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RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS

VOLUME

1

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Russian Maritime Register of Shipping

St. Petersburg, Dvortsovaya Naberezhnaya, 8

Rules for the Classification and Construction of Sea-Going Ships of Russian Maritime Register of Shipping have been approved in accordance with the established approval procedure. The date of coming into force of the present Rules is 1 October 2003.

The Rules are based on the eighth edition taking into account additions and amendments of Notice No.1 (2000), Notice No.2 (2001), Notice No.3 (2002) and those developed immediately before publication.

The unified requirements, interpretations and recommendations of International Association of Classification Societies and the relevant resolutions of International Maritime Organization have been taken into consideration in the Rules.

The Rules are published in two volumes. General Regulations for the Classification and Other Activity, Part I "Classification", Part II "Hull", Part III "Equipment, Arrangements and Outfit", Part IV "Stability", Part V "Subdivision" and Part VI "Fire Protection" are included in Volume 1. Part VII "Machinery Installations", Part VIII "Systems and Piping", Part IX "Machinery", Part X "Boilers, Heat Exchangers and Pressure Vessels", Part XI "Electrical Equipment", Part XII "Refrigerating Plants", Part XIII "Materials", Part XIV "Welding", Part XV "Automation", Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats" are included in Volume 2.

The text of the Rules in Russian published in 2003 shall be considered as the original.

Amendments

No.	Number of circular letter, date of approval	List of paragraphs amended and supplemented
1.	009-1.6-1ц dated 12.01.04	Part VI: para 3.1.6
2.	009-1.6-40ц dated 26.05.04	Part VI: para 1.4.4
3.	007-1.1-59ц dated 22.12.04	Part I: para 1.1.2
4.	009-1.7-52ц dated 18.11.04	Part VI: para 3.1.6.4
5.	010-6.3-67ц dated 27.01.05	Part III: paras 4.3, 5.3, 7.15.8
6.	009-6.6.3-98ц dated 23.06.05	Part VI: para 3.1.2.13

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As compared to the previous edition (1999), the ninth edition contains the following additions and amendments:

GENERAL REGULATIONS FOR THE CLASSIFICATION AND OTHER ACTIVITY

1. The text of Chapter 1.1 "Definitions and explanations" has been transferred to Part I "Classification" of Rules for the Classification and Construction of Sea-Going Ships.

2. A new Chapter 1.1 "Application" defining the application of General Regulations for the Classification and Other Activity as pertinent only to the maritime activity of the Register has been introduced.

3. Provisions dealing with containers have been deleted in view of specific rules and regulations on containers being developed.

4. Chapter 1.3 — rules and regulations dealing with non-maritime activity of the Register (containers, quality management systems) have been deleted. Enumeration of parts of Rules for the Classification and Construction of Sea-Going Ships, Rules for the Equipment of Sea-Going Ships, Rules for the Classification, Construction and Equipment of MODU and FOP, Rules for the Prevention of Pollution from Ships has been deleted.

5. The text of Section 3 "Technical Documentation" has been transferred to Part I "Classification" of Rules for the Classification and Construction of Sea-Going Ships.

6. Provisions included in Rules for the Classification Surveys of Ships and Guidelines on Technical Supervision of Ships in Service (instructions on issue of class and statutory certificates by the Register, certain provisions concerning survey of ships in service) have been deleted.

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS

PART I. CLASSIFICATION

1. Chapter 1.1 "Explanations" has been replaced by a new Chapter 1.1 "Definitions and explanations" containing most of the definitions and explanations from a similar Chapter of General Regulations for the Classification and Other Activity (due to withdrawal of the latter).

2. Chapter 1.2 has been supplemented by reference to other types of ships covered by the present Rules (nuclear ships and floating facilities, nuclear support vessels, gas carriers, chemical tankers, mobile offshore drilling units and fixed offshore platforms, high-speed craft, type A WIG craft, manned submersibles and diving systems, sea-going pleasure boats) to the extent specified in the relevant rules for the classification and construction of such ships and facilities.

3. Chapter 2.1 — one of the reasons for suspending the class of a ship has been specified (when annual survey is not completed within three months of the fixed date).

4. Chapter 2.2 — paragraph 2.2.9 has been supplemented by a reference to distinguishing marks and descriptive notations of the ships and facilities mentioned above, and by a descriptive notation "bilge water removing ship". New distinguishing marks in the class notation of ships fitted with a dynamic positioning system have been introduced.

5. The name of Section 3 has been amended to read "Technical documentation".

The Section has been supplemented by new Chapters 3.1 "General provisions" and 3.2 "Duration of validity of approved technical documentation" which have been deleted from General Regulations for the Classification and Other Activity. The subsequent numbering of chapters and paragraphs has been changed accordingly.

6. Chapter 3.3 — paragraph 3.3.8.1 has been supplemented by reference to the necessity of submitting the calculation of bending vibration of shafting to the Register for consideration.

The list of measures to be taken to ensure the electromagnetic compatibility of ship equipment has been included in the documentation on electrical equipment.

PART II. HULL

1. Chapter 1.1 — the definition of the forward perpendicular of the ship has been specified in accordance with IMO MSC/Circ.855.

2. Chapter 1.2 — the provisions of IACS UR S6.1 have been introduced.

3. Chapter 1.4 — a requirement for considering the loading conditions of ships in ballast with due regard for all the intermediate conditions of ballast tanks according to the provisions of IACS UR S11 (Rev. 2, Nov. 2001) has been introduced.

4. Chapter 2.2 has been supplemented with the requirement for the welded-branch wall thickness of bottom-and-side fittings (the requirement has been transferred from Part VIII "Systems and Piping" of the present Rules).

5. Chapter 3.3 — the provisions of IACS UR S1A, S12 and S17 (Rev. 3, Sept. 2000) have been introduced, as corrected in respect of the term "single side skin bulk carriers".

6. Chapters 3.3, 3.4 and 3.5 — the provisions of IACS UR Z11 in respect of the ship type and ESP notations of particular types of ships have been introduced.

7. Appendix 1 — IMO Resolution MSC.69(69) specifying the requirements for ship compartments tests has been taken into consideration. The revised provisions of IACS UR S14 (Rev. 1, 2001) have been introduced.

8. Appendix 2 considering the provisions of IACS UR S18 (Rev. 3, 2001) has been introduced.

9. Appendix 3 considering the provisions of IACS UR S20 (Rev. 3, Sept. 2000) has been introduced.

10. Appendix 4 considering the provisions of IACS UR No.48 has been introduced.

PART III. EQUIPMENT, ARRANGEMENTS AND OUTFIT

1. Chapter 1.2 — requirements for testing watertightness of hatch covers have been specified in accordance with IACS UR S14.

2. Chapters 3.3 and 10.2 — requirements for characteristics and tests of super high holding power anchors in accordance with IACS UR A1 (Rev. 4, Aug. 1999) have been introduced.

3. Chapter 3.6 — IACS UR L4 (Nov. 2002) in respect of structure of chain lockers and chain pipes has been introduced.

4. Chapter 7.10 — requirements for design loads of cargo hatches of dry cargo holds have been specified.

5. Chapter 8.5 — requirements of IMO Resolution MSC.98(73) in respect of size and other parameters of ship arrangements used as means of escape have been introduced.

PART IV. STABILITY

1. Chapter 1.3 — "light-weight check" has been included in the scope of surveys.

2. Chapter 1.4 — requirements for onboard software, instructions regarding openings to be left open and drawing up Information on Stability have been introduced.

3. Chapter 1.5 — instructions regarding light-weight check have been introduced, and inclining test evaluation procedure has been specified.

4. Chapter 2.1 — requirements for the weather criterion have been harmonized with the requirements of IMO Resolution A.749(18) "Code on Intact Stability for All Types of Ships Covered by IMO Instruments".

5. Chapters 2.2 and 2.3 — requirements of the chapters have been harmonized with the requirements of IMO Resolution A.749(18) "Code on Intact Stability for All Types of Ships Covered by IMO Instruments".

6. Chapter 2.4 — instructions regarding the allowance for icing for ships with framing fitted above open deck sections have been introduced.

7. Chapters 3.3, 3.5 and 3.8 — requirements of the chapters have been harmonized with the requirements of IMO Resolution A.749(18) "Code on Intact Stability for All Types of Ships Covered by IMO Instruments".

8. Chapter 3.12 — instructions for calculating the roll amplitude have been specified.

9. Chapter 4.1 has been revised.

10. Section 5 has been deleted.

11. Appendix 1 has been revised in accordance with IMO MSC/Circ.920.

12. A new Appendix 3 "Instructions on inclining test" has been introduced.

13. A new Appendix 4 "Instructions on light-weight check" has been introduced.

PART V. SUBDIVISION

1. Chapter 1.1 — the words "dry cargo ships having the length $L_s \geqslant 80$ m" have been amended to read "cargo ships having the length $L_s \geqslant 80$ m and more not listed above". This replacement has brought the scope of application of the Rules in compliance with the requirements of SOLAS Convention. Due to this reason 1.1.1.2 has been deleted.

2. Chapter 1.2 — the missing definition of the moulded depth has been introduced in accordance with definitions in the International Convention on Load Lines. The definitions of the margin line in ships provided with the angular-type connection of deck, ore carrier, combination carrier, the ship breadth B_2 (at the level of bulkhead deck), factory-and-mother ships and processing ships, factory freezer have been deleted because notions corresponding to them are not used in the new edition. The definition "the ship draft dice" has been specified.

3. Chapter 1.4 — a requirement of availability of Damage Control Plan and information which shall be contained in it in accordance with IMO MSC/Circ.919 has been introduced.

4. Section 2 has been revised in accordance with the existing international norms of subdivision of sea-going ships.

5. Section 3 has been revised in accordance with the existing international norms of subdivision of sea-going ships.

PART VI. FIRE PROTECTION

1. Additions and amendments have been introduced in accordance with IMO Resolution MSC.99(73) which has replaced the existing text of chapter II-2, SOLAS-74 as amended.

2. References to International Code for Fire Safety Systems (IMO Resolution MSC.98(73)) have been introduced.

3. New Section 6 "Emergency escape breathing devices" and Section 7 "Alternative design and arrangements" have been introduced. The requirements of the above sections comply with the text of regulation II-2/13 and part F of the new text of chapter II-2, SOLAS-74.

4. A new Chapter 3.12 "Aerosol fire extinguishing systems" has been introduced.

5. Requirements for portable fire extinguishers, their number and arrangement have been harmonized with a new text of chapter II-2, SOLAS-74 and IACS UI SC30.

CONTENTS

GENERAL REGULATIONS FOR THE CLASSIFICATION AND OTHER ACTIVITY

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS

PART I. CLASSIFICATION

PART II. HULL

PART III. EQUIPMENT, ARRANGEMENTS AND OUTFIT

PART IV. STABILITY

PART V. SUBDIVISION

PART VI. FIRE PROTECTION

GENERAL REGULATIONS FOR THE CLASSIFICATION AND OTHER ACTIVITY

1 GENERAL

1.1 APPLICATION

1.1.1 The present General Regulations for the Classification and Other Activity cover the activity of Russian Maritime Register of Shipping[1] during:

consideration and approval of ships and floating facilities designs;

surveys of ships under construction and surveys during the manufacture of materials and products;

surveys of ships in service.

Other spheres of the Register activity are regulated by the relevant documents.

1.2 CLASSIFICATION AND OTHER ACTIVITY

1.2.1 The Register is a state institution which carries out surveys of and assigns class to civil ships. The Register is a member to International Association of Classification Societies (IACS) and uses IACS resolutions and the provisions of IACS Code of Ethics in its activity.

The Register maintains a quality system complying with the requirements of IACS and with the applicable requirements of ISO 9001 which is confirmed by the relevant IACS Certificate issued on the basis of appropriate audits.

Besides, being authorized by the government of the Russian Federation[2] and by the governments of other countries to act on their behalf, the Register carries out surveys within its terms of reference for compliance with the requirements of international conventions and agreements to which the above governments are parties.

1.2.2 The Register establishes technical requirements ensuring safe navigation of ships in accordance with their purpose, safety of life at sea and safe carriage of goods by sea and inland waterways as well as pollution prevention from ships; it carries out surveys for compliance with the above requirements, assigns class to ships, determines the net and gross tonnage of sea-going ships and the tonnage measurement characteristics of inland navigation ships in its registry.

1.2.3 The Register activity is based on the rules published by that body and is aimed at determining whether ships in its registry as well as materials and products intended for the construction and repair of ships and their equipment comply with the rules and with additional requirements. The application and fulfillment of the rules and additional requirements are the obligation of design bureaus, shipowners, shipyards and manufacturers of materials and products to which the requirements of the rules apply.

The interpretation of the requirements of the Register rules and other normative documents is within the competence of the Register only.

The Register activity does not substitute for the state surveillance of merchant shipping carried out by both the federal body of executive power responsible for transport and the federal body of executive power responsible for fisheries, nor does it interfere with shipowners', shipyards' or manufacturers' technical control.

1.2.4 Classification activity of the Register covers the following:

.1 development and publication of rules and other normative documents;

.2 consideration and approval of technical documentation;

.3 construction, conversion, modernization and repair surveys of ships, manufacture and repair surveys of products as well as manufacture surveys of materials for shipbuilding;

.4 surveys of ships in service;

.5 assignment, renewal and reinstatement of class;

.6 drawing up and issue of the Register certificates.

1.2.5 Other activity of the Register covers:

.1 construction, conversion, modernization and repair surveys of ships as well as manufacture and repair surveys of products and manufacture surveys of materials for shipbuilding for compliance with the provisions of international conventions and agreements;

.2 ship registry;

.3 investigation and registry of accidents aboard ships;

.4 initiative surveys of ships;

.5 judgement in technical matters;

.6 other activity not connected with classification of ships.

1.2.6 The Register assigns class to the following types of sea-going ships and inland navigation ships both under construction and in service:

.1 passenger ships and tankers, ships designed for the carriage of dangerous goods and tugs irrespective of the main machinery power and gross tonnage;

.2 self-propelled ships not specified in 1.2.6.1 with main engine power of 55 kW and upwards;

.3 ships not specified in 1.2.6.1 and 1.2.6.2 of 80 gross tonnage and upwards or with total primary engine power of 100 kW and upwards.

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[1] Herinafter referred to as "the Register".

[2] Hereinafter referred to as "RF".

1.2.7 The Register carries out surveys of ship refrigerating plants from the point of view of ship's safety, safe carriage of goods, absence of the ozone-destructive effect of refrigerants upon the environment, as well as the classification of ship refrigerating plants.

1.2.8 The Register carries out surveys of ship cargo-handling gear of 1 ton lifting capacity and upwards.

1.2.9 On special agreement, the Register may carry out surveys of ships, installations or arrangements not specified in 1.2.6 to 1.2.8.

1.2.10 The technological and special arrangements of fishing vessels, cable layers, vessels of dredging fleet and special purpose ships are not subject to the Register survey except the equipment specified in the relevant parts of the rules.

1.2.11 Draft standards and other normative documents related to the Register activity are considered and approved by the Register.

1.2.12 The Register may initiate examinations of technical issues related to its activity or participate therein.

1.2.13 The Register of Ships is published by the Register, containing the particulars of self-propelled sea-going ships of 100 gross tonnage and upwards classed with the Register.

1.2.14 For services rendered by the Register fees are charged according to the scales of fees of the Register. If the commitments to the Register including those on payment for its services fail to be performed or are improperly performed, the Register is entitled not to assign a class or, where a class has already been assigned, to suspend or withdraw it from the ship in connection with which the commitments to the Register, including those on payment for its services failed to be performed or were improperly performed, and to withdraw (make an entry indicating cessation of validity) the certificates issued by the Register.

1.3 RULES

1.3.1 Rules to be applied.

1.3.1.1 The following rules are developed, published and used by the Register:

.1 General Regulations for the Classification and Other Activity;

.2 Rules for the Classification and Construction of Sea-Going Ships;

.3 Rules for the Equipment of Sea-Going Ships;

.4 Load Line Rules for Sea-Going Ships;

.5 Rules for the Cargo-Handling Gear of Sea-Going Ships;

.6 Rules for the Classification Surveys of Ships;

.7 Rules for the Classification and Construction of Inland Navigation Ships (for the Danube);

.8 Rules for the Classification, Construction and Equipment of Mobile Offshore Drilling Units (MODU) and Fixed Offshore Platforms (FOP);

.9 Rules for the Prevention of Pollution from Ships;

.10 Rules for the Classification and Construction of Chemical Tankers;

.11 Rules for the Safety of Dynamically Supported Craft;

.12 Rules for the Classification and Construction of Nuclear Ships and Floating Facilities;

.13 Rules for the Classification and Construction of Nuclear Support Vessels;

.14 Rules for the Classification and Construction of Gas Carriers;

.15 Rules for the Classification and Construction of Manned Submersibles and Diving Systems;

.16 Rules for the Classification and Technical Supervision of Sea-Going Pleasure Boats;

.17 Rules for the Classification and Construction of High-Speed Craft;

.18 Rules for the Classification and Construction of Type A WIG Craft;

.19 Rules for the Carriage of Grain.

1.3.1.2 In addition to the rules specified in 1.3.1.1, the following rules are used by the Register:

.1 Rules for the Construction of Hulls of Sea-Going Ships and Floating Facilities Using Reinforced Concrete;

.2 Rules for the Tonnage Measurement of Sea-Going Ships;

.3 Rules for the Tonnage Measurement of Inland Navigation Ships;

.4 Rules for the Measurement of Vessels for the Panama Canal, Rules for the Tonnage Measurement for the Suez Canal;

.5 Rules of the RF River Register and other normative documents approved by the Register.

1.3.1.3 The Register also develops, publishes and uses guidelines on the survey of ships, materials and products for shipbuilding as well as other guidelines and technical requirements regulating the Register activity in other spheres.

1.3.2 Application of the rules to ships under construction and to products.

1.3.2.1 Newly published rules and amendments thereto come into force on the date stated in the annotation on the back of the title page. Before that date, they shall be considered recommendations.

1.3.2.2 Ships and products which designs are submitted for the Register approval after the enforcement of the rules or amendments thereto shall comply with the requirements of these rules or amendments. In respect of ships under construction and the products which technical documentation was approved by the Register before the enforcement of the rules, those rules are to be applied which were in force at the time of this documentation approval (see also Section 3, Part I "Classification" of

Rules for the Classification and Construction of Sea-Going Ships[1]).

1.3.3 Deviations from the Rules.

1.3.3.1 The Register may allow to use materials, ship structures or particular arrangements and products to be installed on board, other than those required by the rules, provided they are as effective as those specified by the rules. Where ships covered by international conventions and agreements are concerned, deviations from the requirements of the rules may only be allowed by the Register if they are accepted by the relevant conventions or agreements.

In the above cases, data are to be submitted to the Register enabling to ascertain that the materials, structures and products in question meet the requirements ensuring the ship safety, safety of life at sea, safe carriage of goods by sea and by inland waterways as well as prevention of pollution from ships.

1.3.3.2 Where the structure of a ship, its machinery, arrangements, installations, equipment and outfit or the materials used cannot be recognized as being adequately verified in service, the Register may require special tests to be held during construction and, in case of a ship in service, may reduce intervals between periodical surveys or extend the scope of these surveys.

If the Register considers it necessary, appropriate restrictive entries may be made in the classification or other certificates issued by the Register or in the Register of Ships. The restrictions are withdrawn subsequent to satisfactory results obtained in service.

1.4 DOCUMENTS

1.4.1 As a result of its activity, the Register issues relevant certificates:

.1 certificates confirming compliance with the requirements of Rules for the Classification and Construction of Sea-Going Ships and rules for the classification and construction of particular types of ships;

.2 seaworthiness certificates stipulated by the Merchant Shipping Code;

.3 certificates stipulated by international conventions and codes;

.4 survey reports serving as the basis for issuing relevant certificates;

.5 certificates for materials and products confirming their compliance with the requirements of the Register rules.

1.5 THE REGISTER RESPONSIBILITIES

1.5.1 The Register entrusts carrying out inspections to experts adequately skilled and performing their duties with proper diligence.

The Register is responsible for failure to perform or for improper performance of its commitments only when found guilty (by intent or carelessness).

The Register covers the losses to persons entering with it into contractual relations, as stipulated by the Rules, and whose losses result from its failure to perform or improper performance of its contractual commitments due to carelessness, to the amount not exceeding the contract fees determined on the basis of the Register scales of fees and provided solely the causal relationship has been proved between such failure to perform or improper performance of contractual commitments by the Register and the suffered losses.

2 SURVEYS

2.1 GENERAL

2.1.1 For the surveys to be carried out, the shipowners, administrations of shipyards, manufacturers and other enterprises shall ensure that the Register representatives have the opportunity to carry out ship surveys, as well as free access to all places where materials and products are manufactured and tested, and shall provide all conditions for the surveys to be carried out.

Where necessary, the Register may require to provide the access to surveyed items as well as the conditions for performing the work by Surveyors to the Register together with IACS auditors when the latter carry out audits of the Register quality system.

2.1.2 Shipowners, shipyards, design bureaus and manufacturers shall fulfil the requirements of the Register or Surveyors to the Register when they are in the course of their duty.

2.1.3 Any alterations on the part of shipowners, shipyards, design bureaus and manufacturers in respect of ship materials and structures, as well as products, to which the requirements of the Rules apply shall be approved by the Register before they are put into service.

2.1.4 Controversial issues arising in connection with the Register activity may be transferred by shipowners, shipyards, manufacturers and other enterprises to the

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[1] Hereinafter referred to as "the Rules".

higher Register Inspectorate. The judgement of the Register Head Office is final.

2.1.5 The Register may refuse from a survey in case a shipyard or manufacturer systematically violates the Rules or if the other party to a contract violates it.

2.1.6 When a material or product proves defective under a valid certificate, the Register may require additional tests or relevant repair to be carried out, and where the defects cannot be repaired, may cancel the certificate.

2.2 SURVEYS DURING THE MANUFACTURE OF MATERIALS AND PRODUCTS

2.2.1 The relevant parts of the Rules contain lists of materials and products the manufacture of which shall be surveyed by the Register, as well as technological processes specified by the Register.

By special agreement, the Register may carry out the surveys of materials and products not mentioned in the above lists.

2.2.2 Materials and products within the Register terms of reference shall be manufactured in accordance with technical documentation approved by the Register.

2.2.3 During surveys, the Register may check compliance with structural, technological and production standards and processes which are not regulated by the Rules, but which may influence the fulfillment of the Rules requirements.

2.2.4 During ship construction or repair, manufacture of materials and products, the Register shall approve the application of new materials, products and processes, or those submitted to it for the first time, that are within its terms of reference. For this purpose, specimens of the material, product or the new process shall be tested in the scope agreed with the Register subsequent to their technical documentation being approved by the Register.

2.2.5 The Register surveys during the manufacture of materials and products are carried out by Surveyors to the Register, or may be entrusted by the Register to another classification body in accordance with Agreement on Mutual Substitution.

2.2.6 In cases specified by the Register, the manufacturing works will be surveyed by the Register to inspect the facilities for manufacturing materials and products complying with the Register requirements.

2.2.7 In the process of surveys during manufacture materials and products shall undergo the surveys and tests according to the procedures and within the scope prescribed by the Register.

2.2.8 Materials and products manufactured in accordance with the Register requirements shall be provided with the documents specified by the Register and, where necessary, the brands and marking enabling to determine their compliance with the above documents.

2.2.9 In sound cases, the Register may establish special conditions for the application of particular products.

2.3 SURVEYS OF SHIPS UNDER CONSTRUCTION, RECONSTRUCTION AND CONVERSION

2.3.1 Surveys of ships under construction, reconstruction and conversion are carried out by Surveyors to the Register on the basis of technical documentation approved by the Register. The scope of examinations, measurements and tests during surveys is determined by the Register on the basis of current instructions and proceeding from the situation.

2.4 SURVEYS OF SHIPS IN SERVICE

2.4.1 Surveys of ships in service is carried out according to Rules for the Classification Surveys of Ships and other normative documents of the Register.

2.5 SURVEYS IN COMPLIANCE WITH THE REQUIREMENTS OF INTERNATIONAL CONVENTIONS AND AGREEMENTS

2.5.1 The requirements of the following international conventions and agreements, as well as amendments thereto, are taken into account in the relevant Rules:

International Convention for the Safety of Life at Sea, 1974, Protocols, 1978, 1988 thereto;

International Convention for the Prevention of Pollution from Ships, 1973 and Protocol, 1978 thereto;

International Convention on Load Lines, 1966;

International Convention on Tonnage Measurement, 1969;

International Convention on Occupation Safety and Health (Dock Work), 1979 (ILO 152);

Shipping Regulations for the Danube, 1975;

Convention on Tonnage Measurement of Ships of Inland Navigation, 1966;

International Regulations for Preventing Collisions at Sea, 1972;

Final Acts of the World Administrative Radio Conference, 1997;

IMO Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk;

IMO Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk;

IMO Code of Safety for High-Speed Craft;

IMO Code for the Construction and Equipment of Mobile Offshore Drilling Units;

IMO Code of Safety for Special Purpose Ships;

IMO Code of Safety for Diving Systems;

inter-governmental agreements on load lines in force;

other normative documents used in international seagoing practice.

The provisions of the above conventions and agreements apply to ships engaged on international voyages.

2.5.2 Surveys of items falling under the requirements of international conventions and agreements are carried out in conformity with approved technical documentation and the normative documents of the Register considering the requirements of the above conventions and agreements.

RULES FOR THE CLASSIFICATION AND CONSTRUCTION OF SEA-GOING SHIPS

PART I. CLASSIFICATION

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1 GENERAL

1.1 DEFINITIONS AND EXPLANATIONS

For the purpose of Rules for the Classification and Construction of Sea-Going Ships the following definitions and explanations have been adopted (unless expressly provided otherwise in particular parts of the Rules).

1.1.1 Definitions.

A tug is a ship specially intended for the towage and pushing of other ships and floating facilities.

Displacement of a light ship means the displacement of a ship without cargo, fuel oil, lubricating oil, ballast, fresh and boiler feed water in its tanks, provisions, consumable stores, and also without passengers, crew and their effects.

A cargo ship is any ship which is not a passenger ship (dry cargo ship, tanker, refrigerating transport ship, icebreaker, tug, pusher, salvage ship, vessel of dredging fleet, cable layer, special purpose ship and other non-passenger ship).

Deadweight means the difference between the displacement of a ship at the load waterline corresponding to the summer freeboard assigned for the water with a density of 1,025 t/m^3 and the displacement of a light ship.

A combination carrier is a ship intended for the carriage of crude oil and petroleum products in bulk, as well as bulk cargoes (by these ships are meant ore/oil carriers, oil/bulk dry cargo carriers and similar ships).

A container ship is a ship intended for the carriage of goods in containers of the international standard and provided with the cellular guides in the holds.

A crane ship is a construction similar to the floating crane, but on a floating hull with ship lines or lines of a similar shape.

Place of refuge is any naturally or artificially sheltered aquatorium which may be used as a shelter by a ship under conditions likely to endanger the safety of the ship.

A bulk carrier is a one deck ship with top-side and hopper-side tanks in cargo spaces which is primarily intended for the carriage of bulk cargoes.

A roll-on/roll-off ship is a ship specially designed for transportation of various wheeled vehicles (cars, rolling stock, tracked vehicles, trailers with and without cargo), in which the cargo loading operations are performed preferably in a horizontal direction – by a roll-on/roll-off.

Docklift ship is a dry cargo ship adapted to carry out cargo handling operations using the docking principle in ports and protected water areas.

A tanker is a ship intended for the carriage of liquid cargoes in bulk, including:

a special tanker is a ship intended for the bulk carriage of liquid cargoes other than oil and oil products. The precise purpose of the special tanker is stated by the descriptive notation in the class notation in accordance with 2.2.9 of the present Part of the Rules;

an oil tanker is a ship intended for the carriage in bulk of crude oil and petroleum products having a flash point 60ºC and below for sea-going ships, 55ºC and below for ships of inland navigation, Reid vapour pressure being below atmospheric pressure;

an oil tanker (>60°C) is a sea-going ship intended for the carriage of petroleum products having a flash point over 60ºC in bulk;

an oil tanker (>55°C) is a ship of inland navigation intended for the carriage of petroleum products having a flash point over 55ºC in bulk;

an oil recovery vessel is a ship intended for recovery of crude oil and petroleum products having a flash point of 60ºC or below from the sea surface;

an oil recovery vessel (>60°C) is a ship intended for recovery of crude oil and petroleum products having a flash point above 60ºC from the sea surface;

bilge water removing ship is a ship designed to remove the bilge water from the machinery spaces of ships.

A passenger is every person other than the master and the members of the crew or other persons employed or engaged in any capacity on board a ship (special personnel) on the business of that ship, and a child under one year of age.

A passenger ship is a ship intended for or carrying more than 12 passengers.

A roll-on/roll-off passenger ship (ro-ro passenger ship) is a passenger ship with enclosed or open cargo spaces which is loaded/unloaded in the horizontal direction, or with special category spaces defined in 1.5.9, Part VI "Fire Protection" of the Rules.

Classed among passenger ro-ro ships are also those ships loaded/unloaded in the horizontal direction which regularly carry passengers and which carry vehicles with fuel in their tanks and/or railway carriages on open decks at ferry crossings.

Floating crane is a crane structure on a floating hull of pontoon or similar type, which is intended for cargo – handling or other working operations (mounting, undersea, hydraulic engineering, salvage, pipe laying, etc.) and may be also used for the carriage of cargoes on deck and/or in the hold.

A fishing vessel is a vessel used directly for catching or for catching and processing the catch (fish, whales, seals, walrus or other living resources of the sea).

Special personnel means all persons who are not passengers or members of the crew and who are carried on board in connection with the special purpose of that ship or because of special work being carried out aboard that ship.

A berth-connected ship is a non-self-propelled floating structure, having the pontoon-type or ship-type hull, which is usually in operation at the quay wall (shore). These ships include floating hotels and hostels, floating workshops, floating power plants, floating warehouses, etc.

A supply vessel is a vessel designed basically for the carriage of supplies and cargoes to the mobile and fixed offshore units intended for the different purposes, and fitted generally with a forward superstructure and an after weather cargo deck for processing of the cargo at sea. The ship may be used for towing operations provided the appropriate requirements of the Register rules are complied with.

A special purpose ship is a mechanically self-propelled ship which by reason of its function carries on board more than 12 persons of special personnel including passengers (by these ships are meant research, expeditionary, hydrographic, training ships; whale and fish factory ships and other ships engaged in processing of living resources of the sea and not engaged in catching, and the like ships).

A ship of river-sea navigation is a self-propelled cargo ship intended for the carriage of cargoes by sea and by inland waterways.

A shipborne barge is a non-self-propelled cargo ship unmanned and appropriated for transportation in specially equipped ships (barge carriers) and for towing (pushing) within the specified restricted area of navigation.

A dry cargo ship is a ship intended for the carriage of different cargoes (general cargoes, containers, timber, bulk cargoes, etc.), except for the liquid bulk cargoes.

Definitions of particular types of ships (nuclear ships and floating facilities, nuclear support vessels, high-speed craft, dynamically supported craft, WIG craft, gas carriers, chemical tankers, pleasure boats, drilling ships, mobile offshore drilling units and fixed offshore platforms, manned submersibles and diving systems) are given in relevant rules for the classification and construction of such types of ships.

The Register rules are listed in 1.3, General Regulations for the Classification and Other Activity.

1.1.2 Explanations.

For the purpose of the present Rules classification means development, publication and application of the Rules continuous compliance with which will, along with the proper maintenance of the ship by the owner or by the operator, ensure:

structural strength and integrity of the hull and its elements including structural fire protection;

seaworthiness (stability) of the ship under all specified loading conditions and under particular sea-and-wind conditions;

safe and reliable operation of its propulsion plant, systems and devices for ship control, other systems, auxiliary machinery and equipment including fire fighting equipment,

and thereby permit safe operation of the ship in accordance with its purpose.

Additional requirements are the requirements imposed by the Register in carrying out its activities, which are not provided for by the Rules but which affect the implementation of the Rules.

см.Б1 Rules means the rules listed in 1.3, General Regulations for the Classification and Other Activity.

Standards, as applied to the Rules, means all kinds of standards and other regulating and technical documents of all countries approved or recognized by the Register.

A ship under construction is a ship during a period from the date of laying the keel till the date of issuing the documents for a ship. The date of laying the keel means the beginning of construction identifiable with a specific ship when the mass of the assembled part of a hull comprises not less than 50 tons or 1 per cent of the estimated mass of all structural material, whichever is less.

A ship in service is a ship which is not under construction.

A shipowner is a physical person or legal entity operating a ship on his (her) or its own behalf irrespective of the fact whether he (she) or it is the proprietor or is operating the ship on some other legal basis.

A proprietor is a physical person or legal entity having proprietary rights to a ship irrespective of the fact whether he (she) or it operates the ship on his (her) or its own, or has placed it in the operation of another person or entity whether on the fiduciary or some other legal basis.

An operator is a physical person or legal entity operating a ship on the basis of a contract concluded with a proprietor or shipowner.

1.2 APPLICATION

1.2.1 Rules for the Classification and Construction of Sea-Going Ships apply to:

.1 passenger ships, tankers, ships intended for the carriage of dangerous goods as well as tugs, irrespective of the power of main engines and gross tonnage; см.Б1

.2 self-propelled ships not specified in 1.2.1.1, with the main engines of power output 55 kW and upwards;

.3 ships not specified in 1.2.1.1 or 1.2.1.2 of 80 gross tonnage and upwards or ships fitted out with machinery and equipment of total prime movers power output 100 kW and upwards;

.4 materials and equipment that are to be installed on the above ships (lists of relevant materials and equipment are given in the appropriate parts of the Rules).

1.2.2 The present Rules also apply to the following types of ships to the extent specified in the relevant rules for the classification and construction of such ships:

.1 nuclear ships and floating facilities (see Rules for the Classification and Construction of Nuclear Ships and Floating Facilities);

.2 nuclear support vessels (see Rules for the Classification and Construction of Nuclear Support Vessels);

.3 gas carriers (see Rules for the Classification and Construction of Gas Carriers);

.4 chemical tankers (see Rules for the Classification and Construction of Chemical Tankers);

.5 mobile offshore drilling units and fixed offshore platforms (see Rules for the Classification, Construction and Equipment of Mobile Offshore Drilling Units and Fixed Offshore Platforms);

.6 high-speed craft (see Rules for the Classification and Construction of High-Speed Craft);

.7 type A WIG craft (see Rules for the Classification and Construction of Type A WIG Craft);

.8 manned submersibles and diving systems (see Rules for the Classification and Construction of Manned Submersibles and Diving Systems);

.9 sea-going pleasure boats (see Rules for the Classification and Technical Supervision of Sea-Going Pleasure Boats).

1.2.3 With the Register consent, the Rules may be applied for the classification of ships not specified in 1.2.1 and 1.2.2.

1.2.4 For special purpose ships of less than 500 gross tonnage, the applicable scope of the present Rules requirements is determined by the Register on the case-to-case basis.

1.2.5 The Rules set down the requirements regulating the assignment of class to a ship or a shipboard refrigerating plant.

1.2.6 Confirmation of compliance with the requirements of the Register rules is the Register's prerogative and is carried out in accordance with the procedure established by it.

Any statements to the effect a supervised item complies with the rules requirements, which are made or documentally supported by a body other than the Register and which are not confirmed by the latter in accordance with the established procedure, cannot be considered as evidence of such a compliance.

2 CLASS OF A SHIP

2.1 GENERAL PROVISIONS

2.1.1 Assignment of the Register class to a ship means confirmation by the Register that the ship construction complies with the applicable requirements of the Register rules and its technical condition complies with the conditions of the ship operation; the ship is registered with the Register for a specified period with performing the surveys stipulated by Rules for the Classification Surveys of Ships for this period.

2.1.2 The Register may assign a class to a ship proceeding from the results of survey during its construction, as well as assign or renew a class to a ship in service.

2.1.3 Renewal of a ship's class means confirmation by the Register that the construction and technical condition of the ship comply with the provisions based on which a class has been assigned as well as extension of vality of the Register documents for a definite period as required by the Rules.

