:12 ÷ 1:20. The push-up oil pressure and the push-up length are to be specially considered by the PRS in each particular case on the basis of calculations submitted by the shipyard.

2.4.9 Rudder Stock, Rudder Axle and Pintle Bearings

2.4.9.1 The bearing surface A_b, defined as the product of the height and external diameter of the bushing, is to be not less than that determined by the formula:

$$A_b = \frac{R}{p_a}, \ [\text{mm}^2] \qquad (2.4.9.1)$$

R – reaction force in bearing, [N], according to 2.2.5;
p_a – allowable surface pressure, [MPa], according to Table 2.4.9.1.

Table 2.4.9.1

Bearing material [3)]	p_a [MPa]
lignum vitae	2.5
white metal, oil lubricated	4.5
synthetic material with hardness between 60 and 70 Shore D[1)]	5.5
steel[2)], bronze and hot-pressed bronze-graphite materials	7.0

[1] Indentation hardness test at 23°C and with 50% moisture, according to a recognized standard.
[2] Combination of stainless and wear-resistant steel with stock liner is to be of a type approved by the PRS.
[3] Synthetic bearing materials are to be of a type approved by the PRS.

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

2.4.9.2 The height/diameter ratio of the bearing surface is to be not greater than 1.2.

2.4.9.3 For carrying the weight of a rudder blade and stock, a thrust bearing is to be applied. The deck under the thrust bearing is to be efficiently strengthened. The rudder stock thrust bearings carrying the radial loads are to comply with the requirements of 2.4.6 for pintles.

2.4.9.4 Means are to 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.

2.4.9.5 Stuffing boxes are to 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 deepest load line, then two independent stuffing boxes are to be applied. The stuffing box is to be accessible for inspection and maintenance.

2.4.9.6 With metal bearings, clearances are to 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 is to be determined taking into account the material swelling and thermal expansion. This clearance is to be not less than 1.5 mm on the bearing diameter.

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

2.5 Construction of Steering Nozzle

2.5.1 Plating

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

$$s = K_1\, l_1 \sqrt{\frac{98.1\, D_d\, l_d\, T + 0.02\, F_d}{D_d\, l_d\, R_e}} + 2, \ \text{[mm]} \qquad (2.5.1.1)$$

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 is not to 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 is not to exceed 0.6 m.

For intermediate values of u_1 / l_1, K_1 is to be determined by linear interpolation.

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

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

T_s – propeller thrust at speed v_m, [kN] (for v_m – see 2.3.2.1);
D_d and l_1 – see 2.5.1.1.

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

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

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

Where stainless or clad steel is used, the thickness s_s may be suitably reduced upon the 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:

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

L_0 – design length of the ship, [m].

2.5.1.4 The middle strake of the nozzle inner plating is to have the width extending not less than to $0.05D_d$ forward and not less than 0.1 D_d abaft the tips of the propeller blades. In no case the width of this strake is to 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 is to be reinforced from inside by the stiffening rings and longitudinal stiffeners (webs). The spacing of these stiffening members is to comply with the requirements of 2.5.1.1. At least four equidistant longitudinal stiffeners are to 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, is to be not less than that of the outer plating as required by 2.5.1.1.

The stiffeners are to be welded with a double continuous full penetration weld. When the thickness of the stiffening is 10 mm and over – edge preparation is to be provided prior to welding. The stiffening rings and longitudinal stiffeners are to 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 are to be fitted with drain plugs of stainless metal. The distance of edges of these openings from the inner and outer plating of the nozzle is to be not less than 0.25 times the height of the stiffening members.

No cover plates are to 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 are to be provided. The thickness of these rings is to be not 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 is to 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 is to be not less than that determined by the formula:

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

A_{st} – surface area of nozzle stabilizer, [m^2];
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 stablizer plating is to 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 are to be of a thickness not less than 1.5 times the plate thickness required by 2.5.1.8. Vertical web plates are to be firmly connected to the top and bottom plates.

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

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

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

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 is to 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 is to be firmly connected to the nozzle.

In strength calculations, the design load F_{st} acting on the stabilizer is to 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 is to 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) are not to 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 is to be not less than that determined by the formula:

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

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 is to be not less than that determined by the formula:

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

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

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

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

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

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:

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

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 is to be gradual and smooth. Where the transition of the nozzle stock diameter is stepped, the fillet radii, as great as practicable, are to be applied. The transition of the nozzle stock into the flange is to 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) is to be not less than that determined by the formula:

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

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, is to be not less than the diameter of the pintle determined according to 2.5.3.1; the taper on the diameter is not to exceed 1:6. The taper is to pass into cylindrical portion without a step.

The outer diameter of the threaded part of the pintle is to be not less than 0.8 times the minimum diameter of the taper. The outer diameter and length of the nut are to be not 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 is to be not 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, is to be not less than 0.5 times the diameter of the pintle without liner. Possible deviation from this requirement will be specially considered by the PRS.

2.5.3.5 To prevent self-loosening, the pintle nut is to 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 are to be checked for surface pressure, taken as:

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

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 is not to 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 the 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 is to be not less than that determined by the formula:

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

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);
ρ – 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 is to be not less than 6. The distance from the centre of any bolt to the flange centre is to be not 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 are to be fitted bolts; only in the case when a key is applied, the number of fitted bolts may be reduced to two. The nuts are to be of standard proportions. The bolts and nuts are to be reliably protected against self-loosening.

2.5.4.3 The thickness of coupling flanges is to be not less than the diameter of bolts. The distance between the centres of the bolt holes and the flange edge is to be not 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 is to be not less than 1.5 times the stock diameter determined according to 2.5.2.2; the taper on diameter is not to exceed 1:6. The taper is to pass smoothly into the cylindrical portion.

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

$$A_f = \frac{26\,M_l}{d_m\left(471 + R_e\right)}, \ [\mathrm{cm}^2] \qquad (2.5.4.5)$$

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 is to be not less than half of its width.

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

The outer diameter and length of the nut are to be not 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 is to be reliably locked, at least by means of two welded washers, or one such washer with cotter pin.

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

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

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

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

$$A_f = \frac{26\,M_l}{d\left(471 + R_e\right)}, \ [\mathrm{cm}^2] \qquad (2.5.4.7\text{-}2)$$

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 is to be equivalent to that of the stock. The design stress is not to 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 are to comply with 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 is to be installed. The deck under the thrust bearing is to be efficiently strengthened.

Effective means are to 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 is to 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 is to 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 is to 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 steering gear compartment is to 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 are to be provided.

Steering gears are to comply with the requirements of *Part VII – Machinery, Boilers and Pressure Vessels*, as well as *Part VIII – Electrical Equipment and Automation*.

2.6.1.2 The main steering gear is to 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 a draught to the full displacement waterline while running ahead with the maximum speed. Under the same conditions, the steering gear is to 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.

2.6.1.3 The auxiliary steering gear is to 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 a draught to the full displacement waterline while running ahead at one half of the maximum speed or 7 knots, whichever is the greater.

2.6.1.4 If the main steering gear is provided with at least two identical power units, then auxiliary steering gear (required in 2.6.1.1) may be not installed, provided that the main steering gear is so constructed, that in the case of a single damage in its piping system, or in one of power unit, the damage cut-off will be possible in such a way, that steering ability is maintained, or is quickly restored. In such case the main steering gear, with one working power unit, shall satisfy the requirements of 2.6.1.2.

2.6.1.5 If the required rudder stock diameter (determined for normal steel of R_e = 235 MPa) exceed 230 mm at the level of a tiller, excluding strengthening for navigation in ice, the reserve source of power, sufficient at least for powering the steering gear power unit satisfying the requirements of 2.6.1.3, as well as powering of the relevant steering system and rudder angle indicator.

2.6.1.6 If the rudder or steering nozzle stock diameter, determined for normal steel of R_e = 235 MPa, does not exceed 120 mm (excluding the ice strengthening), the main steering gear may be powered manually. In all other cases the main steering gear shall be powered by a power unit.

2.6.1.7 If the rudder or steering nozzle stock diameter, determined for normal steel of R_e = 235 MPa, does not exceed 230 mm (excluding the ice strengthening), the auxiliary steering gear may be powered manually (e.g. by means of tiller put on the rudder stock, a tackle fastened to the quadrant, or hydraulic pomp provided in a steering gear compartment). In all other cases the auxiliary steering gear shall be powered by a power unit.

2.6.1.8 The main and auxiliary steering gear are to 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)

2.6.1.9 When the compartment of power units for the main and auxiliary steering gear is located below the full displacement waterline, an emergency propulsion located above the bulkhead deck is to be provided. This propulsion is to ensure putting the rudder or the steering nozzle over from one side to another as in 2.6.1.3.

2.6.2 Rudder Angle Limiters

2.6.2.1 The steering gear is to be provided with rudder angle limiters permitting to put the rudder or steering nozzle over either side only to an angle β, which is to be:

$$(\alpha + 1°) \leq \beta \leq (\alpha + 1.5°) \tag{2.6.2.1}$$

α – maximum rudder or steering nozzle deflection angle to which the steering gear control system is set, but not more than 35°.

The use of greater maximum angle is to be specially agreed with the PRS.

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

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

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 are not to 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 is to be provided both in Combat Information Center/Alternative Command Station and in the steering gear compartment.

2.6.3.2 Each of the main steering gear power units cited in 2.6.1 is to be provided with two independent controls from the Combat Information Center/Alternative Command Station. Duplication of steering wheel or steering handle is not required.

2.6.3.3 The auxiliary steering gear is to be operated from the steering gear compartment.

Power driven auxiliary steering gear is to be provided with a control system operated also from the Combat Information Center/Alternative Command Station. The system is to be independent of the control system for the main steering gear.

Indicators of angular position of the rudder or steering nozzle are to 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 is not to 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 are to be independent of the steering gear remote control system.

2.6.3.4 For ships with ice strengthening, except of the above requirements, provisions given in Chapter 13 also apply.

3 ANCHORING EQUIPMENT

3.1 General

3.1.1 Each ship is to 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 dropped anchors.

The anchoring equipment is designated for assurance of safe laying at the anchor, prompt dropping and hoisting the anchor, as well as – depending on type and character of ship's mission – performance of specific tasks, e.g. pulling off the landing crafts from the beach, holding the ship perpendicularly to the shore line during loading-unloading operations, dynamic positioning in multi anchor systems, etc. The anchoring equipment is not designated for securing the ship against drifting or moving at open rough sea.

3.1.2 Special anchoring systems (e.g. arrangements for holding the ship in a position), as well as systems of special purpose ships will be specially considered by PRS (see 1.7.4.).

3.1.3 Anchoring equipment is to be chosen from Table 3.1.3 in accordance with the equipment number determined in 1.7. However, upon agreement with PRS for choosing anchoring equipment, if tactical-technical demands (TTD) determine hydrological-meteorological conditions in the area of the prospective ship's service, methods, principles and specific of these conditions may be taken into consideration, e.g. for determination of a chain cable length, which may be taken as equivalent to 3-4 anchoring depths.

3.1.4 In a case that on the ship two independent main propulsion/two shaft lines with independent drive are applied the mass of anchors and chain cable may be chosen in accordance with the equipment number from Table 3.1.3 one grade lower than that calculated according to 1.7.

3.1.5 For landing crafts, except for bow anchors, stern anchors are to be applied. The mass of stern anchors is to be determined by calculations depending on main engines' astern run power. Instead of chains wire ropes are to be applied.

Length of anchor wires is to be determined by calculations.

Calculated mass of stern anchors should not be less than determined in Table 3.1.3 mass of bow anchors, unless PRS accepts lighter anchor determined on the basis of calculations, or HHP anchor is applied.

3.1.6 Anchoring equipment for ships without mechanical propulsion is to be chosen assuming equipment number by 25% greater than that required in 1.7.

3.1.7 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 Purcharser. Additional requirements for the remotely controlled equipment are given in 3.4.6 of the present Part of the *Rules*, as well as in *Part VII – Machinery, Boilers and Pressure Vessels* and in *Part VIII – Electrical Installations and Control Systems.*

3.1.8 Two-way audio communication between ship control posts and anchoring equipment operators is to be provided.

3.1.9 Possibility of damaging underwater part of the hull or its protruding parts, including streamliners of underwater detecting system and other systems, is to be excluded during anchoring and anchor hoisting. Verification of the anchoring system operation, during its designing, by means of model operation test or computer simulation is recommended.

Table 3.1.3

Anchoring Equipment

Equipment number	Bow anchors		Stream anchor	Chains for bow anchors				Chain or wire of stream anchor	
					diameter				
	number	mass, [kg]	mass of stream anchor, [kg]	total length of both chains, [m]	normal strength steel (Grade 1), [mm]	higher strength steel (Grade 2), [mm]	high strength steel (Grade 3), [mm]	length, [m]	breaking strength, [kN] of anchor chain or actual strength of wire rope
1	2	3	4	5	6	7	8	9	10
10-15	2	35	12	**	–	–	–	**	34
16-20	2	50	18	**	–	–	–	**	34
21-25	2	65	22	**	–	–	–	**	37
26-30	2	80	28	165	11	–	–	60	44
31-40	2	105	35	192,5	11	–	–	70	44
41-49	2	135	45	192,5	12,5	–	–	70	44
50–70	2	180	60	220	14	12.5	–	80	65
71–90	2	240	80	220	16	14	–	85	74
91–110	2	300	100	247.5	17.5	16	–	85	81
111–130	2	360	120	247.5	19	17.5	–	90	89
131–150	2	420	140	275	20.5	17.5	–	90	98
151–175	2	480	165	275	22	19	–	90	108
176–205	*2	570	190	302.5	24	20.5	–	90	118
206–240	2	660	–	302.5	26	22	20.5	–	–
241–280	2	780	–	330	28	24	22	–	–
281–320	2	900	–	357.5	30	26	24	–	–

1	2	3	4	5	6	7	8	9	10
321–360	2	1020	–	357.5	32	28	24	–	–
361–400	2	1140	–	385	34	30	26	–	–
401–450	2	1290	–	385	36	32	28	–	–
451–500	2	1440	–	412.5	38	34	30	–	–
501–550	2	1590	–	412.5	40	34	30	–	–
551–600	2	1740	–	440	42	36	32	–	–
601–660	2	1920	–	440	44	38	34	–	–
661–720	2	2100	–	440	46	40	36	–	–
721–780	2	2280	–	467.5	48	42	36	–	–
781–840	2	2460	–	467.5	50	44	38	–	–
841–910	2	2640	–	467.5	52	46	40	–	–
911–980	2	2850	–	495	54	48	42	–	–
981–1060	2	3060	–	495	56	50	44	–	–
1061–1140	2	3300	–	495	58	50	46	–	–
1141– 1220	2	3540	–	522.5	60	52	46	–	–
1221– 1300	2	3780	–	522.5	62	54	48	–	–
1301– 1390	2	4050	–	522.5	64	56	50	–	–
1391–1480	2	4320	–	550	66	58	50	–	–
1481–1570	2	4590	–	550	68	60	52	–	–
1571–1670	2	4890	–	550	70	62	54	–	–
1671–1790	2	5250	–	577.5	73	64	56	–	–
1791–1930	2	5610	–	577.5	76	66	58	–	–
1931–2080	2	600	–	577.5	78	68	60	–	–
2081–2230	2	6450	–	605	81	70	62	–	–
2231–2380	2	6900	–	605	84	73	64	–	–
2381–2530	2	7350	–	605	87	76	66	–	–
2531–2700	2	7800	–	632.5	90	78	68	–	–
2701–2870	2	8300	–	632.5	92	81	70	–	–
2871–3040	2	8700	–	632.5	95	84	73	–	–
3041–3210	2	9300	–	660	97	84	76	–	–
3211–3400	2	9900	–	660	100	87	78	–	–

* See 3.2.1.2

** Anchor chains or wire ropes may be applied and breaking strength of anchor chain or actual strength of wire rope should not be less than 44 kN. Length of a chain or rope is to be agreed with PRS.

3.2 Anchors

3.2.1 General

3.2.1.1 Ships are to be provided with approved anchors, the number and mass of which are to comply with the requirements of Table 3.1.3.

3.2.1.2 It is recommended that ships operating in areas with the presence of currents are provided with a permanent stream anchor. Application of the stream anchor is decided by the Purcharser. When applied the stream anchor is to comply with the requirements of Table 3.1.3 and is to be ready to be used.

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 Two bow anchors, selected according to Table 3.1.3, are to be connected to chain cables and ready for use.

3.2.2.2 Upon PRS agreement, instead of two the ship may be equipped with one bow anchor provided that its mass is increased by 25%. The anchor chain should be adequate for the increased mass anchor.

3.2.3 Mass of Anchors

3.2.3.1 The mass of an individual bow anchor may vary by 2% from the value required in Table 3.1.3, provided that the total mass of all bow 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 Table 3.1.3.

3.2.3.3 The mass of the head of a stockless anchor, including pins and fittings, is to be not less than 60% of the total mass of the anchor.

3.2.3.4 In the case of stocked anchors application, the mass of the stock is to 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 The anchor may be considered as a high holding power anchor (HHP anchor), provided that satisfactory comparative tests of previously approved ordinary stockless anchor are carried out at sea according to the requirements of 3.2.4.2 and 3.2.4.3.

3.2.4.2 The tests are to be carried out at sea on various types of bottom and are to be applied to anchors the weight of which is, 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) are to be approximately of the same weight and are to be tested in association with the size of chain cable appropriate to this weight. The tested anchor is to have a holding power at least twice that of an ordinary stockless anchor of the same weight.

The length of cable with each anchor is to be such that the pull on the shank remains practically horizontal. For this purpose, a scope of 10 is considered normal, but a scope of not less than 6 may be accepted. Three tests are to be carried out for each anchor and nature of bed. The pull is to be measured by dynamometer. The stability of the anchor and ease at breaking out should be noted where possible. Measurements of pull based on RPM/bollard pull curve of tug may be accepted instead of dynamometer readings. Tests are normally to be carried out from tug but alternatively shore based tests may be accepted. For the tests, previously approved HHP anchors may be used instead of ordinary stockless anchors.

3.2.4.3 For approval of HHP anchors of the whole range of weight, tests are to be carried out on at least two sizes of anchors and the weight of the maximum size to be approved is not to exceed 10 times the weight of large size tested.

3.2.5 Super High Holding Power (SHHP) Anchors

3.2.5.1 The anchor may be considered as super high holding power anchor (SHHP anchor), provided that comparative tests of previously approved ordinary stockless anchor are carried out in accordance with the requirements of 3.2.5.4, 3.2.5.5 and 3.2.5.6.

3.2.5.2 SHHP anchor is to have a holding power of at least four times that of an ordinary stockless anchor or at least two times that of HHP anchor, of the same mass.

3.2.5.3 When super high holding power anchors of the proven holding power are used as bow 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.

3.2.5.4 The tests, required in 3.2.5.1, are to be carried out at sea on three types of bottom: soft mud or silt, sand or gravel and hard clay or similar compounded material. The tests are to be applied to anchors of mass which is, 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 and SHHP anchor are to be approximately of the same mass and are to be tested in association with the size of chain required for the anchor mass and anchor type. Where an ordinary stockless anchor is not available, a previously approved HHP anchor may be used in its place. The length of the cable with each anchor is to be such that the pull on the shank remains practically horizontal. For this purpose a scope of 10 is considered sufficient. Three tests are to be taken for each anchor and each type of bottom. The pull is to be measured by dynamometer. The stability of the anchor and ease of breaking out should be noted where possible. Tests are to be carried out from a tug but alternatively shore based tests may be accepted.

Measurements of pull, based on the RPM/bollard pull curve of tug, may be accepted as an alternative to dynamometer.

Comparative tests with a previously approved SHHP anchor may be also accepted as a basis for approval.

3.2.5.5 If approval is sought for a range of SHHP anchor sizes, then at least three anchor sizes are to be tested, indicative of the bottom, middle and top of the mass range.

3.2.5.6 The holding power test load is not to exceed the proof load of the anchor.

3.3 Anchor Chains and Anchor Wire Ropes

3.3.1 General

3.3.1.1 The chain diameters, specified in Table 3.1.3, refer to the chains with stud links. For ships with equipment number up to 90, studless link chains of increased diameter may be used instead of stud link chains upon agreement with PRS.