2.1.4 Class of a ship is, generally, assigned or renewed by the Register for 5 years, however, in sound cases the Register may assign or renew a class for a lesser period.

2.1.5 If a ship has the valid Register class this means that the ship's technical condition in full measure or to a degree considered adequate by the Register complies with the requirements of the Rules which apply to it according to its purpose, service conditions and class notation. If a class of a ship is valid it is certified by the valid Classification Certificate on board.

2.1.6 Classification Certificate shall cease to be valid and the class shall be liable to be suspended in the following cases (including cases where the annual survey is not completed and the validity of Classification Certificate is not confirmed within three months from the date fixed for the annual survey):

if the ship as a whole or her separate elements have not been subjected to scheduled periodical or occasional surveys in specified terms;

after an accident, the ship shall be submitted for occasional survey at the port where the accident took place or at the first port of call, if the accident took place at sea;

if alterations not agreed with the Register have taken place in the construction and/or if any change has been made in the equipment which may result in reducing the standards required by the Rules;

when repair of a ship's items has been performed without the agreement of and/or survey by the Register;

when a ship navigates with a draught exceeding that specified by the Register for specific conditions as well as in case of operation of a ship in conditions which do not comply with the requirements for assigned class of a ship or the restrictions specified by the Register;

if the prescribed specific requirements which during previous survey of the ship were the conditions for assignment or confirmation of the Register class have not been fulfilled within the specified period;

if the process of surveying the ship by the Register has been suspended on shipowner's initiative or through his fault;

when the ship has been taken out of service for a long period (more than 3 months) for fulfilment of the Register requirements (except the case when a ship is under repair for these purposes).

The Register shall specially notify the shipowner of suspension of a ship's class and Classification Certificate.

2.1.7 Suspended (as stated in 2.1.6) class of a ship may be reinstated on the basis of satisfactory results of the appropriate periodical or occasional survey carried out by the Register in the case of ship to be submitted for survey. In so doing when the ship is taken out of service for a long period (more than 3 months), the scope of survey for reinstatement of a ship's class shall be specially established by the Register taking into account the age and condition of the ship as well as the period for which she is taken out of service.

During the period from suspension of a class to its reinstatement or renewal the ship is considered to have been lost the Register class.

The class may be suspended for a period of no more than six months.

2.1.8 The class of a ship is withdrawn by the Register in the following cases:

.1 upon expiration of the maximum term of class suspension;

.2 when the Register and/or shipowner consider reinstatement of the class suspended as stated in 2.1.6 to be impossible;

.3 upon transfer of the ship to the class of another classification body;

.4 at the request of the shipowner.

Withdrawal of the ship's class means cessation of the Classification Certificate validity.

2.1.9 The class of a ship shall be cancelled due to her loss or scrapping.

2.1.10 After assigning the class the Register introduces the sea-going self-propelled ships and self-propelled mobile offshore drilling units of 100 gross tonnage and upwards into the Register of Ships and excludes them in case of withdrawal or cancellation of a class. When the validity of a class is suspended, appropriate entry shall be made in the Register Book indicating that the validity of a class is suspended up to the stated date.

2.2 CLASS NOTATION OF A SHIP

The class notation assigned by the Register to a ship or floating facility consists of the character of classification and additional distinguishing marks and descriptive notations defining structure and purpose of a ship or floating facility.

2.2.1 The character of classification assigned by the Register to a ship or floating facility consists of distinguishing marks:

KM✪, **KM★**, **(KM)★** — for self-propelled ships and floating facilities;

KE✪, **KE★**, **(KE)★** — for non-self-propelled ships and floating facilities with total power output of prime movers 100 kW and upwards;

K✪, **K★** , **(K)★** — for other non-self-propelled ships and floating facilities.

2.2.2 Depending on the Rules on the basis of which a ship or a floating facility was surveyed, and the classification body which carried out the survey, the character of classification is established as follows:

.1 ships and floating facilities built according to the Rules of and surveyed by the Register are assigned a class notation with the character of classification: **KM✪** or **KE✪** or **K✪** (see 2.2.1);

.2 ships and floating facilities which were as a whole (or their hull or machinery installation, machinery and equipment) built and/or manufactured according to the Rules of another classification body recognized by the Register and surveyed by that body during their construction and manufacture, when classed with the Register are assigned a class notation with the character of classification: **KM★**, **KE★** or **K★** (see 2.2.1);

.3 ships and floating facilities which were as a whole (or their hull or machinery installation, machinery and equipment) built and/or manufactured without being surveed by a classification body recognized by the Register or without any survey of a classification body at all, when classed with the Register, are assigned a class notation with the character of classification: **(KM)★** or **(KE)★** or (**K)★** (see 2.2.1);

.4 ships and floating facilities for which their design does not permit the main class notation out of those listed in 2.2.2.2 to be assigned a class with the character of classification: **KM★** or **KE★** or **K★**.

This also applies when a ship or floating facilities changes a class to the Register from one of the IACS Member Societies. The possibility of such a change is considered in each case by the Register Head Office.

2.2.3 Ice category marks.

2.2.3.1 Ice category marks are assigned to icebreakers and ice ships:

.1 icebreakers are specialized ships intended for all kinds of icebreaking operations: escort of ships in ice, surmount of ice ridges, breaking of a navigable channel, towing, breaking of ice and rescue operations. There are two main regimes of ice navigation while performing icebreaking operations: continuous motion and ramming;

.2 ice class ships are ships intended for independent ice navigation including motion in fractures between floes, surmounting of ice isthmuses and portions of relatively thin compact ice, or navigation in ice with icebreaker escort;

.3 the following definitions are used for the description of ice navigation conditions:

ice concentration is a measure of ice continuity, which is characterized by the ratio of the area covered by ice to the total water area using 10 number scale;

open floating ice is ice of concentration 4 to 6, where most of the floes do not touch each other;

close floating ice is ice of concentration 7 to 8 where most of the floes touch each other forming ice isthmuses;

very close floating ice is ice of concentration 9 or over, but less than 10;

compact ice is ice of concentration 10.

2.2.3.2 If an icebreaker complies with the requirements of the Rules, one of the following ice category marks is added to the class notation: **ЛЛ6; ЛЛ7; ЛЛ8; ЛЛ9**.

Icebreakers of the above categories have the following tentative service characteristics:

.1 ЛЛ6 — intended for ice breaking operations in harbour and roadstead water areas as well as in non-arctic freezing seas where the ice is up to 1,5 m thick. Continuous motion capability in unbroken ice up to 1 m thick;

.2 ЛЛ7 — intended for ice breaking operations in the arctic seas on coastal routes during winter/spring navigation in ice up to 2,0 m thick and summer/autumn navigation in ice up to 2,5 m thick; in non-arctic freezing seas and mouths of rivers flowing into arctic seas in ice up to 2,0 m thick. Continuous motion capability in unbroken ice up to 1,5 m thick. The total shaft power not less than 11 MW;

.3 ЛЛ8 — intended for ice breaking operations in the arctic seas on coastal routes during winter/spring navigation in ice up to 3,0 m thick and summer/autumn navigation without restrictions. Continuous motion capability in unbroken ice up to 2,0 m thick. The total shaft power not less than 22 MW;

.4 ЛЛ9 — intended for ice breaking operations on coastal routes in arctic seas during winter/spring navigation in ice up to 4,0 m thick and summer/autumn navigation without restrictions. Continuous motion capability in unbroken ice less than 2,5 m thick. The total shaft power not less than 48 MW.

2.2.3.3 Categories of ice class ships:

.1 if a self-propelled ship complies with the relevant requirements of the Rules, one of the following ice category marks is to be added to its class notation: **ЛУ1, ЛУ2, ЛУ3, ЛУ4, ЛУ5, ЛУ6, ЛУ7, ЛУ8, ЛУ9**. Ice category marks need not be added to the class notation of non-self-propelled ships;

.2 categories **ЛУ1, ЛУ2, ЛУ3** which form the group of non-arctic categories refer to ships intended for navigation in freezing non-arctic seas (non-arctic ships);

.3 categories **ЛУ4, ЛУ5, ЛУ6, ЛУ7, ЛУ8, ЛУ9** which form the group of arctic categories refer to ships intended for navigation in arctic seas (arctic ships);

.4 for tugs, depending on the compliance with the appropriate ice category requirements, one of the following marks is added to the class notation: **ЛУ2, ЛУ3, ЛУ4, ЛУ5.**

2.2.3.4 Averaged quantitative data on permitted service areas and ice service conditions presented in Tables 2.2.3.4-1 to 2.2.3.4-3 are to be used when choosing the ice category of arctic ships. It is not permitted to use these data for regulating the allowable navigation conditions of ships in service. It is assumed that during service the owner will follow the requirements of the Ice Certificate or another document specifying the conditions of safe operation of the ship in ice depending on the ice category mark, the ship's specific features, ice conditions and icebreaker escort.

Table 2.2.3.4-1 shows service areas for ships in the Russian arctic seas (the Barents Sea, the Kara Sea, the Laptev Sea, the East-Siberian Sea, the Chukchee Sea) in relation to the season, tactics of ice navigation and type of navigation.

Table 2.2.3.4-2 shows, for arctic category ships, limiting type and thickness of ice enabling a ship to navigate in a channel following an icebreaker at a low speed (3 to 5 knots) without running a heightened risk of damage through contact of hull with ice.

Table 2.2.3.4-3 shows, for arctic category ships operating independently, permissible speeds which a ship under the ice conditions set out in the table may reach when navigating in fractures between floes or surmounting ice isthmuses without running a heightened risk of damage through contact of hull with ice.

Table 2.2.3.4-1

Service areas and conditions for ships of arctic categories

Category of ice strengthening	Type of ice navigation	Winter/spring navigation					Summer/autumn navigation				
		The Barents Sea	The Kara Sea	The Laptev Sea	The East Siberian Sea	The Chuckchee Sea	The Barents Sea	The Kara Sea	The Laptev Sea	The East Siberian Sea	The Chuckchee Sea
		ENHME	ENHME	ENHME	ENHME	ENHME	ENHME	ENHME	ENHME	ENHME	ENHME
ЛУ4	IN	– – –+	– – – –	– – – –	– – – –	– – – –	++++	– –++	– – –+	– – –+	– –++
	IEN	–*++	– – –+	– – – –	– – – –	– – –*	++++	*+++	– –++	– –++	–*++
ЛУ5	IN	– –++	– – –+	– – – –	– – – –	– – – –	++++	–+++	– –++	– –++	– –++
	IEN	*+++	– –*+	– – –+	– – –+	– –*+	++++	*+++	*+++	*+++	*+++
ЛУ6	IN	*+++	– – –+	– – –+	– – –+	– – –+	++++	++++	–+++	–+++	–+++
	IEN	++++	**++	–**+	–*++	–*++	++++	++++	++++	++++	++++
ЛУ7	IN	++++	– –++	– – –+	– – –+	– –++	++++	++++	++++	++++	++++
	IEN	++++	++++	*+++	*+++	*+++	++++	++++	++++	++++	++++
ЛУ8	IN	++++	++++	–*++	–*++	*+++	++++	++++	++++	++++	++++
	IEN	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++
ЛУ9	IN	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++
	IEN	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++

IN — independent navigation
IEN — icebreaker escorted navigation
+ — operation allowed
– — operation not allowed
* — operation connected with the increased risk of damage
EN — extreme navigation (average periodicity once in ten years)
H, M, E — hard, medium, easy navigation (average periodicity once in three years)

Table 2.2.3.4-2

Ship category	Permitted type and thickness of ice	
	Winter/spring navigation	Summer/autumn navigation
ЛУ4	Thin first-year	Medium first-year up to 0,9 m
ЛУ5	Medium first-year up to 0,8 m thick	Medium first-year
ЛУ 6	Medium first-year	Thick first-year up to 1,5 m
ЛУ 7	Thick first-year up to 1,8 m	Second-year
ЛУ8	Multi-year up to 3,4 m	Multi-year
ЛУ9	Multi-year	Multi-year

Note. The classification of ice adopted according to the "Sea Ice Nomenclature" of the World Meteorological Organization (WMO):

Ice type	**Ice thickness**
Multi-year	> 3,0 m
Second-year	> 2,0 m
Thick first-year	> 1,2 m
Medium first-year	0,7 — 1,2 m
Thin first-year	< 0,7 m

2.2.3.5 When choosing the category of ice strengthening for non-arctic ships, it is recommended to use mean values of permitted conditions of ice navigation set forth in Table 2.2.3.5.

2.2.3.6 Arctic ships may navigate in non-arctic freezing seas in ice conditions corresponding to those stated in 2.2.3.4-2 and 2.2.3.4-3.

Table 2.2.3.4-3

Ship category	Permitted speed, in knots	Ice concentration and type	Ice thickness, in m		Methods of surmounting ice ridges
			Winter/spring navigation	Summer/autumn navigation	
ЛУ4	6 — 8	open floating first-year ice	0,6	0,8	Continuous motion
ЛУ5		open floating first-year ice	0,8	1,0	
ЛУ6		open floating first-year ice	1,1	1,3	
ЛУ7		close floating first-year ice	1,4	1,7	Episodic ramming
ЛУ8	10	close floating second-year ice	2,1	3,0	Regular ramming
ЛУ9	12	very close floating and compact multi-year ice	3,5	4,0	Surmount of ice ridges and episodic ramming

Table 2.2.3.5

Ship category	Permitted thickness of ice, in m		Type of operation
	Independent navigation in open pack ice at a speed of 5 knots	Navigation in channel following an icebreaker in compact ice at a speed of 3 knots	
ЛУ1	0,40	0,35	Episodically
ЛУ2	0,55	0,50	Regularly
ЛУ3	0,70	0,65	Regularly

2.2.3.7 In Table 2.2.3.7 an attempt has been made to correspond the ice category marks of the present Rules to those of the Rules, edition 1995. The provisions of 2.2.3.4 to 2.2.3.6 do not apply to the ships built according to the Rules, edition 1995 and earlier.

Table 2.2.3.7

Present Rules	Rules, edition 1995	Present Rules	Rules, edition 1995
Ice ships		Icebreakers	
ЛУ1	**Л4**	**ЛЛ6**	**ЛЛ4**
ЛУ2	**Л3**	**ЛЛ7**	**ЛЛ3**
ЛУ3	**Л2**	**ЛЛ8**	**ЛЛ2**
ЛУ4	**Л1**	**ЛЛ9**	**ЛЛ1**
ЛУ5	**УЛ**		
ЛУ6			
ЛУ7	**УЛА**		
ЛУ8			
ЛУ9			

2.2.4 Subdivision distinguishing marks.

Ships complying with the applicable requirements of Part V "Subdivision" and fully complying with the requirements of Section 3 of the above Part in the case of flooding of any one compartment or any two or three adjacent compartments over complete length of the ship in the case of design side damage specified in 3.2 are assigned subdivision distinguishing mark $\boxed{1}$, $\boxed{2}$ or $\boxed{3}$ added to the character of classification, respectively.

2.2.5 Distinguishing marks for restricted areas of navigation.

2.2.5.1 Ships complying with the Rules requirements provided for ships operating only in restricted areas of navigation are assigned one of the following marks: **I, II, IIСП, IIIСП** or **III** added to the character of classification to clarify restrictions of the ship navigation as follows:

.1 I — navigation in sea areas at seas with a wave height of 8,5 m with 3 per cent probability and with the ships proceeding not more than 200 miles away from the place of refuge and with an allowable distance between the places of refuge not more than 400 miles;

.2 II — navigation in sea areas at seas with a wave height of 7,0 m with 3 per cent probability with ships proceeding from the place of refuge not more than 100 miles and with an allowable distance between the places of refuge not more than 200 miles;

.3 IIСП — river-sea navigation at seas with a wave height of 6,0 m with 3 per cent probability with ships proceeding from the place of refuge:

in open seas up to 50 miles and with an allowable distance between the places of refuge not more than 100 miles;

in enclosed seas up to 100 miles and with an allowable distance between the places of refuge not more than 200 miles;

.4 IIIСП — river-sea navigation at seas with a wave height of 3,5 m with 3 per cent probability with due regard for particular restrictions on the area and conditions of navigation resulting from the wind and wave conditions of the basins with determination of a maximum allowable distance from the place of refuge which in no case shall be more than 50 miles;

.5 III — harbour, roadstead and coastal navigation within limits established by the Register in each case.

Restrictions for particular floating crane operations (cargo-handling operations or navigation with eventual carriage of cargoes on deck and/or in the hold) shall be imposed by the Register in each particular case.

2.2.5.2 The restrictions provided for by 2.2.5.1 define the allowable conditions of ship's navigation resulting from ship's stability and strength which are indicated in the Seaworthiness Certificate and in the Classification Certificate.

2.2.5.3 Particular restrictions on the area and conditions of navigation for ships of river-sea navigation **IIIСП** are determined as the geographical place-names of basins or their parts with the indication, where necessary, of the geographical boundary of the navigation area within the basin, the restrictions on proceeding from the place of refuge and the restrictions of ship navigation by calendar periods, or an indication of voyage between the terminal ports. In this case, the restrictions with due regard to the wind and wave conditions of the basins are to be determined by using the data of Table 2.2.5.3 or the data from the submitted to the Register justifications of possibility of ship's navigation in the certain area or passage, made in accordance with the procedure approved by the Register.

Table 2.2.5.3

Basin	Geographical restrictions	Season
The Sea of Azov	No restrictions	Throughout the year
The Adriatic Sea	South of 42°N, 20-mile coastal area along the East and West coast, crossing the sea in Otranto Strait in the area of p. Brindizi (p. Bari) — p. Bar and in the area of the Cape Franchesco — the Lastovo Island. North of 42°N, 40-mile coastal area with calling at ports of the West coast	Throughout the year
The Baltic Sea	No restrictions, including the Gulfs of Bothnia, Finland, Riga, the Zund, Great and Small Belt, Kattegat Straits to the South of 57°45'N.	Throughout the year
The Baltic Sea and the North Sea	Exit to the Skagerrak Straits in the waters to the East of the line the Cape Skagen — Oslo-Fjord and South of 59°N and also along the coast of Sweden in Sekken and Single-Fjord Straits	March to September
The White Sea	The Onezhsky, Dvinsky and Kandalakshsky Gulfs, as well as 20-mile coastal area to the South of 66°45'N	May to October
The Ionian Sea	20-mile coastal area along the East coast from Kathira to Otronto Straits 20-mile coastal area along the East coast from the Gulf of Patraikos to the Strait of Otranto	March to November Throughout the year
The Kara Sea	20-mile coastal area from p. Dikson to r. Pyasing 20-mile coastal area along the North and West coast of the Yamal Peninsula from Obskaya Guba to p. Kharasavey via the Malygin Straits	July to September August to 15 October
The Caspian Sea	To the North of 44°30'N as well as to the South of 44°30'N within 20-mile coastal area along the East coast up to p. Krasnovodsk, along the West coast to p. Makhachkala and from p. Baku to p. Anzali; passage at the area of p. Beckdash (p. Krasnovodsk) — p. Baku	March to November
The Laptev Sea and the East-Siberian Sea	20-mile coastal area from the mouth of r. Yana to the mouth of r. Kolyma Coastal area within 6 to 15 m isobath from the mouth of r. Kolyma to p. Pevek	20 July to September August to September during years of low to medium ice formation determined by the position of the Ayon ice mass
The Sea of Marmora	No restrictions from Bosporus to Dardanelles Straits	Throughout the year
The Persian Gulf (the Arabian Sea)	East part — from Ormus Strait to 54°E; central part — coastal area along the West coast in the area restricted by 54°E, parallel 28°59'N and line connecting islands Abu-Musa, Khalul, Al-Kharkus, Falaika; north part — from parallel 28°59'N	Throughout the year

Table 2.2.5.3 — continued

Basin	Geographical restrictions	Season
The North Sea	Helgoland Bay to the South of 54°02'N and to the East of 7°58'E	Throughout the year
	Coastal area in the zone of traffic separation along the East-Frisian Islands and farther on with possible calls at the ports of South coast to p. Antwerp inclusive	March to October
The Mediterranian Sea	From Rhodes Strait in 20-mile coastal area to the ports of Israel inclusive with calls at the ports of Cyprus Island	March to November
The Black Sea	20-mile coastal area along the North, West and East coast from p. Batumi to Bosporus	Throughout the year
The Aegean Sea	From the Dardanelles to Karpathos and Kithira Straits to the North of 36°N	Throughout the year
	Passage to the Ionian Sea through the Gulf of Saronikos, Corinth Canal, Gulf of Corinth, Gulf of Patraikos	Throughout the year
The Sea of Japan and the Sea of Okhotsk	20-mile coastal area along the West coast from p. Vladivostok to the Preobrazhenia Bay	Throughout the year
	The Tatar Strait and the Amur Firth from the line of p. Sovetskaya Gavan — p. Uglegorsk to the line of the Cape Menshikov — the Cape Tamlavo	June to October

2.2.5.4 Whatever the area of navigation of ships whose stability does not comply with the requirements of Part IV "Stability" of the Rules imposed upon the ships navigating in winter seasonal zones to the North of parallel 66°30′ N and to the South of parallel 66°00′ S as well as in winter in the Bering Sea, the Sea of Okhotsk and in the Tatar Strait, the Register specifies the appropriate restrictions by introducing the entry into the Classification Certificate that the ship is not allowed to navigate in the above winter seasonal zones and areas.

2.2.6 Distinguishing automation marks. см.Б1

Ships and floating facilities complying with the requirements of Part XV "Automation" are assigned one of the following distinguishing marks: **A1**, **A2** or **A3** added to the character of classification depending on the automation extent of the installation, namely:

.1 A1 — automation extent of the machinery installation of self-propelled ships and floating facilities sufficient for its operation with unattended machinery spaces and main control station as well. Passenger ships and special purpose ships carrying on board more than 200 persons of special personnel are not assigned the distinguishing mark **A1**;

.2 A2 — automation extent of the machinery installation of self-propelled and non-self-proplled ships and floating facilities sufficient for its operation by one operator in the main control station with unattended machinery spaces;

.3 A3 (applicable only to ships and floating facilities with the main machinery power output up to 2250 kW) — automation extent of the machinery installation of self-propelled ships and floating facilities sufficient for its operation with unattended machinery spaces.

2.2.7 Distinguishing mark of one man bridge operated ship.

If the navigational equipment of self-propelled ship installed on the navigating bridge complies with the requirements for self-propelled one man bridge operated ships specified in Part V "Navigational Equipment" of Rules for the Equipment of Sea-Going Ships, a distinguishing mark (**OBHM**) is added to the character of classification.

2.2.8 Distinguishing mark for ships carrying equipment for fire fighting aboard other ships.

If a ship carries supplementary systems, equipment and outfit for fire fighting aboard other ships, offshore drilling units, floating and shore facilities and if the ship is in full compliance with the relevant requirements of the Rules in respect to those appliances, marks **П1В**, **П1**, **П2В**, **П2** or **П3В** are added to the character of classification proceeding from the degree of the ship equipment with these appliances.

The degree of the ship equipment for fire fighting in other structures is determined on the basis of the list of fire fighting equipment and systems prescribed by 2.13, Part VI "Fire Protection".

2.2.9 Descriptive notation in the class notation.

Ships complying with a definite scope of requirements of the Rules taking account of their structural particulars and service conditions are assigned the appropriate descriptive notation added to the character of classification of a ship.

The current Register rules cover certain requirements the fulfilment of which makes possible introducing of the following descriptive notations in the class notation: tug, hopper, dredger, catamaran, container ship, crane vessel, timber carrier, bulk carrier, ro-ro ship, tanker, docklift ship, oil tanker, oil recovery ship, passenger ship, ro-ro passenger ship, floating dock, floating crane, pontoon (transporting pontoon), ore carrier, fishing vessel, bilge water removing ship, salvage ship, special purpose ship, birth-connected ship, supply vessel, shipborne barge, etc.

The descriptive notation "tanker" shall be accompanied by a cargo carried specification in brackets such as "tanker (water)", "tanker (oil)", "tanker (wine)", "tanker (cod-liver oil)".

Distinguishing marks and descriptive notations in the class notations of nuclear ships and floating facilities, nuclear support vessels, gas carriers, chemical tankers, high-speed craft, type A WIG craft, mobile offshore drilling units, manned submersibles and diving systems, sea-going pleasure boats, shall be specified in accordance with the provisions of rules for the classification and construction of such ships (see 1.2.2).

If the scope of the Rules requirements which a ship complies with allows, two of the above-mentioned descriptive notations may be stated in the class notation of a ship (e.g. passenger hydrofoil craft) or the descriptive notation may be written as compounds (oil/bulk carrier, oil/bulk/ore carrier).

If an oil tanker or oil recovery vessel complies with the requirements for the ships, which carry petroleum products or recover them from the sea surface and carry them having flash point above 60°C, this temperature is to be indicated in the descriptive notation. For example "oil tanker (>60°C)", "oil/ore carrier (>60°C)", "oil recovery vessel (>60°C)". см.Б1-добавлено

When adding descriptive notation to the character of classification such as chemical carrier: oil tanker, bulk carrier, ore carrier or the word combinations: oil/bulk carrier, oil/ore carrier etc. after descriptive notation it is sure to be added (ОРП) in Russian text and (ESP) in English text. This means the necessity to survey these ships based on the Enhanced Survey Programme.

For example: oil/ore carrier (>60°C) (ESP).

2.2.10 Limitations on validity of some distinguishing marks.

When the particular scope of requirements of the Rules on the basis of which the appropriate distinguishing marks are introduced in the class notation are met only under limitations specified by the Register, these distinguishing marks and limitations, on exceeding of which these marks become invalid, are added (in parentheses) to the class notation, e.g.: **КМ✪ЛУ72⃞A2ro-ro(ЛУ72⃞** at $d \leqslant 8{,}4$ m).

2.2.11 Distinguishing mark for ships fitted with a dynamic positioning system.

If a ship is fitted with a dynamic positioning system complying with the requirements of Section 8, Part XV "Automation", one of the following marks: **ДИНПОЗ-1**, **ДИНПОЗ-2** or **ДИНПОЗ-3** is added to the ship's character of classification, depending on the redundancy of the dynamic positioning system.

2.2.12 Distinguishing mark for a ship intended for carriage of refrigerated cargo.

Transport ships intended for carriage of refrigerated cargo in specially equipped spaces and/or in thermal containers are assigned the distinguishing mark **РЕФ** added to the character of classification.

Along with that such ships shall have a refrigerating plant classed in compliance with Section 5 of this Part of the Rules and intended specially to maintain the required temperature in the said spaces and/or containers, as well as meet the applicable requirements of Part XII "Refrigerating Plants."

2.3 ADDITIONAL CHARACTERISTICS

2.3.1 When complying with definite requirements of the Rules stipulated by the structural features or operational characteristics of the ship the fulfilment of which is not reflected by distinguishing marks and descriptive notation in the class notation, the confirmation of compliance of the ship with such requirements is certified by the entry in column "Other characteristics" of the Classification Certificate stating for example that the ship is fit for the carriage of dangerous goods as it is indicated in the Certificate...; the ship is equipped for the carriage of cargo in international standard containers on deck and/or in appropriate holds, that the ship is suitable for operation in waters covered with oil, etc. (see also 1.1.5.2 and 3.3.1.5, Part II "Hull").

см.Б1

2.4 ALTERATION OF MARKS IN CLASS NOTATION

2.4.1 The Register may delete or alter any mark in the class notation in the case of any alteration of, or non-compliance with the requirements defining the insertion of this mark in the class notation.

3 TECHNICAL DOCUMENTATION

3.1 GENERAL PROVISIONS

см.Б1

3.1.1 Prior to the commencement of the work on the construction of ships or manufacture of materials and products, the technical documentation within a scope determined in the relevant parts of the Rules shall be submitted to the Register for consideration and approval. If necessary, the Register may require that the scope of documentation be increased.

Standards and norms for individual materials and articles agreed with the Register may be submitted instead of a part of documents or of the documentation as a whole.

The scope of technical documentation for ships and articles of special design and purpose submitted for consideration and approval to the Register is established in each case upon agreement with the Register.

3.1.2 Technical documentation may be submitted to the Register in one of the following variants:

.1 technical documentation in the scope of a technical design with subsequent submission of working plans to the Register for approval;

.2 technical documentation without subsequent submission of the working plans to the Register for approval. In this case, the scope of documentation submitted shall be such that all necessary data are available therein to ascertain the compliance of the designed ship or product with the Rules, as well as to provide the control in the process of manufacture of main structural assemblies of a ship or product.

The scope of technical documentation for each of the above-mentioned variants is given in the relevant parts of the Rules.

3.1.3 Amendments to the technical documentation approved by the Register relating to parts and structures provided for by the requirements of the Rules shall be submitted to the Register for approval before they are made.

3.1.4 The technical documentation submitted to the Register for consideration and approval shall be so worked out or supplied with such additional information that it would provide ground to be sure that the provisions of the Rules are complied with.

3.1.5 Calculations necessary for determination of the parameters and values regulated by the Register Rules are to be performed according to the provisions of these Rules or the procedures agreed with the Register.

The procedures and methods applied for calculations shall provide an adequate degree of accuracy of solving the problem.

Calculations performed by means of computers shall be made according to the programs having the Register Type Approval Certificate. The Register may require to perform the check calculations according to any program.

The Register does not check the correctness of computational operations in making calculations including those according to the programs, having the Register Type Approval Certificate.

General provisions concerning the approval of the computer programs and agreement the procedures of calculations are specified in 12.2, Part 2 "Technical Documentation" of Guidelines on Technical Supervision during Construction of Ships and Manufacture of Materials and Products.

3.1.6 Approval of the technical documentation is confirmed by putting the appropriate stamps of the Register on it.

Approval of the documentation by the Register does not cover those parts or structures shown in it to which the requirements of the Rules are not applicable.

3.2 DURATION OF VALIDITY OF APPROVED TECHNICAL DOCUMENTATION

см.Б1-добавлено

3.2.1 The Register approval of the technical documentation of a ship is valid for the period of 6 years. By the expiry of this term or in case when the interval between the date of the documentation approval and the commencement of ship construction exceeds 3 years, the documentation shall be checked and corrected to take account of the amendments to the Register Rules introduced during this period, and submitted to the Register for consideration.

The approval ceases to be valid if the above requirements is not complied with.

During construction of series ships in well-grounded cases the validity of technical documentation approval may be extended by the Register for the period not exceeding that required for the completion of construction of two next series ships.

3.2.2 The validity of the Register non-recurrent approval of technical documentation on materials and products (in case of their use on a certain ship under construction or in service) is limited, respectively, by the terms materials and products delivery or the terms of construction of ships they are intended for.

Type approval of technical documentation on materials and products (irrespective of a certain ship, but as representatives of certain types of materials or products) is valid for 5 years.

3.2.3 Approval of standards and other regulating documents on materials and products is performed for the period of their validity.

When revising the standards and regulating documents they shall be checked to take account of the current rules and norms of the Register.

The approval of specifications is valid for 5 years.

3.2.4 Notwithstanding the terms of approval, the technical documentation on ships, materials and products, as well as the approved standards, and regulating documents, shall be subjected to compulsory correction to take into account the adopted provisions of the international conventions and agreements to which the country whose flag a ship will be flying is a party.

3.2.5 All the documentation approved by and agreed with the Register shall be corrected to comply with the instructions circulated by the Register which provide for their unconditional fulfilment.

3.3 TECHNICAL DESIGN DOCUMENTATION OF A SHIP UNDER CONSTRUCTION

см.Б1

3.3.1 General provisions.

Before the beginning of the construction of a ship technical design documentation proving that the requirements of the Register rules applicable to the ship concerned are complied with is to be submitted to the Register for consideration. The documentation for consideration is to be submitted to the Register as a rule in three copies completed in accordance with the lists given in 3.3.2 to 3.3.11 taking into account the peculiarities and type of a ship.

3.3.2 General:

.1 general ship's specification (no approval stamps are needed);

.2 general arrangement plans with indication of escape routes;

.3 list of associated equipment and materials with indication of the basic technical data, manufacturer and availability of the approval of the Register or other competent body (no approval stamps are needed);

.4 drawing of explosion-dangerous zones and spaces;

.5 list of regime measures carried out by the shipowner when preparing the oil recovery ship for performing operations on elimination of oil spillage;

.6 list of measures and engineering solutions to ensure electrostatic and galvanic sparking safety including descriptions and arrangement plans of relevant structures and equipment.

3.3.3 Hull documentation.

3.3.3.1 In the case of subsequent approval of working documentation the following documentation is to be submitted[1]:

.1 hull members scantlings determination, as well as analysis of the overall longitudinal strength and stability of members for all specified loading conditions of the ship including the loading and carriage of bulk cargoes other than grain (no approval stamps are needed);

.2 midship section plan with the most typical transverse sections with indication of spacing between main longitudinal and transverse members, main particulars of the ship and their ratios, class notation of a ship;

.3 constructional profile with indication of frame spacings, boundaries of the portions of the ship's length, position of the watertight bulkheads, pillars, arrangement of superstructures and deckhouses;

.4 deck and platform plans with indication of design loads (including the loads induced by lift trucks and containers), positions and dimensions of openings, their strengthening, end structures of the side coamings;

.5 double bottom (single bottom) plan together with sea chest section and with indication of pressure in the blowing system. For bulk carriers and ore carriers an allowable load on inner bottom plating is to be indicated;

.6 shell expansion with indication of the boundaries of the ship's hull sections, positions and dimensions of openings in shell plating, and for ships strengthened for navigation in ice also the upper and lower edges of the ice belt and corresponding forward and aft draughts (with due regard for trim), arrangement of intermediate frames. Shell expansion for glass reinforced ships is to be submitted if the outer shell plating has different thickness;

.7 drawings of longitudinal and transverse bulkheads including tank wash bulkheads (for tanks the heights of overflow and air pipes shall be indicated);

.8 drawing of the after end framing and sternframe;

.9 drawing of the fore end framing and stem;

.10 drawings of propeller brackets and bossings, as well as fixed nozzles;

.11 drawings of seatings of main machinery and boiler bearers with bottom construction in that area with indication of the type and power of machinery as well as with indication that seatings and bearers comply with the requirements of the supplier's technical documentation on main machinery and boilers or that no special requirements are placed by the supplier on the seatings and bearers;

.12 drawing of superstructures and deckhouses;

.13 basic parameters of the hull protection by damping from damages when mooring (for ships to be moored at sea to other ships).

3.3.3.2 With no subsequent approval of working documentation, documentation as stated in 3.3.3.1 is to be submitted with indication of tables of pressure heads, compartments, dimensions and position of manholes and other openings on the double bottom plan (see 3.3.3.1.5).

The following documentation is to be submitted additionally:

.1 scheme of welding quality control and table of hull welding containing the following information:

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[1] All drawings mentioned below are to indicate the scantlings of the hull members, their material (with indication of grades according to Part XIII "Materials"), as well as typical sections and details, types and dimensions of fillet welds.

.1.1 name and thickness of structural components to be joined;

.1.2 shape or symbol of edge preparation;

.1.3 marks and grades of base metal;

.1.4 marks and grades of welding consumables;

.1.5 method of welding and position of joint in space.

If the information indicated in 3.3.3.2.1.1 to 3.3.3.2.1.5 is stated to the full in the drawings of the ship hull, then submission of the table of welding is not required;

.2 subdivision of hull into sections, including brief description of prefabricating and welding methods (no approval stamps are needed);

.3 description of the basic technological process of joining hull parts afloat based on the methods of carrying out such operations acceptable for the Register;

.4 detailed description of the technological hull constructing process, containing the information on materials, methods of forming the structural items, necessary conditions required during hull construction, as well as analysis of the structural strength both local and general (only for ships constructed of glass-reinforced plastic);

.5 scheme of tightness test of hull structures;

.6 drawings of penetrations of piping, ventilation ducts, cable ducts, etc. through bulkheads, decks, inner bottom, watertight floors and web members;

.7 programme of mooring tests and sea trials;

.8 Loading Manual for ships of 65 m and over in length (see 1.4.9, Part II "Hull").