3.3.1.2 In ships where structural and operational reasons preclude application of anchor chains PRS may allow their, partial or total, replacement by anchor wire ropes.

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 are to be composed of separate chain lengths. The lengths are to 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 is to 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 are to 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 is not to be less than the breaking load of the chain and its length is not to be less than 1.5 times the length of the chain required by Table 3.1.3.

3.3.3.2 The end of each anchor wire rope is to be spliced into a thimble, clamp or a socket. Each wire rope is to 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 4 m, whichever is the lesser. The chain section is to 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.

3.3.3.3 Anchor wire ropes are to have at least 114 wires and at least one natural fibre core. The wires used for anchor ropes are to be zinc coated according to the approved standards.

3.4 Anchor Appliances

3.4.1 Stoppers

3.4.1.1 A possibility for stopping each anchor chain or wire rope is to 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 *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 are to be calculated for anchor chain or anchor wire rope force equivalent to double weight of the anchor and the stresses in the stopper parts are not to 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 is to 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 is to 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 are not to exceed 0.95 times the yield stress of the material used. If the stopper includes a chain or rope, their strength is to 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) is to 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 The release device is to be so designed to prevent accidental release of anchor chain.

3.4.2.2 The inboard ends of the chain cables are to 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 Pipes

3.4.3.1 Chains are to be led in a way ensuring their free run when dropping or hoisting the anchor.

3.4.3.2 The anchor shank is to enter hawse pipe easily and is to take off hawse pipe readily. Hawse pipes should be so constructed that in sailing positions the anchor lays properly.

3.4.3.3 The thickness of the hawse pipe is to be not less than 0.4 times the diameter of the used chain.

3.4.3.4 Hawse pipes are to be watertight up to the weather/bulkhead deck and are to be provided with permanently attached closing appliances* to minimize water ingress. Hawse pipes are to be fitted with installation for the anchor and anchor chain flushing.

3.4.4 Chain Lockers

3.4.4.1 Chain lockers are to be fitted for stowing each chain of the bowanchor.

Where only one chain locker is intended for two chains, a division is to be provided for a separate stowage of each chain.

3.4.4.2 The shape, capacity and depth of the chain locker are to 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 are to be watertight up to the weather deck.

3.4.5 Windlasses

Windlasses are to be fitted on the deck for dropping and hoisting the anchors, as well as for holding the ship with the bow anchors dropped.

If technically justified and demanded by service conditions, windlasses should ensure possibility of manual dropping and hoisting the anchors.

The requirements for the design and power of windlasses are specified in sub-chapter 6.3, *Part VII –Machinery, Boilers and Pressure Vessels.*

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* Acceptable closing arrangements are such as:
- steel plates with cut-outs to accommodate chain links,
- canvas hoods with a lashing arrangement that maintains the cover in the secured position.

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 3.1.7) are to be also fitted with devices for the local manual control.

3.4.6.2 The design of anchoring equipment and devices for local manual control are to 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 are to be provided in each ship as the spare parts for anchors chains.

4 MOORING EQUIPMENT

4.1 General

4.1.1 Each ship is to be provided with mooring equipment for warping, by side or by stern, to coastal or floating berth and for proper fastening the ship thereto, as well as assure: possibility of mooring side-to-side with other ships, possibility of minor displacements of the ship with the main propulsion off and mooring to buoys. It is permitted to use mooring facilities for towing operations, loading operations at sea and in port, as well as to other operations in range of system's elements strength.

4.1.2 The number, length and the breaking strength of the mooring ropes are to be determined from Table 4.1.2 according to the equipment number N_c determined in compliance with 1.7. In the case of intended use of mooring equipment to other tasks its elements are to be selected on the basis of calculations' results. Method of calculations and principles of selection are to be submitted for acceptance to PRS.

Table 4.1.2

Mooring and towing equipment

Equipment number	Towing rope		Mooring ropes		
	Length [m]	The actual breaking load [kN]	Number	Length [m]	The actual breaking load [kN]
1	2	3	4	5	6
10-15	–	–	2	30	29
16-20	–	–	2	30	29
21-25	–	–	2	40	20
26-30	–	–	2	50	29
31-40	120	65	2	50	29
41-49	150	81	2	60	29
50–70	180	98	2	80	34
71–90	180	98	2	100	37
91–110	180	98	2	110	39
111–130	180	98	2	110	44
131–150	180	98	2	120	49
151–175	180	98	2	120	54
176–205	180	112	2	120	59
206–240	180	129	2	120	64
241–280	180	150	3	120	69
281–320	180	174	3	140	74
321–360	180	207	3	140	78
361–400	180	224	3	140	88
401–450	180	250	3	140	98
451–500	180	276	3	140	108
501–550	190	306	4	160	123
551–600	190	338	4	160	132

1	2	3	4	5	6
601–660	190	371	4	160	147
661–720	190	406	4	160	157
721–780	190	441	4	170	172
781–840	190	480	4	170	186
841–910	190	518	4	170	201
911–980	190	559	4	170	216
981–1060	200	603	4	180	230
1061–1140	200	647	4	180	250
1141–1220	200	691	4	180	270
1221–1300	200	738	4	180	284
1301–1390	200	786	4	180	309
1391–1480	200	836	4	180	324
1481–1570	220	888	5	190	324
1571–1670	220	941	5	190	333
1671–1790	220	1024	5	190	353
1791–1930	220	1109	5	190	378
1931–2080	220	1168	5	190	402
2081–2230	240	1259	5	200	422
2231–2380	240	1356	5	200	451
2381–2530	240	1453	5	200	480
2531–2700	260	1471	6	200	480
2701–2870	260	1471	6	200	490
2871–3040	260	1471	6	200	500
3041–3210	280	1471	6	200	520
3211–3400	280	1471	6	200	554
3401–3600	280	1471	6	200	588
3601–3800	300	1471	6	200	618
3801–4000	300	1471	6	200	647

The number of mooring ropes determined from Table 4.1.2 should not be less than: four for ships of length over 90 m and six for ships of length over 180 m.

Mooring ropes breaking load may be assorted less than that given in Table 4.1.2 provided that particular calculations are presented to, and approved by PRS.

4.1.3 In ships in which, in accordance with Table 4.1.2, the actual breaking strength of the mooring rope exceeds 490 kN, the following ropes may be used:

– of lesser breaking strength, with number of ropes suitably increased, or
– of greater breaking strength, with number of ropes suitably reduced.

In such cases the total breaking strength of all mooring ropes is not to be less than that required by Table 4.1.2 (taking the requirements of 4.1.3 and 4.1.6 into account), the number of ropes – not less than 6 and the actual breaking strength of a single rope not less than 490 kN.

4.1.4 Where synthetic fibre ropes are used, the actual breaking strength of the rope is to be not less than that determined by the formula:

$$F_s = 0.0742\delta_s F_n^{\frac{8}{9}}, \ [\text{kN}] \qquad (4.1.6)$$

F_n – actual breaking strength of the rope of natural fibres, according to Table 4.1.2, [kN];
δ_s – average elongation at breaking of the rope of synthetic fibres, [%], but not less than 30%.

4.2 Mooring Equipment

4.2.1 Mooring Ropes

4.2.1.1 For mooring ropes, steel wire ropes, as well as natural or synthetic fibre ropes may be used. The diameter of natural and synthetic fibre ropes is to be not less than 20 mm, irrespective of their breaking load determined from Table 4.1.2.

4.2.1.2 Steel wire ropes are to be of flexible construction and are to have not less than:

- 72 steel wires in 6 strands with 7 fibre cores – for actual breaking strength ≤ 216 kN;
- 144 steel wires in 6 strands with 7 fibre cores – for actual breaking strength greater than 216 kN but not exceeding 490 kN;
- 216 steel wires in 6 strands with 1 fibre core – for actual breaking strength exceeding 490 kN.

Wire ropes intended for operation with powered winches and stored on drums may have a wire core instead of fibre core, but the number of wires in such ropes is not to be less than 216. The rope wires are to be covered with thick zinc coating according to approved standards. In all other respects steel wire ropes are to meet the requirements of Chapter 21, *Part IX – Materials and Welding.*

4.2.1.3 Natural fibre ropes are to 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 are to meet the requirements of Chapter 22, *Part IX – Materials and Welding.*

4.2.1.4 Synthetic fibre ropes are to 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 are to meet the requirements of Chapter 22, *Part IX – Materials and Welding*.

4.2.2 Bollards and Fairleads

4.2.2.1 The number and position of mooring bollards, open and closed fairleads, and other mooring appliances are to be determined on the basis of structure particulars, designation and general arrangement of the ship. In ships of displacement 3,000 t and over, minimum four, adequately equipped, groups of mooring stands are to be provided, and for ships of displacement less than 3,000 t at least 3 groups of mooring stands on each ship's side located in forward, middle and aft part of the ship, equipped with bollards and fairleads, are to be provided. In case of small ships (cutters) two stands located at bow and stern of the ship are permitted.

4.2.2.2 Bollards are to be made of steel or cast iron; they may be welded or cast. Application of bollards made of aluminum alloys is permitted provided compliance with 4.2.2.4. Bollards with seating arrangements put down below the deck are not to be applied on decks forming the upper shell of compartments intended for carrying or storing in bulk inflammable liquids with ignition temperature below 60 °C.

4.2.2.3 The outside diameter of the bollard columns is to be not 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 is to be not less than 2.5 diameters of steel wire rope or 3 circumferences of natural fibre rope.

4.2.2.4 Bollards, fairleads and other mooring appliances, except the mooring rope stoppers, as well as their beds are to be so calculated that stresses in their parts do not exceed 0.95 times the yield stress of the material when they are subjected to the strain equal to the actual breaking strength of the mooring rope for which they are intended.

The breaking load of the mooring rope stopper is to be not less than 0.15 times the actual breaking load of the rope for which the stopper is designed.

4.2.3 Mooring Winches

4.2.3.1 Special mooring machinery (capstans, winches, etc.), as well as other deck machinery (windlasses, cargo winches, etc.) fitted with mooring drums may be used for warping the mooring ropes.

4.2.3.2 The number and type of mooring machinery should assure safe and efficient mooring operations. The winches should comply with the requirements of *Part VII –Machinery, Boilers and Pressure Vessels,* and their rated pull is not to be less than 0.22 and not more than 0.33 times the breaking strength of the mooring rope.

4.2.4 Mooring Drums

4.2.4.1 Mooring ropes are to be kept on mooring drums or in baskets in places convenient to perform mooring operations.

4.2.4.2 For wire ropes with a diameter 33.5 mm and over, mooring drums are to be mechanically powered.

4.2.5 Towing-mooring Equipment Arrangement Plan

4.2.5.1 Towing-mooring equipment arrangement plan (required by 1.4.2.4) shall contain following information in relation to each equipment element:
– location on the ship,
– type,
– SWL (safe working load),
– application (mooring).

4.2.5.2 Information concerning safe working load are applicable to a single element of equipment with assumptions: no more than one wrap of one rope on the element.

4.2.5.3 Safe working load shall be permanently marked on each element of equipment, e.g. by welding.

4.2.6 Bumper Devices

4.2.6.1 Set of mooring equipment in every ship should include permanent, hull bumpers devices, protecting sides of the ship during mooring the ship at sea and in port, including mooring to other fixed and floating maritime objects, as well as should include portable pneumatic bumpers or made of natural or synthetic fibre ropes.

4.2.6.2 The bumpers are to be kept in baskets or on racks, in places convenient to perform mooring operations. The number and type of bumpers are agreed each time with PRS. It is recommended to use a minimum of 4 bumpers, two on each side.

5 TOWING ARRANGEMENTS

5.1 General

5.1.1 Each ship is to be provided with an equipment enabling it to be towed, and to tow in emergency conditions a ship of similar or lower displacement. The equipment shall comply with the requirements of 5.2.

5.2 Towing Equipment

5.2.1 Towing Ropes

5.2.1.1 The length and actual breaking strength of the towing rope are to be determined from Table 4.1.2 according to the equipment number N_c, calculated in accordance with 1.7.

5.2.1.2 Towing ropes may be made of steel wire or of natural or synthetic fibre. The requirements of 4.1.4 and 4.2.1 for mooring ropes are also applicable to towing ropes.

5.2.1.3 Towing ropes may be utilized for pulling off grounded ship. Towing rope is to be selected by calculations, depending on thrust of the ship intended to be engaged in pulling off operations.

5.2.2 Bollards and Fairleads

5.2.2.1 The number and position of towing bollards and fairleads are to be determined on the basis of intended towing method and operations mechanization as well as the structure particulars, designation and general arrangement of the ship.

5.2.2.2 The requirements for mooring bollards and fairleads as provided for in 4.2.2.2 to 4.2.2.4 are also applicable to towing bollards and fairleads.

Bollards made of aluminum alloys are not allowed.

5.2.3 Towing-mooring Equipment Arrangement Plan

5.2.3.1 Towing-mooring equipment arrangement plan (required by 1.4.2.4) shall contain following information in relation to each equipment element:

- location on the ship,
- type,
- SWL (safe working load),
- application (port towing/escort towing),
- transition of loads from towing ropes and margin angles between a rope and a plane perpendicular to a winch drum axis.

5.2.3.2 Information concerning safe working load are applicable to a single element of equipment with assumptions: no more than one wrap of one rope on the element.

Safe working load shall be permanently marked on each element of equipment, e.g. by welding.

6 SIGNAL AND ANTENNA MASTS

6.1 General

6.1.1 The requirements given in the present Chapter apply only to signal and antenna masts, i.e. the masts intended exclusively for carrying the signal means, e.g. lights, day signals, as well as aerials of different type and purpose, 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 are to comply with the requirements of *Part VI – Lifting Appliances* of the *Statutory Rules for Sea-going Ships*.

6.1.2 The arrangement and height of signal masts, as well as the number of signal means fitted are to comply with the requirements of *Part X – Statutory Equipment.* Additionally, requirements emerging from Purchaser standards shall be observed.

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 are to be not less than:

$$d = 22l \qquad (6.2.1\text{-}1)$$

$$t = 0.2l + 3 \qquad (6.2.1\text{-}2)$$

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 0.75 d 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 is not to exceed $l/3$.

6.2.2 The mast is to 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 is to be not less than:

$$a = 0.15\,h, \text{ [m]} \qquad (6.2.2\text{-}1)$$

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 is to be not less than:

$$b = 0.30\,h, \text{ [m]} \qquad (6.2.2\text{-}2)$$

.3 a is to 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 is to be not less than:

$$F = 0.49\,(l^2 + 10l + 25),\ [\text{kN}] \qquad (6.2.3)$$

Shroud fittings (shackles, turnbuckles, etc.) are to 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 are to meet the requirements of Chapters 21 and 22, *Part IX – Materials and Welding.*

6.2.4 The requirements, specified in 6.4, are to be complied with where:

.1 the mast is made of higher tensile steel, light alloys;

.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 are to be not less than:

$$d = 3l^2(0.674l + a + 13)\left(1 + \sqrt{1 + \frac{51.5 \cdot 10^4}{l^2(0.674l + a + 13)^2}}\right)10^{-2},\ [\text{mm}] \qquad (6.3.1\text{-}1)$$

$$t = \frac{1}{70}d,\ [\text{mm}] \qquad (6.3.1\text{-}2)$$

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 is to be determined according to Chapter 16, *Part II – Hull.*

The diameter of the mast may be gradually decreased upwards to a value of 0.5 *d* at a height equal to 0.75 *l* from the heel. The thickness of the mast wall is in no case to be less than 4 mm. The mast heel is to be effectively supported in all directions.

6.3.2 The requirements, specified in 6.4, are to be complied with where:

.1 the mast is made of higher tensile steel, light alloys;

.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 is to be carried out. The calculations are to be submitted to PRS for consideration.

6.4.2 The mast structure is to 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 are to be calculated from the following formulae:

$$F_{xi} = m_i a_L + pA_{xi} \tag{6.4.2-1}$$

$$F_{yi} = m_i a_T + pA_{yi}K \tag{6.4.2-2}$$

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 is to 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^2];
A_{yi} – projection area of the considered component part of the mast or its equipment on the ship centre plane, [m^2];
K – coefficient determined by the formula:

$$K = 0.947 - \frac{20.7}{L_0} \tag{6.4.2-3}$$

The value of K is to be taken not less than 0.766.

a_L, a_T – linear accelerations, [m/s^2], to be taken according to the requirements of Chapter 17.4, *Part II – Hull.*

Forces F_{xi} and F_{yi} are to 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 are not to exceed 0.7 times the yield stress of the material where they are made of metal.

Under these loads, the safety factor of the ropes used for stays is to be not less than 3.

6.5 Modular masts (Hardening Topside Antennas)

6.5.1 In the ships where masts of such construction and functions solutions are applied, detailed strength calculations of adopted construction are to be performed. The calculations shall be submitted to PRS for consideration.

6.5.2 The design of the masts should be calculated on the forces resulting from ship motion dynamics and external loads including wind, ice and impact wave load resulting from the air explosion, which parameters are defined in tactical-technical data, and if not defined, according to the present *Rules*.

6.5.3 When selecting the design, and in relation to materials and manufacture technology applied, it is recommended that guidelines included in following NATO publications are used:

- ANEP 65 – Naval Ship Integrated Topside Design;
- ANEP 69 – Guidance to Naval Ship Designers on Analysis and Methods for the Hardening of Topside Antennas Against Blast and Fragments.

7 CLOSING APPLIANCES OF OPENINGS IN HULL AND SUPERSTRUCTURES

7.1 General

7.1.1 The requirements of the present Chapter apply to ships of unrestricted service, as well as to ships of restricted service I and II.

7.1.2 The number of openings in a hull and external bulkheads of superstructures should be limited to necessary minimum.

7.1.3 The arrangement of openings and their closing appliances are to comply with 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:
   - weather deck,
   - superstructure and deckhouse deck of the first tier situated forward of a point located 0.25 of the ship's 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 0.25 *L* from the forward perpendicular.

7.1.5 All the openings in the weather deck, except those mentioned in 7.2.4, 7.11, 7.6, 7.7, 7.8 and 7.10, are to be protected by enclosed superstructure or an enclosed deckhouse. Similar openings in the deck of the enclosed superstructure or enclosed deckhouse are to 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 *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.

7.2 Side Scuttles and Windows

7.2.1 Arrangement of Side Scuttles and Windows

7.2.1.1 Side scuttles are closing appliances of round or oval openings with an area of not more than 0,16 m^2. Closing appliances of above openings with an area over 0.16 m^2, as well as rectangular openings are windows.

On the combat ships side scuttles in side shell below the open deck shall not be applied.

The number of side scuttles in the support ships hull shell plating below the weather deck is to 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 are to have, as far as possible, no side scuttles located below the weather deck in way of mooring appliances. Where, however, side scuttles are located in that region, they are to be so arranged as to exclude the risk of being damaged during the mooring operations.

7.2.1.2 In no case the lowermost edges of side scuttles are to be positioned below a line drawn parallel to the open deck. The lowermost point of this line is to be located at 0.025 of the ship breadth *B* or 500 mm (whichever is the greater) above the waterline corresponding to the maximum displacement waterline.

7.2.1.3 Side scuttles in the shell plating below the open 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 0.25 *L* from the forward perpendicular are to be of a heavy type (see 7.2.2.1.1), and are to be fitted with steel hinged inside deadlights. The deadlights in a closed position are to assure watertightness for side scuttles located below the weather deck, and weathertightness for side scuttles located above the open deck.

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 0.25 *L* from the forward perpendicular, except those in their fore and after bulkheads, may be of normal type.

Side scuttles are to be fitted with steel hinged inside deadlights as defined in 7.2.1.3.

7.2.1.5 Side scuttles in enclosed superstructures and deckhouses of the second tier, except those fitted in a position within 0.25 *L* from the forward perpendicular are to 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. The said side scuttles fitted in side bulkheads of enclosed deckhouses may, in lieu of inside deadlights, be fitted with outside deadlights. In accommodation and other similar spaces in enclosed superstructures and deckhouses of the second tier, not providing 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, except of provision 7.2.1.7, ship type windows, complying with the requirements of 7.2.3, may be used. The arrangement of the windows is to be such as not to affect the structural rigidity of the superstructure.

If the windows are fitted in forward bulkheads of exposed superstructures within 0,25 *L* from forward perpendicular, they are to be provided with the strong outside deadlights.

Deadlights may be removable and, in such case, stored in the windows vicinity.

7.2.1.7 On the combat ships in the end bulkheads of superstructures and deckhouses windows are not to be fitted. Exception is a wheelhouse and the Combat Information Center (CIC), where, installed on the windows shields of removable or swinging type, are to be provided.

Windows' shields in a wheelhouse and CIC should be provided with sights ensuring proper angles of observation. Shields are to be made of armoured plates or equivalent material. Access to windows for setting the shields should be assured.

Application of rotating windows is forbidden. Windows wipers with external drive may be used. Window glasses are to be fixed gastight and should be heated.

7.2.2 Construction of Side Scuttles

7.2.2.1 The present Part of the Rules distinguishes the following types of side scuttle construction:

.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 is to 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 is to 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 400 mm; for intermediate inner diameters, the glass thickness is to be determined by linear interpolation.

7.2.2.2 On the combat ships heavy and normal type side scuttles are to be of non-opening type, i.e. with the glass fixed in the main frame.

Side scuttle glasses are to be reliably and weathertightl/watertight, and where necessary due to DAWMD requirements – also gastight, 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 are to have sufficient strength. The glazing bead and deadlight are to be fitted with gaskets and are to 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 are to 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 are to be made of corrosion-resistant material. Glass used for side scuttles is to be hardened.

7.2.3 Construction of Windows

7.2.3.1 The construction of windows is to comply with the standards recognized by PRS.

7.2.3.2 The glass thickness is to be suitable to the window size and external pressure according to the requirements of *Part II – Hull* for the point located in the geometrical centre of the window.

7.2.3.3 The construction of frame and the frame fastening to the superstructure are to be weathertight and corrosion resistant.

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 are to be fitted with doors.

7.3.1.2 The height of sills of the access openings, specified in 7.3.1.1, is to be at least 380 mm. For weather decks located below open deck line (e.g. poop deck) the height of seals shall be at least 450 mm.

If a bridge or a poop cannot be considered as enclosed, the height of sills of access openings in such a bridge or poop is to be at least 600 mm in position 1 and 380 mm in position 2. (Bridges and poops are not to be considered enclosed if, for the crew passing to the engine room and other spaces located in that structures, the other access, accessible any time when the openings in bulkheads are closed, is provided).

7.3.1.3 The sill height is to be measured from the upper surface of deck steel plating (or wood sheathing, if applied), under the door opening.

7.3.2 Construction

7.3.2.1 In strength calculations of doors, the design pressure p determined in accordance with *Part II – Hull* is to 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 are not to 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 is to be not less than that determined in *Part II – Hull*. 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 are to be permanently attached to the bulkhead or wall and fitted with quick acting means for their opening and closing operated from both sides. Doors should be at least weathertight.

Where required, the doors should satisfy the conditions of DAWMD (Defence Against Weapons of Mass Destruction), (gastightness assured by labyrinth seals or other type approved by PRS, central closing).

7.3.2.4 The door closing appliances and exit ports are to be operable from both sides. Doors are to open as follows:

- **.1** doors of accommodation and service spaces leading to corridor – are to open inwards;
- **.2** doors of public spaces – outwards or to either side;
- **.3** outer doors in the end bulkheads of superstructures and in external transverse bulkheads of deckhouses – outwards in the direction of the nearest ship side;
- **.4** outer doors in the external longitudinal bulkheads of deckhouses – outwards in the forward direction.

In ships of 31 m in length and less, doors, specified in .1, located at the end of a blind corridor and not obstructing exits from other spaces, are to open outwards (to the corridor).

In particular cases, upon consideration by PRS, the doors, mentioned in .3 and .4, may open inwards.

Sliding doors are not to be fitted at emergency exits and on escape routes.

7.3.2.5 The doors are to be of steel or other material approved by PRS.

7.4 Bow Doors and Inner Doors

7.4.1 General

7.4.1.1 The requirements given in the subchapter 7.4 relate to arrangement, strength and securing of bow doors and inner doors leading to a complete or long forward enclosed superstructures or to long non-enclosed superstructures fitted for achieving minimum bow height.

For doors which, for operational reasons, are designated for opening at sea, strength and operation will be separately considered by the PRS.

7.4.1.2 The requirements of subchapter 7.4 are applicable to bow doors:

- 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 will be specially considered by PRS.

7.4.1.3 Bow doors are to be situated on the bulkhead deck above the margin line. A watertight recess in the weather deck located forward of the collision bulkhead and above the deepest waterline fitted for arrangement of ramps or other related mechanical devices.

For bow doors designated for opening at sea, or located below the margin line, spaces safeguarded by the bow door or the inner door, for the purpose of stability or subdivision calculations are to be considered as open.

7.4.1.4 An inner door is to be fitted as a part of the collision bulkhead. The inner door need not be fitted directly above the bulkhead below, provided it is located within the limits for position of the collision bulkhead, specified in *Part II – Hull*. A vehicle ramp may be arranged for this purpose, provided its position complies with *Part II – Hull*. If this is not possible, a separate inner weathertight door is to be installed, as far as practicable, within the limits specified for the position of the collision bulkhead.

7.4.1.5 Bow doors are to 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 are to be weathertight over the full height of the cargo space and arranged with fixed sealing supports on the aft side of the doors.

7.4.1.6 Bow doors and inner doors are to 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 is to be installed, as indicated in 7.4.1.4.

7.4.1.7 The requirements for inner doors are based on the assumption that vehicles are effectively lashed and secured against movement in stowed position.

7.4.1.8 Definitions

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.

Locking device – a device that locks a securing device in the closed position.

7.4.2 Strength Criteria

7.4.2.1 Scantlings of the primary members, securing and supporting devices of bow doors and inner doors are to 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 is not to be taken less than 0.72 unless a direct fatigue analysis is carried out.

7.4.2.2 The buckling strength of primary members is to 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, is not to exceed 0.8 σ_F, where σ_F is the yield stress of the bearing material.

For other bearing materials, the permissible bearing pressure is to be determined according to the manufacturer's specification.

7.4.2.4 The arrangement of securing and supporting devices is to be such that threaded bolts do not carry support forces. The maximum tension in way of threads of bolts not carrying support forces is not to exceed 125/k MPa for k defined in 7.4.2.1 .

7.4.3 Design Loads of Bow Doors

7.4.3.1 The design external pressure, in kN/m^2, to be considered for the scantlings of primary members, securing and supporting devices of bow doors, is to be not less than the pressure given in *Part II – "Hull"* nor than:

$$p_e = 2.75\lambda C_H (0.22 + 0.15\tan\alpha)(0.4Vm\sin\beta + 0.6L^{0.5})^2, \text{ [kN/m}^2\text{]} \quad (7.4.3.1)$$

V_m – maximum ship's speed, as defined in 1.2 [knots];
L – ship's length, [m], to be taken not greater than 200 m;
λ = 1 for ships operated in unrestricted area;
λ = 0.8 for ships operated in area III;
λ = 0.5 for ships operated in sheltered waters;

$C_H = 0.0125\ L$ for $L < 80$ m, [m];
$C_H = 1$ for $L \geq 80$ m, [m];
α – 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;
β – entry angle at the point to be considered, defined as the angle between a longitudinal line parallel to the centreline and the tangent to the shell plating in a horizontal plane.

7.4.3.2 The design external forces, in kN, considered for the scantlings of securing and supporting devices of bow doors are to be not less than:

$$F_x = p_e\ A_x \qquad (7.4.3.2\text{-}1)$$

$$F_y = p_e\ A_y \qquad (7.4.3.2\text{-}2)$$

$$F_z = p_e\ A_z \qquad (7.4.3.2\text{-}3)$$

A_x – area of the transverse vertical projection 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, including a bulwark forming a part of the door, whichever is the lesser, [m^2] – see Fig. 7.4.3.3;
A_y – area of the longitudinal vertical projection 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, including a bulwark forming a part of the door, whichever is the lesser, [m^2] – see Fig. 7.4.3.3;
A_z – area of the horizontal projection 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, including a bulwark forming a part of the door, whichever is the lesser, [m^2];
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, [kN/m^2], as given in 7.4.3.1.1 with angles α and β defined as follows:
- α – flare angle measured at a location on the shell $h/2$ above the bottom of the door and $l/2$ aft of the intersection of the door with the stem (see fig. 7.4.3.2),
- β – entry angle measured at a location on the shell $h/2$ above the bottom of the door and $l/2$ aft of the intersection of the door with the stem (see 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.

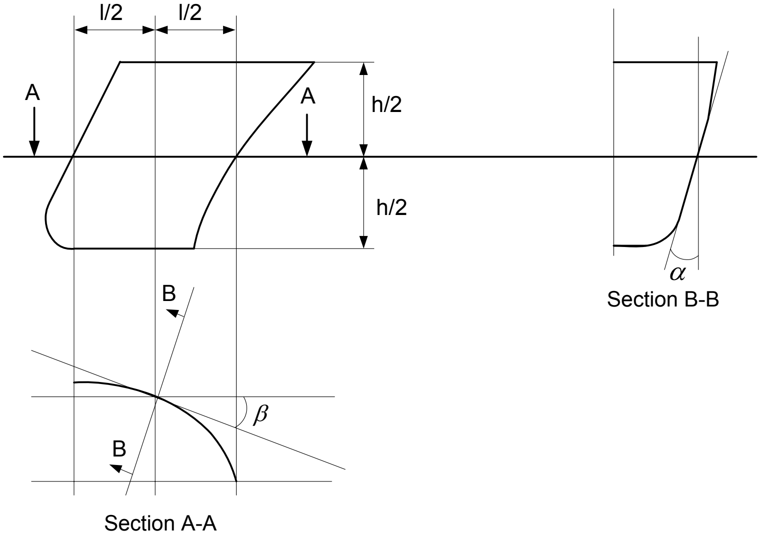


Fig. 7.4.3.2

7.4.3.3 For visor doors, the closing moment M_y under external loads, in kNm, is to be taken as:

$$M_y = F_x\, a + 10W c - F_z\, b,\ \ [\text{kNm}] \tag{7.4.3.3}$$

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, [m], see Fig. 7.4.3.3;

b – horizontal distance from visor pivot to the centroid of the horizontal projected area of the visor door, [m], see Fig. 7.4.3.3;

c – horizontal distance from visor pivot to the centre of gravity of visor mass, [m], see Fig. 7.4.3.3.

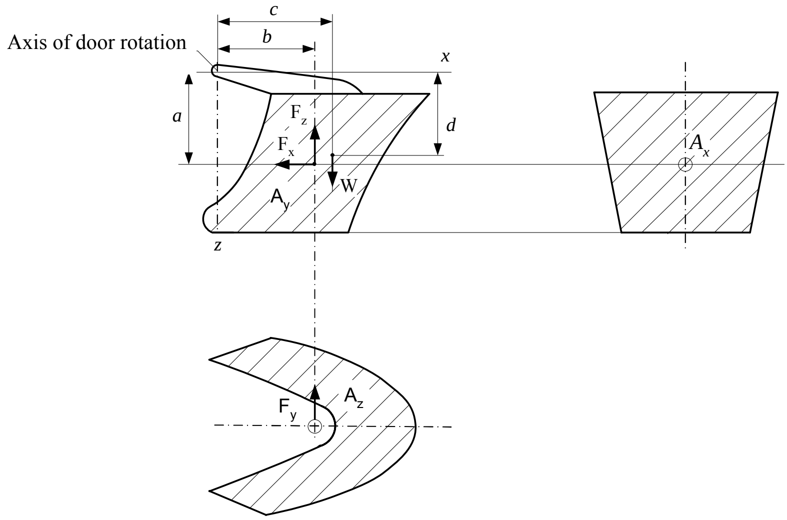


Fig. 7.4.3.3

7.4.3.4 Moreover, the lifting arms of a visor door and their supports are to be dimensioned for the static and dynamic forces applied during the lifting and lowering operations. Minimum wind pressure of 1.5 kN/m^2 is to be also 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 is to be taken as the greater of the following values:

– $p_e = 0.45\ L$, [kN/m^2],
– hydrostatic pressure $p_h = 10\ h$, where h is the distance from the load point to the top of the cargo space, [m],

where L is the ship's length, as determined in 7.4.3.1.

7.4.4.2 The design internal pressure p_i (water pressure) considered for the scantlings of securing devices of inner doors is to be not less than 25 kN/m^2.

7.4.5 Scantlings of Bow Doors

7.4.5.1 The strength of the bow doors is to be equivalent to the strength of the surrounding structure.

7.4.5.2 Bow doors are to be adequately stiffened and means are to be provided to prevent lateral or vertical movement of the doors when closed. For visor doors, adequate strength for the opening and closing operations is to 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 is to be not 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 moduli of horizontal and vertical stiffeners are to be not less than those required for end framing. Consideration is to be given, where necessary, to differences in fixity between ship's frames and bow doors stiffeners.

7.4.5.5 The stiffener webs are to have a net sectional area not less than:

$$A = \frac{Qk}{10}, \ [\mathrm{cm}^2] \qquad (7.4.5.5)$$

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 are to be supported by primary members constituting the main stiffening of the door.

7.4.5.7 The scantlings of primary members are generally to be supported by direct calculations in association with the external pressure according to 7.4.3.1 and permissible stresses given in 7.4.2.1. Normally, formulae for simple beam theory may be applied, assuming their free ends.

7.4.6 Scantlings of Inner Doors

7.4.6.1 The scantlings of primary members are generally to be supported by direct calculations in association with the external pressure according to 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 are to be not 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 are to 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 is to be suitable for the same design loads and design stresses as the securing and supporting devices. Where packing is required, the packing material is to be of a comparatively soft type, and the supporting forces are to be carried by the steel structure only.

Other types of packing may be considered. Maximum design clearance between securing and supporting devices is not generally to exceed 3 mm (see Fig. 7.4.7.1). Means are to be provided for mechanically fixing the door in the open position.

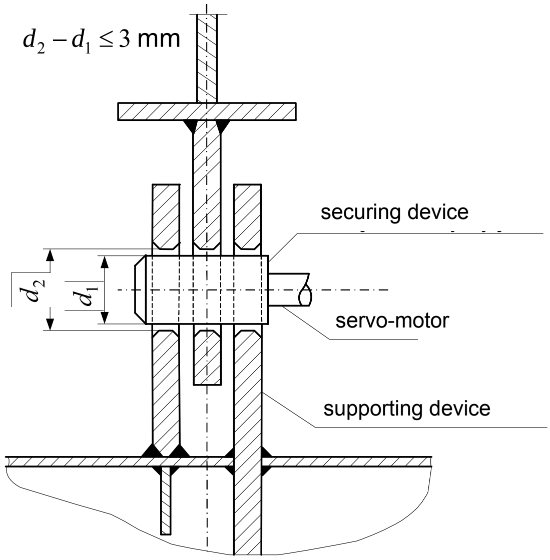


Fig. 7.4.7.1

7.4.7.2 Only the active supporting and securing devices having an effective stiffness in the relevant direction are to 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 provision 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, is to be not less than:

$$M_{yo} = 10Wc + 0.1\sqrt{a^2 + b^2}\sqrt{F_x^2 + F_z^2}\ , \text{ [kNm]} \qquad (7.4.7.3)$$

7.4.7.4 Securing and supporting devices are to 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: 0.7 F_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 door 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: 0.7 F_x and 0.7 F_z acting on both doors and 0.7 F_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, as determined according to 7.4.7.5.1 and 7.4.7.6.1, are to 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 are not to 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 is to 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 are to be provided at the lower part of the door, each capable of providing the full reaction force 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, is to be taken not less than:

$$M_o = 10 W d + 5 A_x a \text{, [kNm]} \qquad (7.4.7.10)$$

d – vertical distance from the hinge axis to the centre of gravity of the door, [m];
a – as defined in 7.4.3.3.

7.4.7.11 For visor doors, the securing and supporting devices, excluding the hinges, are to be capable of resisting the vertical design force ($F_z - 10W$ where W – door mass), 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 (bolts, supporting brackets), including welded connections, are to be to the same strength standard as required for the securing and supporting devices.

7.4.7.13 For side-opening doors, thrust bearing is to 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).

Each part of the thrust bearing is to be kept secured on the other part by means of securing devices. Any other arrangement serving the same purpose may be proposed.

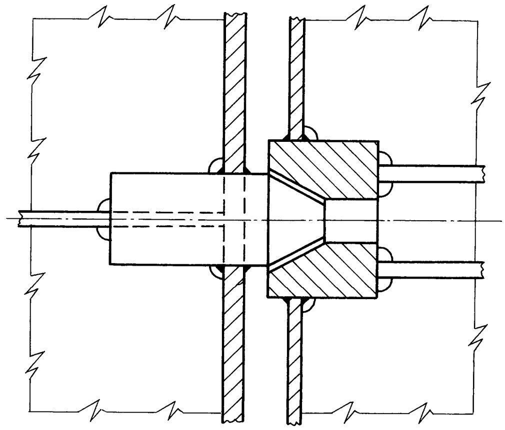


Fig. 7.4.7.13

7.4.8 Securing and Locking Arrangement

7.4.8.1 Securing devices are to be simple to operate and easily accessible. They are to 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 are to be interlocked in such a way that they can only operate in the proper sequence.

7.4.8.2 Bow doors and inner doors giving access to vehicle decks are to be provided with an arrangement for remote control, from a position above the weather deck, of:

- the closing and opening of the doors, and
- associated securing and locking devices for every door.

Indication of the open/closed position of every door and every securing and locking device is to be provided at the remote control stations. The operating panels for operation of doors are to be inaccessible to unauthorized persons. A notice plate, giving instructions to the effect that all securing devices are to be closed and locked before leaving harbour, is to be placed at each operating panel and is to be supplemented by warning indicator lights.

7.4.8.3 Where hydraulic securing devices are applied, the system is to 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 is to be isolated from other hydraulic circuits, when in closed position.

7.4.8.4 Separate indicator lights and audible alarms are to be provided on the navigation bridge and on the operating panel to show that the bow door and inner door are closed and that their securing and locking devices are properly positioned. The indication panel is to be provided with a lamp test function. It shall not be possible to turn off the indicator light.

7.4.8.5 The indicator system is to be designed on the fail safe principle and is to show by visual alarms if the door is not fully closed and not fully locked, and by audible alarms if securing devices become open or locking devices become unsecured. The power supply for the indicator system is to be independent from the power supply for operating and closing the doors. The indicator system is to be provided with the reserve supply from emergency source of power, e.g. UPS. Sensors of the indicator system are to be protected from water, ice formation and mechanical damages.

Note: The indicator system can be considered to be designed with regard to the principle of retaining safety in a case of damage, if:

1. The indicators' panel is equipped with:
   - signalisation of power supply failure,
   - signalisation of earthing system failure,
   - indicators' testing equipment,
   - separate indicators informing on: doors are closed, doors are open, doors are locked, doors are unlocked.
2. Limit switches, when the doors are closed, are electrically connected (if several limit switches are fitted their series connection can be applied),
3. Limit switches, when the securing devices are in correct position, are electrically connected (if several limit switches are fitted their series connection can be applied),
4. The indicator system consists of two electrical circuits (multicore cable can be applied), one for "door open/close" indication, the other for "door locked/unlocked" indication,
5. In a case that limit switches are dislocated the indicators signalling: open/unlocked – securing devices in incorrect position.

7.4.8.6 The indication panel on the navigation bridge is to be equipped with a mode selection function "harbour/ voyage" so arranged that audible alarm is given if the ship leaves harbour with the bow door or inner door not closed and with any of the securing devices not in the correct position.

7.4.8.7 A water leakage detection system with audible alarm and television surveillance is to be arranged to provide an indication to the navigation bridge and to the engine control room of leakage through the inner door. In cases grounded by the ship designation television surveillance, under the agreement with PRS, may not be installed.

Note: The system is to be designed with regard to the principle of safety maintenance in a case of damage – it is to comply with requirements given in a note to 7.4.8.5.

7.4.8.8 Between the bow door and the inner door a television surveillance system is to be fitted with a monitor on the navigation bridge and in the engine control room. The system must monitor the position of doors and a sufficient number of their securing devices. Special consideration is to be given for lighting and contrasting colour of objects under surveillance.