3.3.4 Documentation on arrangements, equipment and outfit.

3.3.4.1 In the case of subsequent approval of working documentation, the following is to be submitted:

.1 arrangement plan of openings in hull, superstructures and deckhouses with indication of coaming heights and type of closing appliances;

.2 strength calculation of closing appliances (no approval stamps are needed);

.3 general arrangement plans of steering gear, active means of ship's steering, anchor, mooring and towing arrangements;

.4 calculations of strength and efficiency of the rudder, calculations of means of ship's active steering, anchor, mooring and towing arrangements, as well as diagram of tractive force for tugs (no approval stamps are needed);

.5 drawings of signal masts and rigging;

.6 calculation of signal masts and rigging (no approval stamps are needed);

.7 general arrangement plan of guide members for containers in holds;

.8 calculation of guide members for containers in holds (no approval stamps are needed);

.9 drawings of openings in subdivision bulkheads and their closing appliances.

3.3.4.2 With no subsequent approval of working drawings the documentation as stated in 3.3.4.1 is to be submitted, as well as:

.1 list of emergency outfit and its arrangement;

.2 programme of mooring tests and sea trials;

.3 documentation stated in 1.3.4, Part III "Arrangements, Equipment and Outfit".

3.3.5 Documentation on stability (no approval stamps are needed):

.1 lines drawing, coordinate tables of lines drawing;

.2 hydrostatic curves;

.3 curves of areas and static moments of hull cross sections;

.4 calculations and curves of arms of form stability (cross-curves) with schemes of hull volumes taken into account;

.5 summary table of displacements, positions of centre of gravity, trim and initial stability for various loading conditions;

.6 calculation materials relating to verification of ship's stability according to the Rules; mass tables for various loading conditions with indication of distribution of cargoes, oil fuel, fresh water and liquid ballast in tanks; calculations of roll amplitude and weather criterion; diagrams of windage area of a ship and calculations of heeling moments; calculations of heel caused by crowding of passengers and by turning; calculations of icing, angles of flooding, corrections for free surface effect of liquid cargoes and stores; arrangement plans of openings in hull, superstructures and deckhouses, etc.;

.7 summary table of the results of stability verification according to the Rules and curves of static or dynamic stability;

.8 capacity curves;

.9 stability calculations for the case of loading and stowage of bulk cargoes other than grain.

3.3.6 Documentation on subdivision:

.1 calculation on probability estimation of subdivision (if required) and curves of floodable length of compartments (no approval stamps are needed);

.2 calculations of damage stability and trim including static stability curves (no approval stamps are needed);

.3 plan of subdivision showing all watertight structures and openings with indication of types of closing appliances, as well as arrangements used for equilizing heel and trim of the damaged ship;

.4 cross-curves of stability (for damaged ship) if necessary for the adopted method of damage stability calculation (no approval stamps are needed);

.5 calculations of sectional areas of cross-flooding fittings and of uprighting time of ship (no approval stamps are needed);

.6 corner point coordinate table for compartments and tanks.

3.3.7 Documentation on fire protection.

3.3.7.1 In the case of subsequent approval of working drawings the following documentation is to be submitted:

.1 arrangement plan of fire-proof divisions (doors included) with indication of the protection method for cargo ships;

.2 elementary diagrams of fire extinguishing systems; arrangement of fire extinction stations, fire stations and control stations of ship's fire extinguishing systems;

.3 diagrams of fire detection and alarm systems;

.4 calculations of fire extinguishing systems: water fire main system, froth fire extinguishing system, etc., (no approval stamps are needed);

.5 schemes or descriptions of insulation, lining, finishing and deck covering with indication of fire risk categories of the materials used, as well as calculation of the amount of combustible materials per 1 m^2 of the floor area of the standard spaces, calculation of calorific values of combustible materials used for veener of non-combustible bulkheads, linings and ceilings, calculation of the maximum limited volume of combustible materials used for facings, mouldings, decorations and veneers (no approval stamps are needed);

.6 full information on fire hazard categories of new materials used (no approval stamps are needed);

.7 diagram of bunkering, storage and distribution system for oil fuel with a flash point below 43°C for ships and helicopters;

.8 list of fire fighting outfit;

.9 control diagram of air medium (for oil recovery ships).

3.3.7.2 With no subsequent approval of working drawings documentation as stated in 3.3.7.1 is to be submitted and additionally:

.1 arrangement plan of fire-proof divisions (doors included) with indication of numbers of their Type Approval Certificates or with Reports containing satisfactory results of the fire test required, drawing of items and elements of fire-proof divisions of types A and B;

.2 drawings of insulation, linings and deck coverings;

.3 arrangement plan of fire fighting outfit;

.4 list of spare parts and tools;

.5 programme of mooring and sea trials;

.6 fire plans according to 1.4, Part VI "Fire Protection".

3.3.8 Documentation on machinery and boiler installations.

3.3.8.1 In the case of subsequent approval of working drawings the following is to be submitted:

.1 general arrangement plans of machinery and equipment in the machinery spaces of category A (see 1.2, Part VII "Machinery Installations") with indication of escape routes also in emergency diesel generator spaces;

.2 diagram and description of the remote control for main machinery complete with information on equipment of remote control stations with control devices, indication and alarm signalling devices, means of communication and other arrangements;

.3 documentation on shafting:

.3.1 general view of shafting;

.3.2 drawings of sterntube and parts of sterntube arrangement;

.3.3 drawings of shafts (propeller, intermediate and thrust);

.3.4 drawings of shaft connections and couplings;

.3.5 drawings of journal and thrust bearings of shafting and their fastening to seatings;

.3.6 strength calculation of shafts and their fastening parts (no approval stamps are needed);

.3.7 calculation of the number of shaft bearings, their position and experienced loads (no approval stamps are needed);

.3.8 calculation of fitting of propeller and shafting couplings (no approval stamps are needed);

.3.9 torsional vibration calculations in conformity with Section 8, Part VII "Machinery Installations" (no approval stamps are needed);

.3.10 sterntube bearing and sterntube seal lubrication and cooling diagrams;

.3.11 calculation of bending vibration of shaft in accordance with the requirements of Section 5, Part VII “Machinery Installations” (no approval stamps are needed);

.4 documentation on propeller:

.4.1 general view of propeller;

.4.2 drawings of blade, boss and items for their securing (for detachable blade propeller and controllable pitch propeller);

.4.3 diagrams of actuating mechanism of CP-propeller and its description (no approval stamps are needed on descriptions);

.4.4 drawings of the main parts of the pitch control gear of CP-propeller, including hydrocylinders, push-pull rods, pistons, slides, lubricating oil supply tube to hydrocylinder in hub;

.4.5 strength calculation of propeller blade and for detachable blade propellers and CP-propellers — also calculation of fastening of blades to the boss (no approval stamps are needed);

.5 documentation on active means of the ship's steering (AMSS):

.5.1 general arrangement plans with necessary sections and sealing details;

.5.2 drawings and calculations of propeller, shafts, couplings, pinions, gear wheels of steerable propellers, waterjets and thrusters (no approval stamps are needed on calculations);

.5.3 drawings of shafts, gearing, rotors, blades and blade turning mechanism of vertical-axis propellers as well as strength calculations of the driving shaft of rotor, blade, gearing (no approval stamps are needed on calculations);

.5.4 drawings of bearings and seals;

.5.5 drawings of propeller nozzles and tunnels;

.5.6 diagrams of cooling, lubricating, hydraulic turning systems for steerable propellers (blades of CP-propellers) as well as particulars of pipings of the above systems;

.5.7 calculations and diagrams of electric drives for electrically driven AMSS (no approval stamps are needed on calculations);

.5.8 documentation on monitoring, control, and protection systems;

.5.9 torsional vibration calculations (for main AMSS and dynamic positioning systems) and service life calculation of rolling bearings (no approval stamps are needed on calculations).

Moreover, the Register may require presentation of rotational and pendular vibration calculations for steerable propellers if used as main AMSS;

.5.10 material specifications for principal components;

.5.11 prototype and pilot specimen test programme;

.5.12 description, service and maintenance manual (no approval stamps are needed).

.6 documentation on refrigerating plants (see 4.3).

3.3.8.2 With no subsequent approval of working drawings, documentation as stated in 3.3.8.1 is to be submitted, including information on treatment and geometry of working surfaces, heat treatment, tolerances on mating parts, hydraulic tests, non-destructive test and additionally:

.1 calculation of parameters of shafting alignment (no approval stamps are needed);

.2 drawings of seating and attachment fittings of main machinery, shafting bearings and boilers;

.3 list of spare parts;

.4 programme of mooring tests and sea trials.

3.3.9 Documentation on automation equipment.

3.3.9.1 In the case of subsequent approval of working drawings, the following is to be submitted:

.1 list of systems, devices and elements used in automation systems, their technical description with indication of the purpose, principle of operation, data on reliability and Register approval;

.2 circuit schemes and block diagrams of alarm and warning systems, including diagrams of power supply;

.3 list of controlled parameters with indication of types of devices, manufacturers, data on reliability and Register approval for devices;

.4 technical documentation on remote automated control for main engines and CP-propellers: circuit schemes and block diagrams, front panels of the remote automated control deck with indication of all devices, diagram of power supply to remote automated control, diagrams of protection, alarm and indication of parameters of main engines and CP-propellers;

.5 circuit schemes and block diagrams of automation systems for main engines (cooling, lubricating oil, fuel oil preparation systems, etc.);

.6 technical documentation on automation of auxiliary engines and electric generating plant: circuit schemes and block diagrams, front panels of control desks for electric generating plant with indication of all devices, diagram of power supply, protection, signalling and indication of parameters of auxiliary engines and electric generators;

.7 technical documentation on automation of boiler installation: circuit schemes and block diagrams, front panels of control desks with indication of all devices, diagrams of power supply, protection, signalling and indication of parameters;

.8 circuit schemes and block diagrams of automation of starting air compressors, including diagrams of protection, alarm and indication;

.9 circuit schemes and block diagrams of automation and remote control of bilge and ballast systems, diagrams of power supply, signalling and indication;

.10 circuit schemes and block diagrams of remote level sounding in tanks;

.11 drawings of front panels of desks and boards of control and alarm signalling systems at the main control station and on the bridge with indication of all devices;

.12 general arrangement plans of automation equipment at the main control station and on the bridge;

.13 list of spare parts for automation systems.

3.3.9.2 With no subsequent approval of working plans documentation as stated in 3.1.9.1 is to be submitted and additionally:

.1 circuit schemes and block diagrams of automation systems supervised by the Register and stated in the appropriate parts of the Rules which are not indicated in 3.1.9.1;

.2 programme of mooring tests and sea trials.

3.3.10 Documentation on systems and piping.

3.3.10.1 In the case of subsequent approval of working plans the following documentation is to be submitted:

.1 documentation on ship's systems:

.1.1 bilge system diagram;

.1.2 ballast system diagram;

.1.3 heeling and trimming system diagrams, as well as diagrams of devices (automatic or manually controlled) for ship trimming by crossflooding;

.1.4 air, overflow and sounding pipes diagrams;

.1.5 diagrams of ventilation and air conditioning systems of accommodation, service, cargo, machinery and working spaces with indication of watertight bulkheads and fire-proof divisions, arrangement of fire dampers, as well as indication of closures of ventilation ducts and openings;

.1.6 diagrams of sewage and other waste water systems, as well as scuppers with indication of watertight bulkheads, freeboard deck and distances from waterline or freeboard deck to appropriate openings, as stated in 4.3.2.4 and 4.3.2.6, Part VIII "Systems and Piping";

.1.7 diagrams of blowing and heating systems of sea chests, heating system of side fittings, heating system for liquids in tanks, steaming system for tanks;

.1.8 diagram of the compressed air system for tyfons, for blowing the sea chests;

.1.9 diagrams of hydraulic systems for drives of mechanisms and arrangements;

.1.10 diagrams of systems: cargo, stripping, vapour emission control and gas vent systems (for oil tankers and combination carriers);

.1.11 calculations of the systems: bilge, ballast, vapour emission control; ventilation of accumulator rooms, cargo pump rooms, enclosed spaces and holds intended for the carriage of motor vehicles (no approval stamps are needed);

.2 documentation on machinery installation systems:

.2.1 diagrams of live and exhaust steam systems;

.2.2 diagrams of blowing-off systems for boilers, machinery and steam piping;

.2.3 diagram of condensate and feed water system;

.2.4 diagram of oil fuel system;

.2.5 diagram of lubricating oil system;

.2.6 diagrams of fresh and sea water cooling systems;

.2.7 diagram of starting air system;

.2.8 diagram of exhaust gas pipes and uptakes;

.2.9 drawing of sea chests and ice chests equipment;

.2.10 calculation of starting air system (no approval stamps are needed);

.2.11 calculation of fuel oil service tank capacity of emergency diesel-generator (no approval stamps are needed).

3.3.10.2 With no subsequent approval of working plans the documentation as stated in 3.3.10.1 is to be submitted including the information on materials, insulation, manufacture, assembling, arrangement, hydraulic tests, etc. and additionally:

.1 drawings of silencers and spark arresters of exhaust gas pipes and uptakes;

.2 programme of mooring tests and sea trials.

3.3.11 Documentation on electrical equipment.

3.3.11.1 In the case of subsequent approval of working plans, the following is to be submitted:

.1 circuit diagrams of power generation and distribution from the main and emergency sources of electrical power: ship's mains, lighting (up to section switchboards) and navigation lights;

.2 circuit diagrams and general arrangement plans of main and emergency switchboards, control desks and other switchboards of non-standard design;

.3 calculation results of necessary output of ship's electric power plant providing for the operating conditions specified in 3.1.5, Part XI "Electrical Equipment", substantiation of the choice of the number and output of generators, as well as calculation of output of emergency sources of electrical power (no approval stamps are needed);

.4 calculation results of cross-sections of cables with indication of their types, currents and protection (no approval stamps are needed);

.5 circuit or detailed diagrams of the main current, excitation, control, pilot, signalling, protection and interlocking of the electric propulsion plant;

.6 calculation results of necessary output of the propulsion generators to ensure normal operation under all operating conditions of ship's service (no approval stamps are needed);

.7 calculation results of short-circuit currents and analysis of selective properties of protection equipment for rated current generators or for generators working in parallel in excess of 1000 A (no approval stamps are needed);

.8 calculation results of illumination intensity for spaces (no approval stamps are needed);

.9 circuit diagrams of electric engine telegraph, telephone communication, general alarm system, fire detection and fire alarm systems, alarms to warn that fire smothering system is put into action, signalling systems of closing of watertight and fireproof doors, alarms in the engineers' accommodation spaces;

.10 circuit diagrams of essential electric drives according to 1.3.2.1.5, Part XI "Electrical Equipment";

.11 diagrams of lubrication systems for electric machines and air cooling systems for main electric machines;

.12 diagrams of earthing of the protection system and, if necessary, calculations of lightning conductors for tankers, gas carriers, drilling units and non-metal ships;

.13 circuit diagram of cable runs with indication of spaces which they pierce;

.14 capacity calculation results for accumulator batteries of emergency lighting, navigation lights, general alarm system, fire alarm system and fire smothering appliances starting devices of the emergency diesel-generator set (no approval stamps are needed);

.15 results of preliminary calculations of factors accounting for voltage anharmonicity in different parts of ship's mains when using power semiconductor units (no approval stamps are needed);

.16 information on electrical equipment installed in explosion dangerous zones, areas and spaces with indication of its version for each space;

.17 calculation of expected efficiency of overload protection of generator sets by means of disconnection of the part of consumers with explanations of the number of disconnection steps and the list of disconnected consumers in every step (no approval stamps are needed);

.18 diagram and drawing of disconnection and blocking system of electrical equipment which is not used in operations on elimination of oil spillage;

.19 instruction on preparation and application of electrical equipment for elimination of oil spillage determining procedure of compulsory disconnection and blocking of electrical consumers without Certificates on Safe Type Electrical Equipment (no approval stamps are needed);

.20 drawings of equipment layout and cable laying in dangerous areas and spaces. Documentation (certificates issued by competent bodies), confirming the possibility of using the electrical equipment in dangerous areas and spaces;

.21 documentation on fixed and portable devices for measuring and signalling of explosive concentrations of gases;

.22 calculation of voltage dip when a consumer with maximum starting power is switched on (no approval stamps are needed);

.23 list of all essential electrical equipment installed on board the ship with indication of technical characteristics and data on approval of this equipment by the Register or another competent body;

.24 list of measures to be taken to ensure the electromagnetic compatibility of ship equipment.

3.3.11.2 With no subsequent approval of working plans, documentation as stated in 3.3.11.1 is to be submitted, as well as the following:

.1 drawings of cable runs and their penetrations through watertight, gastight and fire-fighting bulkheads, decks and platforms with indication of measures taken to suppress radio interferences;

.2 diagrams of main and emergency lighting in the spaces and places of arrangement of essential appliances, evacuation routes, survival craft embarkation stations at the deck and outboard (supplying from section switchboards);

.3 list of spare parts;

.4 programme of mooring tests and sea trials;

.5 drawings of arrangement and installation of electrical equipment in all spaces and zones of the ship;

.6 assembly drawings (only for non-standard articles) of main switchboards, emergency switchboards, electric propulsion plant boards, control stations and desks, special boards, power and lighting switchboards;

.7 diagrams and installation drawings of devices for measuring non-electric values (level, pressure, temperature indicators, etc.).

3.3.11.3 Where refrigerating plants are to be classified, documentation as stated in 3.3.11.1 and 3.3.11.2 is to contain data concerning electrical equipment of refrigerating plant.

3.4 TECHNICAL DOCUMENTATION FOR A SHIP SUBJECT TO CONVERSION OR RECONSTRUCTION

см.Б1

3.4.1 Prior to commencement of work on conversion or reconstruction of a ship, technical documentation relating to parts of the hull, machinery and equipment of a ship liable to conversion or reconstruction is to be submitted to the Register for consideration.

3.4.2 In case new machinery or arrangements are to be installed in a ship in service, which are to meet the requirements of the Rules and which differ substantially from those fitted initially, additional technical documentation on new installations shall be submitted to the Register for consideration in connection with these machinery or arrangements, within a scope necessary for a ship under construction (see 3.3).

3.5 WORKING DOCUMENTATION FOR A SHIP UNDER CONSTRUCTION

см.Б1

3.5.1 General:

.1 lists of emergency, fire extinguishing and other outfit with indication of main technical characteristics and its position in a ship; lists of spare parts and special tools. These lists are to be submitted for all sections where it is specified by the Rules;

.2 programmes of mooring tests and sea trials.

3.5.2 Hull documentation:

.1 stem and sternframe drawings;

.2 drawings of sections and details of the main hull, including decks, transverse and longitudinal bulkheads, sides, bottom, double bottom (with indication of the position of manholes and openings), tanks outside the double bottom being a structural part of the hull, etc.;

.3 drawings of sections and details of superstructures and deckhouses;

.4 drawings of engine and boiler casings, coamings and sills, companions and other guards of openings in the ship's hull;

.5 drawings of propeller shaft tunnel, recesses and escape trunks;

.6 drawings of propeller brackets and bossings;

.7 drawings of seatings for main machinery, boilers and bearings of shafting, seatings of auxiliaries, equipment and arrangements included in the nomenclature;

.8 bulwark drawings;

.9 plan of testing the hull for watertightness;

.10 plan of weld control of hull and superstructures and table of hull welding, containing the information given in 3.3.3.2.1;

.11 plan of subdivision of hull into sections;

.12 description of the basic technological process of joining hull parts afloat, based on the methods of carrying out such operations acceptable for the Register;

.13 Loading Manual for ships of 65 m and over in length (see 1.4.9, Part II "Hull");

.14 Information (booklet) on Stability and Strength for the Case of Loading, Unloading and Stowage of Bulk Cargoes Other than Grain (see 1.4.9.7, Part II "Hull").

3.5.3 Documentation on arrangements, equipment and outfit:

.1 general arrangement plans of assemblies and parts of closing appliances in hull, superstructures and deckhouses, in the subdivision bulkheads;

.2 general arrangement plans of assemblies and parts of steering gear, active means of ship's steering, anchor, mooring and towing arrangements, as well as spar and rigging, and guard rails;

.3 general arrangement plans of assemblies and parts of bulk cargo separation fittings.

3.5.4 Documentation on stability:

preliminary Information on Stability and calculations on which it is based (provided that these are not included in the documentation submitted according to 3.3.5.1 to 3.3.5.9).

3.5.5 Documentation on subdivision:

preliminary Information on Emergency Trim and Stability and calculations on which it is based (provided that these are not included in the documentation submitted according to 3.3.6.)

3.5.6 Documentation on fire protection:

.1 arrangement plan of fire-proof divisions (doors included) with indication of numbers of their Type Approval Certificates or with the Reports containing satisfactory results of the fire test required. Plan may not be submitted within the working documentation if the plan submitted within the scope of technical design according to 3.3.7.1.1 fully complies with the present requirements;

.2 drawings of assemblies and parts of fire-protection divisions of class A and B;

.3 drawings of insulation, linings and deck coverings;

.4 structural drawings and calculations of separate typical assemblies and equipment of fire extinction and fire alarm systems;

.5 diagrams of fire-extinguishing systems;

.6 fire plans according to 1.4, Part VI "Fire Protection";

.7 structural drawing of air medium control system (for oil recovery ships).

3.5.7 Documentation on systems and piping:

.1 ship's system drawings:

.1.1 bilge;

.1.2 ballast;

.1.3 heeling and trimming, diagram and construction of arrangements (automatic and manual-controlled) used for equalizing the damaged ship by means of counterflooding;

.1.4 air, overflow, sounding pipes, liquid level indicators, systems of remote level sounding in fuel tanks, cargo and slop tanks of the tankers;

.1.5 ventilation of accommodation, service, cargo, machinery and working spaces, construction of dampers and shut-off fittings of ventilation and other openings necessary for fire safety of the ship;

.1.6 gas vent pipes and gas vent equipment (design of flame arresters, flame-arresting gauzes, breathing valves and high-velocity devices);

.1.7 sewage, drainage and scuppers;

.1.8 cargo and stripping;

.1.9 liquid cargo heating;

.1.10 fuel oil loading and transfer system;

.1.11 liquid cargo loading and transfer system in dry cargo ships;

.2 drawings of propulsion plant piping:

.2.1 live and waste steam and blow-off pipes;

.2.2 feed water, condensate and evaporator;

.2.3 fuel oil;

.2.4 lubricating oil;

.2.5 cooling;

.2.6 exhaust manifold and uptakes;

.2.7 compressed air;

.2.8 heating system of oil fuel, water and lubricating oil; structural drawings of details and connections of heating elements;

.2.9 position and details of attachment of bottom and side fittings;

.3 structural drawings of leading the pipes and vent ducts through the watertight bulkheads, fireproof divisions, decks and platforms.

3.5.8 Documentation on machinery and boiler installations:

.1 drawings of installation and attachment of main machinery and steam boilers;

.2 drawings of fittings of oil fuel and lubricating oil tanks;

.3 drawings of silencers and spark arresters in exhaust gas pipes and uptakes;

.4 drawings of shafting and stern tube:

.4.1 thrust, intermediate and propeller shafts;

.4.2 main and thrust bearings and their attachment;

.4.3 couplings;

.4.4 stern tube and details of stern tube arrangement (bushes, bearings, sealings);

.5 fixed-pitch propeller (together with details of fastening of blades, if detachable blade propeller is fitted);

.6 controllable pitch propeller (CPP):

.6.1 hub complete;

.6.2 blades;

.6.3 propeller shaft and fastening thereof to the hub;

.6.4 oil transfer block in assembly;

.6.5 pitch actuating mechanism complete (PAM);

.6.6 shaft of pitch actuating mechanism (PAM);

.7 drawings of installation and attachment of AMSS:

.7.1 drawings of propellers and impellers (when CPP are used, see 3.5.8.6);

.7.2 drawings of bearings and seals;

.7.3 drawings of shafts, couplings, gear wheels, pinions.

Note. For propellers not covered by the requirements of the Rules, the list of the working plans is to be agreed with the Register in each individual case.

3.5.9 Documentation on automation systems and devices:

mounting and structural drawings of blocks of automation systems and devices, sensors, alarm devices, instruments, as well as of switchboards and desks of control and monitoring.

3.5.10 Documentation on electrical equipment:

.1 diagrams of main and emergency lighting circuits in the spaces and places of arrangement of essential appliances, evacuation routes, survival craft embarkation stations at the deck and outboard (supplying from the section switchboards);

.2 cable installation drawings with indication of cable penetrations through the watertight, gastight and fire-fighting bulkheads, decks and platforms;

.3 structural assembly drawings (for non-standard articles only) including:

.3.1 main switchboards;

.3.2 electric propulsion plant boards;

.3.3 emergency switchboards;

.3.4 control stations and desks;

.3.5 special boards;

.3.6 power and lighting switchboards;

.4 arrangement and installation drawings and diagrams of devices intended for measuring non-electric values (level, pressure, temperature indicators, etc.);

.5 drawings and diagrams of devices for suppression of radio interference;

.6 arrangement and installation drawings of electrical equipment in all ship's rooms and spaces;

.7 corrected drawings and diagrams specified in 3.3.11.1.

3.5.11 Documentation on refrigerating plants is specified in 4.3.3.

3.6 FINAL DOCUMENTATION ON A SHIP

см.Б1

3.6.1 Upon completion of construction, testing and commissioning of a ship, the final documentation on a ship is to be submitted to the Register for information.

Scope and procedure of submitting the documentation are to be agreed with the Register before the completion of construction.

4 CLASSIFICATION OF REFRIGERATING PLANTS

4.1 GENERAL PROVISIONS

4.1.1 For ensuring safety of a ship and preventing ozone-destructive effect of refrigerants on environment the refrigerating plants installed in ships classed with the Register are subject to surveys in the following cases:

.1 refrigerating plants working with Group II refrigerants in accordance with Table 2.2.1, Part XII "Refrigerating Plants";

.2 refrigerating plants working with Group I refrigerants and comprising the compressors with theoretical suction capacity 125 m^3/h and above;

.3 refrigerating plant ensures the functioning of systems affecting the ship safety.

4.1.2 From the number of the refrigerating plants stated in 4.1.1 the Register assigns a class to:

.1 refrigerating plants intended for developing and maintaining the required temperatures in refrigerated cargo spaces of transport ships, as well as in thermal containers to provide proper carriage of goods;

.2 refrigerating plants intended for developing and maintaining the required temperatures in refrigerated cargo spaces, for cold-treatment of sea products (cooling, freezing) and supplying the cold necessary for operation of process plants in fishing ships and other ships used for processing of the biological resources of sea;

.3 refrigerating plants intended to maintain the required conditions for transportation of liquefied gas in bulk in gas carriers.

Other refrigerating plants from the number of those stated in 4.1.1 subject to the Register supervision are cosidered unclassed.

4.2 CLASS OF A REFRIGERATING PLANT

4.2.1 General provisions.

4.2.1.1 The Register may assign a class to a refrigerating plant after the ship's construction, as well as assign, or renew a class of a refrigerating plant installed in a ship in service.

4.2.1.2 Assignment or renewal of a class means that the refrigerating plant fully or to a degree considered acceptable by the Register complies with the requirements of the relevant Rules. The fact of a class being assigned or renewed indicates that the refrigerating plant complies either fully or to a degree deemed acceptable by the Register, with the requirements of the relevant Rules and is taken under the Register supervision, and that the technical condition of the plant is in accordance with the provisions of design specifications included in the Classification Certificate for the Refrigerating Plant.

4.2.1.3 Assignment or renewal of a class granted to a refrigerating plant shall be confirmed by the issue of a Classification Certificate after the survey carried out.

4.2.2 Class notation of a refrigerating plant.

4.2.2.1 The character of classification of a refrigerating plant consists of the following marks:

.1 Х✪ — for a refrigerating plant built according to the Rules and surveyed by the Register;

.2 Х★ — for a refrigerating plant built according to the Rules of a classification body recognized by the Register, surveyed by that classification body and then classed by the Register;

.3 (Х)★ — for a refrigerating plant built without being surveyed by a classification body recognized by the Register or without being surveyed by a classification body at all, but subsequently classed with the Register;

.4 Х$\underline{\bigstar}$ — for a refrigerating plant built according to the Rules of an IACS Member Society, surveyed by that Society during construction and subsequently classed by the Register, if the refrigerating plant does not fully comply with the requirements of Part XII “Refrigerating Plants".

4.2.2.2 Mark of a capability to cargo refrigeration.

If the refrigerating plant has a capacity sufficient to refrigeration of a non-precooled cargo on shipboard during a period of time that provides preservation of that cargo, a distinguishing mark + shall be added in the character of classification.

In such a case a note specifying the conditions of cargo cooling on shipboard shall be entered into the Classification Certificate for the refrigerating plant and in the Register Book.

4.2.2.3 Mark of capability for cooling or freezing sea products.

An additional mark **P** is added to the character of classification if the plant is intended for cooling or freezing sea products and is in accordance with the relevant requirements specified in Part XII "Refrigerating Plants".

4.2.2.4 Additional character letters of refrigerating plants:

.1 if a refrigerating plant is intended for cooling of cargo transported in thermal containers and complies with applicable requirements of Part XII "Refrigerating Plants" a character letter **К** is added to the character of classification of the plant;

.2 if, in addition to a refrigerating plant, a ship is equipped with atmosphere control system in refrigerated spaces and/or thermal containers which complies with applicable requirements of Part XII "Refrigerating Plants" a character letter **Г** is added to the character of classification of the plant;

.3 if a refrigerating plant is intended to maintain the required conditions for transportation of liquefied gas in bulk in a gas carrier and complies with applicable requirements of Part XII "Refrigerating Plants" a character letter **Н** is added to the character of classification of the plant.

4.2.3 Additional characteristics.

4.2.3.1 Additional details of conditions for cooling cargoes on board, specified temperature conditions for transportation of cargoes and other details are indicated in the Classification Certificate and in the Register of Ships if it is found necessary by the Register to specify the purpose or structural features of the refrigerating plant.

4.2.3.2 Number of thermal containers served by the refrigerating plant is indicated in the Classification Certificate for refrigerating plant and in the Register of Ships.

4.2.4 Alteration of marks in class notation.

4.2.4.1 The Register may delete or alter a mark shown in the class notation in case of any modification or non-compliance with the requirements which served as the basis for the insertion of that mark into the class notation.

4.3 TECHNICAL DOCUMENTATION OF A REFRIGERATING PLANT

4.3.1 Technical design of a refrigerating plant to be classed.

4.3.1.1 General provisions.

Before commencement of ship's construction technical design documentation with a sufficient scope of information to prove that the requirements of the Rules of the Register for a refrigerating plant are complied with, is to be submitted for consideration to the Register. Approximate lists of technical documents to the Register are given in 4.3.1.2 and 4.3.1.3.

4.3.1.2 In the case of subsequent approval of working documentation, the following information is to be submitted:

.1 technical description of a refrigerating plant (no approval stamps are needed);

.2 cooling capacity calculations with indication of thermal load from each refrigerated cargo space and cold consumers (no approval stamps are needed);

.3 general arrangement plans of a refrigerating plant on board the ship;

.4 circuit schemes of working and emergency ventilation systems in the refrigerating machinery spaces with indication of the watertight bulkheads and fire-proof divisions, as well as the number of air changes per hour;

.5 circuit schemes of refrigerant, cooling medium, cooling water systems with indication of places for installation of instruments and automatic devices;

.6 air cooling diagram with indication of watertight bulkheads and fire-proof divisions;

.7 arrangement plans of equipment in refrigerating machinery spaces with indication of escape routes;

.8 arrangement plans of equipment in refrigerated spaces with indication of places for installation of temperature control devices;

.9 construction plans of insulation of refrigerated spaces with specification of insulating materials;

.10 elementary diagram of water screen system of refrigerating machinery spaces (for refrigerants of Group II);

.11 general arrangement plans of freezing and cooling arrangements and other refrigerating processing equipment;

.12 circuit schemes of automatic control, protection and alarm systems;

.13 list of machinery, vessels and apparatus of refrigerating plant with indication of technical characteristics, type (trade-mark), manufacturer and data on Type Approval Certificate (approval) of the Register (no approval stamps are needed);

.14 list of control devices and measuring instruments, protection and alarm systems with indication of technical characteristics, type (trade-mark), manufacturer and data on Type Approval Certificate (approval) of the Register (no approval stamps are needed);

.15 tables of the values of the bounding surface areas of the refrigerated cargo spaces and holds with data on calculated heat transfer coefficient for each surface (no approval stamps are needed);

.16 drawings of cargo cooling air ducts in thermo-insulated containers with an indication of the layout on board;

.17 drawings of air duct insulation with technical data of insulation materials;

.18 drawings of sealing and flexible joints with indication of details on materials;

.19 general arrangement plans of atmosphere control installation;

.20 list of equipment of the atmosphere control system including control and automatic devices and data on their approval by the Register.

4.3.1.3 The documentation specified in 4.3.1.2 is to be submitted without subsequent approval of working documentation, which is also true for the following documentation to be submitted additionally:

.1 drawings of installation and fastening of machinery, vessels and apparatus;

.2 arrangement plans of piping of refrigerant, cooling medium and cooling water system with indication of places of their penetration through the bulkheads, decks and platforms;

.3 arrangement plan of emergency discharge system of refrigerant outboard;

.4 list of spare parts;

.5 test program with indication of the method of design thermal load generation (including a calculation of the power of additional heaters to be used) and the method of determining the actual averaged heat-transfer coefficient for the insulating structure of refrigerated cargo spaces.

4.3.2 Technical design of an unclassed refrigerating plant.

4.3.2.1 In the case of subsequent approval of working documentation, the documentation stated in 4.3.1.2.3 to 4.3.1.2.5 (for refrigerant only), 4.3.1.2.7, 4.3.1.2.10, 4.3.1.2.11 (only for arrangements operating under the pressure of refrigerant), 4.3.1.2.12 (only for protection and alarm system), 4.3.1.2.13, 4.3.1.2.14 (only for protection and alarm devices).

4.3.2.2 The documentation specified in 4.3.2.1, as well as the documentation stated in 4.3.1.3.1, 4.3.1.3.2 (for refrigerant only), 4.3.1.3.3 is to be submitted without subsequent approval of working documentation.

4.3.3 Working documentation on refrigerating plants:

.1 drawings of installation and fastening of machinery, vessels and apparatus;

.2 arrangement plan of refrigerant piping;

.3 arrangement plan of cooling medium and cooling water piping;

.4 drawing of cooling air system;

.5 drawing of water screen and water spraying systems for the refrigerating machinery spaces;

.6 arrangement plan of emergency discharge system of refrigerant outboard;

.7 instructions on maintenance and operation of refrigerating plant (no approval stamps are needed);

.8 list of spare parts;

.9 test programme.

For unclassed refrigerating plants the documentation specified in 4.3.3.1, 4.3.3.2, 4.3.3.5 and 4.3.3.6, is to be submitted.

PART II. HULL

1 DESIGN PRINCIPLES

1.1 GENERAL

1.1.1 Application.

1.1.1.1 Unless provided otherwise, the present Part of the Rules applies to steel ships of welded construction, from 12 to 350 m in length whose proportions are taken within the limits given in Table 1.1.1.1.

Table 1.1.1.1

Proportion of ship	Area of navigation					
	Unrestricted	**I**	**II**	**IIСП**	**IIIСП**	**III**
L/D *B/D*	18 2,5	19 2,5[1]	20 3[2]	21 3	22 3	23 4[3]

[1] For vessels of dredging fleet, not more than 3.

[2] For vessels of dredging fleet, not more than 4.

[3] For floating cranes, not less than 4,5.

1.1.1.2 The scantlings of hull members, essential to the strength of ships whose construction and main dimensions are not regulated by the present Rules are subject to special consideration by the Register.

1.1.2 General.

1.1.2.1 All hull structures regulated by the present Part of the Rules are subject to the Register survey. For this purpose an access shall be provided for their survey.

1.1.2.2 During manufacture of the structures regulated by the present Part of the Rules shall comply with the requirements of Part XIII "Materials" and Part XIV "Welding" and with the approved technical documentation listed in Part I "Classification".