Note: The system is to be designed with regard to the principle of safety maintenance in a case of damage – it is to comply with requirements given in a note to 7.4.8.5.

7.4.8.9 A drainage system is to be arranged in the area between the bow door and the ramp, or, if the ramp is not fitted, in the area between the ramp and inner door. The system is to be equipped with an audible alarm function to the navigation bridge for water level in these areas exceeding 0.5 m or the level which activates high water level alarm, whichever is the lesser. See also note to 7.4.8.5.

7.4.8.10 If the main vehicle deck is not totally closed or is of open type, freeing ports complying with requirements of 10.5.7, *Part III,* and gravity outboard discharges complying with *Part VI – Machinery Installations and Refrigerating Plants*, are to be installed.

7.4.9 Operating and Maintenance Manual

7.4.9.1 An Operating and Maintenance Manual for the bow door and inner door is to be provided on board and is to contain the necessary information on:

- main particulars and design drawings:
  - special means of safety,
  - ships' data, symbol of class,
  - equipment and ramps' design loads,
  - equipment arrangement of doors and ramps,
  - manufacturers recommendations concerning equipment tests,
  - outfit description: doors, inner doors, bow ramps, side and stern doors, the main power supply, bridge and engine control room indicators panel.
- service conditions:
  - heel and trim limitations during loading and unloading,
  - heel and trim limitations due to proper doors functioning,
  - doors/ramps operation manuals,
  - doors emergency operation manuals

- maintenance:
  - inspections and maintenance plan,
  - detection of defects and permissible clearances,
  - manufacturer's inspections and maintenance instruction.
- register of inspections, including inspections of locking, securing and supporting devices:
  - repairs and replacement of elements

The Manual is to be submitted for approval to assure that it contains all above elements 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 shell doors. Any damages recorded during such inspections are to be reported to PRS.

7.4.9.2 Documented operating procedures for closing and securing the bow door and inner door are to 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 These present Rules give requirements for the arrangement, strength and securing of side shell doors (abaft the collision bulkhead) and stern doors leading into enclosed spaces.

7.5.1.2 Stern doors and side shell doors may be situated either below or above the weather deck.

7.5.1.3 Side shell doors and stern doors are to be so fitted as to ensure tightness and structural integrity commensurate with their location and the surrounding structure.

7.5.1.4 Where the doors are designated to be open at sea, or the lower edge of the door opening is below the uppermost load line, the arrangement is to be specially considered by PRS. It is considered that the fitting of a second door of equivalent strength and watertightness is one acceptable arrangement. In that case leakage detection device is to be provided in the compartment between the doors, and drainage of this compartment to the bilges, controlled by an easily accessible screw down valve, is to be arranged. The outer door is to open outwards. In principle, compartments safeguarded by the door, for the purpose of stability and subdivision calculations, are to be considered open

7.5.1.5 Doors are to preferably open outwards.

7.5.1.6 For definitions, see 7.4.1.8.

7.5.2 Strength Criteria

7.5.2.1 Scantlings of the primary members, securing and supporting devices of side shell doors and stern doors are to 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 is to 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 above analysis is to include the buckling strength of primary members.

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 is not to exceed 0.8 σ_F, where σ_F is the yield stress of the bearing material.

For other bearing materials, the permissible bearing pressure is to be determined according to the manufacturer's specifications.

7.5.2.4 The arrangement of securing and supporting devices is to be such that threaded bolts do not carry support forces.

The maximum tension in way of threads of bolts not carrying support forces is not to 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 are to be not less than:

(I) Design forces for securing or supporting devices of doors opening inwards:

external force: $F_e = A\,p_e + F_p$, [kN] (7.5.3.1-1)

internal force: $F_i = F_o + 10W$, [kN] (7.5.3.1-2)

(II) Design forces for securing and supporting devices of doors opening outwards:

external force: $F_e = A\,p_e$, [kN] (7.5.3.1-3)

internal force: $F_i = F_o + 10W + F_p$, [kN] (7.5.3.1-4)

(III) Design forces for primary members:

external force: $F_e = A p_e$, [kN] (7.5.3.1-5)

internal force: $F_i = F_o + 10W$, [kN] (7.5.3.1-6)

whichever is the greater.

A – area of the door opening, [m^2];
W – mass of the door, [t];
F_p – total packing force, [kN]. Packing line pressure is normally to be taken not less than 5 N/mm;
F_o – the greater of F_c and 5 A, [kN];
F_c – accidental force, [kN], due to shift of 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:

$$10\left(T - Z_G\right) + 25, \ \text{[kN/m}^2\text{]} \quad \text{for } Z_G < T \qquad (7.5.3.1\text{-}7)$$

$$25 \ \text{kN/m}^2 \quad \text{for } Z_G \geq T$$

Moreover, for stern doors of ships fitted with bow doors, p_e is to be taken not less than:

$$p_e = 0.6\lambda \ C_H \left(0.8 + 0.6\sqrt{L}\right)^2, \ \text{[kN/m}^2\text{]} \qquad (7.5.3.1\text{-}8)$$

L, λ, 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 baseline, [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 is to be commensurate with that of the surrounding structure.

7.5.4.2 Side shell doors and stern doors are to be adequately stiffened and means are to be provided to prevent any lateral or vertical movement of the doors when closed. Adequate strength is to 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 should 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 are to have well-rounded corners and adequate compensation is to be arranged with web frames at sides and stringers or equivalent above and below.

7.5.4.5 The thickness of the door plating is to be not 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 is to be not less than required for vehicle decks.

7.5.4.6 The section modulus of horizontal or vertical stiffeners is to be not less than that required for side framing. Consideration is to 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 are to be not less than those required for vehicle decks.

7.5.4.7 The secondary stiffeners are to 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 are to have sufficient stiffness to ensure structural integrity of the boundary of the door.

7.5.4.9 Scantlings of the primary members are generally to be supported by direct 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, assuming their free ends.

7.5.5 Securing and Supporting of Doors

7.5.5.1 Side shell doors and stern doors are to 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 is to be suitable for the same design loads and design stresses as the securing and supporting devices. Where packing is required, the packing material is to be of a comparatively soft type, and the supporting forces are to be carried by the steel structure only. Other types of packing may be considered. Maximum design clearance between securing and supporting devices is not generally to exceed 3 mm. Means are to 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 are to 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 provision 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 are to 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 are to 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, including welded connections, are to 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 are to be simple to operate and easily accessible. They are to be equipped with mechanical locking arrangement (self-locking or separate arrangement), or are to be of the gravity type. The opening and closing systems, as well as securing and locking devices are to be interlocked in such a way that they can only operate in the proper sequence.

7.5.6.2 Doors with a clear opening area greater than 6 m^2, located partly or totally below the uppermost cargo waterline or margin line, in a case of doors designated for opening at sea, are to be provided with an arrangement for remote control, from a position above the bulkhead deck, of:

- the closing and opening of the doors,
- associated securing and locking devices of each door.

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 is to be provided at the remote control stations. The operating panels for operation of doors are to be inaccessible to unauthorized persons.

A notice plate, giving instructions to the effect that all securing devices are to be closed and locked before leaving harbour, is to be placed at each operating panel and is to be supplemented by warning indicator lights.

7.5.6.3 Where hydraulic securing devices are applied, the system is to 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 is to be isolated from other hydraulic circuits, when in closed position.

7.5.6.4 Separate indicator lights and audible alarms are to be provided on the navigation bridge and on each operating panel to indicate that the doors are closed and that their securing and locking devices are properly positioned.

The indication panel is to be provided with a lamp test function. It shall not be possible to turn off the indicator light.

7.5.6.5 The indicator system is to be designed on the fail safe principle and is to indicate by visual alarms if the door is not fully closed and not fully locked and by audible alarms if securing devices become open or locking devices become unsecured. The power supply for the indicator system is to be independent of the power supply for operating and closing the doors. The indicator system is to be provided with the reserve supply from emergency source of power, e.g. UPS.

The sensors of the indicator system are to be protected from water, ice formation and mechanical damages.

Note: The indicator system can be considered to be designed with regard to the principle of retaining safety in a case of damage, if it complies with the requirements given in notes to 7.4.8.5.

7.5.6.6 The indication panel on the navigation bridge is to be equipped with a mode selection function "harbour/voyage" so arranged that audible alarm is given if the ship leaves harbour with side shell or stern doors not closed, or with any of securing devices not in the correct position.

7.5.6.7 A water leakage detection system with audible alarm is to be arranged to provide an indication to the navigation bridge.

Note: The requirements of paras. 7.5.6.4 to 7.5.6.7 apply to doors in the boundary of special category spaces or ro-ro spaces, through which such spaces may be flooded. The requirements do not apply to ships, where, in a case of doors designated for opening at sea, no part of the door is below the uppermost waterline or margin line, and the area of the door opening is not greater than 6 m^2.

7.5.7 Operation and Maintenance Manual

7.5.7.1 The requirements of 7.4.9 are applied in their full extent to side and stern doors.

7.5.7.2 Documented procedures for side and stem doors closing and securing are to be kept in appropriate place on the ship.

7.6 Companion Hatches and Ventilating Trunks

7.6.1 To ensure prompt tightening of the ship in alarm or combat conditions, the number of hatches is to be limited to necessary minimum.

7.6.2 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 are to be protected by companion hatches 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 are to comply with the requirements of 7.3.

7.6.3 The height of coamings of companion hatches, skylights and ventilating trunks is to be at least 600 mm in position 1 and 450 mm in position 2.

The construction of the coamings is to comply with the requirements of *Part II – Hull.*

7.6.4 All companion hatches and ventilation hatches are to be provided with covers permanently attached to the coamings with the use of hinges and made of steel or other material approved by PRS.

7.6.5 Companion hatches are to comply with the given below specific requirements. The hatches used as emergency exits are to comply with the given below requirements of paragraph 7.6.5 excluding requirements of 7.6.5.2.1 a) and b), 7.6.5.3.3 and 7.6.5.4.

7.6.5.1 Strength

.1 All companion hatches, skylights and ventilation hatches are to be provided with covers permanently attached to the coamings with the use of hinges and made of steel or other material approved by PRS.

The thickness of steel covers plating should be at least 0.01 of the distance between stiffeners strengthening this plating, but not less than 6 mm. Required thickness may be decreased if the covers are made by stamping method, according to Fig. 7.6.5.1-1 and Table 7.6.5.1-1.

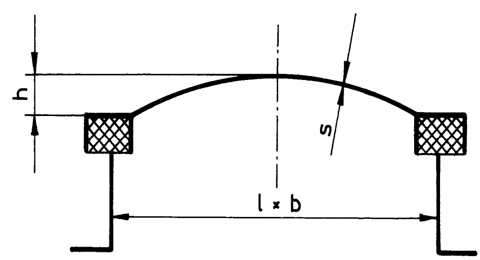


Fig. 7.6.5.1-1

Table 7.6.5.1-1

Inner size of hatch opening *l* x *b*, [mm]	Cover material	*h*, [mm]	Minimum thickness *s*, [mm]
450 x 600	Steel	25	4
	Aluminum alloy		
600 x 600	Steel	28	4
	Aluminum alloy		
700 x 700	Steel	40	4
	Aluminum alloy		6
800 x 800	Steel	55	4
	Aluminum alloy		6

With respect to companion hatches in ships of *L>80 m,* located in area *0.25L* from bow, minimum thickness of a steel cover should be 8 mm, and stiffeners scantlings should correspond to Table 7.6.5.1-2.

Table 7.6.5.1-2
Scantlings for small steel hatch covers on the fore deck

Nominal size (mm x mm)	Cover plate thickness (mm)	Primary stiffeners Flat bar (mm x mm); number	Secondary stiffeners
630x630	8	—	—
630x830	8	100x8; 1	—
830x630	8	100x8; 1	—
830x830	8	100x10; 1	—
1030x1030	8	120x12; 1	80x8; 2
1330x1330	8	150x12; 2	100x10; 2

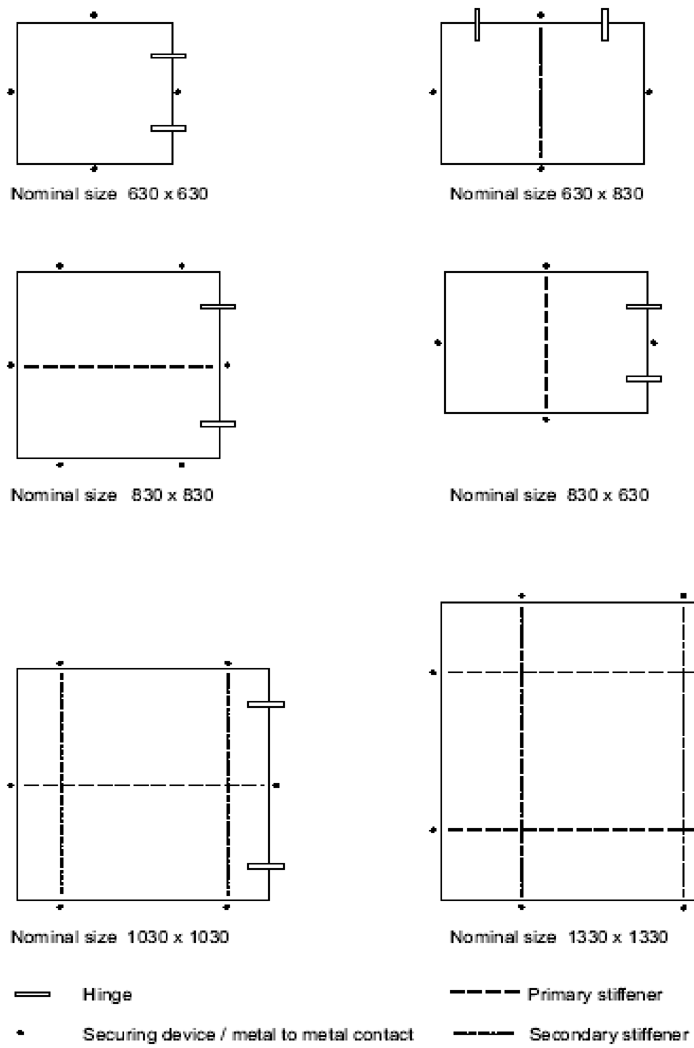
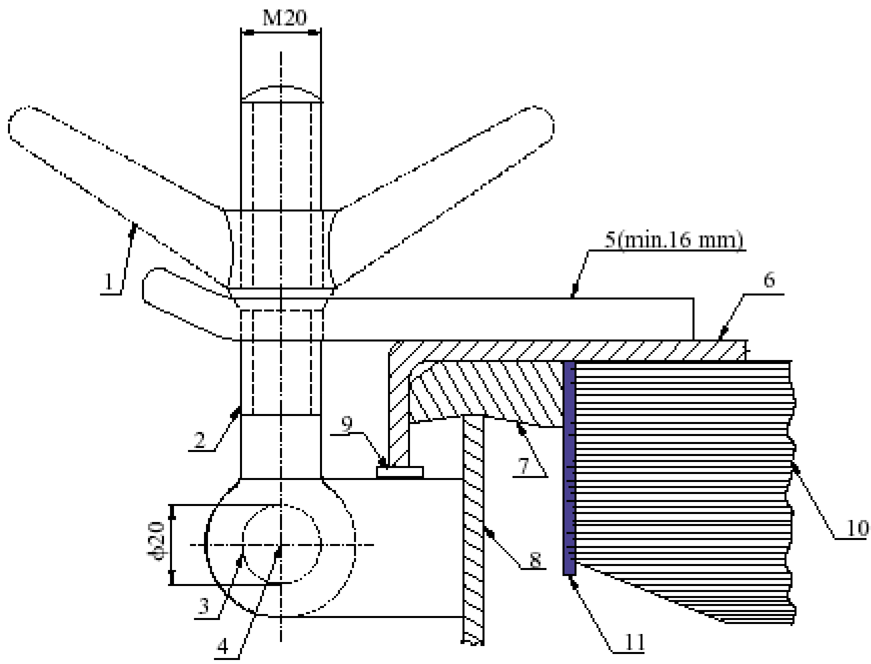


Fig. 7.6.5.1-2 Example of stiffeners arrangement

.2 The stiffeners are to be fitted along the line connecting metal-metal contact points, see fig. 7.6.5.1-2. Girders (main stiffeners) are to be welded to the inner edge of the cover, see fig. 7.6.5.1-3.

.3 Upper edge of the hatch coaming is to be adequately strengthened with a horizontal stiffener fitted in a distance not more than 170-190 mm from the edge.

.4 The thickness of the plating, as well as stiffening of the covers with other shape than rectangular is to be separately considered by the PRS.



1. butterfly nut
2. bolt
3. pin
4. center of pin
5. fork (clamp) plate
6. hatch cover
7. gasket
8. hatch coaming
9. bearing pad welded on the bracket of a toggle bolt for metal to metal contact
10. stiffener
11. inner edge stiffener

Fig. 7.6.5.1-3 Example of a primary securing method

7.6.5.2 Primary Securing Devices

.1 Hatches are to be fitted with primary securing devices by means of any one of the following methods:
a) butterfly nuts tightening onto forks (clamps),
b) quick acting cleats
c) central locking device.

Dogs (twist tightening handles) with wedges - are not recommended for ships of $L \geq 80$ m within 0.25 from the bow. They may be used upon PRS consent.

.2 Butterfly nuts or quick acting cleats are to be of diameter and to be arranged in compliance with ISO or equivalent standard.

7.6.5.3 Requirements for Primary Securing Devices

.1 The hatch cover is to be fitted with a gasket of elastic material. This is to 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. Over compression of the gasket may cause the securing devices to be loosened or dislodged. The metal-to-metal contacts are to be arranged close to each securing device (see Fig. 7.6.5.1-3) and of sufficient capacity to withstand the bearing force.

.2 The primary securing method is to 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) are to 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 is not to be less than 16 mm. An example arrangement is shown in Fig. 7.6.5.1-3.

.4 For small hatch covers located on the exposed deck forward of the foremost cargo hatch, the hinges are to 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.

7.6.5.4 Secondary Securing Devices

Small hatches on the fore deck (0.25 *L* from the bow) are to 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 is to be fitted on the side opposite to the hatch cover hinges.

7.6.6 Covers of companion hatches and ventilating trunks are to 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 are to be capable of being operated from each side of the cover. The covers are to be weathertight when closed. The tightness is to be provided by rubber or other suitable gaskets.

Where required by DAWMD conditions, the covers should also be gastight.

Gastightness shall be assured by labyrinth seals or other, type approved by PRS.

7.6.7 Covers of companion and ventilation hatches shall be fitted with device securing against closing when open.

7.7 Ventilators and Ventilating Ducts

7.7.1 Ventilating ducts in position 1 or 2 to spaces below the weather deck or decks of enclosed superstructures and deckhouses decks are to 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 are to be fitted with substantially constructed coamings of steel or other equivalent material at the weather deck.

The coamings of ventilating ducts are to be at least 900 mm in height in position 1 and at least 760 mm in position 2.

The construction of coamings is to comply with 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 is to 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 are to 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 are to be stowed near ventilators.

7.7.3 The ventilator covers are to be weathertight when closed. The tightness is to be provided by rubber or other suitable gasket.

7.7.4 Watertight trunks and ventilating ducts are to be of the same strength as watertight bulkheads at corresponding levels. Watertight ventilating ducts and trunks are to be carried at least up to the bulkhead deck.

7.7.5 Watertightness of trunks and ventilating ducts shall be verified according to requirements of *Publication No. 21/P – Testing of the Hull Structures.*

7.8 Manholes

7.8.1 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 are to be made of steel or other material approved by PRS. The thickness of the covers is to be, as a rule, not 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 are to be efficiently attached to the coaming or doubling ring by means of bolts or pins with nuts.

7.8.4 When closed, the covers are to be tight under inner pressure according to the requirements for the compartments to which the covers lead.

The tightness is to 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 General

7.9.1.1 The number of openings in watertight bulkheads – taking into account construction and normal ship's service demands – should be the least.

7.9.1.2 In ro-ro ships, watertight doors fitted in bulkheads dividing the ship into sections, separating cargo spaces, may not comply with the requirements of sub-paragraph 7.9.2, provided their compliance with sub-paragraph 7.9.3.