1.1.2.3 Tightness test of ship's hull is to be carried out according to the provisions of Appendix 1.

1.1.3 Definitions and explanations.

The definitions and explanations relating to the general terminology of the Rules are given in Part I "Classification".

For the purpose of the present Part of the Rules the following definitions and explanations have been adopted:

Length L is the distance, in m, on the summer load waterline from the forward side of the stem to the after side of the rudder post or to the centre of the rudder stock if there is no rudder post, or the distance equal to 96 per cent of the length on the summer load waterline from the forward side of the stem to the after side of after end of the ship, whichever is the greater. However, L need not be greater than 97 per cent of the ship's length on the summer load waterline.

Where the fore or after end is of an unusual form, length L is subject to special consideration by the Register.

Moulded breadth B is the greatest moulded breadth, in m, measured amidships from outside of frame to outside of frame.

Moulded depth D is the vertical distance measured amidships from the top of the plate keel or from the point where the inner surface of shell plating abuts upon the bar keel, to the top of the upper deck beam at side. In ships having a rounded gunwale, the depth is measured to the point of intersection of the moulded lines of upper deck and side, the lines extending so as if the gunwale were of angular design.

Draught d is the vertical distance measured amidships from the top of the plate keel, or the point where the inner surface of the shell plating abuts upon the bar keel, to the summer load waterline. In ships with timber freeboard the draught shall be measured at side to the summer timber load waterline.

Summer load waterline is the waterline on the level of the centre of the load line ring for the ship's position without heel and trim.

Block coefficient C_b is the block coefficient at draught d corresponding to summer load waterline, based on length L and breadth B, determined by the formula

$$C_b = \frac{\text{Moulded displacement (m}^3\text{)}}{LBd}.$$

Spacing is the distance between primary members, determined on the basis of the value of standard spacing a_0, in m, obtained from the formula $a_0 = 0{,}002L + 0{,}48$.

Deviation from normal spacing may be permitted within the following limits:

$0{,}75a_0$ to $1{,}25a_0$ for ships of unrestricted area of navigation and limited area of navigation **I**;

$0{,}7a_0$ to $1{,}25a_0$ for ships of limited areas of navigation **II** and **IIСП**;

$0{,}65a_0$ to $1{,}25a_0$ for ships of limited areas of navigation **III** and **IIIСП**.

In the fore and after peaks the spacing of primary members is not to exceed 0,6 m; between the fore peak bulkhead and 0,2L aft of the forward perpendicular — not more than 0,7 m. Variations from these values are subject to special consideration by the Register.

In all cases the spacing of primary members is not to exceed 1 m.

Forward perpendicular is a vertical line run through the ship centre plane at a point where the summer loadline and the fore side of stem intersect.

After perpendicular is a vertical line run through the ship centre plane, which limits the ship length L at the aft end.

Midship section is the hull section at the middle of ship's length L.

Midship region is the part of the ship's length equal to 0,4L (0,2L forward and aft of amidships), unless expressly provided otherwise.

Ship's ends are portions of the ship's length beyond the midship region.

Machinery space aft corresponds to the position of the mid-length of the machinery space beyond 0,3L aft of amidships.

Upper deck is the uppermost continuous deck extending the full length of the ship.

Strength deck is the deck forming the upper flange of hull girder. The uppermost continuous deck, long bridge deck, long forecastle or long poop deck outside end regions, or quarter deck outside the transition area may be considered as the strength deck (see 2.12.1.2).

Bulkhead deck is the deck to which the main transverse watertight bulkheads are carried.

Freeboard deck is the deck from which the freeboard is calculated.

Lower decks are the decks located below the upper deck.

Where the ship has several lower decks, they are called: second deck, third deck, etc., counting from the upper deck.

Platform is a lower deck extending over portions of the ship's length or breadth.

Superstructure deck is a deck forming the top of a tier of superstructure. Where the superstructure has several tiers, the superstructure decks are called as follows: first tier superstructure deck, second tier superstructure deck, etc., counting from the upper deck.

Deckhouse top is a deck forming the top of a tier of a deckhouse. Where the deckhouse has several tiers, the deckhouse tops are called as follows: first tier deckhouse top, second tier deckhouse top, etc., counting from the upper deck. If a deckhouse is fitted on a superstructure deck of first tier, second tier, etc., the deckhouse top is called accordingly the top of second tier deckhouse, third tier deckhouse, etc.

Superstructure is a decked structure on the upper deck extending from side to side of the ship or with the side plating not being inboard of the shell plating more than 4 per cent of the breadth of the ship.

Deckhouse is a decked structure on the upper deck or superstructure deck with its side plating, on one side at least, being inboard of the shell plating by more than 4 per cent of the breadth of the ship.

Main frames are vertical side framing members fitted in the plane of floors or bilge brackets within a spacing of each other.

Intermediate frames are additional frames fitted between main frames.

Tight structure is a structure impervious to water and other liquids.

Specified speed of ship v_0 is the maximum speed of the ship, in knots, at the summer load waterline in still water at rated engine speed of propulsion plant.

$g = 9{,}81$ m/s^2 — acceleration due to gravity;

$\rho = 1{,}025$ t/m^3 — density of sea water.

1.1.4 Basic provisions for determining the scantlings of hull members.

1.1.4.1 The scantlings of hull members are regulated based on the Rule design loads, calculation methods and safety factors with due regard to corrosion allowance (see 1.1.5).

1.1.4.2 Derivation of the scantlings of hull members in the Rules is based on structural idealization using beam models subject to bending, shear, longitudinal loading and torsion having regard to the effect of adjacent structures.

1.1.4.3 For the purpose of the present Part of the Rules, the design characteristics of the material used for hull structures are to be as follows:

R_{eH} = upper yield stress, in MPa;

σ_n = design specified yield stress for normal stresses, in MPa, determined by the formula

$$\sigma_n = \frac{235}{\eta} \qquad (1.1.4.3\text{-}1)$$

where η = application factor of mechanical properties of steel, obtained from Table 1.1.4.3;

τ_n = design specified yield stress for shear stresses, in MPa, determined by the formula

$$\tau_n = 0{,}57\sigma_n. \qquad (1.1.4.3\text{-}2)$$

Table 1.1.4.3

R_{eH}	235	315	355	390
η	1,0	0,78	0,72	0,68

1.1.4.4 The requirements for strength of structural members and structures as a whole aiming at determining their scantlings and strength characteristics are set forth in the Rules by assigning the specified values of permissible stresses for design normal $\sigma_p = k_\sigma \sigma_n$ and shear $\tau_p = k_\tau \tau_n$ stresses (where k_σ and k_τ = factors of permissible normal and shear stresses respectively).

The values of k_σ and k_τ are given in the relevant chapters of this Part of the Rules.

1.1.4.5 The buckling strength requirements are imposed upon the structural members subject to considerable compressive normal and/or shear stresses (see 1.6.5).

1.1.4.6 The thickness of hull structural members determined according to the requirements of the present Part of the Rules is to be the minimum thickness specified for particular structures in the relevant chapters of the present Part of the Rules.

For ships of limited areas of navigation **II**, **IIСП**, **III** and **IIIСП**, a reduction in the thickness of hull members is permitted, but not in excess of the values to be found in Table 1.1.4.6.

Table 1.1.4.6

Permissible reduction of minimum hull member thickness

Hull members	Service area	
	II and **IIСП**	**III** and **IIIСП**
Web frames in way of ballast tanks	15 per cent	30 per cent
Other hull members	10 per cent	20 per cent

In all cases, unless expressly provided otherwise, the hull member thickness is not to be less than 4 mm.

1.1.4.7 In the present Part of the Rules, the requirements for determining the hull member scantlings are based on the assumption that during the construction and service of a ship measures are taken for the corrosion prevention of the hull in accordance with current standards and other current normative documents.

In any case, the internal surfaces of seawater ballast tanks shall have epoxy protective coatings or equivalent anticorrosive coatings in conformity with the manufacturer's instructions approved by the Register. The coatings shall preferably be of light colour. Where appropriate, anodic corrosion protection should also be used.

1.1.5 Corrosion allowance.

1.1.5.1 Corrosion allowance Δs, in mm, is set for the structures whose planned service life exceeds 12 years and is determined by the formula

$$\Delta s = u(T-12) \qquad (1.1.5.1)$$

where u = average annual reduction in thickness of the member, in mm per annum, due to corrosion wear or tear, taken with regard to service conditions;

T = planned service life of structure, in years; if service life is not specially prescribed, T shall be taken equal to 24.

For the structures whose planned service life is less than 12 years, $\Delta s = 0$.

1.1.5.2 When there are no special requirements for service conditions and means of corrosion prevention of the hull for determining the scantlings of hull members according to the Rules one should be guided by the data on the average annual reduction in thickness u of structural member given in Table 1.1.5.2 depending on the group of ships and the designation of the space.

Table 1.1.5.2 provides for division of all ships into two groups depending on corrosion wear conditions:

Group I: dry cargo ships and similar ships as regards the service conditions;

Group II: tankers, bulk carriers, combination carriers and similar ships as regards the service conditions.

For the webs separating the different purpose compartments, u is determined as the average value for adjacent compartments.

For ships of restricted service intended to operate only in fresh water basins, the value of u may be reduced 2,5 times for group I and 1,2 times for group II; for ships intended to operate in fresh water basins for a part of time, u is to be determined by linear interpolation in proportion to that part of time.

In well-founded cases on agreement with the shipowner a reduction of scantlings of certain hull members may be permitted within the limits agreed with the Register.

The reduced scantlings shall be expressly indicated in hull structural drawings submitted to the Register for consideration.

For ships where the reduction of scantlings is permitted by the Register a special notation will be entered in the Classification Certificate (see 2.3.1, Part I "Classification").

1.1.5.3 The factor ω_K taking into account corrosion allowance with regard to the cross-sectional area of the web and to the section modulus of members of rolled section is determined by the formula

$$\omega_c = 1 + \alpha_c \Delta s \qquad (1.1.5.3)$$

where $\alpha_c = 0{,}07 + \frac{6}{W'} \leqslant 0{,}25$ for $W' < 200$ cm^3;

$\alpha_c = \frac{1}{0{,}15}\left(0{,}01 + \frac{1}{W'}\right)$ for $W' \geqslant 200$ cm^3

where W' = section modulus of the member under consideration in accordance with 1.6.4.2;

for Δs, see 1.1.5.1.

1.1.6 Requirements of international conventions to be taken into account.

1.1.6.1 Peak and machinery space bulkheads, shaft tunnels, etc. in passenger ships[1].

1.1.6.1.1 A fore peak or collision bulkhead shall be fitted which shall be watertight up to the bulkhead deck. This bulkhead shall be located at a distance from the forward perpendicular of not less than 5 per cent of the length of the ship L_s and not more than 3 m plus 5 per cent of the length of the ship L_s (Fig. 1.1.6.1).

Where the stem forms the external contour of the hull from the forward end with no protruding parts except the bulbous bow, the forward perpendicular is to coincide with the forward edge of the stem on the level of the deepest subdivision load line.

1.1.6.1.2 Where any part of the ship below the waterline extends forward of the forward perpendicular, e.g. a bulbous bow, the distances stipulated in 1.1.6.1.1 shall be measured from a point either at the midlength of such extension, or at a distance 1,5 per cent of the length of the ship forward of the forward perpendicular, or at a distance 3 m forward of the forward perpendicular, whichever gives the smallest measurement (see Fig. 1.1.6.1).

1.1.6.1.3 Where a long forward superstructure is fitted, the fore peak or collision bulkhead on all passenger ships shall be extended weathertight to the next full deck above the bulkhead deck. The extension shall

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[1] For the purpose of the present paragraph "bulkhead deck", "length of ship", "deepest subdivision load line" and "margin line" have the meanings as defined in 1.2, Part V "Subdivision".

Table 1.1.5.2

Average annual reduction in thickness of structural members

Nos	Structural member	*u*, in mm per annum	
		Group I	Group II
1	**Plating of decks and platforms**		
1.1	Upper deck	0,1	0,2 [1, 2]
1.2	Lower deck	0,11	—
1.3	Deck in accommodation and working spaces	0,14	0,14
2	**Side plating**		
2.1	Side (no inner skin is provided):		
2.1.1	freeboard	0,1	0,13 [2]
2.1.2	in the region of alternating waterlines	0,17	0,19 [2]
2.1.3	below the region of alternating waterlines	0,14	0,16
2.2	Side (inner skin is provided) (compartments of double skin side are not designed to be filled):		
2.2.1	freeboard	0,1	0,1
2.2.2	in the region of alternating waterlines	0,17	0,17
2.2.3	below the region of alternating waterlines	0,14	0,14
2.3	Side (inner skin is provided) (compartments of double skin side are designed for the of carriage cargo, oil fuel or water ballast):		
2.3.1	freeboard:		
	.1 tanks filled with oil fuel	0,19	0,19
	.2 tank for reception of water ballast	0,21	0,21
2.3.2	in the region of alternating waterlines:		
	.1 tank filled with oil fuel	0,18	0,18
	.2 tank for reception of water ballast	0,21	0,21
2.3.3	below the region of alternating waterlines:		
	.1 tank filled with oil fuel	0,17	0,17
	.2 tank for reception of water ballast	0,18	0,18
3	**Bottom plating**		
3.1	Bottom (inner bottom is not provided):		
3.1.1	including bilge	0,14	—
3.1.2	in way of cargo tanks	—	0,17
3.1.3	in way of oil fuel tanks	0,17	0,17
3.1.4	in way of ballast compartments	0,2	0,2
3.2	Bottom (inner bottom is provided):		
3.2.1	including bilge	0,14	0,14
3.2.2	in way of oil fuel tanks	0,15	0,15
3.2.3	in way of ballast compartments	0,2	0,2
4	**Plating of inner bottom, hopper tank and trapezoidal stools under transverse bulkheads**		
4.1	Inner bottom in the area of cargo holds (tanks):		
4.1.1	in way of oil fuel tanks	0,12	0,17
4.1.2	in way of ballast compartments	0,15	0,2
4.1.3	in way of boiler room	0,3	0,3
4.1.4	in way of engine room	0,2	0,2
4.1.5	with no wood sheathing in holds if cargo is expected to be discharged by grabs	0,3	0,3
4.2	Hopper tanks, trapezoidal stools under transverse bulkheads, margin plate:		
4.2.1	plating of hopper tanks and trapezoidal stools:		
	bottom strake	0,25	0,3
	other strakes	0,12	0,17
4.2.2	margin plate (inclined and horizontal)	0,2	0,22
4.2.3	margin plate in boiler room:		
	inclined	0,28	0,3
	horizontal	0,23	0,28
5	**Plating of longitudinal and transverse bulkheads of inner skin**		
5.1	Watertight bulkheads:		
5.1.1	top strake (0,1*D* from the upper deck)	0,1	—
5.1.2	middle strake	0,12	—
5.1.3	bottom strake	0,13	—
5.2	Bulkheads between holds loaded with bulk cargoes:		
5.2.1	top strake (0,1*D* from the upper deck)	—	0,13
5.2.2	other strakes	—	0,18
5.3	Bulkheads between holds loaded with oil cargo or bulk cargo:		
5.3.1	top strake (0,1*D* from the upper deck)	—	0,16
5.3.2	other strakes	—	0,18
5.4	Bulkheads between cargo tanks:		
5.4.1	top strake (0,1*D* from the upper deck)	—	0,2 [2]

Table 1.1.5.2 — continued

Nos	Structural member	*u*, mm per annum	
		Group I	Group II
5.4.2	middle strake	—	0,13[2]
5.4.3	bottom strake	—	0,18
5.5	Bulkheads between cargo and ballast compartments:		
5.5.1	top strake (0,1D from the upper deck)	0,13	0,3
5.5.2	middle strake	0,15	0,25
5.5.3	bottom strake	0,16	0,2
5.6	Topside tanks	0,12	0,2
6	**Framing of decks and platforms**		
6.1	Deck longitudinals and beams of decks and platforms forming boundaries of:		
6.1.1	holds loaded with general cargoes	0,12	—
6.1.2	holds loaded with bulk cargoes	—	0,15
6.1.3	holds loaded with crude oil and petroleum products or bulk cargoes	—	0,18
6.1.4	cargo tanks	—	0,25[2]
6.1.5	oil fuel tanks	0,15	0,17
6.1.6	ballast compartments	0,18	0,2
6.2	Deck girders, transverses of decks and platforms forming boundaries of:		
6.2.1	holds loaded with general cargoes	0,12	—
6.2.2	holds loaded with bulk cargoes	—	0,13
6.2.3	holds loaded with crude oil and petroleum products or bulk cargoes	—	0,15
6.2.4	cargo tanks	—	0,2[2]
6.2.5	oil fuel tanks	0,19	0,19
6.2.6	ballast compartments	0,21	0,21
6.3	Cargo hatch coamings	0,1	0,12
7	**Framing of sides and bulkheads**		
7.1	Longitudinals, main and web frames, cross ties, vertical stiffeners and horizontal girders of sides and bulkheads forming boundaries of:		
7.1.1	holds loaded with general cargoes	0,1	—
7.1.2	holds loaded with bulk cargoes	—	0,13
7.1.3	holds loaded with crude oil and petroleum products or bulk cargoes	—	0,15
7.1.4	cargo tanks	—	0,2[2, 3]
7.1.5	oil fuel tanks	0,18[3]	0,18[3]
7.1.6	ballast compartments	0,21	0,21
8	**Framing of bottom and inner bottom**		
8.1	Bottom centre girder, side girders, floors and bottom longitudinal girders (inner bottom is omitted):		
8.1.1	in general cargo compartments	0,14	—
8.1.2	in cargo tanks	—	0,2
8.1.3	in ballast compartments	0,2	0,2
8.1.4	under the boilers	0,3	0,3
8.2	Bottom centre girder, side girders, floors, bottom and inner bottom longitudinals in double bottom compartments:		
8.2.1	not intended to be filled	0,14	0,14
8.2.2	in oil fuel tanks	0,15	0,15
8.2.3	in water ballast tanks	0,2	0,2
8.2.4	under the boilers	0,25	0,25
9	**Superstructures, deckhouses and bulwarks**		
9.1	Shell plating	0,1	0,1
9.2	Framing	0,1	0,1

[1] For combination carriers and ships for the carriage of bulk cargoes, $u = 0{,}15$ mm per annum.

[2] With a compartment filled with inert gas, u is increased by 10 per cent.

[3] For horizontal stiffeners arranged in the upper portion having a width of 0,1 times the compartment height, $u = 0{,}25$ mm per annum.

be so arranged as to preclude the possibility of the bow door causing damage to it in the case of damage to, or detachment of, the bow door.

1.1.6.1.4 The extension required in 1.1.6.1.3 need not be fitted directly above the bulkhead below, provided that all parts of the extension are not located forward of the forward limit specified in 1.1.6.1.1 or 1.1.6.1.2.

However, in ships constructed before 1 July 1997:

.1 where a sloping ramp forms part of the extension, the part of the extension which is more than 2,3 m above the bulkhead deck may extend no more than 1 m forward of the forward limits specified in 1.1.6.1.1 or 1.1.6.1.2;

.2 where the existing ramp does not comply with the requirements for acceptance as an extension to the collision bulkhead and the position of the ramp prevents the siting of such extension within the limits specified in 1.1.6.1.1 or 1.1.6.1.2, the extension may be sited within a limited distance aft of the aft limit specified in 1.1.6.1.1 or 1.1.6.1.2. The limited distance aft shall be no more than is necessary to ensure non-interference with the

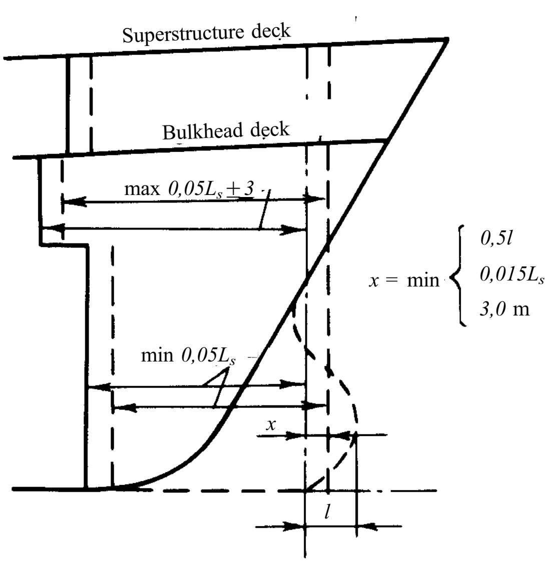

Fig. 1.1.6.1

ramp. The extension to the collision bulkhead shall open forward. The extension shall comply with the requirements of 1.1.6.1.3 and shall be so arranged as to preclude the possibility of the ramp causing damage to it in the case of damage to, or detachment of, the ramp.

1.1.6.1.5 Ramps that do not comply with the above requirements shall be disregarded as an extension of the collision bulkhead.

1.1.6.1.6 In ships constructed before 1 July 1997, the requirements of 1.1.6.1.3 and 1.1.6.1.4 shall apply not later than the date of the first periodical survey after 1 July 1997.

1.1.6.1.7 An after peak bulkhead dividing the machinery space from the cargo and passenger spaces forward and aft, is also to be fitted and made watertight up to the bulkhead deck.

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

1.1.6.1.8 In all cases sterntubes are to be enclosed in watertight spaces of moderate volume. The stern gland is to be situated in a watertight shaft tunnel or other watertight space separate from the sterntube compartment and of such volume that, if flooded by leakage through the stern gland, the margin line will not be submerged.

1.1.6.2 Peak and machinery space bulkheads and sterntubes in cargo ships[1].

1.1.6.2.1 A collision bulkhead shall be fitted which shall be watertight up to the freeboard deck. This bulkhead shall be located at a distance from the forward perpendicular of not less than 5 per cent of the length of the ship or 10 m, whichever is the less, in separate cases other value may be permitted, but not more than 8 per cent of the length of the ship.

1.1.6.2.2 Where any part of the ship below the waterline extends forward of the forward perpendicular, e.g. a bulbous bow, the distances stipulated in 1.1.6.2.1 shall be measured from a point either at the mid-length of such extension, or at a distance 1,5 per cent of the length of the ship forward of the forward perpendicular, or at a distance 3 m forward of the forward perpendicular, whichever gives the smallest measurement.

1.1.6.2.3 The bulkhead may have steps or recesses provided they are within the limits prescribed in 1.1.6.2.1 or 1.1.6.2.2.

1.1.6.2.4 Where a long forward superstructure is fitted, the collision bulkhead is to be extended weathertight to the deck next above the freeboard deck. The extension need not be fitted directly above the bulkhead below provided it is located within the limits prescribed in 1.1.6.2.1 or 1.1.6.2.2 with the exemption permitted by 1.1.6.2.5 and the part of the deck which forms the step is made effectively weathertight.

1.1.6.2.5 Where bow doors are fitted and a sloping loading ramp forms part of the extension of the fore peak bulkhead above the freeboard deck, the part of the ramp which is more than 2,3 m above the freeboard deck may extend forward of the limit specified in 1.1.6.2.1 or 1.1.6.2.2. The ramp is to be weathertight over its complete length.

1.1.6.2.6 The number of openings in the extension of the fore peak bulkhead above the freeboard deck is to be restricted to the minimum compatible with the design and normal operation of the ship.

1.1.6.2.7 Bulkheads shall be fitted separating the machinery space from cargo and passenger spaces forward and aft and made watertight up to the freeboard deck.

1.1.6.2.8 Sterntubes shall be enclosed in a watertight space (or spaces) of moderate volume. Other measures may be taken to minimize the danger of water penetrating into the ship in case of damage to sterntube arrangements.

1.1.6.3 Double bottoms in passenger ships.

1.1.6.3.1 A double bottom shall be fitted extending from the fore peak bulkhead to the after peak bulkhead as far as this is practicable and compatible with the design and proper working of the ship.

In ships of 50 m and upwards but less than 61 m in length a double bottom shall be fitted at least from the machinery space to the fore peak bulkhead, or as near thereto as practicable.

In ships of 61 m and upwards but less than 76 m in length a double bottom shall be fitted at least outside the machinery space, and shall extend to the fore and after peak bulkheads, or as near thereto as practicable.

In ships of 76 m in length and upwards, a double bottom shall be fitted amidships, and shall extend to the

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[1] For the purpose of the present paragraph "freeboard deck", "length of ship" and "forward perpendicular" have the meanings as defined in 1.2 of Load Line Rules for Sea-Going Ships.

fore and after peak bulkheads, or as near thereto as practicable.

1.1.6.3.2 Where a double bottom is required to be fitted, its depth shall be in accordance with the requirements of 2.4.4.1 and the inner bottom shall be continued out to the ship's sides in such a manner as to protect the bottom to the turn of the bilge. Such protection will be deemed satisfactory if the line of intersection of the outer edge of the margin plate with the bilge plating is not lower at any part than a horizontal plane passing through the point *A* at midship section, as shown in Fig. 1.1.6.3.

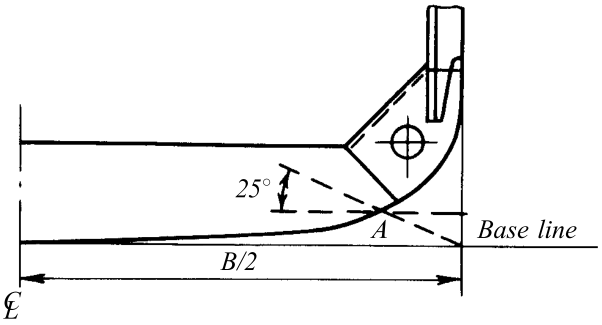

Fig. 1.1.6.3

1.1.6.3.3 Small wells constructed in the double bottom in connection with drainage arrangements of holds, etc. shall not extend downwards more than necessary. The depth of the well shall in no case be more than the depth less 460 mm of the double bottom at the centreline, nor shall the well extend below the horizontal plane referred to in 1.1.6.3.2. A well extending to the outer bottom is, however, permitted at the after end of the shaft tunnel. Other wells (e.g., for lubricating oil under main engines) may be permitted if the arrangements give protection equivalent to that afforded by a double bottom complying with the present paragraph.

1.1.6.3.4 A double bottom need not be fitted in way of watertight compartments of moderate size used exclusively for the carriage of liquids, provided the safety of the ship, in the event of bottom or side damage, is not thereby impaired.

1.1.6.4 Double bottoms in cargo ships other than tankers.

1.1.6.4.1 A double bottom shall be fitted extending from the collision bulkhead to the after peak bulkhead, as far as this is practicable and compatible with the design and proper working of the ship.

1.1.6.4.2 The double bottom depth shall be in conformity with 2.4.4.1, and the inner bottom shall be continued out to the ship's side in such a manner as to protect the bottom to the turn of the bilge.

1.1.6.4.3 Small wells constructed in the double bottom, in connection with the drainage arrangements of holds, shall not extend in depth more than necessary. A well extending to the outer bottom may, however, be permitted at the after end of the shaft tunnel of the ship. Other wells may be permitted if the arrangements give protection equivalent to that afforded by a double bottom complying with the present paragraph.

1.1.6.4.4 A double bottom need not be fitted in way of watertight compartments used exclusively for the carriage of liquids, provided the safety of the ship in the event of bottom damage is not thereby impaired.

1.1.6.5 The freeing ports in bulwarks shall be assigned proceeding from 3.2.13 of Load Line Rules for Sea-Going Ships.

The lower edges of freeing ports shall be arranged as near to the deck as practicable, but they shall not bear upon the sheerstrake.

In ships of 65 m in length and upwards a continuous slot shall generally be provided between the freeboard and sheerstrake edge instead of freeing ports.

1.1.6.6 Construction of watertight decks, trunks, etc. in passenger ships and cargo ships.

1.1.6.6.1 Watertight decks, trunks, tunnels, duct keels and ventilation ducts shall have a strength equal to that of watertight bulkheads fitted on the same level. Watertight ventilation ducts and trunks shall be carried at least to the bulkhead deck in passenger ships and at least to the freeboard deck in cargo ships.

1.1.6.6.2 Where a ventilation trunk passing through a structure penetrates the bulkhead deck, the trunk shall be capable of withstanding the water pressure that may be present within the trunk, after having taken into account the maximum heel angle allowable during intermediate stages of flooding, in accordance with 3.5.1.9, Part V "Subdivision".

1.1.6.6.3 Where all or part of the penetration of bulkhead deck is on the main ro-ro deck, the trunk shall be capable of withstanding impact pressure due to internal water motions of the trapped water on the vehicle deck.

1.1.6.6.4 In ships constructed before 1 July 1997, the requirements of 1.1.6.6.2 shall apply not later than the date of the first periodical survey after 1 July 1997.

1.2 MATERIALS

1.2.1 General.

The materials used for hull structures regulated by this Part of the Rules are to comply with the requirements of Part XIII "Materials".

1.2.2 Steel for hull structures.

1.2.2.1 Hull elements are to be fabricated of ordinary structural steel of grades A,B,D and E with the upper yield stress R_{eH}=235MPa and of AH,DH,EH and FH higher tensile steel of grades A32, D32, E32 and F32 with the upper yield stress R_{eH} =315 MPa, A36, D36, E36 and F36 steel grades with the upper yield stress R_{eH}=355 MPa, and A40, D40, E40 and F40 steel grades with the upper yield stress

R_{eH} = 390 MPa. The application of high strength steel grades D,E,F with the upper yield stress of 420 MPa and above is subject to special consideration by the Register in each case.

The application of high strength steel grades D, E, F with the upper yield stress of 420 MPa and above is subject to special consideration by the Register in each case.

1.2.2.2 In case of high local stresses in the thickness direction, steel with improved mechanical through-thickness properties (Z-steel, see 3.14, Part XIII "Materials") is to be used for the fabrication of structural members having a thickness in excess of 18 mm unless no measures are taken to structurally prevent lamellar tearing.

1.2.2.3 Where clad steel is used, the mechanical properties of the base material are not to be lower than those required for the steel grade specified in 1.2.3.1.

Hull structural steel stated in 3.2, Part XIII "Materials" is to be used as the base material.

1.2.3 Selection of steel grades for hull structures.

1.2.3.1 Steel grades for structural members, including those intended for prolonged exposure to low service temperatures, are to be selected according to Figs 1.2.3.1-1, 1.2.3.1-2 and 1.2.3.1-3 for various categories of structural members based on the adopted design thickness of the member concerned and the design temperature of the structure determined by a method approved by the Register.

1.2.3.2 The design temperature of the structures which come constantly or periodically in contact with ambient air are expressed in terms of minimum design temperature of ambient air T_A.

In the absence of any other provisions, for the value of T_A the minimum average daily air temperature is adopted which can take place during a five-year period of operation on the routes passing in the most unfavourable waters as regards cooling conditions.

1.2.3.3 In all cases the value of T_A is not to exceed:

- 40°C[1] for icebreakers of categories **ЛЛ9**, **ЛЛ8**, **ЛЛ7** and ships with ice strengthening of categories **ЛУ9**, **ЛУ8**, **ЛУ7**, **ЛУ6**, **ЛУ5**;
- 30°C for icebreakers of category **ЛЛ6** and ships with ice strengthening of category **ЛУ4**;
- 10°C for ships with ice strengthening of categories **ЛУ3**, **ЛУ2**;

0°C for ships with ice strengthening of category **ЛУ1**, as well as without ice strengthening.

1.2.3.4 An approximate determination of temperatures of structures is permitted based on the values of T_A obtained by this method in accordance with the recommendations given in Table 1.2.3.4.

1.2.3.5 At the design tensile stresses in the upper deck and side longitudinals (of sheerstrake) due to the still water hogging moment (σ_{sw}), exceeding the value $65/\eta$, the design temperature of longitudinals may be corrected by the value of $\Delta T_d = -10(\sigma_{sw}/65-1)$°C.

1.2.3.6 The design temperature of hull structures located within the refrigerated cargo spaces is to be assumed equal to the temperature in the refrigerated cargo space.

The design temperature of the structures forming boundaries of the refrigerated cargo spaces is to be assumed as follows:

with no insulation fitted on the side of the refrigerated cargo space, the temperature in this space;

Table 1.2.3.4

Hull structure	Insulation	Heating	Design temperature T_d		
			Cargo space region		Region of spaces other than cargo spaces
			tanks	holds	
Exposed part of strength deck, side plating portion above summer load waterline (for ships intended to operate in ice — above ice belt) as well as adjacent framing and portions up to 1,0 m wide of bulkhead structures, decks, platforms, topside tanks, etc.	Fitted	Not provided	T_A		
	Not relevant	Provided	$0{,}50T_A$		
	Not fitted	Not provided	$0{,}70T_A$	$T_A + 5$°C	$0{,}60T_A$
Strength deck portion under unheated superstructures	Not relevant	Not provided	-10°C		
External structures of superstructures and deckhouses	Fitted	Provided	$0{,}50T_A$		
		Not provided	$0{,}70T_A$		
Structures cooled on both sides with ambient air	Not fitted	Not provided	T_A		
Side plating portion in the region of alternating waterline. Ice belt of ships intended to operate in ice	Fitted	Not provided	$0{,}55T_A$		
	Not relevant	Provided	$0{,}35T_A$		
	Not fitted	Not provided	$0{,}40T_A$		

Note. For external structures of underwater portion of the hull T_d = 0°C.

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[1] If operation involves sailing into the mouths of northern rivers, the value of T_A is not to exceed -50°C.