7.9.1.3 Piping and electric cables passages through watertight bulkheads shall comply with requirements of *Part VI – Machinery Installations and Refrigerating Plants* and *Part VIII - Electrical Installations and Control Systems.*

7.9.2 Doors in Bulkheads Dividing the Ship into Sections

7.9.2.1 The doors fitted in bulkheads dividing the ship into sections shall comply with the requirements of present sub-paragraph. Types of doors are determined in a Table 7.9.2.1. Doors are to be made of steel. Application of other materials is a subject of separate consideration by PRS.

Table 7.9.2.1
Types of doors in watertight bulkheads

Type	Characteristics
1	Hinged doors
2	Manually operated sliding doors
3	Manually and mechanically operated sliding doors

7.9.2.2 The doors are to withstand a water head pressure equal to a distance from the lower edge of a door opening to the lower surface of the bulkhead deck plating in a ship's plane of symmetry, but not less than 49.0 kPa. Under that pressure stresses in a door frame and plating shall not exceed 0.6 of yield point.

7.9.2.3 Every door's closing appliance should ensure that they close at heel of 15° on any side, and at any trim of 5°. Application of doors closing under its own, or suspended mass is not permitted.

7.9.2.4 For its tight closing, doors of type 1 are to be provided with quick-closing devices, which can be operated from both sides of the bulkhead. The doors should be provided with a seal made of rubber, or other proper material.

7.9.2.5 Doors of type 2 may be sliding in horizontal or vertical direction.

The design of the doors' drive should enable their opening and closing from the both sides of the bulkhead by means of knob, lever, or other similar devices. Furthermore, it should be possible to operate the door from easy accessible place over the bulkhead deck. The force on a knob, lever, etc., necessary for sliding the door should not exceed 157 kN. If from the operating place located above the bulkhead deck doors are not visible, sliding device should be provided with an indicator informing, that the doors are open, or closed. For ships in an upright position, complete closing of the doors should be possible during a time not exceeding 90 s.

7.9.2.6 Doors of type 3 should, with respect to manual drive, satisfy requirements for the type 2 doors. Furthermore, it should be possible to operate the door from an easy accessible place over the bulkhead deck.

Design of mechanical drive of the doors type 3 should enable their closing and opening from the both sides of the bulkhead, and both levers activating the drive should be so located, that the persons passing through the doors were able to hold that levers in a drive-off position.

Independently of the local launch of the type 3 doors mechanical drive, the possibility of their operation from the central control stand located on the bridge should be assured. Possibility of closing all doors simultaneously, as well as closing of each individual door from that stand should be provided. The device closing doors automatically, when the doors closed from the central stand were open by means of local control, should also be provided. The possibility of locking the doors in closed position by the local device, preventing their opening from the central stand, should be assured.

7.9.2.7 For ships in an upright position, mechanical drive of the type 3 doors should assure their complete closing during a time not exceeding 40 s, but not less than 20 s.

Process of opening the doors should, from the beginning, be accompanied by continuous audible signal. Signalling devices are to be fitted on both sides of the bulkhead.

When closing the doors from the central control stand the above signalling device should also transmit continuous warning signal, activated 5 – 10 s before the doors movement and sounding until their complete closing. The time is not to be included in required period of doors closing.

7.9.2.8 Power supply of mechanical drive for closing and opening doors of type 3 should be possible from at least two independent sources; each of them shall assure simultaneous operation of all doors. Both sources shall be controlled from the central stand, defined in 7.9.2.6. For this purpose should be located there all necessary indicators, enabling to ascertain, that performance of necessary operations with employment of each of the two power sources is possible.

Electrical installation of type 3 doors shall comply with the requirements of *Part VIII – Electrical Installations and Control Systems.*

7.9.2.9 Where hydraulic drive is applied, each of the two power sources required in 7.9.2.8 should include a pump. The third source of power – hydraulic accumulator with capacity sufficient for at least triple operation of all doors, e.g. for their closing, opening and re-closing – should be provided.

Independent hydraulic system for each door, with power source consisting of motor and pump, capable of opening and closing the door, is permitted. In such case the above hydraulic accumulator, is also required.

Liquid used in hydraulic installation should not freeze at the lowest temperature expected during the operation of the ship.

7.9.2.10 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 doors may be hinged or sliding type, but they cannot be remotely controlled.

The side edge of a door opening should be, as a minimum, at a distance of 0.2 ship's breadth from the shell plating; the distance is to be measured at the level of the highest subdivision waterline, perpendicularly to the ship's plane of symmetry.

7.9.2.11 In relation to the door openings, which lower edges are below the highest waterline, the following principles are to be observed:

.1 if the number of such doors (excluding doors to shaft tunnels) exceeds 5, then all the doors, including doors to shaft tunnels shall be of type 3;

.2 if the number of such doors is 5 or less, all the doors may be of type 2.

7.9.2.12 Type 1 doors in 'tween deck's crew accommodations and designated for specialized personnel, as well as in service compartments may only be applied in cases when upper edges of their sills are at least 300 mm above damage waterlines, located on both sides of the bulkhead in which the doors are to be fitted, corresponding to the most unfavourable compartments' flooding conditions (or their combination, if required in *Part IV –Stability and Subdivision*), or corresponding to the condition after equalization of the ship after mentioned flooding.

7.9.2.13 If the conditions of 7.9.3.12 concerning location of the upper edges of doors sills are not satisfied, than the doors shall be at least of type 2. For the ships, for which *Part IV – Stability and Subdivision* requires two compartment subdivision – the doors shall be of type 3.

7.9.2.14 In each watertight bulkhead of compartments, where there are main engines, boilers and auxiliary machinery, only one doors, not counting shaft tunnel doors, may be fitted.

If the ship is provided with two or more propeller shafts, their tunnels may be connected with passage, and with the machinery room shall be connected:

with one door – for ships with two propellers;

with two doors – for ships with more than two propellers.

All those doors should be fitted as high as practicable. The manual closing devices of those doors (including doors to propeller shaft tunnels), designed for operation from above the bulkhead deck, shall be situated outside of machinery spaces.

7.9.3 Watertight Doors in Bulkheads of Ro-ro Ships

7.9.3.1 The requirements of the present sub-chapter apply to watertight doors fitted in watertight bulkheads of cargo holds intended for the carriage of vehicles.

7.9.3.2 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.

7.9.3.3 Watertight doors are to 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 is to be measured at right angle to the centre plane of the ship at the level of the deepest waterline.

7.9.3.4 Watertight doors are to 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 are not to be used. The doors are to be fitted with devices to ensure satisfactory tightness, securing and locking. If the sealing gasket material is not classed as non-combustible, the gasket is to be suitably protected against the effect of fire to the satisfaction of PRS.

The doors are to be provided with devices preventing the door opening by unauthorized persons.

7.9.3.5 The construction of watertight doors is to 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 is to 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.

7.9.3.6 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 is to be provided at each corner of the door (or door section, when the doors consist of sections). Such a closing appliance is to be calculated for the force determined by the formula:

– for closing appliances fitted at the lower edge of the doors:

$$F_1 = \frac{9.81\,A}{n_1}\left(\frac{H_1}{2} - \frac{h}{6}\right) + 29.42\,, \ [\text{kN}] \qquad (7.9.3.6\text{-}1)$$

– for closing appliances fitted at the upper edge of the doors:

$$F_2 = \frac{9.81\,A}{n_2}\left(\frac{H_1}{2} - \frac{h_i}{3}\right) + 29.42\,, \ [\text{kN}] \qquad (7.9.3.6\text{-}2)$$

– for closing appliances fitted at the vertical edge of the doors:

$$F_3 = \frac{a}{A}\left[F_1\left(n_1 - 1\right)h_i + F_2\left(n_2 - 1\right)\left(h - h_i\right)\right], \ [\text{kN}] \qquad (7.9.3.6\text{-}3)$$

A – clear area of watertight door, [m^2];
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 are not to exceed 0.5 times the yield stress of the material used.

7.9.3.7 The operation of such doors is to be possible by means of a local control only. Indicators are to be provided on the bridge to show automatically when each door is closed and all door fastenings are secured.

7.9.3.8 The watertight doors are also to comply with the requirements of 7.9.2.2.

7.9.4 Manholes in Watertight Subdivision Bulkheads

7.9.4.1 The requirements of 7.8 relating to the manholes located on the freeboard deck, are, as a rule, applicable to the manholes fitted in the watertight subdivision bulkhead.

7.9.4.2 No manholes are permitted:
- in the collision bulkhead below the bulkhead deck,
- in watertight subdivision bulkheads separating cargo spaces from adjacent cargo spaces or from fuel oil tanks, except cases when PRS acknowledges the necessity of applying a manhole; in such case the cover of each manhole is to be attached to it prior to the commencement of the voyage.

7.9.5 Side Scuttles

Side scuttles are to be of the non-opening type if they would become immersed by final or any intermediate stage of flooding.

7.10 Cargo Hatches

7.10.1 General

7.10.1.1 The deck openings used for loading and unloading the cargo or ship's stores are to be protected by strong hatches.

PRS may require additional protection of these openings against the influence of weather.

7.10.1.2 The requirements of the present Section 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 normal strength hull structural steel.

The use of other materials will be specially considered by PRS.

7.10.1.3 If the hatches are situated in positions 1 and 2 (see 7.1.4), their covers are to be weathertight. The tightness is to be provided by gaskets made of rubber or other suitable material and by clamping devices.

Clamping devices in the form of flats or angle bars adjoining gaskets are to have rounded edges and are to be made of corrosion-resistant materials.

7.10.1.4 Hatch covers are to be so constructed as to prevent their accidental opening under the action of the sea.

In order to avoid excessive deformation of gaskets, the covers, when closed, are to rest on the coaming structure.

7.10.1.5 Driving gears provided for closing, opening and locking hatch covers are to comply with the requirements specified in Chapter 7, *Part VII – "Machinery, Boilers and Pressure Vessels"*.

The construction of hatch covers and driving gear is to enable closing and securing the hatches if the event of damage to the main drive. Provision is to be made for locking the covers in the open position.

7.10.1.6 Dry cargo holds intended for the carriage of dangerous goods (see *Part V – Fire Protection)* are to be provided with steel hatch covers on the upper deck. The driving gear of hatch covers on the lower and upper decks is to ensure a smooth motion of the covers and their parts. The drive construction is to be such as to prevent unintended closing of covers during their closing or opening operations in the case of driving gear damage.

Precautions are to be taken against penetration of oil from the hatch cover driving gear into the hold.

7.10.1.7 Ships with hatches of large dimensions, in which considerable strains of hatch coamings are likely to occur during navigation in rough sea, are to meet the following requirements:

.1 the construction of the closing appliance is to 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 are to have adequate clearance allowing for their relative horizontal shifts;

.3 the bearing surface of the hatch coaming is to ensure suitable sliding contact permitting the cover sections to be shifted along it;

.4 the bearing flange of the hatch coaming is to be reinforced in such a way as to ensure continuous contact with the cover sections (metal to metal).

7.10.1.8 The present Section covers the structural requirements for steel hatch covers with the following systems of stiffeners and girders:

– only longitudinal stiffeners or only transverse stiffeners,
– one direction stiffeners crossing perpendicular girders.

If, besides one direction stiffeners, girders perpendicular and parallel to these stiffeners, have been applied, it is recommended that girder scantlings be determined on the basis of hatch cover stress analysis according to 7.10.8.

7.10.2 Hatch Coamings

7.10.2.1 The height of hatch coamings in positions 1 and 2 is to be at least 600 mm and 450 mm, respectively.

The construction of coamings in these positions is to comply with the requirements of *Part II – Hull*.

7.10.2.2 The height of cargo hatch coamings with steel covers and gaskets may be reduced as compared with that required in 7.10.2.1 or the coamings may be entirely omitted if the tightness of covers and closing arrangements are, in PRS opinion, fully effective.

7.10.2.3 Hatches with coamings reduced in height or hatches without coamings are to be strengthened in accordance with 7.10.4.3 if they are situated in exposed parts of the weather deck within 0.25 *L* from the forward perpendicular.

7.10.3 Materials

7.10.3.1 For steel and light alloys used for hatch covers, the requirements, specified in 1.5, are to be applied.

7.10.3.2 Rubber for sealing gaskets of hatch covers is to be elastic and weather resistant. Rubber is to have a sufficient hardness.

7.10.3.3 Adhesives used for fastening the rubber in the groves of hatch covers are to be approved by PRS.

7.10.4 Design Loads

7.10.4.1 The scantlings of steel hatch covers:
– plating thickness,
– dimensions of plating stiffeners,
– dimensions of girder elements

are to be determined taking into account the following design pressures, specified in *Part II – Hull:*
$p = p_3$, $p = 1.5\ p_7$, $p = p_8$, $p = p_9$, $p = p_{12}$ and $p = p_{13}$, whichever applicable.
Assumed calculation load should not be less than pressure p_{15} specified in 7.4.10.2 and 7.4.10.3.

7.10.4.2 For hatch covers in positions 1 and 2, irrespective of pressures specified in 7.10.4.1, pressure p_{15} is to be taken into consideration which is equal to:

$$p_{15} = \left(a + \frac{c\,L_0}{76} \right) g\ ,\ \ [\text{kPa}] \qquad (7.10.4.2)$$

$a = 0.76$, $c = 0.75$ – in position 1,
$a = 0.58$, $c = 0.55$ – in position 2.
The pressure does not exceed 17.16 kPa in position 1 and 12.75 kPa in position 2;

7.10.4.3 For the cargo hatches which are provided with hatches without coamings or with coamings of reduced height in the exposed parts of weather deck within $x > 0.25\ L_0$ (see 7.10.2.3), the pressure p_{15} (see 7.10.4.2) is to be determined from the formula:

$$p_{15} = \left(a + \frac{c\,L_0}{76} \right) \left(1 + 0.15 \frac{h_o - h}{h_o} \right) g\ ,\ \ [\text{kPa}] \qquad (7.10.4.3)$$

a, c – as in 7.10.4.2;
h_o – height of hatch coaming required in 7.10.2.1, [mm];
h – applied height of hatch coaming, [mm].

7.10.4.4 If hatch covers are intended for the carriage of containers, the loads from containers are to be assumed as concentrated loads in sockets at the containers corners. The load value is to be determined according to *Part II – Hull*. The hatch cover additional load from pre-tensioning of container lashing is to be taken into account, where applicable.

7.10.4.5 When a hatch cover is under design load due to cargo forklifts, pressure *p*, determined according to *Part II – Hull* is to be taken into account when determining the scantlings of the hatch cover elements.

7.10.4.6 When the hatch covers are designated for carriage of cargo, than the load determined according to *Part II – Hull* is to be taken into account when determining the scantlings of the hatch cover elements.

7.10.4.7 Stiffeners loaded with point forces are subject to special consideration by PRS.

7.10.5 Hatch Cover Plating

7.10.5.1 The thickness of hatch covers top plating is to be determined according to the requirements specified in *Part II – Hull*, taking into account the pressures given in 7.10.4 and permissible stresses σ equal to:

$\sigma =$ 0.58 R_e, [MPa] – for hatch covers in position 1 and 2 at assumed design pressure $p = p_3$,

$\sigma =$ 0.67 R_e, [MPa] – elsewhere.

$R_e \leq 0.7\ R_m$ is to be assumed, where R_m – tensile strength of steel applied, [MPa].

7.10.5.2 The thickness of hatch cover top plating is to be not less than:

$$t = 10s, \text{ [mm]} \qquad (7.10.5.2)$$

s – spacing of hatch cover plating stiffeners, [m],
nor it is to be less than 6 mm.

For closed hatch covers, the thickness of the bottom plating is to be not less than 6 mm.

7.10.5.3 Where such cover load conditions occur that the plating, being the effective flange of stiffeners or girders simply supported at both ends, is subject to compression, the following condition is to be satisfied:

$$\sigma_c \geq \frac{\sigma W_1}{\eta W_r}, \text{ [MPa]} \qquad (7.10.5.3)$$

σ_c – the critical stress of plating which is the effective flange of girder in question, determined according to *Part II – Hull*, [MPa].
The necessary value of the ideal elastic buckling stress σ_E is to be determined according to *Part II – Hull,* assuming $k_2 = 1$.

σ – permissible stress, determined according to 7.10.5.1, [MPa];

W_1 – girder section modulus, required by 7.10.6.1 or 0.7 times the section modulus required in 7.10.6.2 – whichever is the greater, [cm^3];

W_r – actual section modulus of this girder determined for the considered compressed effective flange, [cm^3];

η – factor determining the allowable degree of cover plating actual critical stress utilization,

η = 0.77 – if the plating load was determined applying $p = p_3$, p_8 , p_9 , p_{13} and 1.5 p_7 pressures,

η = 0.87 – otherwise.

Compliance with condition 7.10.5.3 refers to plating being the effective flange in the middle of the girder span. The girder span is measured between its two free support points.

7.10.6 Hatch Cover Stiffeners

7.10.6.1 The required section modulus of the hatch cover plating stiffeners is to be determined according to 13.5, *Part II – Hull*, assuming the design pressure p according to 7.10.4 and the permissible stress σ according to 7.10.5.

The m factor is to be taken as equal to:

m = 8 – for stiffeners simply supported at one or both ends;

m = 12 – for stiffeners fixed at both ends.

Where the stiffener transmits point load from heavy unit cargoes, its strength and stiffness are subject to special consideration by PRS.

7.10.6.2 For hatch covers in position 1 and 2, the section modulus of stiffeners made of normal strength steel, irrespective of compliance with the requirement 7.10.6.1, is to be not less than:

$$W = \frac{103}{m} l^2 s q w_k, \quad [\text{cm}^3] \qquad (7.10.6.2)$$

l, s – see 7.10.6.3;

q – the assigned sea water acting on 1 m^2 of hatch cover area, [t/m^2],

$q = a + \frac{c L_0}{76}$, but not more than 1.75 t/m^2 in position 1 and 1.30 t/m^2 in position 2;

a = 0.76, c = 0.75 – in position 1,

a = 0.58, c = 0.55 – in position 2.

w_k – corrosion allowance coefficient, determined according to *PartII – Hull.*

7.10.6.3 The moment of inertia of stiffeners and girders cross-section of hatch covers in positions 1 and 2, supported only on longitudinal or transverse hatch coamings of the hatch, is to be not less than:

$$J = 22 l^3 s q, \quad [\text{cm}^4] \qquad (7.10.6.3)$$

q – as in 7.10.6.2;

l – span of stiffener measured between the support points on the hatch coaming, [m];

s – spacing of stiffeners, [m].

7.10.6.4 The requirements for section modulus and moment of inertia of hatch cover stiffeners, given in 7.10.6.2 and 7.10.6.3, are based on the assumption that their cross-sectional area is constant over the whole span.

Where stiffeners with changing dimensions of web or flange over their span are applied, they are to be so designed that the maximum bending stresses and maximum deflection are not increased.

7.10.6.5 The net cross-sectional area of the stiffener web for each cross-section is to be not less than:

$$A = 0.14\left(0.5 - \frac{x}{l}\right) l\,s\,p + 10\,h\,t_k, \quad [\text{cm}^2] \qquad (7.10.6.5)$$

t_k – corrosion addition;
x – distance from the end cross-section of the stiffener to the cross-section considered, [m], $x \le 0.25\,l$ is to be taken;
h – the stiffener web height at the cross-section considered, [m].

7.10.6.6 Hatch cover stiffeners are to be connected to intersecting girder webs and to the cover edges by means of fillet weld of cross-sectional area not less than:

$$a = 5 + 0.07\left(l_1 + l_2\right) s\,p + a_k, \quad [\text{cm}^2] \qquad (7.10.6.6)$$

l_1, l_2 – span of the stiffener at both sides of the intersecting girder, [m];
a_k – weld area corrosion addition corresponding to corrosion addition t_k, [cm^2].

7.10.6.7 Welded joints of hatch cover stiffeners, except those specified in 7.10.6.6, are to be made according to general principles given in *Part II – Hull.* The connection of stiffeners to hatch cover plating at cargo tank or cargo hold intended for the carriage of ballast water is not to be made with the use of staggered or chain weld.

7.10.7 Hatch Cover Girders

7.10.7.1 The required section modulus and moment of inertia of girders are to be determined according to 7.10.6.1 ÷ 7.10.6.4 as for stiffeners, assuming in particular formulae $s = b$, where s – spacing of stiffeners, b – width of the hatch cover area supported by the girder in question. The width b is equal to the half of the sum of spacing of stiffeners supported by the girder at both sides.

7.10.7.2 When determining the actual values of section modulus and moment of inertia of the girder cross-section, the width of effective flange of hatch cover plating is to be taken according to 3.2, *Part II – Hull*.

7.10.7.3 The net cross-sectional area of the girder web at its ends is to be not less than:

$$A = 0.7\,l\,b\,p + 10\,h\,t_k, \quad [\text{cm}^2] \qquad (7.10.7.3)$$

b – as in 7.10.7.1;
h – as in 7.10.6.5.

The required cross-sectional area may be reduced by the value of 0.14 *sbp* towards the middle of the span at each intersection of girder web with stiffener (*s* – spacing of stiffeners supported by girder). The reduced value of girder cross-section is to be taken not less than half of the cross-section area *A* required at girder ends – see formula 7.10.7.3.

The girder webs are to be stiffened against buckling.

7.10.7.4 The hatch cover framing girders are to be sufficiently resistant to forces acting on the cover during the opening and closing operations.

7.10.7.5 To ensure sufficient packing pressure at the distance between the securing devices, the hatch cover framing girders are to have proper stiffness. Their moment of inertia is to be not less than:

$$J = k\, p_l\, a^4, \quad [\mathrm{cm}^4] \qquad (7.10.7.5)$$

k – factor depending on stiffness of beading to which the hatch cover elements are tightened. It may be taken as:
k = 6 for cover edges tightened to each coaming,
k = 12 for cover edges tightened to other cover of the same stiffness;
a – spacing of hatch cover securing devices, [m];
p_l – packing pressure acting on 1 m of the tightened edge length, [kN/m], but not less than 5 kN/m.

When determining pressure p_l for tank hatch cover, the internal pressure in the tank is to be taken into account.

7.10.8 Stress Analysis of Hatch Covers

7.10.8.1 When hatch covers are of special construction, e.g. they are designed as a grillage, are supported in additional points or support other covers, it may be required that, analogically to zone strength analysis of hull structure, stress analysis should be carried out (see *Part II – Hull*). This applies particularly to hatch covers of combination (open) carriers, where deformations of hull structure may affect the hatch cover tightness.

7.10.8.2 Hatch covers load conditions are to be determined taking into account pressures given in 7.10.4.

7.10.8.3 Where strength analysis of hatch covers is made according to beam theory, the following permissible stresses may be assumed:
σ = 0.58 R_e, τ = 0.37 R_e – for hatch covers in positions 1 and 2 subjected to pressure p_3;
σ = 0.67 R_e, τ = 0.37 R_e – elsewhere.

The sum of girder bending stress and local bending stress in parallel stiffener, being part of the girder effective flange, is not to exceed 0.8 R_e.

7.10.8.4 The critical stress σ_c of plating being the effective flange of hatch cover girder, determined as in 7.10.5.3, is to satisfy the condition:

$$\sigma_c \geq \frac{\sigma_r}{\eta} \qquad (7.10.8.4)$$

σ_r – compressive stress in plating being the effective flange of the girder, [MPa];
η – as in 7.10.5.3.

7.10.8.5 For hatch covers in positions 1 and 2, the hatch cover load with pressure $p = p_{15}$, see 7.10.4.2 and 7.10.4.3, is to be taken into account. In this case, the permissible girder bending stress is σ = 95 MPa.

The maximum deflection at the middle of the cover is not to exceed 0.0028 l, where l – length or breadth of the hatch, whichever is the lesser.

7.10.8.6 Where the cover closes tank or hold in which water ballast may be carried, the scantlings of cover structural elements, determined from the stress analysis, are to be increased by corrosion addition t_k, determined according to *Part II – Hull*.

7.10.9 Hatch Covers Closing Devices

7.10.9.1 Each section of cover in positions 1 and 2 is to be fitted with suitable closing devices at each side to ensure the efficient tightness of hatch cover.

7.10.9.2 The number of closing devices at each side of hatch cover section is to be not less than 2. If the closing device is fitted at the section corner, it may be considered as closing both sides of the section.

At least one closing device, tightening the longitudinal or transverse side of the cover section is to be fitted directly at the cover corner.

7.10.9.3 Net sectional area of the bolt clamping the cover to the hatch coaming or cover to cover is to be not less than:

$$A = k\,n\,a\,c, \quad [\text{cm}^2] \qquad (7.10.9.3)$$

a – bolt spacing, [m];
n = 1.4 – for weathertight covers fastened to the coamings,
n = 3.0 – for covers of deep and cargo tanks, fastened to other covers,
n = 0.08 (0.5 $l\,p$ + p_l) – for tank covers fastened to hatch coamings;
l – span of girder or stiffener perpendicular to the considered cover edge, [m]. If such stiffeners are not applied, l is to be taken as half of the distance measured from the cover edge to the nearest stiffener or girder parallel to the edge in question.
p – the greatest of the applicable pressures: $p = 1.5\,p_7$, $p = p_8$, $p = p_9$, $p = p_{10}$, [kPa];
$p_7 \div p_{10}$ – design pressures, determined according to *Part II – Hull* (B/17.6.6.2), [kPa];

p_l – linear pressure of hatch cover edge to the coaming or hatch cover, [kN/m] – $p_l \geq 5$ kN/m is to be assumed for the calculations;

c = 0.2 p_l ; $c \geq 1.0$ is to be assumed for the calculations;

$k = \left(\frac{235}{R_e}\right)^e$ – material factor of the bolts;

e = 1 for $R_e \leq 235$ MPa,

e = 0.75 for $R_e > 315$ MPa.

7.10.9.4 Where in positions 1 and 2 hatch with reduced coaming height has been arranged (see 7.10.2.2), then each cover section is to be fitted with at least two securing devices along each side and the maximum distance between them is not to exceed 2.5 m.

7.10.9.5 Where the hatch cover area exceeds 5 m^2, the bolt core diameter of securing devices is to be not less than 19 mm.

7.10.9.6 Securing devices of hatch covers designed on stress analysis basis (see 7.10.8) are to be chosen depending on the forces acting in the bolts.

Permissible tensile stress in the bolts is equal to $\sigma = 125/k$, [MPa].

Permissible stress in other devices is equal to:

– normal stress $\sigma = 120/k$, [MPa];
– shear stress $\tau = 80/k$, [MPa];
– equivalent stress $\sigma_{zr} = \sqrt{\sigma^2 + 3\tau^2} = 150/k$, [MPa].

7.10.9.7 Hatch covers in positions 1 and 2 intended for the carriage of cargo are to be secured with strong stoppers against horizontal displacement. The stoppers are to be designed taking into account transverse P_t or longitudinal P_l mass forces determined according to *Part II – Hull.*

If the cargo carried on the hatch cover is fastened to the deck outside the cover, the values of these forces may be reduced by 10%.

7.10.9.8 Location of the stoppers is to be chosen taking into consideration the movement of coamings, covers and deck due to hatch displacement caused by the sea motion.

7.10.9.9 At cross-joints of multi-panel covers, vertical guides are to be fitted to prevent excessive relative vertical deflections between the panels.

7.10.10 Drainage Arrangement

7.10.10.1 Drainage is to be arranged inside the line of gasket by means of a gutter bar or vertical extension of the hatch side and end coaming.

7.10.10.2 Drain openings are to be arranged at the ends of drain channels and are to be provided with effective means for preventing ingress of water from outside, such as non-return valves or equivalent.

7.10.10.3 Cross-joints of multi-panel covers are to be arranged with drainage of water from the space above the gasket and a drainage channel below the gasket.

7.10.10.4 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.

7.11 Machinery and Boiler Room Casings

7.11.1 Openings in decks located in positions 1 and 2 above machinery and boiler spaces are to be protected with casings of adequate strength, raised above decks to the suitable height. The casings are to be covered with decks or skylights are to be installed above them. The design of the casings is to comply with the requirements of *Part II – Hull.*

7.11.2 Casings are to be weathertight.

7.11.3 Casings are to be made of steel or other material approved by PRS (see also *Part V – Fire Protection*).

7.11.4 Openings in casings leading to machinery and boiler spaces are to be provided with permanently attached doors complying with the requirements of 7.3.2.3 ÷ 7.3.2.5. The height of door opening sills is to be at least 600 mm in position 1 and at least 380 mm in position 2.

7.11.5 For air intake systems to machinery spaces protected in a range of DAWMD arrangements are to be provided enabling prompt transition from the free air flow condition to air flow through air filtering system. The air flow transition system should be of simple design and easy to operate.

7.11.6 The cases and openings for transportation for repairs of the engines, generators and auxiliary machinery should be provided.

Alternatively, upon agreement with PRS, places in a ship sides and decks can be appointed, through which, after cutting the openings, transportation of repaired elements to/from engine room may take place.

8 AMMUNITION CHAMBERS AND PARKS

8.1 General

8.1.1 Scope

8.1.1.1 Requirements of Chapter 8 apply to ships and auxiliary floating objects, which provide for the storage of ammunition.

8.1.1.2 These requirements are additional special provisions for installation and deployment, issued by the manufacturer of a particular type of weapons and ammunition.

Basing on the detailed provisions Purchaser shall:

– specify a list of ammunition carried in various magazines, noting the types of munitions that can be placed in the same stores,
– determine the environmental conditions, the requirements for resistance to vibration, conductivity requirements for coverage of decks in relation to the carried ammunition,
– determine acceptable materials in the construction of magazines,
– determine the measures to be taken to mitigate the effects of ammunition fire, including missile ammunition,
– determine the requirements relating to the marking of magazines and provision of instructions,
– determine liquid media pressures in pipes located in the storage space.

8.1.2 General Requirements

8.1.2.1 *The armament plan* should be developed taking into account the arrangement of ammunition chambers and parks, roads, transport of ammunition and missiles, as well as security assurance measures.

8.1.2.2 When designing the construction and equipment of magazines the following risk factors should be taken into account:

– impact of the enemy attack means creates splinters and / or vibration and gust acting on the ammunition,
– fire as a result of the enemy action or accidental incident,
– terrorist attack or sabotage,
– collision or grounding of the ship,
– the impact of electromagnetic impulse (EMI) or electrostatic discharge (ESD) causing an explosion of ammunition,
– effects of nuclear explosion,
– failure of air-conditioning/ventilation system.

8.1.3 Definitions and Descriptions

For the purposes of section 8, the following additional definition are introduced:

.1 ammunition – all kinds of destruction means, including explosives, pyrotechnics, initiating the explosion, nuclear materials, biological or chemical used for the purpose of fighting or practice;

.2 ammunition chamber – specifically isolated and properly equipped space, meeting the requirements of storing certain types of ammunition..

Among them are:

- integral ammunition chambers, whose boundary walls are part of the hull structure;
- self-contained ammunition chambers, which are not an integral part of the hull, with an area greater than 3 m ^{2};
- small ammunition chambers, whose shape and dimensions necessitate the handling of ammunition stored from outside the chamber;
- igniters magazine, used for storage of materials initiating explosion.

.3 mechanized ammunition chamber – specifically isolated and properly equipped space, meeting the requirements of storage and transportation of ammunition in internal relations and directly: chamber – weapons/equipment;

.4 construction chamber's equipment – equipment inside or outside the chamber, forming part of the ship's structure or its installations, and designed to safeguard the basic functions of the chamber;

.5 ammunition park – a metal container on board located in the vicinity of weapons or separate part of the superstructure of area not exceeding 3 m^{2,} available from the open deck, where the ammunition is ready for immediate use;

.6 small arms magazine – a space or a metal cabinet designed to store small arms and its ammunition;

.7 hand grenades magazine – a metal container for storing hand grenades;

.8 ammunition cabinet – a metal cabinet (container) deployed in the ammunition chamber or other (proper) space designed to store ammunition or its components;

.9 TTR – tactical-technical requirements.

8.1.4 External Conditions for the Design of the Chambers

8.1.4.1 For high speed crafts and hydrofoils rolling amplitude ± 30 ° with a period of 7 ÷ 10 s and pitching to ± 7 ° is to be taken. On other ships the amplitude of rolling ± 45 and period 7 ÷ 16 s is assumed.

8.1.4.2 Regardless of the size and type/kind of the ship, the possibility of long-term heel up to 15 ° and long-term trim up to 5° should be taken into account.

8.1.4.3 Resistance of chambers' equipment for explosion (single mechanical shock) should be at least equal to the resistance of weapons, for which ammunition is designated, or the most sensitive marine equipment, deciding on the use of ammunition. Equipment of chambers must meet the requirements of resistance to acceleration occurring at the impact of the hull of the ship against oncoming waves (slamming), and for the landing craft - an additional requirement of resistance to acceleration occurring at the entrance to the shore, or laying aground, with maximum speed.

8.1.5 Standards for Chambers Microclimate

8.1.5.1 Construction and equipment of the chambers should allow to maintain the chambers' microclimate in accordance with the following requirements.

8.1.5.2 In ammunition chambers, the temperature must be kept within the range of 5 ÷ 30° C with a change of not more than ± 5° C/24 hours, and relative humidity of air within the range of 40 ÷ 43%. An optimum temperature is a temperature around 15° C.

8.1.5.3 Rise of temperature up to +25° C, and humidity up to 85% for a period of 12 h under sunlight conditions is permissible.

8.1.5.4 In extreme conditions rise of temperature up to +30 °C, lasting no longer than 8h/24 hours is permitted.

8.2 Ammunition Chambers

8.2.1 Location and the Design of Ammunition Chamber

8.2.1.1 Ammunition chamber for specified type of ammunition should be located near the weapon (equipment) for which it is intended and, if possible, in the same watertight compartment.

8.2.1.2 Wherever possible, the chamber should be located in the ship's plane of symmetry, in the bow or stern section – but away from the propeller, rudder and shaft line.

8.2.1.3 Chamber for artillery ammunition and rocket-powered ammunition, should be so placed, that the ship's waterline was above the level of stored ammunition.

8.2.1.4 Chamber for ammunition containing pyrotechnic substances should be of a minimum volume and be located directly under the deck, well away from the important compartments and ship's mechanisms.

8.2.1.5 The chamber walls shall be made of steel and watertight, floor coverings shall be anti-sliding. It is recommended that the chamber's walls were made as Class A-60 divisions.

In ships with a displacement of 500 tonnes, exemptions from this recommendation, including the execution of the chamber as the construction of Class A-0, are allowed. In ships with a displacement of more than 500 tonnes, in special cases the execution of the walls as divisions of Class A-0 may be permitted. In such cases spraying of external wall of the chamber is to be applied.

8.2.1.6 The walls of the chamber should not be adjacent to the engine room, compartments containing electrical switchgear and a galley. If such arrangement is necessary (except that it is unacceptable for the chamber mentioned in 8.2.1.4), a safety section of width not less than 600 mm shall be applied. Safety section shall be empty and equipped with ventilation. If the chamber is constructed as a structure of A-0 or A-15 Class, then one of the walls forming the safety section shall be made as a Class A-30 division – if bordering the engine room, or A-15 – if bordering the galley. For the chambers designed as A-30 or A-60 structure, such provisions are not required.

8.2.1.7 The walls of the chamber should not be adjacent to the compartments for storage of paints and varnishes, battery rooms and fuel tanks or tanks for other liquid/gas vulnerable to fire/explosion.

8.2.1.8 For chambers with walls made of A-0 Class divisions, adjacent to the compartments where the temperature remains above 25 ° C, thermal insulation should be applied outside the chamber.

8.2.1.9 No installations should pass through the chamber. The exception is the chamber protection installation.

8.2.1.10 Arranging spaces adjacent to the chamber, their role as a chamber's shield against shells (missiles) and fragments hitting the ship is to be anticipated. For this purpose, equipment of those spaces should also be adequately arranged..

8.2.1.11 Ammunition chamber provided with the flooding installation shall be so situated, that after being flooded there was not significant deterioration in the stability of the ship.

8.2.1.12 Non-mechanized ammunition chamber can be divided into smaller, separate chambers, if its flooding may cause the loss of stability of the ship, or the capacity of flooding installation does not guarantee flooding the chamber within the required time.

8.2.1.13 It is recommended that the thickness of the steel walls of ammunition chamber is at least 8 mm.

The plating, together with applied ballistic shields, shall assure protection of the ammunition chamber against, specified in TTD, shell fragments and small-calibre guns.

8.2.1.14 Plating thickness and scantling of the deck stiffening of the ammunition chambers, which can be flooded, should not be less than those resulting from the load of a water head of height up to the ceiling of the chamber.

8.2.1.15 It is recommended that the ammunition chambers' walls forming the side, and decks of ships and landing crafts be strengthened or made of armored steel plates, or sheltered with armored plates or missiles shields.

8.2.1.16 Ammunition chamber with a height less than 1600 mm should be provided with a means facilitating the safe movement of cases with ammunition in the manhole/door direction.

8.2.2 Communication Routes

8.2.2.1 Communication routes between the ammunition chamber and weapons/ a place for ammunition preparation to use, should allow the supply of ammunition in the possible shortest time: reliably, safely and using a minimum number of the ship's crew.

8.2.2.2 During the planning of routes, the possibility of free movement through them of a man carrying two boxes – dimensionally equivalent to boxes for cartridges caliber up to 30 mm, or two men carrying a box - dimensionally equivalent to box for cartridges caliber 37 ÷ 100 mm, or a man carrying a cartridge caliber 76 ÷ 100 mm without packaging, should be taken into account.

8.2.2.3 For the ammunition chamber remote from the weapons of more than one watertight compartment, and one level of the deck, must provided with two ways of communication –basic and emergency – are to be provided.

8.2.2.4 The entrance to the ammunition chamber may not lead from:
- the compartments vulnerable to fire,
- the common corridors; an exemption is permitted subject to installation of additional gas-tight steel door in the passage.

8.2.2.5 Communication routes for loading and unloading should be provided in relations:

.1 shore (supply ship) – the ship's deck – the place for preparation of the ammunition for storage – the chamber, and vice versa;

.2 weapons – a place of storage cartridges, belts, packaging, etc.

8.2.2.6 The chamber must ensure compliance with ergonomic standards - in all conditions of loading the chamber.

8.2.2.7 For ammunition, which need not be prepared for use on the open deck (eg, due to the effects of electromagnetic fields), on the communication route: chamber – weapons, areas for ammunition preparation located inside the ship, or separated areas of open decks, sheltered from the top by the metal structure should be provided.

8.2.2.8 For weapons having more than one point of ammunition charging, placed in the base of launching tower / launcher, the number of chambers adequate for the number of charging points may be applied, or the number of doors / manholes adequate for the number of charging points may be applied in the chanber.

8.2.2.9 When planning communication in the relation shore – ammunition chamber, for the hand-transported unpacked ammunition, the need of spreading a string carpet all over the ammunition transportation way is to be foreseen.

8.2.2.10 For chambers with a height up to 2000 mm, located directly under the deck, on which the weapons are arranged (the place of use of ammunition), where the mass of the ammunition does not exceed 30 kg and it is in the package that allows its handling, manual vertical delivery of ammunition through a manhole, is allowed. Otherwise, the use of mechanical means of ammunition feeding is to be applied.

8.2.3 Doors and Communication Manholes

8.2.3.1 Ammunition chamber should be fitted with manholes and/or watertight doors.

8.2.3.2 Manholes and doors to the chamber should be so constructed to allow them to be open from both sides.

8.2.3.3 The dimensions of manholes should be not less than 600×600 mm (∅ 600 mm is allowed), recommended dimensions are 600×800 mm. Dimensions of manholes/doors should be based on dimensional analysis, related to transfer of ammunition through them.

8.2.3.4 Manholes/doors design should allow their reliable securing in the open position.

8.2.3.5 If the exit from the chamber leads to the inner compartments of the ship, the chamber door should open inwards.

8.2.3.6 The manholes from the open deck shall be so arranged, that when they get opened, the sun rays do not fall directly on ammunition.