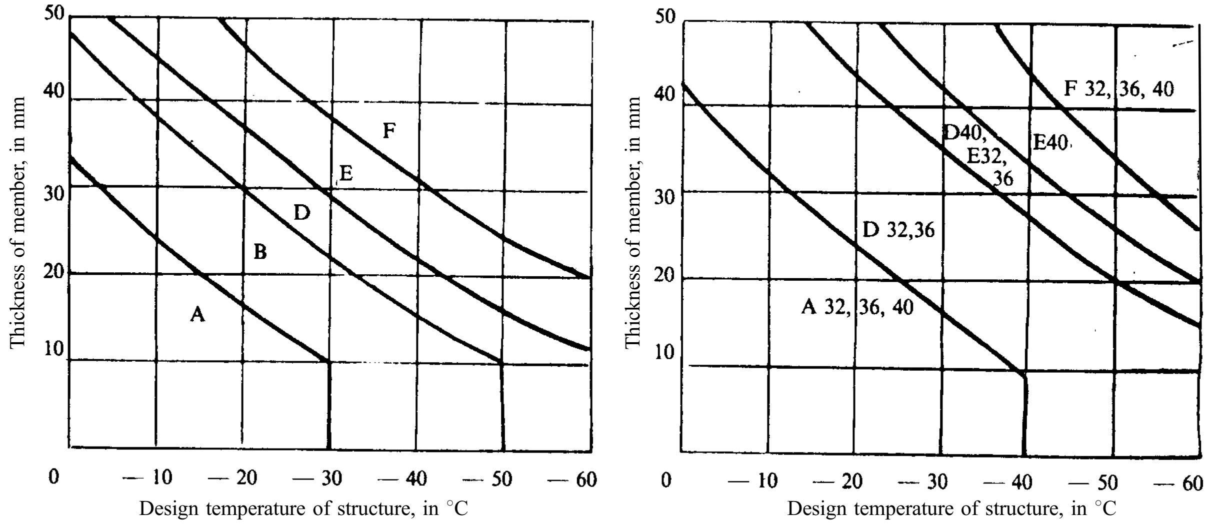


Fig. 1.2.3.1-1 Structural members of category I

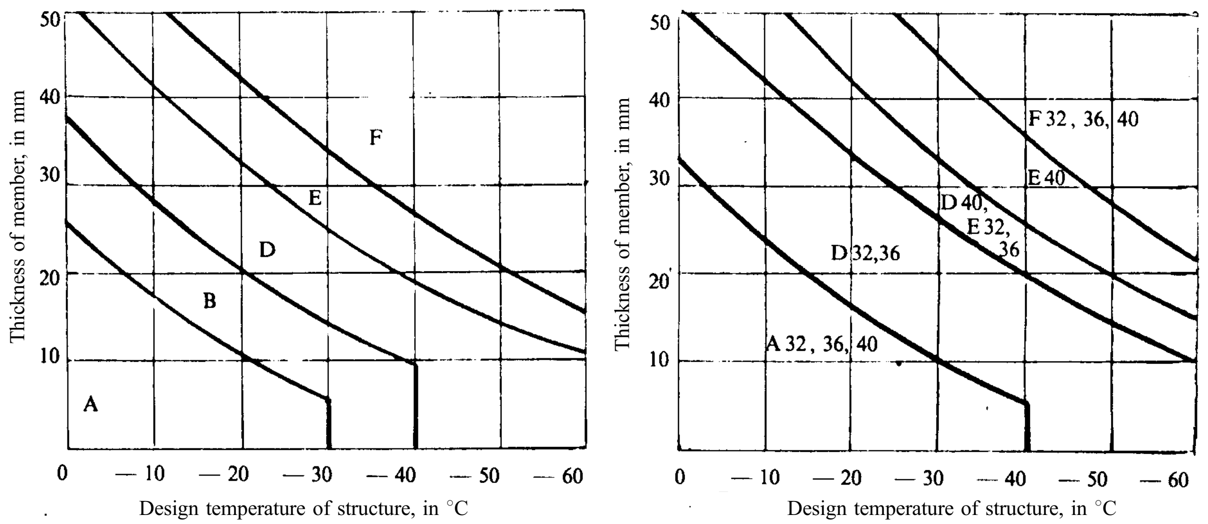


Fig. 1.2.3.1-2 Structural members of category II

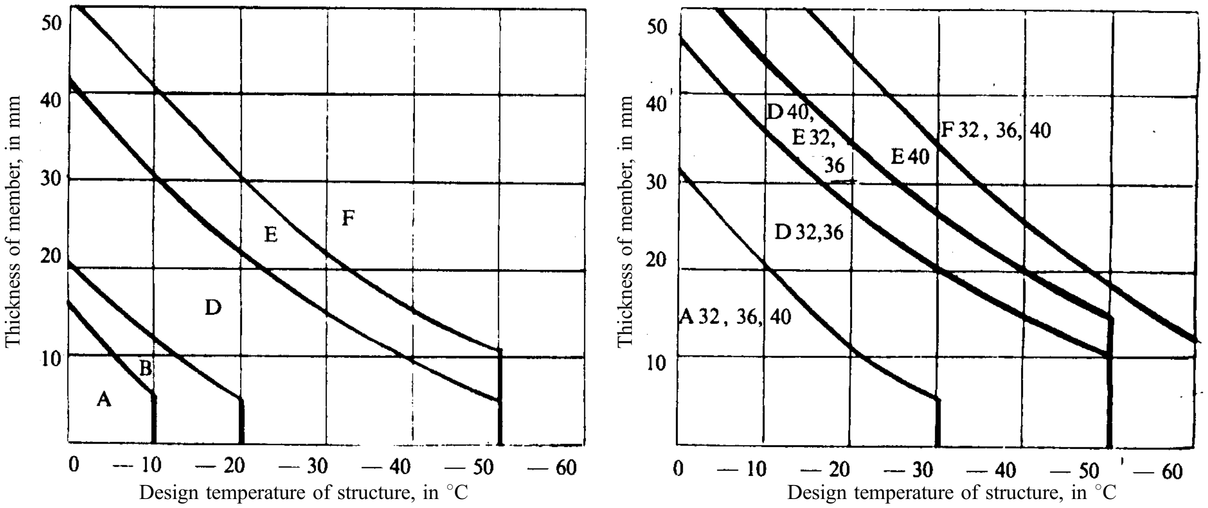


Fig. 1.2.3.1-3 Structural members of category III

with insulation fitted on the side of the refrigerated cargo space and with no insulation on the other side, the temperature on the uninsulated side of the boundary in the space;

with insulation fitted on both sides, arithmetical mean of the temperatures in the adjacent spaces.

см.Б1 **1.2.3.7** Depending on the level and type of applied stress, presence of stress concentrations, complexity of structural design of the assemblies and the workmanship, the assumed damage consequences for safety of the ship as a whole, the structural members are grouped into three application categories according to Table 1.2.3.7.

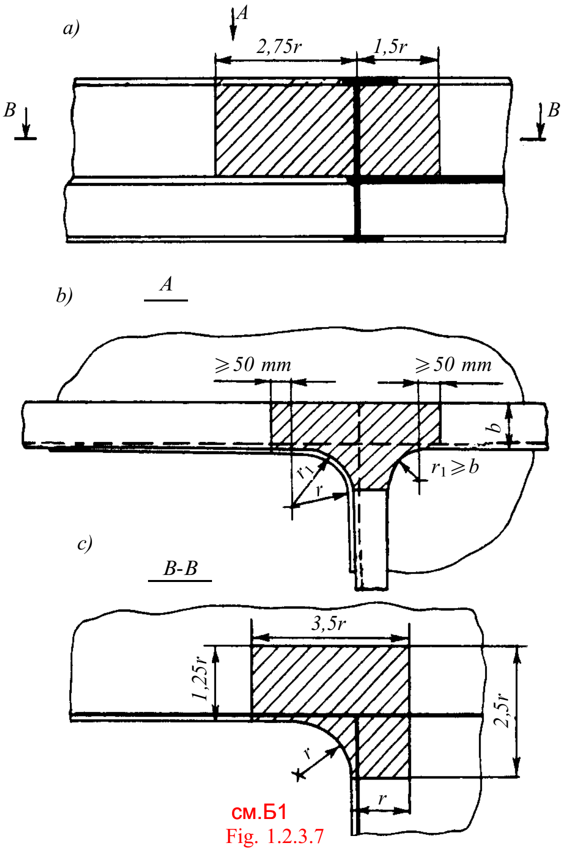
1.2.3.8 Structural members not mentioned in Table 1.2.3.7, whose scantlings are regulated by this Part of the Rules, are to be referred to category I.

1.2.3.9 For structures with high level of stress concentration, subject to dynamic loads (e.g. when mooring at sea) or being in combined stress state, the use of Grade D or Grade E steel may be required. Steel of Grade A is not permitted.

1.2.3.10 In the midship region, the breadth of strakes referred to category III or made of grade E or EH steel is not to be less than $800+5L$ mm, but it may not exceed 1800 mm.

1.2.3.11 For ships less than 40 m in length, steel specified for the categories of structural members outside the midship region according to Table 1.2.3.7 may be used throughout the length of the ship.

см.Б1-добавлено 1.2.3.12



см.Б1
Fig. 1.2.3.7
Areas of cargo hatch corners (lined) belonging to members referred to category III

см.Б1-добавл Table 1.2.3.7

Nos	Structural members	Member category	
		Midship region	Outside midship region
1	Sheerstrake and strength deck stringer plate[1]	III	II (I outside 0,6*L*)
2	Bilge strake[2,3]	III	II (1 outside 0,6*L*)
3	Strength deck strakes adjacent to longitudinal bulkheads[4], strength deck strakes at cargo hatchway corners including those of lower decks in refrigerated cargo spaces[5]	III	II (I outside 0,6*L*)
4	Continuous longitudinal coamings[6]	III	II (I outside 0,6*L*)
5	Transition sections of superstructures sides (see Fig. 2.12.5.3)	III	II (I outside 0,6*L*)
6	Other strength deck strakes except those between transverse edges of hatch openings	II	I
7	Strength deck longitudinals including those of upper strakes in longitudinal bulkheads, sheerstrake, sides of topside tanks	II	I
8	Strakes of bottom shell plating including plate keel and inner bottom plating	II	I
9	Upper strakes of longitudinal bulkheads and topside tanks	II	I
10	Discontinuous side coamings of hatchways on strength deck	II	I
11	External longitudinal members, plating and framing of long superstructures and plating of sides of short superstructures and deckhouses (1st tier)	II	I
12	Side plating at cargo ports corners[7]	II	I
13	Plating and framing (welded members) in ice-strengthening region I (see Figs 3.10.1.3.2 and 3.10.1.3.3); welded plate stems and sternframes of:		
	.1 ships of ice categories **ЛУ4, ЛУ3, ЛУ2, ЛУ1**	I	I
	.2 ships of ice categories **ЛУ9, ЛУ8, ЛУ7, ЛУ6, ЛУ5** and icebreakers irrespective of category	II	II
14	Rolled section framing of:		
	.1 ships irrespective of ice category and icebreakers of category **ЛЛ6**	I	I
	.2 icebreakers of categories **ЛЛ9, ЛЛ8** and **ЛЛ7**	II	II

[1] In the midship region of ships longer than 250 m, steel grades not lower than E or EH are to be used.

[2] In ships 150 m in length or below, category II members are to be fitted throughout their length, if double-bottomed from side to side.

[3] In ships longer than 250 m, steel grades not lower than D or DH are to be used.

[4] In ships broader than 70 m, at least three plating strakes adjacent to the longitudinal bulkhead are to be referred to member category III.

[5] The borders of areas where members referred to this category are used correspond to those shown in Fig. 1.2.3.7, *c*.

[6] A steel grade not lower than D or DG is to be used. The borders of areas where members referred to this category are used correspond to those shown in Fig.1.2.3.7 *a,b*.

[7] To be referred to member category II all along the ship length.

1.2.4 Aluminium alloys.

1.2.4.1 This Part of the Rules admits the following applications of aluminium alloys:

hull, superstructures and deckhouses, if $12 < L \leqslant 40$ m;

superstructures and deckhouses, if $L > 40$ m.

1.3 DESIGN LOADING

1.3.1 General.

1.3.1.1 This Chapter contains the basic formulae for determining the design weather loading on hull, ship acceleration at motions as well as loading from dry and liquid cargoes.

1.3.1.2 Wave impacts loading on the forward portion of the bottom and flare, loading from vehicles and deck heavy cargo as well as emergency loading are given in the chapters of the Rules pertaining to the appropriate structures.

1.3.1.3 Rules of determining the value and the load point of the design loading are specified in the appropriate chapters pertaining to particular structures. In the absence of such provisions the loading is assumed to be on the lower edge of the plate, at the middle of design span of the member or at the centre of the area taking up distributed load.

1.3.1.4 The basic parameter of design loading and accelerations on ship's hull exposed to weather is the wave factor c_w determined by the formulae:

$$c_w = 0{,}0856L \text{ for } L \leqslant 90 \text{ m},$$

$$c_w = 10{,}75 - \left(\frac{300 - L}{100}\right)^{3/2} \text{ for } 90 < L < 300 \text{ m},$$

$$c_w = 10{,}75 \text{ for } 300 \leqslant L \leqslant 350 \text{ m}. \qquad (1.3.1.4)$$

1.3.1.5 For ships of restricted area of navigation the wave factor c_w is to be multiplied by the reduction factor φ_r obtained from Table 1.3.1.5.

Table 1.3.1.5

Area of navigation	φ_r
I	1
II	$1{,}25 - 0{,}25L \cdot 10^{-2} \leqslant 1$
IIСП	$1{,}0 - 0{,}20L \cdot 10^{-2}$
IIIСП	$0{,}86 - 0{,}18L \cdot 10^{-2}$
III	$0{,}75 - 0{,}18L \cdot 10^{-2}$

1.3.2 External loading on ship's hull exposed to weather.

1.3.2.1 The design pressure p, in kPa, acting on the ship's hull exposed to weather is determined by the following formulae:

for the points of application of the loads below the summer load waterline

$$p = p_{st} + p_w; \qquad (1.3.2.1\text{-}1)$$

for the points of application of the loads above the summer load waterline

$$p = p_w \qquad (1.3.2.1\text{-}2)$$

where p_{st} = static pressure, in kPa, determined by the formula

$$p_{st} = 10z_i;$$

z_i = distance form the point of application of the load to the summer load waterline, in m;

p_w = as defined in 1.3.2.2.

1.3.2.2 The design pressure p_w, in kPa, due to ship's hull motion about the wave contour is determined by the following formulae:

for the points of application of the loads below the summer load waterline

$$p_w = p_{w_o} - 1{,}5c_w\frac{z_i}{d}; \qquad (1.3.2.2\text{-}1)$$

for the points of application of the loads above the summer load waterline

$$p_w = p_{w_o} - 7{,}5a_xz_i \qquad (1.3.2.2\text{-}2)$$

where $p_{wo} = 5c_wa_va_x$;

for c_w, see 1.3.1.4 and 1.3.1.5;

$$a_v = 0{,}8\frac{v_o}{\sqrt{L}}\left(\frac{L}{10^3} + 0{,}4\right) + 1{,}5;$$

$$a_x = k_x\left(1 - \frac{2x_1}{L}\right) \geqslant 0{,}267;$$

k_x = factor equal to 0,8 and 0,5 for hull sections forward and aft of the midship section respectively;

x_1 = distance of the considered section from the nearest fore or after perpendicular, in m;

for z_i, see 1.3.2.1.

In any case, the product a_va_x is not to be taken as less than 0,6.

Distribution of load p_w over the hull section contour is shown in Fig. 1.3.2.2.

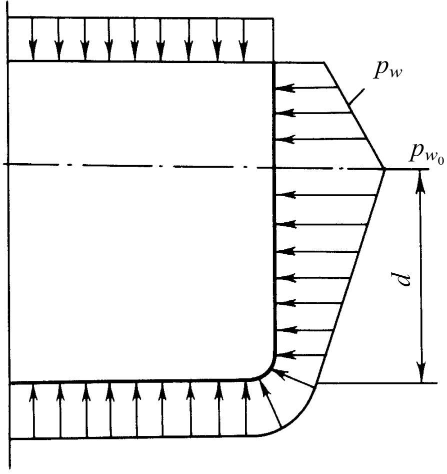


Fig. 1.3.2.2

1.3.3 Ship's acceleration at motions.

1.3.3.1 Design acceleration a, in m/s^2, at motions in waves is determined by the formula

$$a = \sqrt{a_c^2 + a_p^2 + 0,4a_r^2} \qquad (1.3.3.1\text{-}1)$$

where a_c = projection of ship's centre of gravity acceleration on the appropriate direction;

a_p, a_r = projections of pitching and rolling acceleration on the appropriate directions at the point under consideration.

Acceleration projections for the considered member on the vertical (index z), horizontal-transverse (index y) and horizontal-longitudinal (index x) directions are determined by the following formulae:

$$\begin{aligned}
a_{cx} &= 0,1(100/L)^{1/3}g\varphi_r;\\
a_{cy} &= 0,2(100/L)^{1/3}g\varphi_r;\\
a_{cz} &= 0,2(100/L)^{1/3}g\varphi_r;\\
a_{px} &= (2\pi/T_p)^2\psi z_0;\\
a_{py} &= 0;\\
a_{pz} &= (2\pi/T_p)^2\psi x_0;\\
a_{rx} &= 0;\\
a_{ry} &= (2\pi/T_r)^2\theta z_0;\\
a_{rz} &= (2\pi/T_r)^2\theta y_0
\end{aligned} \qquad (1.3.3.1\text{-}2)$$

where φ_r is given in Table 1.3.1.5 ($\varphi_r = 1$ for ships of unrestricted service);

T_p and T_r = pitching and rolling periods, in s, determined by the formulae:

$$T_p = \frac{0,8\sqrt{L}}{1 + 0,4\frac{v_0}{\sqrt{L}}\left(\frac{L}{10^3} + 0,4\right)}; \qquad (1.3.3.1\text{-}3)$$

$$T_r = cB/\sqrt{h}$$

where c = numerical factor determined on the basis of the data for the ship of similar type. As a first approximation, $c = 0,8$;

h = metacentric height for the most unfavourable conditions of operation; for a ship in fully loaded condition, $h \approx 0,07B$ unless more detailed data are available.

For a tanker in ballast condition, T_r, as a first approximation, can be determined by the formula

$$T_r \approx 3\sqrt[3]{B};$$

ψ = design angle of trim, in rad, determined by the formula

$$\psi = \varphi\frac{0,23}{1 + L\cdot10^{-2}} \qquad (1.3.3.1\text{-}4)$$

where for φ, see Table 1.4.4.3 ($\varphi = 1$ for ships of unrestricted service);

θ = design angle of heel, in rad, determined by the formula

$$\theta = \varphi_r\frac{0,6}{1 + 0,5L\cdot10^{-2}}; \qquad (1.3.3.1\text{-}5)$$

x_0 = distance of the considered point from the transverse plane passing through the ship's centre of gravity, in m;

y_0, z_0 = distance of the considered point from the centreline and the horizontal plane passing through the ship's centre of gravity respectively, in m.

If $L \leqslant 40$ m in the Formulae (1.3.3.1-4) and (1.3.3.1-5) L is to be taken equal to 40 m.

At all types of motions, the total acceleration in the vertical direction a_z, in m/s^2, can by determined be the formula

$$a_z = g\frac{0,9}{\sqrt[3]{L}}(1 + k_a) \qquad (1.3.3.1\text{-}6)$$

where $k_a = 1,6(1 - 2,5\,x_1/L) \geqslant 0$ in the forward region;

$k_a = 0,5(1 - 3,33x_1/L) \geqslant 0$ in the aft region;

for x_1, see 1.3.2.2.

If $L < 80$ m in the Formula (1.3.3.1-6), L is to be taken equal to 80 m.

1.3.4 Cargo, fuel and ballast loading.

1.3.4.1 Design pressure p_c, in kPa, on the grillages of cargo decks, platforms and double bottom from package cargo is determined having regard to inertia forces by the formula

$$p_c = h\rho_c g(1 + a_z/g) \qquad (1.3.4.1)$$

where h = design stowage height, in m;

ρ_c = density of the cargo carried, in t/m^3;

a_z = design acceleration in the vertical direction determined in accordance with 1.3.3.1,

but not less than 20 kPa.

1.3.4.2 The design pressure on the structures forming boundaries of the compartments intended for the carriage of liquid cargoes and ballast in tankers, the ballast tanks in dry cargo ships as well as the tanks for ballast and oil fuel is determined depending on their dimensions, the extent of filling and the height of air pipe.

By compartment is meant a tank or a part of a tank confined between the effective bulkheads. Both watertight and wash bulkheads with the total area of openings not over 10 per cent of the bulkhead area are considered as effective bulkheads.

1.3.4.2.1 The design pressure p_c, in kPa, on the structures of fully loaded compartments is determined by the following formulae:

$$p_c = \rho_c g(1 + a_z/g)z_i, \qquad (1.3.4.2.1\text{-}1)$$

$$p_c = \rho_c g(z_i + b\theta), \qquad (1.3.4.2.1\text{-}2)$$

$$p_c = \rho_c g(z_i + l\psi), \qquad (1.3.4.2.1\text{-}3)$$

$$p_c = 0,75\rho_c g(z_i + \Delta z), \qquad (1.3.4.2.1\text{-}4)$$

$$p_c = \rho_c g z_i + p_v \qquad (1.3.4.2.1\text{-}5)$$

where ρ_c = cargo, ballast or fuel density, in t/m^3, whichever is appropriate;

a_z = design acceleration in the vertical direction according to 1.3.3.1;

z_i = distance, in m, from the member concerned to the deck level (tank top) as measured at the centreline;

θ and ψ = as determined by the Formulae (1.3.3.1-4) and (1.3.3.1-5);

Δz = height, in m, of air pipe above deck (tank top), but is not to be less than: 1,5 m for the ballast tanks of dry cargo ships and for fresh water tanks, 2,5 m for the tanks of tankers and for fuel oil and lubricating oil tanks; for small expansion tanks and for lubricating oil tanks of less than 3 m^3 capacity, the minimum values of Δz are not stipulated;

p_v = pressure, in kPa, for which the safety valve is set, if fitted, but is not to be less than: 15 kPa for the ballast tanks of dry cargo ships and for fresh water tanks, 25 kPa for the tanks of tankers and for fuel oil and lubricating oil tanks; for small expansion tanks and for lubricating oil tanks of less than 3 m^3 capacity, the minimum values of p_v are not stipulated;

l and b = length and breadth, in m, of a compartment as measured at mid-height; if the values of l and/or b change abruptly over the compartment height, l and/or b are measured at mid-height of each compartment section where their variation is not appreciable; the Formulae (1.3.4.2-2) and (1.3.4.2-3) are used for each measured value of l and b accordingly,

whichever is the greater.

1.3.4.2.2 Where a compartment is to be partially filled proceeding from service conditions, with the compartment length $l \leqslant 0{,}13L$ and compartment breadth $b \leqslant 0{,}6B$, the design pressure p_c, in kPa, for the structures mentioned below should not be less than:

for the side, longitudinal bulkheads and adjoining compartment top within $0{,}25b$ of the line of compartment top and side intersection, or of the longitudinal bulkhead

$$p_c = \rho_c(5 - B/100)b; \qquad (1.3.4.2.2\text{-}1)$$

for transverse bulkheads and adjoining compartment top within $0{,}25l$ of the line of compartment top and transverse bulkhead intersection

$$p_c = \rho_c(4 - L/200)l. \qquad (1.3.4.2.2\text{-}2)$$

l and b are to be measured on the level of the free surface of liquid.

For compartments where $l > 0{,}13L$ and/or $b > 0{,}6B$, the design pressure for the case of partial flooding is determined in accordance with a special procedure approved by the Register.

1.3.4.3 The design pressure p_c, in kPa, on structures bounding the bulk cargo hold is determined by the formula

$$p_c = \rho_c g k_c(1 + a_z/g)z_i \qquad (1.3.4.3)$$

where for ρ_c, see 1.3.4.1;

$k_c = \sin^2\alpha\, \mathrm{tg}^2(45° - \varphi_{a.p}/2) + \cos^2\alpha$,

or

$k_c = \cos\alpha$,

whichever is the greater;

α = angle of web inclination to the base line, in deg.;

$\varphi_{i.f.}$ = internal friction angle of bulk cargo, in deg.;

a_z = design acceleration in the vertical direction according to 1.3.3.1;

z_i = vertical distance from the load application point to the free surface level of cargo, in m,

but not less than 20 kPa.

The pressure on the inner bottom is determined by the Formula (1.3.4.3) where $k_c = 1$.

1.3.4.4 The design pressure from package cargo acting upon the structures in horizontal plane is determined with regard for inertia forces. In the Formula (1.3.3.1-1) the acceleration in the horizontal-transverse direction is determined by the formula

$$a_y = \sqrt{a_{cy}^2 + (a_{ry} + g\sin\theta)^2}\,; \qquad (1.3.4.4\text{-}1)$$

and in the horizontal-longitudinal direction

$$a_x = \sqrt{a_{cx}^2 + (a_{px} + g\sin\psi)^2} \qquad (1.3.4.4\text{-}2)$$

where θ and ψ are determined by the Formulae (1.3.3.1-4) and (1.3.3.1-5).

1.4 LONGITUDINAL STRENGTH

1.4.1 General provisions and definitions.

1.4.1.1 The requirements of this Chapter apply to ships of unrestricted service and of restricted areas of navigation **I** and **II**, 65 m in length and upwards, as well as to ships of restricted areas of navigation **IIСП**, **IIIСП** and **III**, 60 m in length and upwards, whose proportions are stated in 1.1.1.1.

Ships with large deck openings and vessels of dredging fleet are to comply additionally with the requirements of chapters 3.1 and 3.6 respectively.

1.4.1.2 Special consideration is to be given to ships having the following characteristics:

.1 proportion

$L/B \leqslant 5$;

$B/D \geqslant 2{,}5$ (for ships of restricted areas of navigation **II**, **IIСП**, **IIIСП** and **III** the ratio B/D is obtained from Table 1.1.1.1);

.2 block coefficient $C_b < 0{,}6$;

.3 specified speed v_0 exceeding the value of v, in knots, determined by the formula

$$v = k\sqrt{L} \qquad (1.4.1.2.3)$$

where $k = 2{,}2$ if $L \leqslant 100$ m;

$k = 2{,}2 - 0{,}25\ (L - 100)/100$ if $L > 100$ m.

Special consideration will also be given to ships carrying heated cargoes and ships of unusual design and/or type.

1.4.1.3 For longitudinal strength calculation, design loads shall include still water bending moments and shear forces, wave bending moments and shear forces, and for ships with large flare, bending moments due to wave impacts on the flare as well.

Design wave and impact loads may be calculated both from formulae given in the Rules and according to the approved procedure taking into consideration the rolling in waves, long-term distribution of wave conditions and area of navigation.

1.4.1.4 Downward shear forces are assumed to be taken as positive values and upward shear forces — as negative values. The hogging bending moments are assumed to be taken as positive values and sagging bending moments — as negative values.

For the calculation of still water bending moment and shear force, transverse loads are to be integrated in the forward direction from the aft end of L; in this case, downward loads are assumed to be taken as positive values.

The sign conventions of still water bending moment and shear force are as shown in Fig. 1.4.1.4.

1.4.2 Symbols.

L_1 = length of the compartment considered, in m;

B_1 = breadth of the compartment considered, in m;

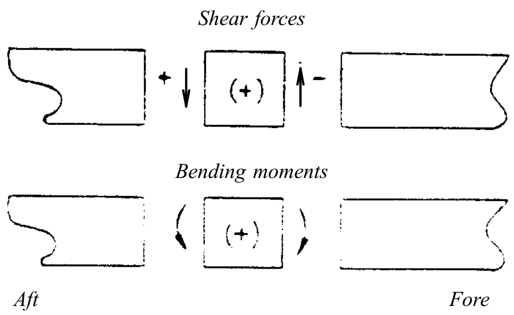


Fig. 1.4.1.4

A_F = difference between the area of horizontal upper deck projection (including forecastle deck) and summer load waterline on a length up to 0,2L aft from the forward perpendicular, in m^2;

z_F = vertical distance from the summer load waterline to the upper deck (forecastle deck included), as measured on the forward perpendicular, in m;

I = actual inertia moment of the hull about the horizontal neutral axis of the hull section under consideration, in cm^4;

S = actual statical moment, about the neutral axis, of the portion of the considered hull section, located above or below the level at which the thickness of the web is determined, in cm^3;

x = distance of the considered hull section from the after perpendicular, in m.

1.4.3 Still water bending moments and shear forces.

1.4.3.1 The still water bending moments and shear forces are to be calculated for all actually possible cases of weight distribution over the length of the ship including full-load and ballast conditions for departure and arrival of the ship. см.Б1

As a rule, when determining the scantlings of framing members, consideration is to be given to the following loading conditions:

.1 for dry cargo ships, ships with large deck opening, roll on-roll off ships, refrigerated cargo ships, bulk carriers and ore carriers:

homogeneous loading conditions at maximum draught;

ballast condition;

special loading conditions, e.g. container or light load conditions at less than the maximum draught, heavy cargo, empty holds or non-homogeneous cargo conditions, deck cargo conditions, etc., where applicable;

short voyage, where applicable;

loading and unloading transitory conditions;

docking condition afloat; см.Б1

.2 for oil tankers:

homogeneous loading conditions (excluding dry and clean ballast tanks);

partly loaded and ballast conditions for both departure and arrival;

any specified non-uniform distribution of loading;

mid-voyage conditions relating to tank cleaning or other operations where these differ significantly from the ballast conditions;

loading and unloading transitory conditions;

docking condition afloat;

.3 for combination carriers:

loading conditions as specified for dry cargo ships and oil tankers.

If partially filled ballast tanks are used in the ballast condition of the ship, all intermediate conditions of the above tanks filling between empty and full shall be considered.

1.4.3.2 The maximum absolute values of sagging and hogging bending moments M_{sw} and shear force N_{sw} are to be determined for any section along the ship's length for all the still water loading conditions, which are possible in service.

The values M_{sw} and N_{sw} are regarded further as design values for the section under consideration.

1.4.3.3 For ships without effective longitudinal bulkheads, with non-uniform distribution of loading, i.e. alternation of loaded and empty holds, the still water shear force curve may be corrected by reducing its ordinates on transverse bulkheads by a value equal to the total of bottom longitudinal responses in way of those bulkheads in the event of bottom bending (Fig. 1.4.3.3).

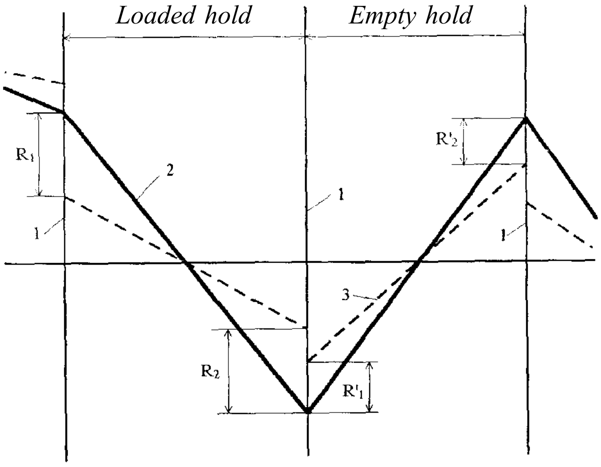


Fig. 1.4.3.3
Shear force curve correction diagram:
1 — transverse bulkhead; *2* — uncorrected curve;
3 — corrected curve; R_1 and R_2 — total of bottom longitudinal responses for a loaded hold in way of aft bulkhead and forward bulkhead accordingly; R'_1 and R'_2 = same for an empty hold

The bottom longitudinal responses in way of transverse bulkheads are to be determined on the basis of the bottom grillage calculation in accordance with 3.3.4.1. The design loads to be considered are not to include the wave loads mentioned under 1.3.2.2, the angles of heel, trim and accelerations at motions determined in accordance with 1.3.3.1.

1.4.3.4 Where provision is made in ship's design for loading conditions resulting in regular change of a sign of the still water bending moment (in fully loaded and ballast conditions on direct and return voyages), its components at the section with the maximum range of bending moment (Fig. 1.4.3.4) are to be determined for use in the calculation under 1.4.6.3.

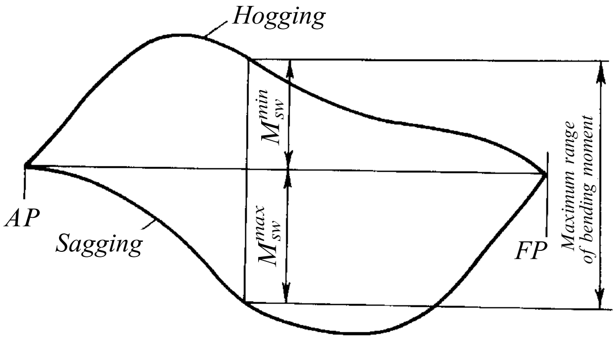


Fig. 1.4.3.4

1.4.4 Wave bending moments and shear forces.

1.4.4.1 The wave bending moment M_w, in kN/m, acting in the vertical plane at the section under consideration is to be determined by the formulae:

hogging bending moment

$$M_w = 190 c_w B L^2 C_b \alpha \cdot 10^{-3} ; \quad (1.4.4.1\text{-}1)$$

sagging bending moment

$$M_w = -110 c_w B L^2 (C_b + 0{,}7) \alpha \cdot 10^{-3} \quad (1.4.4.1\text{-}2)$$

where c_w = as determined from 1.3.1.4;
α = coefficient determined from Table 1.4.4.1 and Fig. 1.4.4.1;
C_b = as defined in 1.1.3, but not less than 0,6.

Table 1.4.4.1

Position of section along the ship's length	α
$\frac{x}{L} < 0{,}4$	$2{,}5\,\frac{x}{L}$
$0{,}4 \leqslant \frac{x}{L} \leqslant 0{,}65$	1
$\frac{x}{L} > 0{,}65$	$\frac{(1-x/L)}{0{,}35}$

1.4.4.2 The wave shear force N_w, in kN, at the section concerned is to be determined by the formulae:

positive

$$N_w = 30 c_w B L (C_b + 0{,}7) f_1 \cdot 10^{-2}; \quad (1.4.4.2\text{-}1)$$

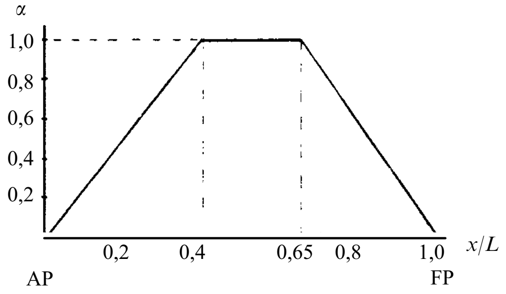


Fig. 1.4.4.1

negative

$$N_w = -30 c_w B L (C_b + 0{,}7) f_2 \cdot 10^{-2} \quad (1.4.4.2\text{-}2)$$

where c_w = as determined from 1.3.1.4;
C_b = as defined in 1.1.3, but not less than 0,6;
f_1 and f_2 = coefficients determined from Table 1.4.4.2, Figs 1.4.4.2-1 and 1.4.4.2-2.

Table 1.4.4.2

Position of section along the ship's length	f_1	f_2
$0 \leqslant x/L < 0{,}2$	$7{,}945 f_0 x/L$	$4{,}6x/L$
$0{,}2 \leqslant x/L \leqslant 0{,}3$	$1{,}59 f_0$	0,92
$0{,}3 < x/L < 0{,}4$	$1{,}59 f_0 - (15{,}9 f_0 - 7) \times (x/L - 0{,}3)$	$0{,}92 - 2{,}2(x/L - 0{,}3)$
$0{,}4 \leqslant x/L \leqslant 0{,}6$	0,7	0,7
$0{,}6 < x/L < 0{,}7$	$0{,}7 + 3(x/L - 0{,}6)$	$0{,}7 + (17{,}3 f_0 - 7) \times (x/L - 0{,}6)$
$0{,}7 \leqslant x/L \leqslant 0{,}85$	1,0	$1{,}73 f_0$
$0{,}85 < x/L \leqslant 1{,}0$	$1 - 6{,}67(x/L - 0{,}85)$	$f_0[1{,}73 - 11{,}53(x/L - 0{,}85)]$
$f_0 = \frac{C_b}{C_b + 0{,}7}$		

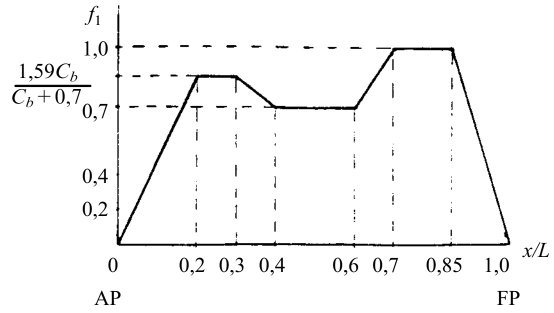


Fig. 1.4.4.2-1

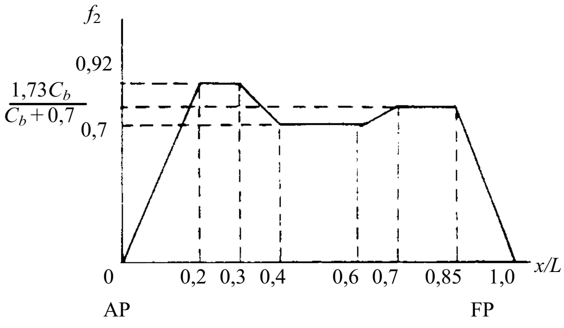


Fig. 1.4.4.2-2

1.4.4.3 For ships of restricted area of navigation, the wave bending moments and shear forces determined in accordance with 1.4.4.1 and 1.4.4.2 are to be multiplied by the reduction factor φ obtained from Table 1.4.4.3 as well as by the factors ϕ and v determined by the following formulae:

$$\phi = 0{,}95(1 + \rho_n f \cdot 10^{-2}); \qquad (1.4.4.3\text{-}1)$$

$$v = \frac{1}{1 + \Delta} \qquad (1.4.4.3\text{-}2)$$

where $\rho_n = \alpha^2(0{,}5 + 2{,}5\sin\beta_0) \geqslant \alpha$ for conventional bow shape (no bulb);
$\rho_n = \alpha^2(1 + \alpha^2) \geqslant 1$ for a bulbous bow;
α = waterplane area coefficient for summer load waterline;
β_0 = angle, in deg., between a frame tangential and a vertical at the level of summer load waterline at the section within $0{,}4(1 - C_b)L \leqslant 0{,}1L$ from the fore perpendicular;

$$f = \left\{\frac{Lv_0}{430D_1\eta\varphi}\left[\frac{2{,}5}{\varphi^{0{,}3}} + 1{,}5\left(\frac{L}{100}\right)^{2/3}\right]\right\}^{1{,}5}\left(\frac{L}{100}\right)^{0{,}75};$$

$D_1 = D + h_c$;
h_c = height of continuous hatch side coamings, in m (where these are not fitted, $h_c = 0$);

$$\Delta = 0{,}045(\alpha - 0{,}25)^2 \frac{L}{20D_1\eta\varphi} \cdot \frac{L}{100}.$$

The above requirements apply to ships of restricted area of navigation, from 60 to 150 m in length. Application of the requirements to ships of a different length is subject to special consideration by the Register.