8.2.3.7 Design of manholes and doors of the ammunition chamber should allow their sealing.

8.2.4 Decompression Manholes

8.2.4.1 In the chambers designated for storing of rocket-powered ammunition, decompression manholes should be provided – if the below relation occurs:

$$\frac{2m_s}{W_k} \geq 0.2 \qquad (8.2.4.1)$$

m_s – mass of throwing load in a rocket engine, [kg];
W_k – volume of the ammunition chamber, [m^3].

8.2.4.2 If the relation 8.2.4.1 is satisfied, two manholes, each with a cross-section (in light) of not less than 0.36 m^2 shall be applied.

8.2.4.3 For the chambers, which are not located directly under the open deck, ventilation ducts, withstanding pressure of 8 kPa, passing through the compartment located above the chamber, shall be applied. Number of channels should correspond to the number of manholes, and the area of the channel opening should be equal to the area of the manhole opening. Respectively, increasing its section, one channel serving two or more manholes may be applied.

8.2.4.4 Manholes on board should, as far as possible, be located outside the attended communication routes, and have protection against the possibility of stepping on them by the crew members.

8.2.4.5 It is allowed to locate a decompression manhole outside the contour of the decompression chamber, by using the sloping decompression duct.

8.2.4.6 In the vicinity of decompression manholes flammable devices/materials shall not be distributed.

8.2.4.7 Decompression manhole may not be located in the area of influence of the starting rocket ammunition jet gases, as well as the area of impact wave influence accompanying artillery firing.

8.2.4.8 If the requirement of 8.2.4.1 can not be met, and the chamber is located directly under the deck, the local deck weakening (so called weak link), of a circular shape, which will be broken out under the increased pressure exceeding 8 kPa, shall be applied instead of decompression manholes. Total area of the weak links shall be equal to the manholes opening area.

8.2.4.9 For the chambers referred to in 8.2.1.4, the manhole designated for disposal of gases resulting from burning pyrotechnic masses flushed of flooded with water, shall be applied. The manhole should be opened locally manually, remotely or automatically.

8.2.5 Range of Chambers Equipment

8.2.5.1 Means for flooding the chamber within the time given in TTD should be provided.

8.2.5.2 Ammunition chambers located below the ship's draft line shall be equipped with air ducts and overflow installation, preventing the formation of excessive pressure during water flooding of the compartment.

8.2.5.3 Ammunition chamber shall be equipped with a sprinkler installation of parameters specified in the TTD.

8.2.5.4 The ammunition chambers shall be provided with drainage specified in the TTD. The minimum section area of drainage pipes should correspond to 125% of the chamber sprinkler system efficiency. Overboard valves should be remotely controlled from the bulkhead deck or the deck above the bulkhead deck.

8.2.5.5 The chamber shall be equipped with the signalization of the chamber's door opening.

8.2.5.6 The casing of ammunition transport appliance should be sprayed with the rate specified in TTD.

8.2.5.7 Remaining chamber's equipment requirements are contained in *Part V - Fire Protection.*

8.3 Ammunition Parks

8.3.1 When arranging park equipment, communication ways in relation: weapons (where ammunition is used) – park – the place of awaiting so called pursuing numbers (ammunition users) shall be provided. The communication shall be safe, reliable, and shall enable the operations related to the supply of ammunition in the minimum time.

8.3.2 The capacity of the park is determined by the Purchaser.

8.3.3 Distribution of parks should be avoided in a place, where:
- flushing or flooding of ammunition may occur in the park, with sea state allowing the use of weapons and the ship's combat speed; the park must be arranged with its back or side part to the direction of splashing by waves – if it does not impair speed and reliability of supply of ammunition;
- there are ventilation openings (and other) from the compartments, from which vapors of flammable, caustic, etc. gases are emitted;
- a raised temperature and/or possibility exists of influence of exhaust gases on the park.

8.3.4 The parks shall not be located in the area of impact wave and flames influence, accompanying artillery and rocket firing.

8.3.5 When arranging the park, the possibility of its rapid emptying by throwing away the ammunition overboard should be taken into account.

8.3.6 It is not recommended to locate the parks directly over compartments endangered by fire, and next to such compartments.

8.3.7 Ammunition park shall have assured effective natural ventilation.

8.3.8 Ammunition park shall be constructed of steel with minimum thickness of 3 mm.

8.3.9 Park's doors shall be watertight, suitable for a padlock closing and sealing.

8.3.10 The park's doors shall open to the width corresponding to an angle of ≥ 180 °, and it shall be possible to lock them in this position. As necessary, parks with left or right-hand opened doors shall be applied.

8.3.11 Free-standing park shall be away from the ship structure items at least 300 mm, and be located outside the passage and communication runs.

8.3.12 Each park shall be equipped with an external spraying installation, or be located in the area of such installation operation, with the valve located near the park and controlled manually.

8.3.13 Possibility of fitting a shield/screen protecting the park against direct sunlight shall be provided.

8.3.14 Cutters and landing ships parks, which may be exposed to shooting, shall have additional armor protecting against splinters and small arms projectiles, or shall be made of steel, which satisfies the conditions imposed on anti-ballistic shield.

8.3.15 The design of fastening and structure of free-standing ammunition park shall be calculated for the action of the impact wave from a nuclear explosion from a distance adopted for the ship, and for the conditions listed in 8.1.3.

8.3.16 For signaling and illuminating munitions intended for navigation security purposes, separate parks can provided located on the deck/navigating stand, the open wing of navigation bridge or on signal deck. The requirements for combat ammunition parks do not apply to them, but they shall be watertight, closed on patent lock or padlock, sealed and permanently attached to the structure of the ship.

8.3.17 For dummy ammunition, practice, and especially for salute ammunition, the space may be provided, unless in the special chamber for fixing a mobile park, put on the ship together with ammunition. Fire protection of such mobile park shall be organized on a case-by-case basis.

8.3.18 The scope of ammunition chambers and parks testing shall be included in the shipyard testing program, and cover:
- checking of chambers', parks' and equipment manufacture in accordance with the documentation;
- tests of ammunition transport equipment under load – in accordance with technical conditions;
- tests of sprinkler, flooding, drying and ventilation systems;
- tests of signaling installation;
- checking of as-carried-out documentation.

8.4 Detonators Magazines

8.4.1 Detonators shall be stored in watertight metal cabinets. The cabinet should be fixed to the structural elements of a ship. The cabinet should be closed with a patent lock, and be of construction enabling its sealing.

8.4.2 The cabinets containing detonators of the total weight of explosive not exceeding 1 kg may be located in the same chamber as the ammunition, which they are intended for, or in the selected chamber, if the ammunition, which they are intended for, is located outside the chambers (mines, torpedoes).

It is allowed to locate cabinets in a dry, specially separated compartments with walls of A-60 Class.

8.4.3 If the mass of detonators' explosive exceeds 1 kg, they shall be stored in a special dry compartments, located below the waterline, with a wall of the A-60 Class.

8.4.4 Detonators may not be stored in compartments with temperatures above 32° C, as well as they can not be located in areas of excessive vibration.

8.4.5 The cabinets with detonators should be located at a distance of not less than 100 mm from the walls of the compartment, and shall not be attached to the sides of the ship.

8.4.6 Air gap between the cabinets containing detonators shall not be less than 300 mm. If ensuring a gap of 300 mm is not possible, then a smaller gap (but at least 100 mm) may be allowed, provided that a steel plate, with a thickness of at least 8 mm, is placed between the cabinets.

8.5 Small Arms Magazine

8.5.1 Walls of the magazine should be at least of A-0 Class. Magazine should have a metal door closed with use of two locks (including one patent lock).

Attachment of the door should prevent their removal from hinges in closed position. Doors should have a structure enabling the sealing of the magazine.

8.5.2 Magazine should provide maintenance of the required environmental conditions.

8.5.3 Small arms magazine should be so located, that the entrance to it is arranged from the compartment of duty service of the ship. If this is impossible, the magazine of small arms should be located in the vicinity of the compartment of duty service of the ship.

8.5.4 Magazine of small arms should be provided with alarm system, warning of the entry to it of unauthorized persons. Alarm signalling equipment should be placed in compartments of duty service and in the wheelhouse.

8.6 Hand Grenades Magazine

8.6.1 Hand grenades should be stored in a ammunition chamber.

On ships which do not have ammunition chambers, a container, or a metal box for the boxes with grenades, equipped with the patent lock, and having a structure enabling its sealing shall be provided in the compartment of duty service of the ship.

9 HOLDS EQUIPMENT

9.1 All elements of holds equipment exposed to damages by cargo or cargo gear (manholes, air or sounding pipes, etc.) should be, in proper places, protected by means of covers, grids, boxes, etc.

9.2 Holds and compartments designated for the carriage of general cargo are to be provided with side battens (cargo battens) made of wood or metal. Thickness of wooden cargo battens should be at least 40 mm.

The distance between cargo battens should not exceed 305 mm. The battens are to be fixed to side structural elements in such a way, that they are easily removable or changeable. If PRS considers reasonable, with respect to ship's design and kind of cargo, cargo battens may be exempted.

9.3 Cargo holds designated for carriage of explosives and other dangerous cargoes shall comply with the requirements of *Part V – Fire Protection*.

9.4 Landing crafts and special ships designated for: transportation of landing loading and unloading means (special design ramps, cutters, barges, helicopters, floating platforms, etc.), transportation of military equipment (military vehicles, towed and self-propelled combat equipment), landing cargoes, shall be provided, depending on a ship designation, with following separated compartments and special equipment, enabling reliable fastening, safe transport, servicing and application in landing operations:

– dock chambers with a full necessary equipment for the ship's service and unloading by landing cutters or other floating means of the landing crafts equipment – *Landing Platform Dock*;
– hangars with equipment necessary for transport and service of transport-combat and special helicopters;
– holds, open decks and 'tween decks with necessary fittings and equipment for fastening of carried military equipment in conditions specified in TTD.

9.5 Outfitting of the decks and cargo holds should be selected to ensure transportation in proper conditions of all likely to be used military equipment, in various combinations and variations of equipment, as well as transportation of modular cargoes, such as containers of various size and type. The holds, due to conditions of service and convenience of loading operations should be designed without pillars.

9.6 Carried ro-ro cargo shall be arranged in line with PS. Possibility of another arrangement is subject to separate consideration by the PRS.

9.7 Carried equipment should not block passages, impede access to compartments and essential marine equipment. It should be arranged in a manner ensuring access for the service and inspection of the fastening fittings. The distance between the hull structure and the end of the vehicle shall not be less than 450 mm. With the arrangement of transport cutters and other floating unloading means in the ship dock chamber, a longitudinal and transverse leeway not less than 600 mm shall be ensured between objects and the ship structure. The gap between the highest point of the floating object and the ship's dock construction, at the entrance to the dock chamber, shall not be less than 800 mm.

9.8 On the holds decks, air-sheds and cargo decks, the presence of any projecting parts, equipment and facilities which hamper the passage through these decks is not allowed. In justified situations circumstances the installation of equipment and individual parts with the height up to 60 mm may be permitted, with the consent of PRS. Elements of a fastening system for vehicles and cargoes shall be of recessed type (i.e., hidden in the deck plating). Surface fitting of the vehicles and cargo fastening equipment is permitted, however, it may not project above the surface of the deck more than 60 mm, and its strength and stiffness should provide a reliable fastening in adverse weather conditions, as well as ensure long durability and resistance to damage by overriding vehicles.

9.9 In order to ensure a secure fastening, release, and to achieve a high rate of discharge, especially for self-propelled equipment, an individual fastening system for vehicles, with application of standard elements and devices in accordance with the principles contained in the Rules, should be provided. Other non-typical solutions shall be submitted to the acceptance of PRS.

9.10 In designing military equipment fastening system, solutions shall be applied ensuring three-step way of fastening and releasing, covering:
- the initial fastening of the vehicle ensuring its quick, individual fastening when the vehicle reaches stopping place on the ship after being loaded from water or the shore, and fast, individual release when unloading of the ship starts. As the system calculation loads, the loads generated by the wave resulting from the sea state 3 shall be taken. For the landing craft, application of a mechanized release system, controlled remotely from Combat Information Center (CIC), is recommended;
- complex fastening of the military equipment for a period of leaving the place of loading and crossing the sea, at the sea state 4. The solution of use of elements for the initial fastening with the addition of the elements of the complex attachment, is permitted;
- the storm fastening for a long stay at sea in stormy weather conditions. The fastening system should ensure elimination of any slack, deflections, and the vehicles shock-absorption to protect vehicles and cargo against movement. The system should transfer the loads resulting from the following conditions: a period of rolling 5 s, pitching 12 s, standard heal angle 20º, storm heel angle 50º, pitching angle 15º and the ship grounding at the maximum speed.

9.11 In order to create an efficient and clear system for fastening the military equipment, all the rings, sockets and other fixed fastening elements should be given order numbers by means of legible marking, adopting the principle of numbering from bow to stern and from the port side to the starboard, using the even marking for the port side, and odd to the starboard. The marking must be given on fasteners or decks in the vicinity of the fastening elements.

9.12 In order to ensure better contact between moving parts of the military equipment with the deck in the spaces for their transport, i.e. in the holds and on the ramps, as well as in places of their fastening and passage areas on the deck, the anti-skid flat bars (rods) 20 x 30 x 600 mm should be welded. The distance between the flat bars (in the direction of travel) should be 250 – 500 mm depending on the place of their location. The distance between rows of rods 1000 – 2000 mm. Arrangement plan of the elements for fitting the military equipment on decks should also include the distribution of areas covered by the anti-skid protection of the wheels and tracks.

9.13 The development of the ship technical documentation shall include the plan of arrangement and fastening of the carried modular cargo (different types of containers, pallets, etc.) and other vehicles, including, among others, requirements of 9.4 – 9.12.

9.14 On the ship adapted for carring military equipment, the equipment for dragging of the damaged equipment or for the transport of other units foreseen by the user, should be provided as an outfitting of holds and/or the cargo deck. The system design shall be submitted to PRS for acceptance.

9.15 For the lighting of holds and decks of landing crafts, and all traffic routes in the area of deployment of military equipment to be transported, the basic, emergency and masking lighting shall be provided. To control traffic during the loading and unloading, cargo spaces and decks (in the region of ramps and gates) shall be fitted with traffic control lights (green and red), framing lamps (contour of the gates opening and entrances to hold), as well as yellow direction light (leading) in PS under the upper deck, for one row of vehicles, or for each row in the case of multi-lane systems, in their planes of division. Control of the lights from the unloading control stand should be provided.

10 COMMUNICATION OUTFITTING

10.1 General

Location and arrangement of exits, doors, corridors, stairways and ladders shall ensure prompt passage from the accommodation evacuation points and combat stands.

10.2 Exits

10.2.1 On each tier of accommodation, for each separated compartment, or group of compartments, at least 2 exits, maximum apart from each other, shall be provided.

10.2.2 In all cargo spaces intended for horizontal loading, in which crew usually works, number and location of exit routes for open deck are subject of separate consideration by PRS, but in any case at least two, apart from each other, exit routes shall be provided.

10.2.3 In exceptional cases PRS – taking into account designation and location of the compartment in question, as well as number of persons normally present in it – may allow for omitting one of the required exits.

10.2.4 In ships with displacement 500 t and more, each hold, except of holds designated for the carriage of liquid bulk cargoes, shall be provided with minimum 2 exits, maximum apart from each other. From refrigerated holds only one exit may be provided.

10.2.5 From the wheelhouse the exits shall lead to each wing of the bridge/wheelhouse – passage through the wheelhouse from one ship's side to another shall be ensured.

10.2.6 Width of exits from accommodation and service compartments shall be not less than 0.6 m. Dimensions of exit hatches from the holds shall not be less than 0.6 x 0.6 m.

10.3 Corridors and Passages

10.3.1 All corridors and passages shall have possibly simple run and sufficient clear width.

Length of corridors or their parts, from which there is only one exit, shall not be more than 7 m.

10.3.2 Width of the main corridors in area of crew and specialized personnel accomodation shall not be less than 0.9 m, and width of their branches – not less than 0.8 m.

In the ships with displacement less than 500 tonnes width of the main corridors branches may be reduced to 0.70 m.

In communication routes to/from the hospital block, dispensary, other medical accommodation, or temporarily considered as medical accommodation, leading to the open deck, transport of sick and wounded on stretcher shall be ensured.

10.3.3 Routes of manual loading of explosives and dangerous materials shall meet the requirements of sub-chapter 8.2.2. On the deck the route width shall be more than 1 m.

10.3.4 In CIC/wheelhouse the width of passages shall be at least:

– in ships with displacement of 500 tonnes and above – 0.8 m,
– in ships with displacement below 500 tonnes – 0.6 m.

If the wheelhouse and chartroom are located in separate, but adjacent compartments, the passage between them, fitted with a door, a screen or a curtain, shall be provided.

10.3.5 The width of the deck passages leading to lifeboats and life rafts embarkation places shall be at least 0.8 m.

10.4 Stairways and Ladders

10.4.1 All stairways ans ladders connecting decks shall be made of steel and have a framework structure, at the consent of the PRS they can be made of other equivalent material (see *Part V – Fire Protection*). Special requirements as to stairway casing and protection of escape routes are contained in *Part V – Fire Protection*.

10.4.2 The width of the stairway shall not be less than the width of the corridor, specified in 10.3.2 i 10.3.3.

10.5 Guard Railings, Bulwarks, Freeing Ports

10.5.1 All exposed parts of the freeboard deck, as well as those of the superstructure and deckhouse decks are to be provided with barriers by means of guard rails or bulwarks.

10.5.2 The height of the bulwark or guard rail above the deck is to be not 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.

10.5.3 The spacing between the guard railing stanchions is not to exceed 1.5 m. At least every third stanchion is to be supported by a bracket or stay. Provision is to be made for fastening removable and hinged stanchions in the upright position.

10.5.4 Handrails of bulwarks, as well as guard railings are to be, in general, of a rigid construction; only in special cases wire ropes may be applied as barriers, but only at limited length sections. In this case wire ropes shall be made taut by means of turnbuckles.

Chains, in lieu of handrails and guard rails, may be accepted provided that they are fitted between two fixed stanchions or between a fixed stanchion and bulwarks.

10.5.5 The gap below the lowest rail of the guard railing is not to exceed 230 mm. The spacing between the other rails is not to exceed 380 mm. In the case of ships with a rounded gunwale, the guard rails stanchions and handrails are to be placed on the flat part of the deck.

10.5.6 The bulwark is to comply with the requirements of *Part II – Hull.*

10.5.7 If the bulwarks on the exposed decks form wells, freeing ports shall be applied. Minimum area of freeing ports, *A*, in the cases of normal or greater sheer in the area of the well, for each side of the ship and for each well on the exposed deck shall be calculated according to below given formulae. The minimum area of well ports on the superstructure deck should be equal to a half area determined by the formulae:

– where length of the bulwark l in the well does not exceed 20 metres:

$$A = 0.6 + 0.035l, \quad [\text{m}^2] \qquad (10.5.7\text{-}1)$$

– where l exceeds 20 metres:

$$A = 0.07l, \quad [\text{m}^2] \qquad (10.5.7\text{-}2)$$

The value l in no case should be assumed greater than $0.7L$.

Where the mean height of the bulwark is greater than 1.2 m, the area of ports calculated according to above formulae shall be increased by 0.004 m^2 for each metre of length, and for each 0.1 m bulwark's height difference.

Where the mean height of the bulwark is less than 0.9 m, the required area of ports may be reduced by 0.004 m^2 for each metre of length and for each 0.1 bulwark's height difference.

For ships without sheer the area calculated according to above formulae shall be increased by 50%. If the sheer is less than required, intermediate values are to be obtained by linear interpolation.

10.5.8 On each external wall, in the area of communication passages, storm handles in a form of rails fitted directly to superstructures' and deck houses' walls shall be provided. The distance of the rail from the walls shall be about 70 mm.

10.6 Deck Gangways

10.6.1 Each ship should be provided with communication with the shore by means of deck gangway or gang board, according to patterns accepted by PRS. In a further part of the present sub-chapter common term: deck gangway, is applied.

10.6.2 The deck gangways should ensure communication with the shore from any side of the ship.

10.6.3 Minimum breadth of the deck gangway shall be 600 mm.

10.6.4 The length of the deck gangway should be such, that under angle 50° it reaches from the deck, where installed, to the lowest waterline.