Table 1.4.4.3

Area of navigation	φ
I	$1{,}1 - 0{,}23L \cdot 10^{-2} \leqslant 1$
II	$1{,}0 - 0{,}25L \cdot 10^{-2}$
IIСП	$0{,}94 - 0{,}26L \cdot 10^{-2}$
IIIСП	$0{,}71 - 0{,}22L \cdot 10^{-2}$
III	$0{,}60 - 0{,}20L \cdot 10^{-2}$

1.4.5 Bending moment due to wave impacts on the flare.

1.4.5.1 The bending moment due to wave impacts on the flare is to be calculated only for ships of length from 100 to 200 m where the relationship $A_F/Lz_F \geqslant 0{,}1$ is satisfied.

1.4.5.2 The sagging bending moment due to wave impacts on the flare M_F is to be calculated as follows:

$$M_F = -k_F c_w BL^2(C_b + 0{,}7)\alpha_F \cdot 10^{-3} \qquad (1.4.5.2)$$

where $k_F = 7(1 + 1{,}25v_0/\sqrt{L})c_1c_2$, but not more than 23;
$c_1 = (L - 100)/30$ for $100 \leqslant L < 130$ m;
$c_1 = 1$ for $130 \leqslant L \leqslant 170$ m;
$c_1 = 1 - (L - 170)/30$ for $170 < L \leqslant 200$ m;
$c_2 = 5A_F/Lz_F - 0{,}5$ at $0{,}1 \leqslant A_F/Lz_F \leqslant 0{,}3$;
$c_2 = A_F/Lz_F + 0{,}7$ at $0{,}3 < A_F/Lz_F < 0{,}4$;
$c_2 = 1{,}1$ at $A_F/Lz_F \geqslant 0{,}4$;
for c_w, see 1.3.1.4;
α_F is obtained from Table 1.4.5.2 and Fig. 1.4.5.2.

Table 1.4.5.2

Position of section along the ship's length	α_F
$x/L \leqslant 0{,}15$	$0{,}667x/L$
$0{,}15 < x/L < 0{,}45$	$0{,}1 + 3(x/L - 0{,}15)$
$0{,}45 \leqslant x/L \leqslant 0{,}75$	1
$x/L > 0{,}75$	$1 - 4(x/L - 0{,}75)$

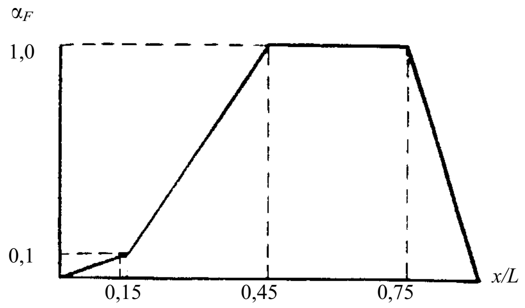


Fig. 1.4.5.2

1.4.5.3 For ships of restricted area of navigation, the bending moment due to wave impacts on the flare M_F calculated in accordance with 1.4.5.2 is to be multiplied by the reduction factor φ determined from Table 1.4.4.3. For ships of restricted areas of navigation **IIIСП** and **III** $M_F = 0$.

1.4.6 Hull section modulus and moment of inertia.

1.4.6.1 The requirements of this paragraph regulate the hull section modulus and moment of inertia about the horizontal neutral axis.

1.4.6.2 The hull section modulus (for deck and bottom) W, in cm³, at the section concerned is not to be less than:

$$W = \frac{M_T}{\sigma} \cdot 10^3 \qquad (1.4.6.2)$$

where $M_T = |M_{sw} + M_w|$ — design bending moment, in kN·m, at the section concerned equal to the maximum absolute value of algebraic sum of M_{sw} and M_w components at this section;
for M_{sw}, see 1.4.3, in kN·m;
for M_w, see 1.4.4;

$$\sigma = \frac{175}{\eta} \text{ MPa}.$$

1.4.6.3 In cases specified by 1.4.3.4 the section modulus W determined in accordance with 1.4.6.2 is to be multiplied by the factor m obtained from the formula

$$m = 1 + \frac{M_{sw}^{\min}}{10M_{sw}^{\max}}\left(\frac{M_{sw}^{\min} + M_{sw}^{\max}}{0{,}076c_wBL^2(C_b + 0{,}7)} - 1\right) \qquad (1.4.6.3)$$

where $M_{sw}^{\min}$, $M_{sw}^{\max}$ = absolute values of hogging and sagging bending moments at the maximum range section, in kN·m (see Fig. 1.4.3.4),

but not less than 1.

1.4.6.4 For ships for which the bending moment due to wave impacts on the flare (see 1.4.5) is to be considered the section modulus W, in cm^3, at the section concerned is not to be less than:

$$W = \frac{M_T}{\sigma} \cdot 10^3 \quad (1.4.6.4)$$

where $M_T = |M_{sw} + M_w + M_F|$ — design bending moment, in kN·m, at the section concerned equal to the maximum absolute value of algebraic sum of M_{sw}, M_w and M_F components at this section;
M_{sw} = maximum still water sagging bending moment or minimum hogging bending moment if solely the hogging bending moments occur at this hull section, in kN·m;
M_w = wave sagging bending moment (see 1.4.4);
M_F = as determined from 1.4.5;
for σ , see 1.4.6.2.

1.4.6.5 The hull section modulus determined from 1.4.6.2 to 1.4.6.4 for maximum value of design bending moment is to be maintained within 0,4L amidships. However, if the maximum design bending moment occurs outside 0,4L amidships, the steady section modulus requirement is applicable over the ship's length up to the section where maximum design bending moment acts.

The section modulus is to be gradually reduced towards the ship's ends outside the region in which it is being maintained.

1.4.6.6 For sharp-lined ships without middle-body, deviation from the requirements of 1.4.6.5 may be permitted on agreement with the Register.

1.4.6.7 In any case, the hull section modulus, in cm^3, within the midship region (for deck and bottom) is not to be less than:

$$W_{\min} = c_w B L^2 (C_b + 0{,}7)\eta \quad (1.4.6.7\text{-}1)$$

where for c_w, see 1.3.1.4.

For ships of restricted area of navigation, the minimum hull section modulus, in cm^3, within the midship region (for deck and bottom) is not to be less than $W_{\min_1}$ or $W_{\min_2}$, whichever is the greater, determined by the following formulae:

$$W_{\min_1} = \varphi W_{\min}; \quad (1.4.6.7\text{-}2)$$

$$W_{\min_2} = 0{,}95 \phi \nu \varphi W_{\min} \quad (1.4.6.7\text{-}3)$$

where for φ, see Table 1.4.4.3;
for ϕ, see the Formula (1.4.4.3-1);
for ν, see the Formula (1.4.4.3-2).

1.4.6.8 Scantlings of all continuous longitudinal members of hull girder based on the section modulus requirement in 1.4.6.7 are to be maintained within 0,4L amidships. However, in special cases, based on consideration of type of ship, hull form and loading conditions, the scantlings may be gradually reduced towards the ends of the 0,4L part, bearing in mind the desire not to inhibit the vessel's loading flexibility.

1.4.6.9 The moment of inertia of hull section I, in cm^4, within the midship region is not to be less than:

$$I_{\min} = 3 c_w B L^3 (C_b + 0{,}7) \quad (1.4.6.9\text{-}1)$$

where c_w = as determined from 1.3.1.4.

For ships of restricted area of navigation, $I_{\min}$ is to be multiplied by the reduction factor φ_0 determined by the formula

$$\varphi_0 = \varphi\eta \frac{18}{(L/D)_{\max}} \quad (1.4.6.9\text{-}2)$$

where for φ, see Table 1.4.4.3;
for η, see 1.1.4.3;
$(L/D)_{\max}$ = maximum permissible value of L/D for the area of navigation under consideration, obtained from Table 1.1.1.1.

1.4.7 Thickness of side shell plating and continuous longitudinal bulkhead plating.

1.4.7.1 The thickness of side shell plating s, in mm, at the considered section over the length and depth of the ship where longitudinal bulkheads are not fitted is not to be less than:

$$s = \frac{0{,}5(N_{sw} + N_w)}{\tau} \frac{S}{I} \cdot 10^2 \quad (1.4.7.1)$$

where N_{sw} = as defined in 1.4.3.2, in kN;
for N_w, see 1.4.4.2 and 1.4.4.3;
τ = 110/η MPa.

1.4.7.2 The thickness of side shell plating s_s and thickness of longitudinal bulkhead plating s_l, in mm, at the section under consideration for ships with two plane longitudinal bulkheads are not to be less than:

$$s_s = \frac{N_{sw} + N_w}{\tau} \frac{S}{I} \alpha_s \cdot 10^2 ; \quad (1.4.7.2\text{-}1)$$

$$s_l = \frac{N_{sw} + N_w}{\tau} \frac{S}{I} \alpha_l \cdot 10^2 \quad (1.4.7.2\text{-}2)$$

where for N_{sw}, N_w, see 1.4.7.1;
α_s = 0,27;
α_l = 0,23.

1.4.7.3 For ships having one or more than two continuous plane longitudinal bulkheads as well as longitudinal bulkheads with horizontal corrugations the required thickness of side plating and members in question is to be calculated according to the procedure approved by the Register.

Appropriate calculation may also be required for ships with two continuous longitudinal bulkheads if the transverse distribution of load is substantially different from uniform distribution.

1.4.8 Calculation of actual hull section modulus.

1.4.8.1 The hull section modulus is determined:

for strength deck W_d, at moulded deck line at side (lower edge of deck stringer);

for bottom W_b, at moulded base line (top of plate keel).

For ships with continuous longitudinal strength members above strength deck including trunk and continuous hatch side coamings, W_d is calculated by dividing the moment of inertia of hull section about the horizontal neutral axis by the value of z_t determined by the formula

$$z_t = z(0,9 + 0,2y/B) \qquad (1.4.8.1)$$

where z = distance from neutral axis to the top of continuous strength member above deck included in the calculation of W_d, in m;

y = horizontal distance from the centreline of the ship to the top of continuous strength member above deck included in the calculation of W_d, in m.

z and y are to be measured to the point giving the largest value of z_t.

1.4.8.2 When calculating the hull section modulus, all continuous longitudinal strength members are to be taken into account, including continuous hatch side coamings, and, where the ship's design provides for multiple hatchways — the longitudinal deck strips between them on condition the deck strips are effectively supported by longitudinal bulkheads, including the topside tank bulkheads (inner skins).

The sectional area of long bridges or deckhouses is to be included with the reduction coefficient which similarly to stresses in the ship's hull and superstructure (deckhouse) is determined according to the procedure approved by the Register.

Continuous hatch side coamings in ships with single hatches not above the mentioned structures may be included in the calculation of the hull section modulus only if the calculation has been specially approved to this effect.

The sectional area of longitudinal deck strips, each being of a uniform width throughout the length, including deck plating with longitudinal framing and hatch side coamings not supported by longitudinal bulkheads, is included with the reduction coefficient ξ determined by the formula

$$\xi = m + \frac{0,65 + C_b}{3} \cdot \frac{L}{\Sigma l_H + \Delta l_1 + \Delta l_2} \qquad (1.4.8.2)$$

where $m = \begin{cases} - \ 0,10 \text{ at } n = 1; \\ - \ 0,12 \text{ at } n = 2; \end{cases}$

n = number of longitudinal strips over ship's breadth;

Σl_H = total length of longitudinal deck strips, in m;

Δl_1, Δl_2 = length of end attachments of longitudinal deck strips aft and forward, in m.

If the end of the longitudinal deck strip is effectively attached to continuous deck and/or longitudinal bulkhead (Fig. 1.4.8.2),

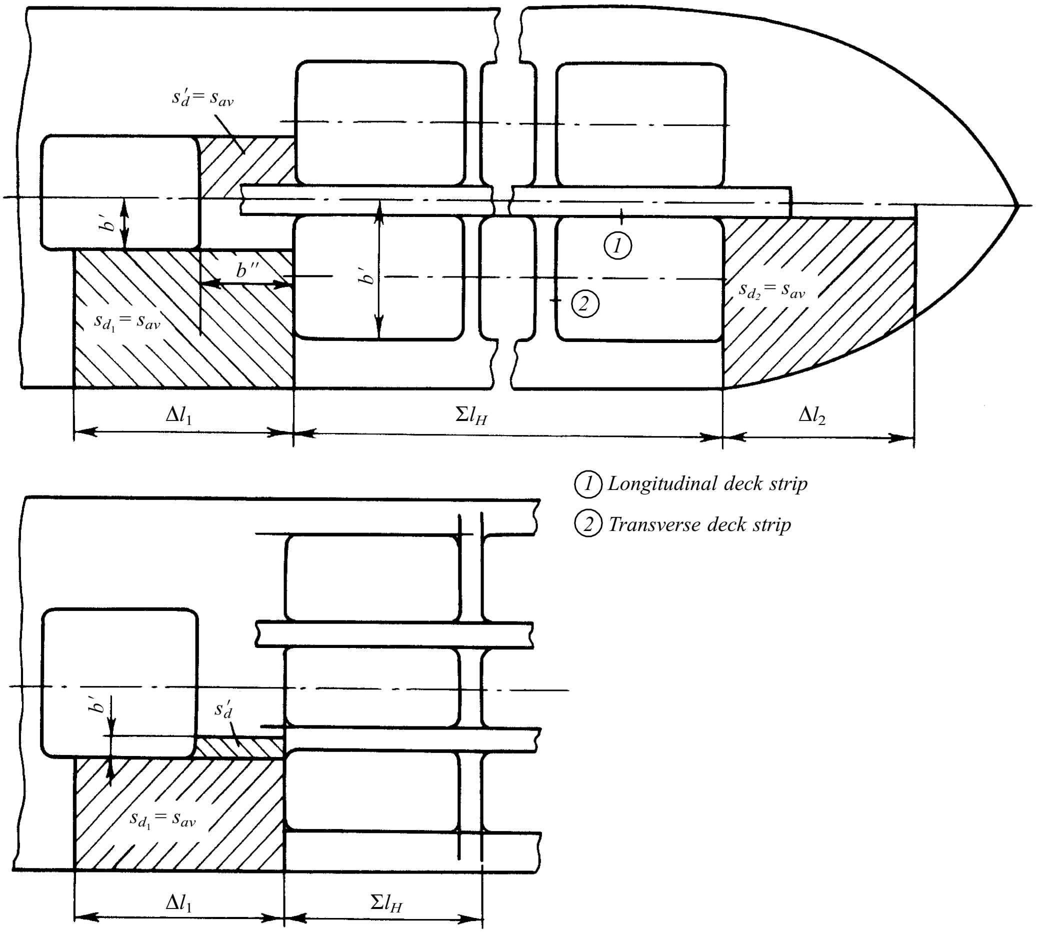


Fig. 1.4.8.2
Longitudinal deck strips to be included in the calculation of hull section modulus

$$\Delta l_{1,2} = 4f/B_{1,2}\, s_{d_{1,2}}$$

where f = sectional area of one longitudinal deck strip, in cm^2;
$B_{1,2}$ = breadth of ship in way of longitudinal deck strip termination, in m;
$s_{d_{1,2}}$ = average thickness of the portion of deck plating between the extension of longitudinal deck strip and ship's side along the effective attachment, in mm.

Where a longitudinal deck strip terminates at the transverse deck strip, provided $10b''s'_d \geqslant nf$ and $b'' > b'$

$$\Delta l_{1,2} = 1{,}3n \frac{f}{10s'_d} (b'/b'' + 1)$$

where s'_d = average plate thickness of the transverse deck strip, in mm;
b' = distance between longitudinal edge of the hatch opening and symmetry plane of the longitudinal deck strip, in m;
b'' = length of transverse deck strip, in m.

1.4.8.3 Large openings, i.e. openings exceeding 2,5 m in length and/or 1,2 m in breadth, and scallops, where scallop-welding is applied, are to be deducted from the sectional areas used in the section modulus calculation.

Smaller openings (manholes, lightening holes, single scallops in way of welds, etc.) need not be deducted, if the following conditions are met:

the sum of their breadths and shadow area breadths (Fig. 1.4.8.3) in one transverse section of the hull does not exceed 0,06 ($B - \Sigma b$) (where Σb is the total breadth of openings) or does not reduce the section modulus at deck or bottom by more than 3 per cent;

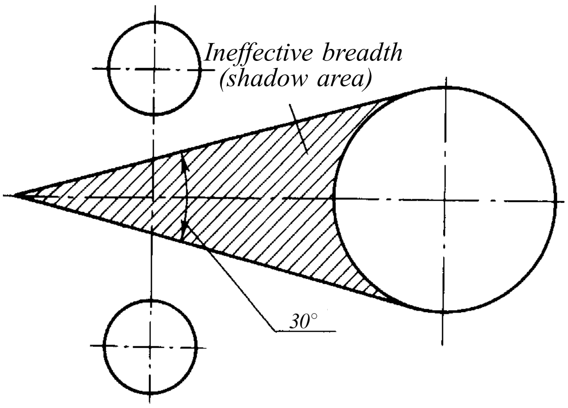


Fig. 1.4.8.3
Design section

the height of lightening holes, drain holes and single scallops in longitudinal members does not exceed 25 per cent of the web depth, and the height of scallops in way of welds is not over 75 mm.

1.4.8.4 Where continuous longitudinal members are built of higher tensile steel, they are to extend so far beyond amidships towards the ends as to provide a hull section modulus in way where the yield stress changes not less than required for an identical hull of ordinary steel.

1.4.8.5 The continuous longitudinal members at a distance from horizontal neutral axis of hull section greater than:

$$\frac{z}{\eta}\ \frac{W_a}{W_{\eta=1}} \tag{1.4.8.5}$$

where z = distance of strength deck (upper face plate of continuous hatch side coaming) or bottom from neutral axis, in m;
η = factor given in Table 1.1.4.3 for the members of the remainder of hull section;
W_a, $W_{\eta=1}$ = actual section modulus and Rule section modulus with $\eta = 1$ for the deck (continuous hatch coaming) or bottom respectively,

are to be made of steel with the same yield stress as the strength deck (continuous hatch coaming) or bottom.

1.4.9 Loading control facilities.

1.4.9.1 By loading control facilities are meant Loading Manual and loading instrument by means of which it can be ascertained that the still water bending moments, shear forces, and the still water torsional and lateral loads, where applicable, in any load or ballast condition will not exceed the specified permissible values.

1.4.9.2 Ships to be provided with loading control facilities are categorized as follows.

Category I:

ships with large deck opening, for which combined stresses due to vertical and horizontal hull girder bending, as well as torsional and lateral loads, have to be considered;

ships for which uneven loading, i.e. uneven distribution of cargo and/or ballast, is possible. Ships of less than 120 m in length, which design takes uneven distribution of cargo or ballast into account, belong to category II;

chemical tankers and gas carriers.

Category II:

ships with arrangement giving small possibilities for variation in cargo and ballast distribution, ships on regular and fixed trading pattern where the Loading Manual gives sufficient guidance and in addition ships not falling under category I.

1.4.9.3 A Loading Manual is a document approved by the Register which describes:

the loading conditions on which the design of the ship has been based;

permissible limits of still water bending moment and shear force and, where applicable, limitations due to torsional and lateral loads;

the results of the calculations of still water bending moments, shear forces for loading conditions stated in 1.4.3.1;

the allowable local loadings for the structure (hatch covers, decks, double bottom, etc.).

1.4.9.4 A loading instrument is an instrument approved by the Register, which is either analog or digital by means of which the still water bending moments, shear forces and torsional and lateral loads, where required, in any load or ballast condition can be easily and quickly checked at specified readout points.

The number and position of sections and permissible still water bending moments and shear forces as well as the limitations due to torsional and lateral loads are to be approved by the Register.

Single point loading instruments are not acceptable.

An approved operational manual is to be provided for the loading instrument.

1.4.9.5 All ships other than category II ships of less 90 m in length, which deadweight is not greater than 30 per cent of summer loadline displacement, are to be provided with the Loading Manual approved by the Register. In addition to the Loading Manual, all ships of category I are to carry a loading instrument approved by the Register (requirements for loading instruments are given in Annex 4).

1.4.9.6 For bulk carriers, ore carriers, ore-oil carriers and oil-bulk carriers having a length of 150 m and more, additional requirements for strength control during loading are given in 3.3.6.

1.4.9.7 Information (booklet) on stability and strength during loading, unloading and stowage of bulk cargoes other than grain.

To prevent excessive hull stresses, provision should be made for Information (booklet) on stability and strength during loading, unloading and stowage of bulk cargoes other than grain to be carried on board, including the following as a minimum:

.1 stability data required in 1.4.11.4, Part IV "Stability";

.2 data on the capacity of ballast tanks and of equipment for their filling and emptying;

.3 maximum permissible load upon a unit of double-bottom plating surface;

.4 maximum permissible cargo hold load;

.5 general instructions concerning loading and unloading and pertinent to hull strength, including any limitations due to the worst operating conditions during loading, unloading, handling of water ballast, and during the voyage;

.6 any special limitations, for instance, those due to the worst operating conditions, where applicable;

.7 where necessary — strength calculations: maximum permissible forces and moments affecting the hull during loading, unloading and the voyage.

The Information (booklet) is to be drawn up in the language familiar to the ship officers, and in English.

1.4.9.8 When developing the Loading Manual and Information (booklet) on Ship Stability and Strength During Loading, Unloading and Stowage of Bulk Cargoes Other Than Grain, one should be guided by the recommendations contained in Collection of Regulating Documents of the Register No 9.

1.5 VIBRATION OF HULL STRUCTURES. VIBRATION STANDARDS

1.5.1 General.

1.5.1.1 Main and local hull vibration may be determined for a preliminary assessment of vibration parameters at the design stage. Irrespective of the results of vibration calculations for the first ship of a series or for single buildings, vibrations are to be measured in order to determine the vibrational characteristics of ships proceeding from the standards of permissible vibration parameters given in 1.5.7.

The measurement procedure stipulating the scope and sequence of measurements is to be approved by the Register.

1.5.1.2 The standards of permissible parameters of the main hull vibration of ships under way and local vibration of hull structures are the basic criterion for an estimate of their vibration characteristics. The standards have been established proceeding from the condition of ensuring the strength of hull structures.

Besides the purposes of 1.5.1.1, the vibration standards may be used for evaluation of vibration in ships being designed by comparing them with the appropriate calculation results (see 1.5.5).

Vibration standards for ship machinery and equipment shall be found in Section 9, Part VII "Machinery Installations".

1.5.2 Application.

The requirements of this Chapter specifying the procedure of performing the calculations of the main hull vibration (see 1.5.3) apply to sea-going displacement ships with metal hull of 80 m in length and above.

1.5.3 Definitions.

Main hull vibration means vibration of ship's hull generated by the forces involved on account of operation of propeller, main engine or caused by the action of waves.

Vibration of superstructures and deckhouses means vibration of superstructures and deckhouses about the hull generated by its vibrations (mainly, bending and longitudinal).

Local vibration means vibration of hull structures (plates, stiffeners, framing members, grillages, etc.) generated by propeller, unbalanced machinery located near these structures or by the main hull vibration of the ship under way.

Exciting forces means any external forces or moments of forces acting on vibrating system and causing its vibration.

First-order frequency means frequency of exciting forces variation equal to the propeller speed. Forced vibration of the system arising at this frequency is called first-order vibration.

Top-order frequencies means frequencies of exciting forces variation equal to the doubled, trebled, etc. propeller speed. Forced vibration of the system arising at such frequencies multiple to propeller speed is called vibration of the second, third, etc., order, respectively. In this case frequency of exci-ting force variation equal to the product of propeller speed by the number of blades is called first-blade (or blade); frequencies multiple to it are called second-blade, third-blade, etc., and vibration arising at these frequencies, for example, in case of four-bladed propeller is called blade vibration of the fourth order, second-blade vibration of the eighth order, etc., respectively.

Main order frequencies of exciting forces generated by internal combustion engines means frequencies of variation of unbalanced forces and moments of inertia forces equal to the engine crankshaft speed (first order) or double speed (second order) as well as frequencies of variation of capsizing moments the order of which is equal to the cylinder number (two-stroke engines) or to half the number of cylinders (four-stroke engines).

1.5.4 Technical documentation.

Upon completion of mooring and sea trials the technical conclusion on the results of vibration measurements is to be submitted to the Register. The technical conclusion is to be approved by the management of the organization conducting the measurements and is to contain the assessment of ship vibration characteristics proceeding from the existing standards. This document includes the information on arrangements to be carried out with a view to reducing the vibration as well as on check (repeated) measurements used for confirmation of efficiency of the arrangements.

In separate cases, the Register reserves the right to require the preliminary conclusion of the enterprise taking measurements of vibration.

1.5.5 Calculation of main hull vibration of the ship under way.

1.5.5.1 Calculations of frequencies and basic modes of natural frequencies of hull vibration for ship being designed as well as estimation of parameters of its forced vibration under way are carried out according to the procedure approved by the Register.

1.5.5.2 Calculations of main hull vibration of the ship under way are to be carried out for the main operating loading conditions.

The calculation of natural (resonant) frequency spectra of hull vibration in vertical and horizontal-transverse directions within the range of inducing forces frequency variation to the blade frequency inclusive is to be made.

In this case for horizontal-transverse vibrations of hull of dry cargo ships, as a rule, consideration is to be given to their interdependency with torsional vibrations; deviations may be permitted on special agreement with the Register. When calculating the natural frequency of vibration, it is recommended to take into account the interaction of hull and added large masses (grillages, deckhouses, etc.). For the top mode vibrations (generally, above the third mode) account of such interaction is necessary.

In addition, the amplitude estimation of vibration displacement of the hull forced vibration (including resonant) is to be carried out in the aftermost section at the point where vibration is normalized. Such estimation is carried out for the main specified running conditions. The obtained values are compared with the values specified in 1.5.7.

1.5.6 Calculation of local vibration of hull structures.

1.5.6.1 The local vibration strength of the hull structures subject to vibration loads is checked by the appropriate calculations performed at the designing stage according to the procedure approved by the Register.

1.5.6.2 The basic condition of ensuring the vibration strength of hull structures in way of influence of vibration loading is to prevent the possibility of origination of their resonance oscillations for the main operating conditions of the ship.

In this case, only local vibration calculation is to be made to evaluate the lowest natural frequencies of hull structure vibration and to correlate them with the relevant frequencies of excitation forces listed in 1.5.6.7. When comparing these frequencies, one should be guided by conditions of prevention of resonant phenomena stated in 1.5.6.6.

1.5.6.3 For the hull structures in way of direct influence of pulsating pressures from propellers (see 1.5.6.4.1) as well as for the structures in way of unbalanced machinery (see 1.5.6.4.3) in addition to the calculations specified by 1.5.6.2 it is recommended to make additional calculations of their forced vibration under the action of forces with the blade frequency (for the region stated in 1.5.6.4.1) or with the rotor speed (for rotor-type machinery), or with the first- and second-order frequencies for internal combustion engines (as applied to the region according to 1.5.6.4.3). These calculations are carried out to determine the vibration stresses arising in the plates and framing members which are to be correlated with the standards given in Table 1.5.7.2.4.

Note. When the propeller is located in the nozzle, the calculations of forced vibration of hull structures of the after end of the ship according to 1.5.6.4.1 need not be performed. However, in this case it is necessary to carry out the estimation of the local vibration strength of structures of the nozzle itself according to 1.5.6.2.

1.5.6.4 Calculations specified in 1.5.6.2 are to be performed for the hull structures arranged in the following regions of the ship:

.1 in way of the direct influence of pulsating hydrodynamical pressures from propellers; this region extends from the aftermost section (transom) to the section located at a distance equal to single propeller diameter forward of the disc centre of the latter;

.2 in machinery spaces in way of unbalanced main and auxiliary machinery;

.3 in other spaces in way of unbalanced machinery.

1.5.6.5 To be calculated according to 1.5.6.4 under vibration loading are the following structures:

.1 after peak structures (see also 1.5.6.4.1) — shell plating with associated framing, inner bottom plating, bulkhead plating and stiffeners, plating and stiffening of platforms;

.2 engine room structures similar to those listed in 1.5.6.5.1;

.3 structures of other ship spaces in way of unbalanced machinery similar to those listed in 1.5.6.5.1.

1.5.6.6 To prevent origination of the resonance vibration, natural frequencies of the first mode hull structure vibration are to exceed the relevant frequencies of the excitation forces specified in 1.5.6.7 at least 1,5 times for the plates and 1,3 times for the framing members and stiffeners.

1.5.6.7 When determining the possibility of origination of resonance vibration of hull structures, the frequencies of excitation forces are to be taken equal to:

.1 double blade frequency corresponding to the range of full speed of the ship for the structures subject to direct action of pulsating pressures from propellers (see 1.5.6.4.1). As an exception and on special agreement with the Register the blade frequency may be used as design frequency of the excitation forces for the structures stated in 1.5.6.4.1;

.2 blade frequency corresponding to the range of full speed of the ship for the structures of engine room (where located aft) as well as for the hull part between the engine room and region according to 1.5.6.4.1. Where the engine room is located amidships or displaced aft the frequencies corresponding to the first and second orders of variation of unbalanced forces of main and auxiliary machinery are taken as design frequencies;

.3 the first and second orders of frequencies of unbalanced forces of unbalanced machinery for the structures in way of this machinery.

1.5.7 Vibration standards.

1.5.7.1 Standard vibration parameters.

1.5.7.1.1 The root-mean-square value of the vibration rate measured in 1/3-octave band is taken as the basic parameter characterizing the vibration.

Vibration measurement in the octave band is permitted together with analysis in 1/3-octave band.

1.5.7.1.2 The measured parameters may be the root-mean-square value of vibration acceleration together with vibration rate and, in well-grounded cases, the root-mean-square or peak values of vibration displacement.

1.5.7.1.3 The vibration parameters are measured in absolute units or in the appropriate logarithmic level unit — in decibels about the standard threshold limit values of vibration rate or acceleration equal to $5/10^{-5}$ mm/s and $3/10^{-4}$ m/s^2.

1.5.7.2 Permissible values of vibration.

1.5.7.2.1 Main hull and superstructure vibration and local vibration of ship structures are considered permissible if the root-mean-square values of vibration rate or vibration acceleration measured in 1/3-octave band do not exceed the values (levels) stated in Table 1.5.7.2.1 (Fig. 1.5.7.2.1) for each of three inter-perpendicular di-

Table 1.5.7.2.1

Mean geometric frequencies of $^1/_3$-octave band, in Hz	Rigid members of hull and superstructure[1]				Ship's structures							
					framing members[2]				plates			
	Permissible values of specified parameter											
	rate		acceleration		rate		acceleration		rate		acceleration	
	mm/s	dB	m/s^2	dB	mm/s	dB	m/s^2	dB	mm/s	dB	m/s^2	dB
1,6	5,6	101	0,054	45	5,6	101	0,054	45	5,6	101	0,054	45
2	5,6	101	0,067	47	5,6	101	0,067	47	5,6	101	0,067	47
2,5	5,6	101	0,084	49	5,6	101	0,084	49	5,6	101	0,084	49
3,15	5,6	101	0,106	51	7,1	103	0,135	53	7,1	103	0,135	53
4	5,6	101	0,135	53	8,9	105	0,21	57	8,9	105	0,21	57
5	5,6	101	0,17	55	11	107	0,34	61	11	107	0,34	61
6,3	5,6	101	0,21	57	11	107	0,43	63	14	109	0,54	65
8	5,6	101	0,27	59	11	107	0,54	65	16	110	0,75	68
10	5,6	101	0,34	61	11	107	0,65	67	16	110	0,94	70
12,5	5,6	101	0,43	63	11	107	0,84	69	16	110	1,2	72
16	5,6	101	0,54	65	11	107	1,06	71	16	110	1,5	74
20	5,6	101	0,67	67	11	107	1,35	73	16	110	1,9	76
25	5,6	101	0,84	69	11	107	1,7	75	16	110	2,4	78
31,5	5,6	101	1,06	71	11	107	2,1	77	16	110	3,0	80
40	5,6	101	1,35	73	11	107	2,7	79	16	110	3,8	82
50	5,6	101	1,7	75	8,9	105	2,7	79	12,5	108	3,8	82
63	5,6	101	2,1	77	7,1	103	2,7	79	10	106	3,8	82
80	5,6	101	2,7	79	5,6	101	2,7	79	8	104	3,8	82

[1] Places of intersection of decks with strong transverse and longitudinal bulkheads, sides, transom, sides of superstructure, etc.

[2] Including supporting girders under foundations for machinery, apparatuses and equipment.

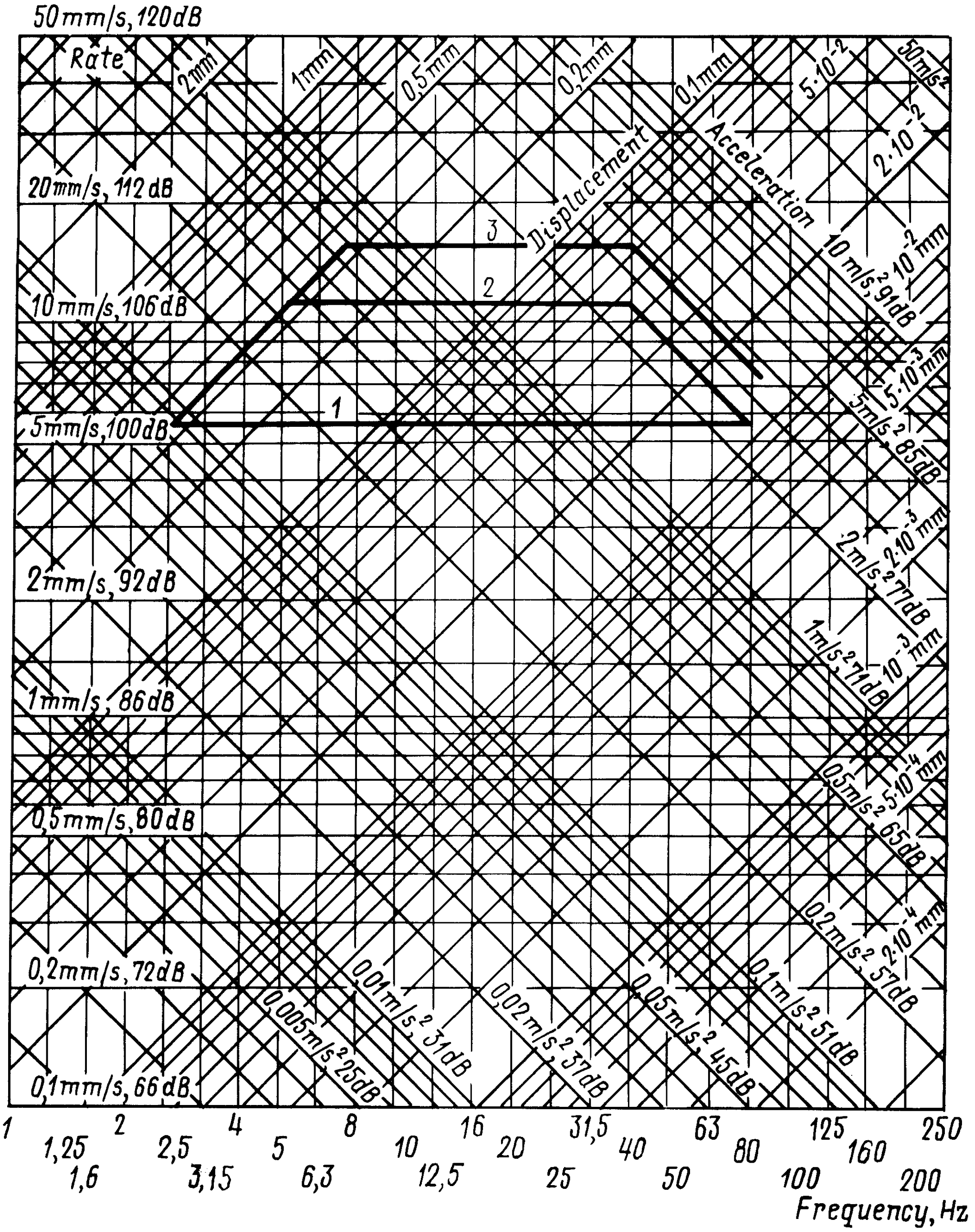


Fig. 1.5.7.2.1

Vibration standards for hull, superstructures and ship structures (the root-mean-square values):

1 — rigid members of hull and superstructure;

2 — framing members including supporting girders under foundations for machinery, apparatuses and equipment;

3 — plates

rections about ship axes: vertical, horizontal-transverse and horizontal-longitudinal (main vibration) or for the direction normal to the structure plane (plate members, panels, grillages and their girders and stiffeners) or for the direction corresponding to the lowest bending rigidity for isolated girders and beam members (local vibration).

1.5.7.2.2 When measuring the vibration in octave bands the permissible levels (values of the measured parameter may be increased $\sqrt{2} = 1{,}41$ times (by 3 dB) as compared with the values given in 1.5.7.2.1 for the bands with mean-geometric frequencies of 2, 4, 8, 16, 31,5 and 63 Hz.

1.5.7.2.3 Permissible values of the vibration parameters (levels) stated in 1.5.7.2.1 and 1.5.7.2.2 are not to be exceeded in specified ranges of ship speed (including the range without speed if such range is a specified one) under operating loading conditions.

1.5.7.2.4 For the plates and framing members, exceeding of permissible values (levels) is allowed provided the vibration strength of these structural members is found to be sufficient and the vibration of the equipment contacting with the members in question is considered allowable.

The local vibration strength of plates and framing members is considered to be sufficient if the values of the vibration stresses therein do not exceed the permissible values given in Table 1.5.7.2.4.

1.5.7.2.5 Deviations from these standards may be permitted on agreement with the Register.

1.6 REQUIREMENTS FOR SCANTLINGS OF HULL STRUCTURAL MEMBERS

1.6.1 General.

1.6.1.1 This Chapter contains general requirements for plating and framing.

1.6.1.2 Plate structure means a portion of plating bounded by stiffening members.

By plate structures are meant portions of the deck, platform and inner bottom plating and portions of the bottom, side, bulkhead plating as well as webs of deep members.

1.6.1.3 In the present Part of the Rules the term "framing" includes primary members and deep members strengthening the plate structures. Deep members also serve as supporting structures for primary members.

Primary members are deck longitudinals, side longitudinals, bulkhead longitudinals, inner bottom plating and bottom longitudinals, as well as vertical and horizontal stiffeners of bulkheads, frames, beams, reverse and bottom frames of bracket floors, etc.

Deep members are deck transverses, deck girders, web frames, side stringers, floors, side girders, centre gir-der, vertical webs and horizontal girders of bulkheads, etc.

1.6.1.4 The scantlings of primary and deep members are based on the required section modulus, moment of inertia, web sectional area, thicknesses of web and face plate, as well as width of the face plate.

Geometric properties of the member section, unless stated otherwise, are determined taking into account the effective flange.

If the member is so arranged that it is not normal to the effective flange, the section modulus is to be increased in proportion to $1/\cos\alpha$ (where α is the angle, in degrees, between the member web and the perpendicular to the effective flange at the section considered. If $\alpha \leqslant 15°$, no increase of section modulus is required.

1.6.1.5 Rounding off the required scantlings of structural members is generally to be made in the direction of increase. Plate thickness is to be rounded off to the nearest 0,5 or integer of millimetres.

The values of negative rolling tolerances for plates are to comply with the requirements of 3.2.7, Part XIII "Materials".

1.6.2 Symbols.

l = span of concerned member, determined from 1.6.3.1, in m;

p = design pressure at the point of load application, determined in the relevant chapters of the present Part of the Rules, in kPa;

a = spacing, in m, of concerned primary or deep members of longitudinal or transverse framing system; where this varies, a is a half-sum of distances of adjacent members from the member concerned;

h = depth of the member web, in cm;

Table 1.5.7.2.4

Material	Upper yield stress R_{eH}, in MPa	Permissible normal stresses in way of welded joints, in MPa
Steel	235 — 390	40
Aluminium alloy	150 — 220	20

Notes: 1. This Table shows permissible stresses for T-connections with double welds.

2. The maximum vibration stresses σ, in MPa, acting in the plates may be estimated by the formulae:

for steel plates

$$\sigma = 3{,}5\bar{f}s/a^2;$$

for aluminium alloy plates

$$\sigma = 1{,}25\bar{f}s/a^2$$

where $\bar{f} = f_c - f_p$;

f_c, f_p = amplitudes of vibration in the centre of plate and its contour, in mm;

s = thickness of plate, in mm;

a = length of short side of plate, in m.

3. The maximum vibration stresses σ, in MPa, acting in the framing members can be estimated by the formulae:

for steel framing members

$$\sigma = 64 I\bar{f}/(l^2 W_{\min});$$

for members of aluminium alloy

$$\sigma = 23 I\bar{f}/(l^2 W_{\min})$$

where I = moment of inertia of member section, in cm^4;

$\bar{f} = f_m - f_p$;

f_m = vibration amplitude of the member in mid-span normal to the grillage, in mm;

f_p = as defined in Note 2;

l = length of beam between supports, in m;

$W_{\min}$ = minimum section modulus of the member, in cm^3.

I = actual moment of inertia of the hull about the horizontal neutral axis, in cm^4;

z_i = vertical distance from horizontal neutral axis of ship to the centre of section area of the longitudinal considered, in m;

σ_n = design specified yield stress for normal stresses, in MPa, determined from 1.1.4.3;

τ_n = design specified yield stress for shear stresses, in MPa, determined from 1.1.4.3;

Δs = corrosion allowance, in mm, determined from 1.1.5.1.

1.6.3 Span and effective flange of member.

1.6.3.1 The span of primary and deep member l is measured along the member face plate as the distance between its span points. Unless provided otherwise, where the end brackets are fitted, the span points are to be taken at the mid-length of the bracket. In this case, the span point position is to be such that the height of the end bracket in it does not exceed the web depth of the member considered (Fig. 1.6.3.1).

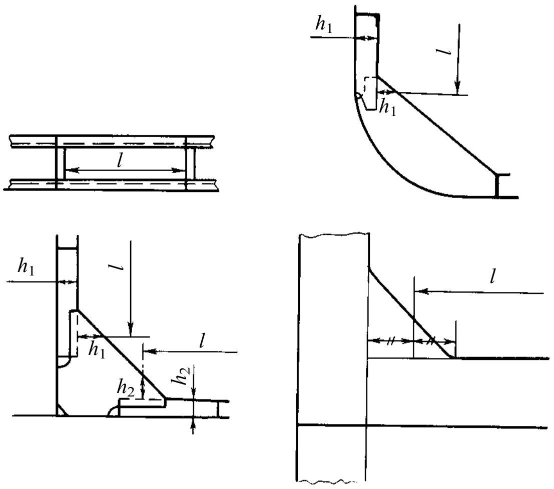


Fig. 1.6.3.1

For curvilinear members the span is to be taken equal to the chord connecting the span point centres.

1.6.3.2 The thickness of the effective flange is taken equal to its mean thickness in the considered section of the member.

1.6.3.3 The width of the effective flange a_f, in m, of primary members is to be determined by the formulae:

$$a_f = l/6; \qquad (1.6.3.3)$$

$$a_f = 0,5(a_1 + a_2), \text{ whichever is the smaller}$$

where a_1, a_2 = distance of the considered member from the nearest members of the same direction located on both sides of the considered member, in m.

1.6.3.4 The width of the effective flange of deep members c_f, in m, is determined by the formula

$$c_f = kc \qquad (1.6.3.4)$$

where $c = 0,5(c_1 + c_2)$;

c_1, c_2 = distance of the considered deep member from the nearest deep members of the same direction located on both sides of the considered member, in m;

k = factor obtained from Table 1.6.3.4 depending on c, given span l_{sp} and number n of members supported by considered deep members.

Table 1.6.3.4

Number of members n	k values at l_{sp}/c equal to:						
	1	2	3	4	5	6	7 and more
⩾6	0,38	0,62	0,79	0,88	0,94	0,98	1
⩽3	0,21	0,4	0,53	0,64	0,72	0,78	0,8

Note. For intermediate values of l_{sp}/c and n, the factor k is determined by linear interpolation.

For simply supported deep members the given span $l_{sp} = l$, and for fixed deep members $l_{sp} = 0,6l$.

The way in which the framing members are to be supported (simple supporting or fixing) is determined proceeding from the general engineering principles with regard for the actual structure (presence of brackets, welding of webs, face plates, etc.) and is characterized by the presence or absence of bending moment effects in the span point of the member.

1.6.3.5 The width of the hatch coaming effective flange is to be equal to one-twelfth of their span but not more than half the distance between the cargo hatch and the ship's side for the side coaming and, accordingly, half the distance between a cargo hatch and a transverse bulkhead (or the beam nearest to the cargo hatch) for the hatch end coaming.

1.6.3.6 The width of the effective flange of deep members located normal to the direction of corrugations is to be taken equal to 15s and 20s for trapezoidal and wave-shaped corrugations respectively (s = thickness of corrugated plates, in mm) or 0,1c (for c, see 1.6.3.4), in mm, whichever is less.

1.6.3.7 Where primary members parallel to deep members are fitted over the width of the effective flange of the latter, full cross-sectional areas of the above primary members shall be adopted for calculation when determining the inertia moment and section modulus of the deep members.

1.6.3.8 In case the area of the effective flange is less than that of the face plate, the determination of section modulus and moment of inertia of the deep members is subject to special consideration by the Register. This requirement applies to deep members of corrugated structures.

1.6.4 Scantlings of structural members.

1.6.4.1 The section modulus W, in cm^3, of primary members of rolled section is not to be less than:

$$W = W'\omega_c \qquad (1.6.4.1)$$

where W' = section modulus of member considered, in cm^3, determined from 1.6.4.2;

ω_c = multiplier taking into account corrosion allowance, determined in accordance with 1.1.5.3;

The section modulus of built-up welded members is to satisfy the requirements of 1.6.4.2. In this case the thickness of section elements is to be increased by corrosion allowance Δs.

1.6.4.2 The section modulus of member considered, in cm^3, without taking into account corrosion allowance is determined by the formula

$$W' = \frac{Ql \cdot 10^3}{m\,k_\sigma\,\sigma_n} \qquad (1.6.4.2)$$

where $Q = pal$ — transverse load on member considered, in kN;
m, k_σ = factors of bending moment and permissible stresses to be found in the relevant chapters of the present Part of the Rules.

1.6.4.3 The net sectional area (excluding openings) f_w, in cm^2, of primary and deep member webs is not to be less than:

for members of rolled section

$$f_w = f'_w \omega_c \qquad (1.6.4.3\text{-}1)$$

where $$f'_w = \frac{10 N_{\max}}{k_\tau \tau_n} \qquad (1.6.4.3\text{-}2)$$

$N_{\max}$, k_τ = maximum shear force value and permissible shear stress factor as defined in the relevant chapters of the Rules;
for ω_c, see 1.1.5.3;

for built-up welded members, the required web cross-sectional area is to be determined by the Formula (1.6.4.3-2) with a subsequent increase in thickness by the value of Δs.

1.6.4.4 The thickness s, in mm, of the plates under transverse loading is not to be less than:

$$s = mak\sqrt{\frac{p}{k_\sigma\,\sigma_n}} + \Delta s \qquad (1.6.4.4)$$

where m, k_σ = bending moment and permissible stress factors as defined in the relevant chapters of the Rules;
$k = 1{,}2 - 0{,}5a/b$, but not greater than 1;
a and b = smaller and greater sizes, in m, of supporting contour sides of plate structure.

1.6.4.5 The scantlings of the corrugated structures are to comply with the following requirements:

.1 the thickness of the trapezoidal corrugations is to be determined by the Formula (1.6.4.4) taking a equal to b or c, whichever is the greater (Fig. 1.6.4.5).

The following relationship is to be satisfied:

$$b/s \leqslant 0{,}06\sqrt{\eta} \qquad (1.6.4.5.1)$$

where b = width of the panel parallel to the bulkhead plane, in m (see Fig. 1.6.4.5).

Angle φ (see Fig. 1.6.4.5 *a*) is to be assumed not less than 40°;

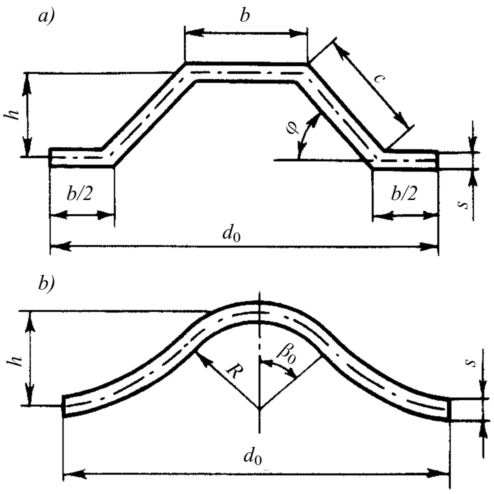


Fig. 1.6.4.5
Trapezoidal (*a*)
and wave-shaped (*b*) corrugations

.2 the thickness of the wave-shaped corrugations, s, in mm, is not to be less than:

$$s = 22\beta_0 R\sqrt{\frac{p}{k_\sigma\,\sigma_n}} + \Delta s \qquad (1.6.4.5.2\text{-}1)$$

where β_0 = half-angle of spread of corrugation (see Fig. 1.6.4.5, b) in rad.;
R = radius of corrugation, in m;
k_σ = factor of permissible stresses determined in the relevant chapters of the present Part of the Rules.

In this case, the following relationship is to be satisfied:

$$R/s \leqslant 17/R_{eH}; \qquad (1.6.4.5.2\text{-}2)$$

.3 The section modulus of the corrugation is determined according to 1.6.4.1 and 1.6.4.2 taking $Q = pd_0l$ (for d_0, see Fig. 1.6.4.5).

The spacing and section modulus of corrugations can be determined by the formulae given in Table 1.6.4.5. (Linear dimensions are expressed in cm, φ and β_0 — in deg.).

Table 1.6.4.5

Type of corrugation	Spacing of corrugations	Section modulus
Trapezoidal	$d_0 = 2(b + c\cos\varphi)$	$W = hs(b + c/3)$
Wave-shaped	$d_0 = 4R\sin\beta_0$	$W = \gamma s R^2$

Factor γ is obtained from the formula

$$\gamma = 2\,\frac{\beta_0 + 2\beta_0\cos^2\beta_0 — 1{,}5\sin 2\beta_0}{1 — \cos\beta_0}\ . \qquad (1.6.4.5.3)$$

In calculating the factor γ, the angle β_0 is to be taken in radians.

1.6.4.6 Permissible stress factors k_σ and k_τ defined in the relevant chapters of the Rules may be increased by 5 per cent for ships of restricted areas of navigation **II** and **IIСП** and by 10 per cent for **IIIСП** and **III** unless dependent upon the factors k_B and k_D obtained from the Formula (2.2.4.1).

1.6.5 Buckling strength of hull structural members.

1.6.5.1 The buckling strength of longitudinals, shell plates and hull structure plating is to be ensured within the midship region of ships of unrestricted service and ships of restricted areas of navigation **I** and **II**, 65 m and greater in length, of restricted areas of navigation **IIСП**, **IIIСП** and **III**, 60 m and greater in length subject to compressive stresses due to longitudinal bending of the hull girder.

Effective compressive streses σ_c, in MPa, are to be calculated by the following formula:

$$\sigma_c = \frac{M_T}{I} z_i \cdot 10^5 \geqslant 30/\eta \qquad (1.6.5.1\text{-}1)$$

where M_T = design bending moment, in kN·m, at the section under consideration equal to the maximum absolute value of algebraic sum of the moment components;

M_T = $|M_{sw} + M_w|$ — for longitudinal members arranged below the neutral axis;

M_T = $|M_{sw} + M_w + M_F|$ — for longitudinal members arranged above the neutral axis;

M_{sw} = as defined in 1.4.3, in kN·m;

M_w = as determined from 1.4.4;

for M_F, see 1.4.5.

The maximum hogging bending moment is to be assumed as design value M_T for longitudinal members arranged below the neutral axis, and the maximum sagging bending moment — for longitudinal members arranged above the neutral axis.

The buckling strength of side shell and longitudinal bulkheads at the section considered is to be ensured under shear stresses τ_c, in MPa, calculated by the following formulae:

for side shell plating in ships without effective longitudinal bulkheads

$$\tau_c = \frac{N_{sw} + N_w}{2s} \, \frac{S}{I} \cdot 10^2 \, ; \qquad (1.6.5.1\text{-}2)$$

for side shell plating in ships with two effective longitudinal bulkheads

$$\tau_c = \frac{N_{sw} + N_w}{s_s} \, \frac{S}{I} \, \alpha_s \cdot 10^2 \, ; \qquad (1.6.5.1\text{-}3)$$

for longitudinal bulkhead plating in ships with two effective longitudinal bulkheads

$$\tau_c = \frac{N_{sw} + N_w}{s_l} \, \frac{S}{I} \, \alpha_l \cdot 10^2 \qquad (1.6.5.1\text{-}4)$$

where N_{sw} = still water shear force at the section considered, defined in 1.4.3, in kN;

N_w = wave vertical shear force determined from 1.4.4.2;

s = actual thickness of side shell plating in ships without longitudinal bulkheads, in mm;

s_s, s_l = actual thicknesses of side shell plating and longitudinal bulkhead plating at the section considered in ships with two longitudinal bulkheads, in mm;

S, I = as defined in 1.4.2;

for α_s, α_l, see 1.4.7.2.

Where one or more than two continuous longitudinal plane bulkheads or longitudinal bulkheads with horizontal corrugations are fitted, the shear stresses are determined by a procedure approved by the Register.

1.6.5.2 The buckling strength of longitudinal members is considered sufficient if the following conditions are met:

$$k\sigma_c \leqslant \sigma_{cr} \, ; \qquad (1.6.5.2\text{-}1)$$

$$\tau_c \leqslant \tau_{cr}$$

where k = 1 for plating and for web plating of stiffeners;

k = 1,1 for stiffeners;

for σ_c, τ_c, see 1.6.5.1;

for σ_{cr}, τ_{cr}, see 1.6.5.3.

For plate panels, the factor k may be reduced in respect of ships of restricted navigation areas: **I** — by 10 per cent, **II** and **IIСП** — by 15 per cent, **IIIСП** and **III** — by 20 per cent. In this case, when determining the actual section modulus of hull in accordance with 1.4.8, the strength reduction of compressed plate shall be considered, i.e. where $\sigma_{cr} < \sigma_c$ the plates shall be included in the hull girder section, except for the areas adjoining the longitudinals and having a breadth equal to 0,25 of the shorter side of supporting contour, with the reduced factor ψ_n to be determined from the formula

$$\psi_n = \sigma_{cr}/\sigma_c. \qquad (1.6.5.2\text{-}2)$$

1.6.5.3 Critical stresses σ_{cr} and τ_{cr}, in MPa, are to be determined by the formulae:

$$\sigma_{cr} = \sigma_e \text{ when } \sigma_e \leqslant 0{,}5R_{eH}; \qquad (1.6.5.3)$$

$$\sigma_{cr} = R_{eH}(1 - R_{eH}/4\sigma_e) \text{ when } \sigma_e > 0{,}5R_{eH};$$

$$\tau_{cr} = \tau_e \text{ when } \tau_e \leqslant 0{,}29R_{eH};$$

$$\tau_{cr} = R_{eH}(0{,}58 - 0{,}08R_{eH}/\tau_e) \text{ when } \tau_e > 0{,}29R_{eH}$$

where σ_e, τ_e = Euler normal and shear stresses to be determined in accordance with 1.6.5.4 and 1.6.5.5.

1.6.5.4 When checking the buckling strength, the Euler stresses σ_e, in MPa, for primary and deep longitudinal members are to be determined by the following formulae:

.1 for column buckling of primary longitudinal members without rotation of the cross section

$$\sigma_e = 206i/fl^2 \qquad (1.6.5.4.1)$$

where i = moment of inertia, in cm^4, of longitudinal, including plate flange and calculated with thickness reduced by the value of Δs (for Δs, see Table 1.6.5.5-2);

f = cross-sectional area, in cm^2, of longitudinal, including plate flange and calculated with a thickness reduced by the value of Δs (for Δs, see Table 1.6.5.5-2); a plate flange equal to the frame spacing may be included;

.2 for torsional buckling of primary longitudinal members

$$\sigma_e = (203/l^2)(i_w/i_p)(m^2 + k/m^2) + 79310 i_t/i_p \qquad (1.6.5.4.2)$$

where $k = 0{,}05cl^4/i_w$;

m = number of half waves, given by Table 1.6.5.4;

Table 1.6.5.4

k	$0<k<4$	$4<k<36$	$36<k<144$	$(m-1)^2m^2<k<m^2(m+1)^2$
m	1	2	3	m

i_t = moment of inertia, in cm^4, of profile under simple torsion (without plate flange), determined as follows:

$i_t = \frac{h_w s_w^3}{3} \cdot 10^{-4}$ for flat bars;

$i_t = \frac{1}{3}[h_w s_w^3 + b_f s_f^3(1 - 0{,}63 s_f/b_f)] \cdot 10^{-4}$ for angles, bulb, symmetrical bulb and T-profiles;

i_p = polar moment of inertia, in cm^4, of profile about connection of stiffener to plate, determined as follows:

$i_p = \frac{h_w^3 s_w}{3} \cdot 10^{-4}$ for flat bars;

$i_p = (\frac{h_w^3 s_w}{3} + h_w^2 b_f s_f) \cdot 10^{-4}$ for angles, bulb, symmetrical bulb and T-profiles;

i_w = sectional moment of inertia, in cm^6, of profile about connection of stiffener to plate, determined as follows:

$i_w = \frac{h_w^3 s_w^3}{36} \cdot 10^{-6}$ for flat bars;

$i_w = \frac{s_f b_f^3 h_w^2}{12} \cdot 10^{-6}$ for T- and symmetrical bulb profiles;

$i_w = \frac{b_f^3 h_w^2}{12(b_f + h_w)^2}\left[s_f(b_f^2 + 2b_f h_w + 4h_w^2) + 3s_w b_f h_w\right] \cdot 10^{-6}$ for angles and bulb profiles;

h_w = web height, in mm;

s_w = web thickness, in mm, reduced by the value of Δs (for Δs, see Table 1.6.5.5-2);

b_f = flange width, in mm, for angles and T-profiles or bulb width, in mm, for bulb and symmetrical bulb profiles;

s_f = flange thickness or bulb thickness, in mm, reduced by the value of Δs (for Δs, see Table 1.6.5.5-2). For bulb and symmetrical bulb profiles, s_f may be adopted equal to the mean thickness of the bulb;

c = spring stiffness exerted by supporting plate panel, determined by the formula

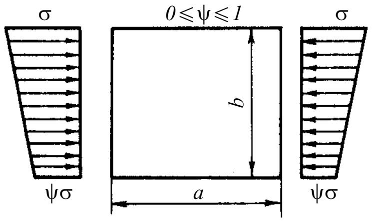
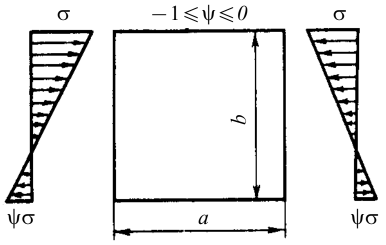
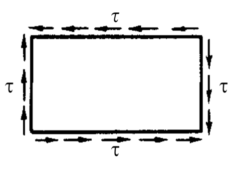
$$c = \frac{68{,}7 k_p s^3}{(1 + \frac{1{,}33 k_p h_w s^3}{a s_w^3} \cdot 10^{-3})a}$$

$k_p = 1 - \sigma_c/\sigma_e \geqslant 0$ (to be taken not less than 0,1 for angles, bulb, symmetrical bulb and T-profiles);

σ_c = compressive stress according to 1.6.5.1;

σ_e = Euler stress of supporting plate according to 1.6.5.5;

Table 1.6.5.5-1

Type of load	$\gamma = a/b$	n
	$\gamma > 1$	$\frac{8{,}4}{\psi + 1{,}1}$
	$\gamma \leqslant 1$	$\varepsilon(\gamma + \frac{1}{\gamma})^2 \frac{2{,}1}{\psi + 1{,}1}$
	$\gamma > 1$	$10\psi^2 - 6{,}4\psi + 7{,}6$
	$\gamma \leqslant 1$	$\varepsilon[10\psi^2 - 14\psi + 1{,}9(1 + \psi)(\gamma + 1/\gamma)^2]$
	$\gamma > 1$	$5{,}34 + 4/\gamma^2$

Notes: 1. ψ = ratio between smallest and largest compressive stress when linear variation across panel.

2. $\varepsilon = 1{,}3$ when plating is stiffened by floors or deep girders;

$\varepsilon = 1{,}21$ when stiffeners are angles, symmetrical bulbs or T-sections;

$\varepsilon = 1{,}1$ when stiffeners are bulb flats;

$\varepsilon = 1{,}05$ when stiffeners are flat bars.

s = supporting plate thickness, in mm, reduced by the value of Δs (for Δs, see Table 1.6.5.5-2);
a = distance between longitudinals;

.3 for web and flange buckling

$$\sigma_e = 7{,}83(s_w/h_w)^2 \cdot 10^5 \text{ for web plates of longitudinal deep members;} \qquad (1.6.5.4.3\text{-}1)$$

for flanges of deep longitudinal members buckling is taken care by the following requirement:

$$b_f/s_f \geqslant 15 \qquad (1.6.5.4.3\text{-}2)$$

where b_f = flange width, in mm, for angles, half the flange width for T-sections;
s_f = flange thickness, in mm.

1.6.5.5 Euler normal σ_e and shear τ_e stresses, in MPa, for plate structures are to be determined as for rectangular plates by the formulae:

$$\sigma_e = 0{,}1854n(s'/b)^2; \qquad (1.6.5.5\text{-}1)$$

$$\tau_e = 0{,}1854n(s'/b)^2 \qquad (1.6.5.5\text{-}2)$$

where n = factor depending on the load type of the plate and the ratio of sides (Table 1.6.5.5-1);
s' = actual thickness of the plate reduced by the value of Δs obtained from Table 1.6.5.5-2;
b = plate side located normal to the direction of normal compressive stresses; when the plate is exposed to shear stresses, b is the smaller side of the plate, in m.

Table 1.6.5.5-2

Structure	Δs, mm
Compartments carrying dry bulk cargoes. Vertical surfaces and surfaces sloped at an angle greater than 25° to the horizontal line. One side exposure to ballast and/or liquid cargo	$0{,}05s$ $(0{,}5 \leqslant \Delta s \leqslant 1)$
Horizontal surfaces and surfaces sloped at an angle less than 25° to the horizontal line. One side exposure to ballast and/or liquid cargo Vertical surfaces and surfaces sloped at an angle greater than 25° to the horizontal line. Two side exposure to ballast and/or liquid cargo	$0{,}10s$ $(2 \leqslant \Delta s \leqslant 3)$
Horizontal surfaces and surfaces sloped at an angle less than 25° to the horizontal line. Two side exposure to ballast and/or liquid cargo	$0{,}15s$ $(2 \leqslant \Delta s \leqslant 4)$
s = actual thickness, in mm, of the structural member under consideration.	
Note. $\Delta s = 0$ otherwise.	

1.6.5.6 The moment of inertia i, in cm^4, of the stiffeners on deep girder webs (see 1.7.3.2) is not to be less than determined by the formulae:

for the stiffeners fitted normal to the girder face plate

$$i = \gamma a s^3 \cdot 10^{-3}; \qquad (1.6.5.6\text{-}1)$$

for the stiffeners parallel to the girder face plate

$$i = 2{,}35\frac{(f + 0{,}1as)l^2}{\eta}. \qquad (1.6.5.6\text{-}2)$$

where γ = coefficient obtained from Table 1.6.5.6 depending on the ratio of the girder web depth h to the spacing of stiffeners a_1;
a = spacing of stiffeners, in cm;
s = actual thickness of the web, in mm;
f = actual cross-sectional area of the stiffener, in cm^2;
l = span of the stiffener, in m.
η = as determined according to 1.1.4.3.

Table 1.6.5.6

h/a	1 and less	1,2	1,4	1,6	1,8	2,0	2,5	3,0	3,5	4,0
γ	0,3	0,6	1,3	2,0	2,9	4,1	8,0	12,4	16,8	21,2
Note. The intermediate values of γ are determined by linear interpolation.										

1.6.6 Aluminium alloy structures.

1.6.6.1 The scantlings of aluminium alloy structures are to be determined by conversion of the scantlings relating to the corresponding steel structures. The conversion is to be made using the formulae of Table 1.6.6.1 without considering the limits by minimum scantlings of steel structures.

Table 1.6.6.1

Parameter	Requirement
Thickness of plating for the shell, decks (without covering), bulkheads, enclosures and other details made of plates	for superstructures $s_1 = s\sqrt{R_{eH}/R_{p_{0,2}}}$ for main hull $s_1 = 0{,}9s\sqrt{R_{eH}/R_{p_{0,2}}}$
Section modulus of framing members	$W_1 = WR_{eH}/R_{p_{0,2}}$
Cross-sectional area of pillars	$f_1 = fR_{eH}/R_{p_{0,2}}$
Moment of inertia of pillars and framing members	$I_1 = 3I$
Notes: 1. $R_{p_{0,2}}$ = proof stress of aluminium alloy, in MPa. 2. The values of s, W, f, I as stipulated by the Rules may be adopted without corrosion allowance.	

1.6.6.2 The sectional area of sternframe, stem, bar keel and propeller shaft brackets is to be 1,3 times that required for steel application.

1.6.6.3 Where continuous welds (fillets, butt welds) are located in most stressed positions, account is to be taken of the reduction in strength at the welded joint location depending on the given aluminium alloy and the process of welding.

1.6.6.4 On agreement with the Register, the bimetallic (steel — aluminium) pressed elements for connection of steel and aluminium alloy structures may be used.

1.7 WELDED STRUCTURES AND JOINTS

1.7.1 General.

1.7.1.1 Any change in the shape or section of the members of welded hull structure is to take place gradually. All openings are to have rounded corners and smooth edges.

1.7.1.2 The scantlings of sections and the thicknesses of plates used for longitudinal members are to change gradually throughout the ship's length.

Any change of framing system and plating thicknesses used for the strength deck, bottom, side shell and longitudinal bulkheads shall not be permitted in areas where mechanical properties of steel change.

1.7.1.3 Continuity is to be ensured for as many of main longitudinal members as possible, and a gradual change of their sections is required in way of the ends together with other arrangements, contributing to the reduction of stress concentration.

1.7.1.4 In tight structures, as well as in non-tight structures subject to intense vibration, stiffeners and similar details are to be fitted to prevent hard spots in the plating at the toes of brackets and in way of face plates of the members passing through, or terminating at the above-mentioned structures.

1.7.1.5 The length of unsupported plating between the end of a longitudinal and the nearest web normal to direction member is to be as short as possible, however, not more than 4*s* or 60 mm, whichever is less (s = plate thickness, in mm).

1.7.1.6 For the purpose of this Part of the Rules, the hull structures subject to intense vibration are those situated in way of machinery and equipment which constitute a source of vibration.

Considered as regions with high level of vibration in all ships are the regions situated below the lower platform continuous within the machinery space and bounded:

at aft end, by a section forward of the edge of propeller boss at twice the propeller diameter, but not less than to the after peak bulkhead;

in the machinery space, by the bulkheads of this space.

The bulkheads forming boundaries of machinery space, the after peak bulkhead and the lower continuous platform in the above regions throughout the length of the ship are considered to be structures subject to intense vibration.

1.7.1.7 In way of the ends of bulwark, bilge keels, and other details welded to the hull, as well as generally of gutterway bars, their height is to decrease on a length of at least 1,5 times the height of these members. The ends of bulwarks are to be tapered.

This is also recommended for the portions of the ends of the gutter bars.

1.7.1.8 Welded joints, welding consumables and procedures, testing and inspection methods of welded joints are to comply with requirements of Part XIV "Welding".

1.7.2 Connections of framing members.

1.7.2.1 In general, the framing members are to have butt-welded joints. Overlapping joints may be allowed on agreement with the Register, except in regions with high level of vibration, deep member connections and in way of heavy concentrated loads.

In general, brackets are to be made of steel having the same yield stress as the steel of the members connected.

1.7.2.2 Connections of primary members.

1.7.2.2.1 Unless provided otherwise, the size of brackets *c*, in cm, measured in accordance with Fig. 1.7.2.2.1 is to be determined by the formula

$$c = 5\sqrt{W/s} \qquad (1.7.2.2.1)$$

where W = Rule section modulus of the member attached, in cm^3;
s = thickness of bracket, in mm.

The thickness of bracket is taken equal to that of the member web. Where the web thickness is more than 7 mm the bracket thickness may be reduced by 1 mm; where the web thickness is more than 12 mm, the bracket thickness may be reduced by 2 mm.

Where a bracket connects two members of different profile, the characteristics of the smaller profile are to be used for determining the bracket size.

The bracket height *h* (see Fig. 1.7.2.2.1) is to be not less than 0,7 times the required size *c*.

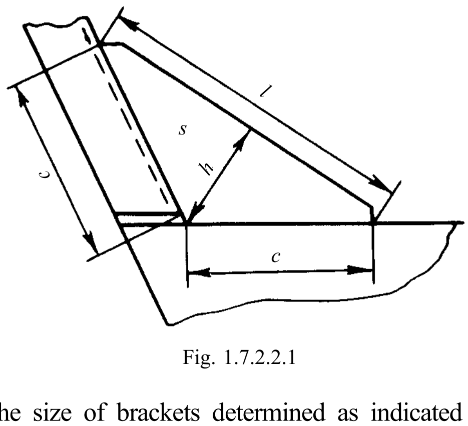


Fig. 1.7.2.2.1

The size of brackets determined as indicated above, refers to the case when the members to be interconnected are not welded to each other or the member butts are not welded to the plating. The allowable gap is not to exceed 40 mm or 25 per cent of size *c*, whichever is less. Otherwise, *c* may be required to be increased.

1.7.2.2.2 If the free edge l, in mm, of a bracket (see Fig. 1.7.2.2.1) is longer than $45s$ (s = thickness of the bracket, in mm), the bracket is to have a flange (face plate). The width of the flange is to be not less than 50 mm, the width of the face plate, not less than 75 mm. The thickness of the face plate is not to be less than that of the bracket. The width of the flange (face plate) is to be in accordance with the requirements of 1.7.3.1.

1.7.2.2.3 The size of brackets may be reduced:

by 10 per cent, where the framing members are welded to each other or to the plating;

by 15 per cent, where a face plate or flange is provided;

by 25 per cent, where the framing members are welded to each other and the brackets are provided with a face plate or flange.

1.7.2.2.4 In regions with high level of vibration the butt ends of framing members are to be generally connected, with the minimum dimensions of the plating portions unsupported by the framing (Fig. 1.7.2.2.4).

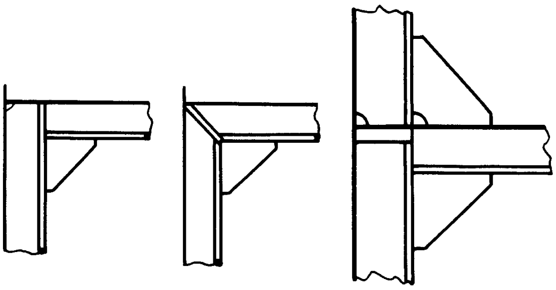


Fig. 1.7.2.2.4

1.7.2.2.5 Where there is a gap between the butt of beam and the frame in way of side strengthening of ships mooring at sea, in region I of ice strengthening in categories **Л9**, **Л8**, **Л7**, **Л6**, **Л5** ships and in region AI of category **Л3** ships, the beam bracket is to have a face plate or flange.