10.6.5 If the length of the deck gangway exceeds 10 m, then two span gangway is to be fitted.

10.6.6 For the deck gangway operation, the davit with electric or manual hoist shall be provided.

10.6.7 On the ships instead of a deck gangway a gang board may be applied provided that its angle of inclination to the level from the deck, where installed, to the lowest waterline is less that 20°.

10.6.8 The length of the gang board shall not be greater than 9 m.

10.6.9 Each ship, on which the height of the side over the lowest service waterline is more than 2 m, shall be provided with the Jacob's ladder, irrespective that equipped with the deck gangway.

10.6.10 The width of the Jacob's ladder shall not be less than 480 mm.

10.6.11 Place of the Jacob's ladder suspension shall be lit, and in the vicinity the lifebuoy with the light buoy shall be provided.

10.6.12 The length of the Jacob's ladder shall not be greater than 9 m..

10.7 Ramps

10.7.1 General

10.7.1.1 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 issued by PRS *Rules* concerning lifting appliances.

10.7.2 Structure

10.7.2.1 If the loading, bow and stern ramps are also closing appliances of the hull openings, they shall constitute reliable, watertight hull closure during the ship motion.

10.7.2.2 The ramps' drive installation shall be provided with reserve drive system and shall ensure normal operation in ambient minus temperature, as well as with icing and occurrence of the phenomenon of ice accumulation on the closure's coaming.

10.7.2.3 The ramps' design solution should provide a device or an intermediate element (ramp segment), to ensure a smooth descent of vehicles on the quay, and the smooth entry and exit of undeveloped shore and deep water. This solution should reduce the unit pressure on the quay during unloading of heavy vehicles up to 8 t/m^2

10.7.2.4 In order to prevent icing of the rubber sealing of the movable decks leading to the external decks, as well as external unloading ramps, the system heating coamings in the region of their contact with rubber shall be provided.

10.7.2.5 The loading ramps, similarly to the holds, shall be provided with anti-skid flat bars, in accordance with 9.12.

10.7.2.6 In order to ensure safe bringing the vehicles on the cargo deck, ramps shall be fitted with the longitudinal curbs (rails) with a view to guiding the vehicle on the loading path, to prevent lateral slide of the vehicles from the ramp, especially during the loading operation from the water and undeveloped shore, and the lack of visibility from the cab driver - the operator of the equipment. The height of the curbs shall be not less than 300 mm, (the height of 500 mm is recommended), and their slope at the leading part shall be in range of 50/300 mm up to 100/500 mm.

10.7.2.7 Ramps of the ships in service in cold zones shall be provided with the heating system.

10.7.2.8 Regions of loading, as well as loading ramps shall be provided with sand flushing and water draining systems.

10.7.2.9 If in a stowage position the movable ramp is loaded with the vehicles, the relevant requirements for movable decks – specified in Chapter 12, shall be met.

10.7.2.10 Each ramp shall be equipped with lifting and lowering mechanism, tightening and releasing devices, and locking stoppers. Tightening, releasing and locking devices shall be of design preventing self-acting lowering of the ramp under its own weight; however the lowering system shall enable self-acting lowering of the ramp, under its own weight, with the drive off or when the drive is damaged. Possibility to stop the ramp at any time and to maintain this state for any period, with additional load foreseen for such case, shall be provided.

10.7.3 Loads

10.7.3.1 Loads occurring in all expected positions and types of operation are to 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.

10.7.3.2 In case A, the assumed loads are to include:
– mass of the ramp,
– maximum or the most unfavourably distributed total mass of vehicles which may be simultaneously placed on the ramp, as well as way of their supporting: symmetrical, unsymmetrical, spot or linear.

Static load is to be calculated taking into account the heel and trim angles, as well as the ramp inclination.

Static load is to 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.

10.7.3.3 In case B, loads are to include static and dynamic loads due to the ship's motions in waves, calculated according to *Part II – Hull*. Ramp icing and wind pressure are to be included in load calculations within appropriate extent.

10.7.3.4 In case C, the assumed loads are to include the mass of the ramp (platform) and the testing load, taking into account dynamic component loads due to the ramp (platform) motion.

10.7.3.5 Dynamic loads due to vehicles motion are to be calculated taking into account the vertical acceleration determined by the formula:

$$a_v = \frac{6}{\sqrt{M_0}}, \ \ [\text{m/s}^2] \qquad (10.7.3.5)$$

M_0 – maximum mass per one axle, [t].

10.7.3.6 Dynamic loads due to raising and lowering a ramp are to be calculated assuming the vertical acceleration not less than $a_v = 4$ m/s^2.

10.7.4 Scantling

10.7.4.1 Plating and stiffeners of ramps are to comply with the requirements of sub-chapter 9, *Part II – Hull.*

10.7.4.2 The scantlings of girders of ramps and supporting structures are to be, in general, based on stress analysis.

The calculation model is to take into account the actual condition of supports and the nature of operation. The calculations are to be carried out for the cases specified in 10.7.3.

10.7.4.3 The following permissible stresses, [MPa] are to 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:
$k = 0.78$ for $R_e = 315$ MPa,
$k = 0.72$ for $R_e = 355$ MPa.

The allowable deflection of the steel structure under load determined for cases A and B is not to exceed $l/400$ (l – span supports in the ramp structure under the considered load).

11 SHIPS OF RESTRICTED SERVICE

11.1 General

11.1.1 Application

The provisions of the present Chapter apply to ships assigned additional restricted service mark I, II or III in the symbol of class.

11.2 Anchoring Equipment

11.2.1 When choosing anchoring equipment for ships of restricted service **II**, the equipment number is to be reduced by 15%, while for ships of restricted service **III** – by 25%.

11.3 Closing Appliances of Openings in Hull and Superstructures

11.3.1 For ships with restricted service **I**, **II** i **III**, except of cases separately indicated, the requirements of Chapter 7 may be reduced, and the degree of reduction is subject of separate consideration by PRS.

11.3.2 In ships of restricted service **III**, the side scuttles with deadlights, required in 7.2.1.3, 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.

11.3.3 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**.

11.3.4 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**.

11.3.5 The height of coamings of companion hatches, skylights and ventilating trunks, required by 7.6.3, 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.**

11.3.6 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.**

11.3.7 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.**

11.3.8 For ships of restricted service, 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.

12 SHIPS WITH MOVABLE DECKS

12.1 General

12.1.1 Application

12.1.1.1 The requirements of Chapter 12 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.

12.1.2 General

12.1.2.1 The requirements concerning movable ramps enabling loading or discharging from decks are given in 10.7.

12.1.2.2 The arrangements for raising, lowering and fixing these structures are to comply with the requirements specified in issued by PRS Rules relating to lifting appliances.

12.1.2.3 The supporting structures at sides, decks and bulkheads, pillars or tie rods ensuring reliable securing the movable structures in an operational position are to comply with the general provisions of *Part II – Hull*.

12.2 Scantlings

12.2.1 Arrangements are to be provided for a reliable fastening of movable structures in a non-operational position.

12.2.2 When a movable structure is in a non-operational position, the raising arrangements and parts of the structure are not to be under load.

Ropes are not to be used for suspension of movable structures.

12.2.3 Movable car decks are to 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 *Part II – Hull.*

12.2.4 The scantlings of structural members, particularly the scantlings of plating, stiffeners and girders of movable car decks are to comply with the requirements of *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 are to be taken as equal to allowable stresses for transverse girders specified in *Part II – Hull*.

12.2.5 The scantlings of supports and suspensions are to be calculated with the use of direct stress analysis. The following is to 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 are to 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 to be agreed with PRS.

In stress analysis, particular attention is to be paid to stress concentrations. For slender supports subject to compression, determining the permissible stresses may require special consideration of PRS.

Steel wire ropes and chains used in the arrangements mentioned in 12.2.1 are to comply with the requirements of *Part IX – Materials and Welding*.

13 SHIPS WITH ICE STRENGTHENINGS

13.1 General

13.1.1 Application

The requirements of the present Chapter apply to ships assigned additional marks **L1A**, **L1**, **L2** and **L3** in the symbol of class.

13.2 Rudder and Steering Arrangements

13.2.1 The scantlings of rudder post, rudder stock, pintles, steering engine, etc. as well as the capability of the steering engine are to be determined according to the requirements of PRS *Rules*. The maximum service speed of the ship to be used in the calculations is to be, however, taken not less than stated below:

L1A – 20 knots,
L1 – 18 knots,
L2 – 16 knots,
L3 – 14 knots.

If the actual maximum service speed of the ship is higher, that speed is to be used.

13.2.2 The number of rudder pintles supporting the rudder on the sternframe is to be not less than that indicated in Table 13.2.2. Steering nozzles are to be supported on the sole piece.

Table 13.2.2

Ice strengthening marks	Number of rudder pintles
L1	1
L1A	2

13.2.3 In ships with ice strengthening **L1A** and **L1**, the rudder stock and the upper edge of the rudder are to be protected against ice pressure by an ice knife or equivalent means.

13.2.4 For ships with ice strengthening **L1A** and **L1**, due regard is to be paid to the excessive load caused by the rudder being forced out of its position by ice pressure.

13.2.5 Relief valves for hydraulic pressure are to be effective. The components of the steering gear are to be dimensioned to stand the yield torque of the rudder stock. Where possible, rudder stoppers working on the blade or rudder head are to be fitted.

13.2.6 The horizontal and vertical stiffeners and web plates of a rudder required by 2.4.2.4 are not to be welded directly to the rudder side plating, but by means of flat bars having the same thickness as the plating and the width not less that 5 times the thickness.

13.2.7 The stiffening rings and longitudinal stiffeners, required by 2.5.1.5, are to be welded to the nozzle plating by means of flat bars having the thickness equal to that of the outer plating as required by 2.5.1.1 and the width not less that 5 times the thickness.

13.2.8 The horizontal and vertical web plates, required by 2.5.1.9, are to be welded to the stabilizer plating by means of flat bars having the thickness equal to that of the plating and the width not less that 5 times the thickness.

13.2.9 Steering arrangements with suspended rudders and other non-typical solutions for ships operating in ice shall be presented to PRS for acceptance.

13.3 Side Scuttles

Side scuttles are not to be fitted in way of the ice strengthening belt of the shell plating, determined in Chapter 26, *Part II – Hull.*

14 HELICOPTERS' LANDING GROUND AND VERTREP PLANES

14.1 Descriptions

For the needs of the Chapter 14 the following additional descriptions have been introduced:

14.1.1 Landing ground – a plane on the ship's deck adapted for landing, standing and transport of the helicopter to a hangar.

14.1.2 Rope device supporting touchdown – winch lift with fixed traction, providing, after mounting of the rope to a helicopter which is in hovering, a constant force drawing a helicopter to the deck, that supports the helicopter touchdown, especially in difficult weather conditions.

14.1.3 VERTREP – Vertical Replenishment – transfer of external loads from the hovered helicopter to the ship, and vice versa.

14.1.4 VERTREP plane – a plane on a ship's deck, suitable for loading and unloading of cargo as a part of operation VERTREP. VERTREP plane can be placed on a landing ground or in another appropriate location. If there is landing ground on the ship, then, in principle, VERTREP is located on it.

14.1.5 RAST – Recovery Assist, Secure and Traverse – system of mechanical appliances supporting helicopter's touchdown on the deck, fastening it, and transporting the helicopter (to a hangar).

14.1.6 Grid – in Chapter 14 a term grid means a grid located in a plane of a landing ground, enabling prompt fastening of the helicopter by means of a harpoon ejected from helicopter.

14.2 General

14.2.1 Chapter 14 covers general requirements, relating to the part of ship's aviation infrastructure, which is a part of a hull and superstructures construction.

14.2.2 Design and equipment of helicopters' landing grounds and VERTREP planes shall satisfy specific requirements, included in applicable current national standard, referred to the ship's aviation infrastructure, hereinafter referred to the Standard, defined by the Purchaser.

14.3 Location and the Dimensions of the Landing Grounds and VERTREP Planes

14.3.1 Location on the ship's deck and the dimensions of the landing grounds and VERTREP planes should assure:

– appropriate size of the landing grounds and sufficient distance from obstacles for all anticipated types and versions of helicopters landing on board the ship,

- appropriate dimensions of the VERTREP plane and sufficient distances from obstacles for the biggest helicopter expected for VERTREP operations on board the ship,
- easy access to ways and transportation means of ammunition and other cargoes provided for the handling off and on the helicopter landed on board of landing ground or hovered over the landing ground and/or VERTREP plane,
- possibly a long distance from the sources of turbulence (disruption of airflow), and in particular the outlets of the main engine exhaust gases.

14.3.2 Underneath the landing grounds any compartments, which, during helicopter's starts or landings, or during VERTREP operations, may be attended by persons, or in which liquid fuel or ammunition is stored, should not be located. If such arrangement can not be avoided, then the whole structure of landing deck shall satisfy strength requirements of *Part II – Hull* with respect to loads in emergency touchdown conditions.

14.3.3 The plane of the landing ground should be continuous, i.e. should not include hatches and hatch covers. Manholes, if necessary, should have coamings of the height specified in the Standard, and the covers to be opened from the upper surface of the deck.

14.3.4 Means should be provided for de-icing of the landing ground and VERTREP plane for the time of the operations performance. Application of that means should not adversely affect the condition of antiskid coating.

14.4 Surface and Marking of Landing Grounds and VERTREP Planes

14.4.1 Coefficient of friction on the surface of the landing ground and VERTREP plane measured in accordance with the requirements of the Standard should meet the requirements of the Standard. Appropriate coefficient of friction can be achieved by application for the deck plating with appropriately shaped surface, or by application of antiskid coating recognized by PRS.

14.4.2 On the surface of landing ground and on the surface of the VERTREP plane marking, complying with the Standard and agreed with PRS, who makes the certification of aviation infrastructure of the ship, should be applied. Coefficient of friction on the surface of the deck in areas where marking is affixed, should not be lower than the required in the Standard.

14.4.3 The height of the obstacles on the surface of the landing ground and/or VERTREP plane, as well as in the landing ground and VERTREP operational area should not exceed allowed values, determined in the Standard.

14.4.4 On each landing ground surface VERTREP marking should also be affixed.

14.4.5 On all boundaries of the landing ground and VERTREP planes, protection nets, complying with the Standard, should be installed.

14.4.6 Possibility of easy fastening and securing of the protective nets, and other equipment elements, which are deployed before commencement of helicopter's landing, should be assured.

14.5 Equipment for Helicopter Anchoring

14.5.1 Landing ground shall be equipped with sockets for helicopters anchoring, in a number adequate to anchoring in heavy weather conditions of all types of helicopters provided for landing on a ship's deck.

14.5.2 Cross-bar sockets, conforming with the Standard, shall be applied.

14.5.3 The design of the sockets should enable their easy drainage and de-icing.

14.6 Location and Equipment of Flight Control Stand

14.6.1 Flight control stand should be located by the landing ground, in a place, from which undisturbed visual observation of the landing ground, and surrounding air space, is possible.

14.6.2 If the prompt movement on- and from the deck during VERTREP operations is not possible, then location of the flight control stand should enable, during temporary storing of the cargoes on the separated part of the landing ground deck, possibility of observation of the landing ground and surrounding air space.

14.6.3 The floor of the flight control stand should be located above the plane of landing ground, or on its level.

14.6.4 The flight control stand beside the landing ground should be closed, permanently equipped compartment, designated exclusively for flights control.

14.6.5 The flight control stand should be weathertight.

14.6.6 The flight control stand should be heated and ventilated.

14.6.7 Windscreen wipers and blow of a warm air should be applied.

14.6.8 Location of the flight control stand in a ship's wheelhouse is permitted. In such case undisturbed observation of the landing ground and surrounding air space from the wheelhouse and the bridge wings should be assured. The flight chief officer should be provided on the wheelhouse and the bridge wings with access to communication means, as well as to other means necessary for flights control.

PRS may accept the existence of limited blind field of visual observation of the airfield and surrounding airspace, provided that they are fitted with reliable means of the technical monitoring of the field, such as industrial television.

14.7 Location and Equipment of VERTREP Control Stand

14.7.1 The requirements of subchapter 14.7 concern VERTREP operations control stand located on the VERTREP plane, outside the landing ground.

14.7.2 VERTREP operations control stand should be located in a place, from which undisturbed visual observation of the VERTREP plane and surrounding air space.

14.7.3 VERTREP operations control stand may be opened or closed, and may be located in the wheelhouse and the bridge wings.

14.7.4 If the separated, closed stand is provided, it shall comply with the requirements of 14.6.5 and 14.6.7.

14.7.5 The VERTREP operations chief officer should be provided with access to communication means, as well as to other means necessary for operation's control.

14.8 Air-shed Outfit and Equipment

14.8.1 The air-shed on the ship is designated for the specified type of the air craft. The requirements concerning air-shed dimensions are applicable in relation to the specified type of the helicopter.

14.8.2 Internal dimensions of the air-shed and in the clear dimensions of the air-shed doors shall enable safe transport of the helicopter into the air-shed, stay in the air-shed and execution of provided technical services, and particularly:

- **.1** vertical distance inside the air-shed, from the uppermost point of the helicopter with the folded rotor blades, to the lowest point of the air-shed ceiling structure, shall be at least 0.5 m;
- **.2** horizontal distance in all directions inside the air-shed, measured at the level of the air-shed deck and up, to the height of 2 m, for the helicopter in the parking position, shall be at least 1 m. At the height above 2 m from the air-shed deck, the horizontal distance in all directions shall be at least 0.5 m;
- **.3** vertical distance, in the clear of air-shed doors, during the whole, into the air-shed, helicopter's transport operation shall be at least 0.3 m;
- **.4** horizontal distance, in the clear of air-shed doors, during the whole, into the air-shed, helicopter's transport operation shall be at least 0.6 m from each side of the helicopter.

14.8.3 The air-shed doors shall comply with the following requirements:

- **.1** the doors shall be weathertight and light-tight. If the air-shed constitutes a part of citadel, the doors shall remain tight under adequate internal overpressure;
- **.2** the doors shall be provided with a thermal insulation;

.3 the doors shall be provided, for the rescue-fire fighting group, with the observation window, covered with the fire resistant cover;
.4 in the doors or air-shed wall, escape doors opening from the both sides, shall be provided;
.5 mechanical drive of the doors shall be operable from the both sides of the doors;
.6 mechanical drive of the doors shall be equipped with the safety devices, blocking the doors, in case of the drive damage, in given position. Emergency manual opening and closing the doors shall be assured.

14.8.4 In the air-shed, or adjacent to it, office room and spare parts store room, shall be located.

14.8.5 In the air-shed, or adjacent to it, 12 m^2 of workshop area shall be provided.

14.8.6 In the air-shed, a place for storage of large spare parts shall be provided.

14.8.7 The air-shed shall be equipped with lifting appliances adequate to the provided air craft.

14.8.8 In the air-shed deck and walls cross-bar sockets for anchoring the helicopter, in a number adequate to anchoring in a heavy weather conditions, shall be fitted.

14.8.9 The surface of the air-shed deck shall comply with 14.4.1.

14.8.10 On the deck surface, where reasonable, the linear signs supporting the safe helicopters shedding, shall be affixed.

14.9 Rope Devices Supporting the Touch-down

14.9.1 The rope supporting helicopter's touch-down shall be led-out on the deck in such place, that the touch-down of helicopters, which utilize the device, is taking place in the landing circle, in compliance with the *Standard* requirements.

14.9.2 Touch-down supporting device control stand shall be located in a place, from which undisturbed visual observation of the helicopter approaching to landing, the landing ground, the rope and all personnel performing duties on the landing ground, is possible.

14.10 RAST Equipment

14.10.1 Location of the RAST Control System Stand

The RAST control system stand shall be located in a place, from which visual observation of the helicopter approaching to landing, as well as the landing ground, appliances for quick fastening and transport and all personnel performing duties on the landing ground, is possible. Moreover, the possibility of observation of the helicopter being transported to the air-shed, should be assured.

14.10.2 RAST appliances' leading rails shall be fitted in a plane of the deck and secured against solid debris between the rails' slots

14.10.3 Drainage of the water from the rail system and from underneath the grid, as well as possibility of their de-icing, shall be assured.

Passage of the rails and/or leading ropes of the RAST system through the air-shed doors shall be sealed.