1.7.2.3 Deep members are recommended to be connected by rounded brackets with smooth change of web depth and face plate size.

1.7.2.3.1 The height and width of brackets interconnecting the members, or attaching them to bulkheads are, unless provided otherwise, to be not less than the members web depth (or the lesser web depth of the members connected). The bracket thickness is assumed equal to the lesser of the member web thicknesses. In member connections no gaps are permissible.

1.7.2.3.2 The brackets connecting the members are to have a face plate or flange along the free edge. In places of transition from the face plates of brackets to those of members, the width and thickness of the face plate along the free edge at different sizes of the member face plates are to change smoothly. The area of face plate (or flange) of tripping bracket is to be taken not less than 0,8 times the area of lesser face plate of the members connected.

If the distance, in mm, between bracket ends exceeds $160s\sqrt{\eta}$ (s = thickness of bracket, in mm), a stiffener is to be fitted parallel to the line connecting bracket ends at the distance a equal to $^1/_4$ of the bracket height or 35 times its thickness (whichever is less). The inertia moment of the stiffener is to be determined by the Formula (1.6.5.6-2).

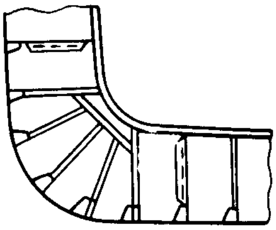


Fig. 1.7.2.3

Brackets are to be additionally stiffened depending on their size and configuration (see 1.7.3.2.2).

1.7.2.3.3 The radius of rounding is not to be less than the depth of the smaller members connected.

The webs and face plates are to be supported by stiffeners and tripping brackets in way of rounding (Fig. 1.7.2.3).

1.7.2.4 The constructions used for the attachment of primary members to supporting members are to comply with existing standards.

1.7.3 Construction of deep members.

1.7.3.1 The depth h and thickness s_w of member webs (as well as of built-up primary members) and their sectional area are regulated by the relevant chapters of this Part of the Rules. The width of member face plate b, in mm, as measured from its web, is not to be more than:

$$b = 200s_{f.p}/\sqrt{R_{eH}} \qquad (1.7.3.1)$$

where $s_{f.p}$ = thickness of member face plate, in mm.

The thickness of face plate is not normally to exceed a triple thickness of the web plate.

1.7.3.2 Where $h/s_w > 60\sqrt{\eta}$ (for h and s_w, in mm, see 1.7.3.1), the webs of members (except for those whose buckling strength is to be checked in accordance with 1.6.5) shall be stiffened by tripping brackets and stiffeners (Fig. 1.7.3.2).

1.7.3.2.1 Where $h/s_w \geqslant 160\sqrt{\eta}$, the webs of members are to be stiffened with the stiffeners fitted parallel to the member face plate (see Fig. 1.7.3.2 *a*). Where $h/s_w < 160\sqrt{\eta}$, stiffening may be carried out as shown in Fig. 1.7.3.2 *b,c*.

The spacing of stiffeners (width of non-stiffened web area), in mm, is not to be greater than $a = 90s_w/\sqrt{\eta}$.

On agreement with the Register, the structure shown in Fig. 1.7.3.2 *d* may be permitted.

In way of portions equal to $0{,}2l$, but not less than $1{,}5h$ from supports (l and h are the span and depth of member web respectively), the spacing a is to be reduced 1,5 times.

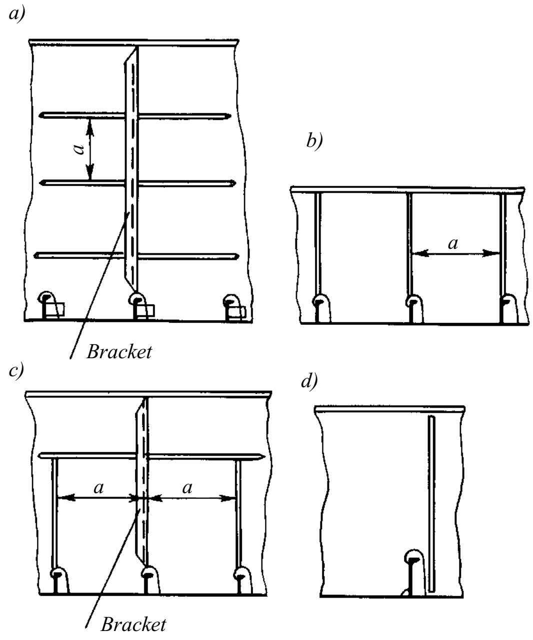


Fig. 1.7.3.2

Stiffeners fitted normal to the face plate of the member supporting primary members (e.g. longitudinals, bulkhead stiffeners, frames, etc.) are to be fitted not further than in line with every second member in question.

Variation from the above spacing of stiffeners may be allowed on the basis of the results of direct strength calculation.

1.7.3.2.2 The thickness of stiffener is not to be less than $0,8s_w$. Moment of inertia of the stiffeners is determined according to 1.6.5.6.

1.7.3.2.3 The tripping brackets stiffening deep members are to be fitted at the toes of brackets securing the members in way of roundings and struts as well as in way of span of the member (see Fig. 1.7.3.2 *a* and *b*). In any case, the spacing of brackets is not to exceed 3,0 m or $15b_{f.p}$ ($b_{f.p}$ = full width of face plate, in mm), whichever is less.

The thickness of the tripping brackets is to be not less than required for the member web. The brackets are to be extended to the member face plate and be welded to it if the width of the face plate exceeds 150 mm, as measured from the member web to the free edge of face plate. The width of the bracket section being welded shall be at least 10 mm smaller than the face plate width.

Where the width of face plates symmetric to the member web exceeds 200 mm, small brackets are to be fitted at the opposite side of the web in line with the tripping bracket. The width of the tripping brackets, measured at the base is not to be less than half their depth.

The bracket is to have a face plate or flange if the length of free edge $l > 60s$ (s = thickness of bracket, in mm). The width of the face plate or flange is not to be less than l/s.

1.7.3.3 Lightening holes, cut-outs for the passage of framing members, etc. are permitted in the member webs.

The total depth of openings in the same section is not to exceed 0,5 of the member depth. For deck transverses, deck girders, webs and girders of watertight bulkheads in dry cargo ships, this value may be increased to 0,6 of the member depth.

The distance from the edges of all openings in deep members to the edges of cut-outs for the passage of primary members is not to be less than the depth of these members. The openings in deep member webs, except for cut-outs for the passage of primary members, are to be located at a distance not less than half the deep member depth from the toes of brackets attaching this member. Where it is impossible to satisfy this requirement, compensation is to be provided by local thickening of the web, fitting of collars, etc.

In all cases, the sectional area of a deep member (excluding openings) is not to be less than required in the relevant chapters of this Part of the Rules.

For requirements regarding openings in floors, side girders and centre girder, see 2.4.2.7.

1.7.4 Details of welded structures.

1.7.4.1 The face plates and/or webs are to be sniped at the member ends depending on the construction used for attachment of members.

1.7.4.2 The width of flange (face plate) of brackets is not to be less than 8 bracket thicknesses unless expressly provided otherwise in the relevant chapters of this Part of the Rules.

1.7.4.3 The edges of brackets, face plates and webs of the members shall be welded all round and shall have no craters. This requirement also applies to air and drain holes and cut-outs for the passage of framing members and welded joints.

Where these openings are carried to the deck or bottom shell plating, their length as measured at the plating, is to comply with the requirements of 1.7.5.8.

1.7.4.4 Welded joints are to be arranged in least stressed structural sections, as far as practicable from abrupt changes of sections, openings and details which were subject to cold forming.

1.7.4.5 The butt joints of face plates of the intersection girders under variable dynamic loads (e.g. in regions with high level of vibration) are to be made with smooth transition by means of diamond plates.

1.7.4.6 It is recommended that local concentration of welds, crossings of welds at an acute angle, as well as close locations of parallel butts or fillet welds and butt welds, be avoided. The distance between parallel welded joints, whatever their direction, is not to be less than:

200 mm between parallel butt welds;

75 mm between parallel fillet and butt welds;

50 mm between parallel fillet and butt welds on a length not exceeding 2 m.

On agreement with the Register, the distance between welded joints may be reduced.

The angle between two butt welds is not to be less than 60° (Fig. 1.7.4.6).

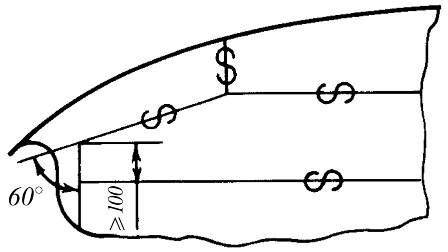


Fig. 1.7.4.6

1.7.4.7 The butts (seams) in assembling joints of the plating shall be located at a distance not less than 200 mm from the bulkheads, decks, inner bottom plating, deep members fitted parallel to the above-mentioned joints.

In assembling joints, the welded butts of built-up members shall be arranged so that the butts of a member web are not less than 150 mm clear of the butts of this member face plate.

On agreement with the Register, the butts of webs and face plates may be arranged in the same plane provided that:

full penetration welding is ensured at the connection of the web to face plate on a length of at least 100 mm each side of the butt by non-destructive testing of the welded butt in every third member;

overlapping of the butt by the framing elements (knees, brackets, etc., fitted in line with the web) is ensured on a length not less than the face plate width each side of the butt.

1.7.5 Types and dimensions of fillet welds.

1.7.5.1 The design throat thickness a, in mm, of fillet welds for tee-connections for manual and semi-automatic welding is not to be less than:

$$a = \alpha\beta s \qquad (1.7.5.1)$$

where α = weld factor given in Table 1.7.5.1-1. For structures inside cargo tanks of tankers α is to be increased by 0,05;

β = factor given in Table 1.7.5.1-2 depending on the ratio of weld pitch t, in mm, to weld length l, in mm (Fig. 1.7.5.1-1);

s = thickness of the lesser of the parts joined.

Table 1.7.5.1-1

Nos	Connection of structural members	Weld factor α
1	**Double bottom**	
1.1	Centre girder and duct keel to plate keel	0,35
1.2	Ditto to inner bottom plating	0,25
1.3	Ditto to inner bottom plating in the engine room and in way of thrust bearings	0,35
1.4	Floors to centre girder and duct keel under engines, boilers, thrust bearings and within 0,25L from F.P.	0,35
1.5	Floors to centre girder and duct keel elsewhere	0,25
1.6	Floors to margin plate and inner bottom plating under the corrugated bulkhead plates	0,35
1.7	Watertight floors, portions of side girders or centre girder round the boundaries of tanks, plating of bilge wells to their bottom plates and to inner bottom, floors and side girders	0,35
1.8	Floors and side girders to shell plating within 0,25L from F.P.	0,25
1.9	Ditto, elsewhere	0,2
1.10	Floors and side girders to inner bottom plating under engines, boilers and thrust bearings	0,25
1.11	Ditto, elsewhere	0,15
1.12	Floors to side girders within 0,25L from F.P.	0,25
1.13	Ditto, elsewhere	0,2
1.14	Margin plate to shell plating	0,35
1.15	Inclined margin plate to inner bottom plating	0,35
1.16	Bracket floors: bottom frames and brackets to shell plating	0,15
1.17	Reverse frames and brackets to inner bottom plating	0,1
1.18	Brackets, frames (see 2.4.4.5) to duct keel, plate keel, shell and inner bottom plating	0,35
1.19	With longitudinal framing, bottom transverses to shell, inner bottom plating, centre girder and duct keel, margin plate where the floor spacing is less than 2,5 m outside the regions defined in 1.4 and 1.7	0,25
1.20	Ditto, with floor spacing 2,5 m and more, in all regions	0,35
1.21	Longitudinals to shell plating within 0,25L from F.P.	0,17
1.22	Ditto, elsewhere	0,13
1.23	Longitudinals to inner bottom plating	0,1
1.24	Brackets (see 2.4.2.5.2) to shell plating, margin plate, inner bottom plating and longitudinals	0,25
2	**Single bottom**	
2.1	Centre girder to plate keel	0,35
2.2	Centre girder to face plate	0,25
2.3	Floors to centre girder and longitudinal bulkheads	0,45
2.4	Floors and side girder webs to their face plates and to shell plating under engines, boilers and thrust bearings, as well as in the after peak	0,25
2.5	Floors and side girder webs to shell plating elsewhere	see 1.8, 1.9, 1.19 and 1.20
2.6	Floors and side girder webs to their face plates elsewhere	0,15
2.7	Side girder webs to floors	0,2

Table 1.7.5.1-1 — continued

Nos	Connection of structural members	Weld factor α
2.8	Bottom longitudinals to shell plating	see 1.21 and 1.22
3	**Side framing**	
3.1	Frames (including web frames) and side stringers to shell plating within 0,25L from F.P. in tanks, in the engine room, in way of ice strengthening and strengthening of sides of ships mooring at sea alongside other ships or offshore units	0,17
3.2	Ditto, elsewhere	0,13
3.3	Frames (including web frames) and side stringers to their face plates in regions defined in 3.1	0,13
3.4	Ditto, elsewhere	0,1
3.5	Frames (including web frames) and side stringers to shell plating in the after peak	0,25
3.6	Ditto to their face plates	0,17
3.7	Side stringers to web frames	0,25
3.8	Side longitudinals to shell plating	0,17
3.9	Ditto to face plates	0,13
3.10	Bilge brackets to margin plate and face plates of floors outside double bottom	0,35[1]
3.11	Ditto to shell plating	0,25
4	**Deck framing and decks**	
4.1	Deck transverses and girders to deck plating	0,17
4.2	Ditto to their face plates	0,13
4.3	Cantilever beams to deck plating and to their face plates	0,25
4.4	Webs of deck transverses to girder webs and bulkheads	0,25
4.5	Beams in way of tanks, fore and after peaks, as well as hatch end beams, to deck plating	0,15
4.6	Ditto, elsewhere	0,1
4.7	Deck longitudinals to deck plating and their face plates	0,1
4.8	Stringer plate of strength deck to shell plating	0,45[2]
4.9	Ditto for other decks and platforms	0,35[1]
4.10	Hatch coamings to deck plating at hatch corners	0,45[2]
4.11	Ditto, elsewhere	0,35[3]
4.12	Face plates of hatch coamings to vertical plates of same	0,25
4.13	Stays, horizontal and vertical stiffeners to vertical plates of hatch coamings	0,2
4.14	Side and end bulkheads of superstructures and deckhouses to deck plating	0,35
4.15	Other bulkheads of superstructures and deckhouses to deck plating	0,25
4.16	Bulwark stays to bulwark plating	0,2
4.17	Bulwark stays to deck and guard rails	0,35
4.18	Pillars to deck and inner bottom, pillar brackets to pillars, decks, inner bottom and other structures	0,35
5	**Bulkheads and partitions**	
5.1	Fore and after peak bulkheads, tank (cargo oil tank) boundaries, bulkheads (including wash bulkheads) inside after peak around the perimeter	0,35
5.2	Other watertight bulkheads (including wash bulkheads) to bottom shell or inner bottom plating, shell plating in way of the bilge	0,35
5.3	Ditto to sides and deck	0,25
5.4	Vertical box corrugations of corrugated bulkheads to inner bottom plating and upper strake of lower stool	0,35
5.5	Shaft tunnel plating all round	0,35
5.6	Vertical and horizontal stiffeners to bulkhead plates under 5.1, and to wash bulkheads	0,15
5.7	Ditto of other bulkheads	0,1
5.8	Vertical webs and horizontal girders to bulkhead plates according to 5.1, and to wash bulkheads	0,17
5.9	Ditto to their face plates	0,13
5.10	Vertical webs and horizontal girders to plating of other bulkheads	0,13
5.11	Ditto to their face plates	0,1
5.12	Transverse bulkheads to wash bulkheads	0,35[1]
6	**Brackets and stiffeners**	
6.1	Brackets for interconnection of structural members	0,35[3]
6.2	Stiffeners and tripping brackets (see 1.7.3.2) of deep members, floors, etc.	0,1
7	**Foundations for main engines, boilers and other machinery**	
7.1	Vertical plates to shell, inner bottom and deck plating	0,35[4]
7.2	Top plates (face plates) to longitudinal girders, brackets, knees	0,45[2]
7.3	Brackets and knees of foundations to vertical plates, shell plating, inner bottom (floor face plates) and to deck plating	0,35[4]
7.4	Brackets and knees to their face plates	0,25

[1] Double continuous weld is to be applied.

[2] Full penetration welding is to be provided.

[3] Fillet welds attaching face plates to member webs are to be welded in way of brackets with weld factor 0,35.

The face plates are to be welded to the brackets by the same weld as that of the face plate of the member in the span between the brackets.

[4] The structures under the girder webs, brackets and knees of foundations are to be welded to the inner bottom and decks by double continuous fillet welds with factor 0,35.

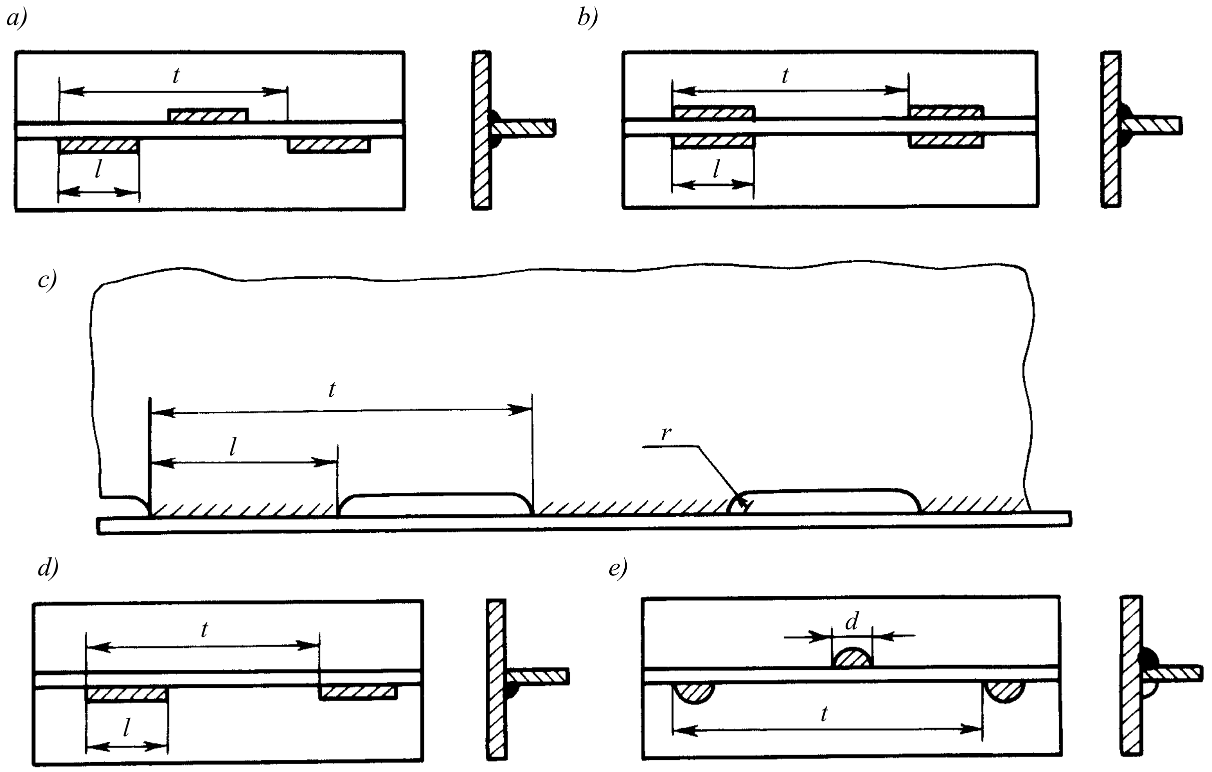


Fig. 1.7.5.1-1
Weld types:
a — staggered intermittent; *b* — chain intermittent; *c* — scalloped; *d* — single intermittent; *e* — staggered spot

Table 1.7.5.1-2

Type of fillet weld	β
Double continuous	1,0
Staggered, chain and scalloped	*t/l*
Single continuous	2,0
Single intermittent	2*t/l*

The relationship between the leg length of the fillet weld and the height of the isosceles triangle inscribed into the cross section of the weld (Fig. 1.7.5.1-2) is to be assumed as $k = 1{,}4a$ or $a = 0{,}7k$.

When automatic welding is employed instead of the proposed manual welding, the weld throat or leg length, whichever is adopted in calculation, may be reduced in height for single-run welds by not more than 30 per cent.

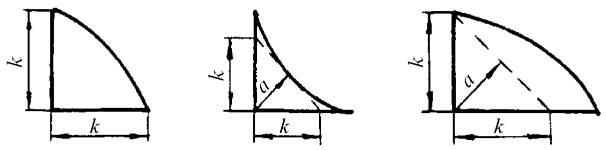


Fig. 1.7.5.1-2

For multirun welds the percentage of the above reduction is subject to special consideration by the Register.

If the thickness of the thinner of the items to be joined is less than half the thickness of the thicker item, then the leg lengths are subject to special consideration by the Register.

The throat thickness *a* of a fillet weld is not to be less than:

2,5 mm for $s \leqslant 4$ mm;
3,0 mm for $4 < s \leqslant 10$ mm;
3,5 mm for $10 < s \leqslant 15$ mm;
$0{,}25s$ for $s > 15$ mm.

The dimensions of fillet welds taken from calculations are not to exceed $a \leqslant 0{,}7s$ ($k \leqslant s$).

1.7.5.2 Overlapping connections, if allowed (see 1.7.2.1), are to be welded all round by continuous weld with factor 0,4.

The length of overlap, in mm, is to be not less than $b = 2s + 25$, but not more than 50 mm (s = thickness of the thinner of the plates joined).

1.7.5.3 The primary members (beams, deck longitudinals, frames, bulkhead stiffeners, etc.) are to be connected to supporting members (deck girders, deck transverses, side stringers, horizontal girders, etc.) by welds with factor 0,35.

The sectional area f, in cm^2, of the welds connecting the primary members to supporting members is not to be less than determined by the formula

$$f = 25pal/\sigma_n \qquad (1.7.5.3)$$

where p = pressure, in kPa, specified in appropriate chapters of this Part of the Rules;
a = spacing of members, in m;
l = span of member, in m;
for σ_n, see 1.1.4.3.

The weld sectional area f is determined by summing up the results obtained by multiplying the throat thickness by the weld length of each portion of the connection of member web to supporting member.

1.7.5.4 The framing members cut at intersection with other structures are to be in good alignment. A non-alignment is not to exceed half the thickness of the member. Where continuity is obtained by directing welding of the members to the structure involved, the throat thickness of the weld is to be determined considering the thickness of the member concerned. Otherwise, through penetration welding is to be performed. If the thickness of the thinner of the parts joined is less than 0,7 of the thickness of the other part, the throat thickness is to be calculated with regard to the particular loading conditions in way of the intersection.

Where longitudinals are cut at transverse bulkheads, the construction used for their attachment is to comply with the following requirements:

.1 when the brackets are fitted in line on both sides of the bulkhead, the area f_1, in cm^2, of the weld connecting the brackets (and the longitudinal butt ends, if they are welded) to transverse bulkheads (Fig. 1.7.5.4 *a*) is not to be less than determined by the formula

$$f_1 = 1{,}75S_0 \qquad (1.7.5.4.1)$$

where S_0 = cross-sectional area of the longitudinal (effective flange excluded), in cm^2;

.2 if one continuous bracket plate welded in the appropriate slot cut in the bulkhead plating is fitted (Fig. 1.7.5.4 *b*), the sectional area of the bracket at the bulkhead is not to be less than $1{,}25S_0$;

.3 the arm length l_{br} of the bracket, in mm, over the longitudinals is not to be less than determined by the formula

$$l_{br} = \frac{1{,}75S_0 - S_1}{2a} \cdot 10^2 \qquad (1.7.5.4.3)$$

where S_1 = area of weld connecting longitudinal butt ends to transverse bulkheads, in cm^2;
a = accepted design thickness of fillet weld connecting bracket to longitudinal, in mm.

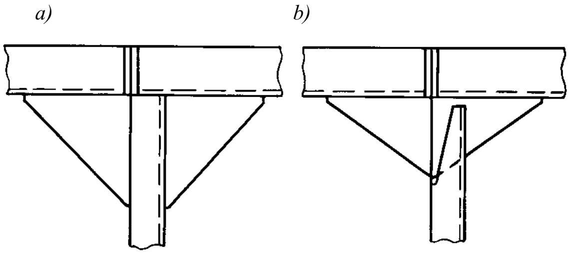


Fig. 1.7.5.4

1.7.5.5 Where plate thickness exceeds 18 mm, for connections made by fillet welds in which excessive stress in Z-direction may be caused by welding process or by external loads, Z-steel (see 1.2.2.2) is to be used or structural measures are to be taken to prevent lamellar tearing. In all cases, reducing of residual stress level is to be provided.

1.7.5.6 Double continuous welds are to be used in the following regions (see also Note 1 to Table 1.7.5.1-1):

.1 within 0,25L from the forward perpendicular in ships with length $L \geqslant 30$ m, for connection of framing members to bottom shell, and in case of only a single bottom in this region, also for welding of the webs of centre girder, side girders and floors to face plates of these members;

.2 in region I of ice strengthening in ships of categories **ЛУ9**, **ЛУ8**, **ЛУ7**, **ЛУ6**, **ЛУ5**, **ЛУ4** and in region AI of category **ЛУ3** ships, for connection of side framing to shell plating;

.3 in way of foundations for machinery and equipment which may constitute a source of vibration (see 1.7.1.6), for connection of framing members to bottom and inner bottom platings, deck framing to deck plating;

.4 for the structures in the after peak;

.5 in way of supports and member ends, for connection of framing members to the plating (see 1.7.5.8);

.6 in tanks (including double bottom tanks), exclusive the tanks for oil fuel or lubricating oil;

.7 for structures providing tightness.

1.7.5.7 Single continuous welds are not to be used:

.1 within 0,2L from F.P. for connection of side framing to shell plating, and within 0,25L from F.P. for connection of bottom framing to shell plating;

.2 for structures subject to intense vibration (see 1.7.1.6);

.3 in region I of ice strengthening of ships;

.4 for welding of side framing in ships mooring alongside other ships at sea or offshore units;

.5 for connections where the angle between a member web and the plating differs by more than 10° from a right angle.

1.7.5.8 For all types of intermittent joints the weld length (see Fig. 1.7.5.1-1) is not to be less than 15a (for a, see 1.7.5.1) or 50 mm, whichever is the greater. The spacing of welds ($t-l$) — for chain welds and scalloped framing, and ($t-2l$)/2 — for staggered welds) is not to exceed 15s (s = plate thickness or web thickness, whichever is less). In any case, the spacing of welds or scallop length, where scalloped frames are used, is not to exceed 150 mm.

Intermittent or single continuous welds connecting the framing members to the plating are to be substituted in way of supports and member ends by double continuous welds having the same throat thickness as the intermittent or single continuous welds of the remaining part of the members. The length of joints welded from both sides is to be not less than the sum of bracket arm and the web depth, if a bracket is fitted, and is to be twice the web depth if no bracket is fitted. Where the framing members pass through supporting structures (deck transverses, deck girders, floors, etc.), the aforesaid reinforcement is to be provided on both sides of supporting member. Where single continuous welds are used, back runs at least 50 mm long and spaced not more than 500 mm apart are to be welded on the reverse side of the detail joined. The throat thickness of back weld is to be the same as that of the single continuous weld.

1.7.5.9 Staggered spot welds and single intermittent welds (see Fig. 1.7.5.1-1 *d*, *e*) may be used in the structures of deckhouses and superstructures of the second tier and above, on decks inside first tier superstructures, casings, enclosures inside the hull, not subject to intense vibration and impact loads and not affected by active corrosion, provided that the maximum plate or member web thickness is not more than 7 mm.

The spot diameter *d*, in mm, is not to be less than:

$$d = 1{,}12\sqrt{\alpha t s} \qquad (1.7.5.9)$$

where t = pitch of spot weld (see Fig. 1.7.5.1-1);
$t_{\max}$ = 80 mm;
for α and s, see 1.7.5.1.

If $d > 12$ mm, as obtained from the Formula (1.7.5.9), the weld pitch is to be increased or another type of weld is to be chosen.

1.7.5.10 Scalloped construction is not to be used:

.1 for side framing within 0,2*L* from F.P. and for connection of framing members to bottom shell plating within 0,25*L* from F.P.;

.2 in regions with high level of vibration (see 1.7.1.6);

.3 for side and bottom framing in region I of ice belt and for side framing in ships mooring at sea alongside other ships or offshore units;

.4 for connection of bottom centre girder to plate keel;

.5 for deck and inner bottom framing in locations where containers, trailers and vehicles may be stowed and for upper deck framing under deckhouses in way of their ends at a distance less than 0,25 of the deckhouse height from the intersection of deckhouse side and end bulkhead.

1.7.5.11 In scalloped construction (see Fig. 1.7.5.1) the welding is to be carried round the ends of all lugs. The depth of scallop in member web is not to exceed 0,25 of the member depth or 75 mm, whichever is less. The scallops are to be rounded with radius not less than 25 mm. The spacing of lugs *l* is to be not less than the length of the scallop.

Scallops in frames, beams, stiffeners and similar structures are to be kept clear of the ends of structures, as well as intersections with supporting structures (decks, side stringers, deck girders, etc.) by at least twice the member depth, and from the toes of the brackets by at least half the member depth.

1.7.5.12 In the framing of tanks (including double-bottom tanks and the tanks of tankers), provision shall be made for openings to ensure free air flow to air pipes, as well as an overflow of liquid.

It is recommended that openings in longitudinals shall be elliptical with a distance from the edge of opening to deck plating or bottom shell plating not less than 20 mm.

In way of air and drain holes, cut-outs for the passage of framing members and welded joints the joints are to be welded as double welds on a length of 50 m on both sides of the opening.

1.7.5.13 Where welding of tee-joints by fillet welds is impracticable, plug welds (Fig. 1.7.5.13 *a*) or tenon welds (Fig. 1.7.5.13 *b*) may be used. The length *l* and pitch *t* are to be determined as for scalloped frames under 1.7.5.11.

For plug welding, the slots are to be of circular or linear form, with throat thickness of weld equal to 0,5 of plate thickness. In general, the ends of slots in plug welding are to be made semicircular. The linear slots are to be arranged with longer side in the direction of the parts to be joined (see Fig. 1.7.5.13 *b*).

Complete filling of slot is not permitted.

In regions of high level of vibration (see 1.7.1.6) welded joints with complete root penetration and permanent backing ring (Fig. 1.7.5.13 *c*) are recommended instead of tenon welds or plug welds.

1.7.5.14 Where aluminium alloy structures are welded according to Table 1.7.5.1-1, it is not permitted:

.1 to use intermittent welds (except in scalloped construction);

.2 to use scalloped construction in regions of high level of vibration (see 1.7.1.6).

The throat thickness of welds is to be not less than 3 mm, but not more than 0,5*s* (for *s*, see 1.7.5.1).

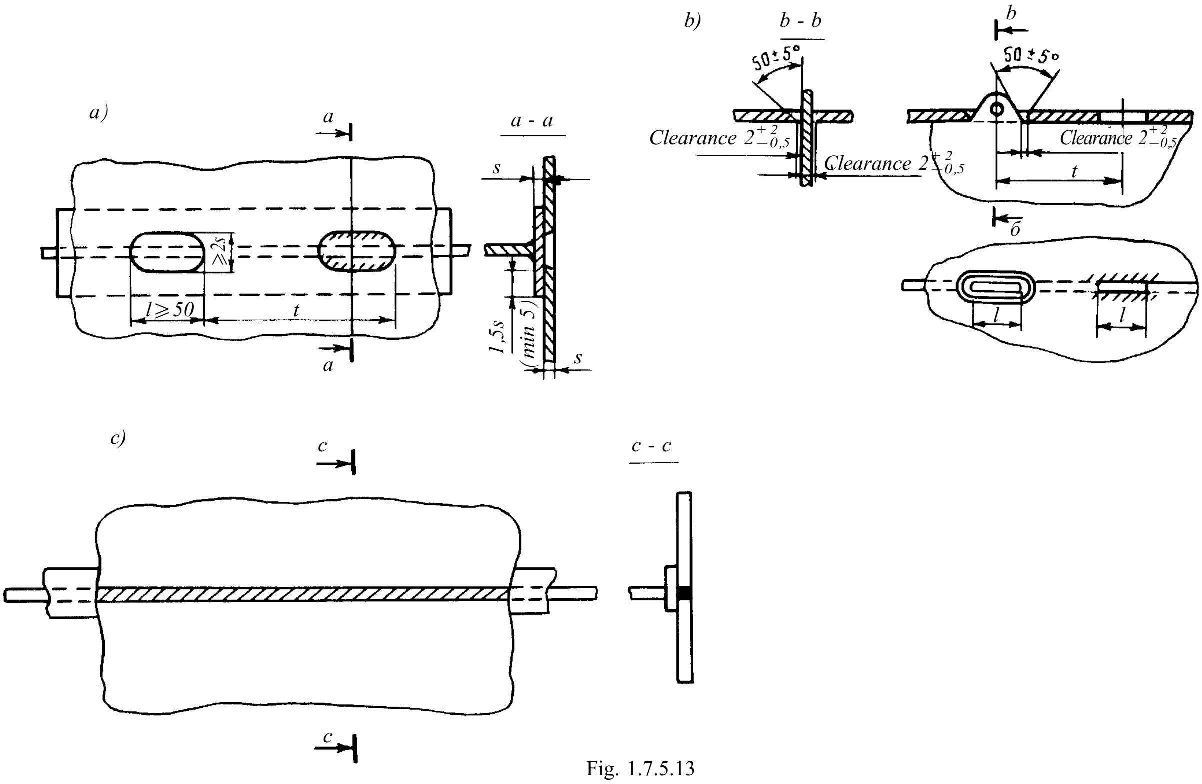


Fig. 1.7.5.13

2 GENERAL REQUIREMENTS FOR HULL STRUCTURES

2.1 GENERAL

2.1.1 Application.

The requirements given in this Section apply to sea-going ships of all types and purposes, having regard to additional provisions of Section 3 "Requirements for Structures of Ships of Special Design".

The Section contains the requirements for hull structures: shell plating, platings, primary and deep members, pillars, stems, sternframes, seatings, etc.

2.1.2 Symbols.

L_1 = length of the compartment, in m, measured as follows:

with plane bulkheads, as the distance between bulkhead platings;

with corrugated bulkheads, as the distance between corrugation axes or the axes of trapezoidal stools at the inner bottom level;

with cofferdam bulkheads, as the distance between middle cofferdam axes;

B_1 = breadth of the compartment, in m, measured at its mid-length as follows:

for single skin construction, as the distance between the sides or between the side and the longitudinal bulkhead at the upper edge of the floor;

for double skin construction, as the distance between inner skins or between the inner skin and the longitudinal bulkhead;

where hopper side tanks are fitted, as the distance between hopper tanks at the inner bottom level or between the longitudinal bulkhead and the hopper side tank;

where several longitudinal bulkheads are fitted, as the spacing of longitudinal bulkheads or as the distance between the longitudinal bulkhead nearest to the side and the appropriate side;

l = span of the member, in m, defined in 1.6.3.1, unless provided otherwise;

h = depth of the member web, in cm;

a = spacing of primary or deep members concerned (longitudinal or transverse framing); where the spacing varies, a is the half-sum of the distances of adjacent members from the member concerned;

s = plate thickness, in mm;

W = section modulus of members, in cm^3;

I = moment of inertia of members, in cm^4;

Δs = corrosion allowance to the plate thickness, in mm (see 1.1.5.1);

ω_c = factor taking account of corrosion allowance to the section modulus of members (see 1.1.5.3).

2.2 SHELL PLATING

2.2.1 General and symbols.

2.2.1.1 Requirements are given in this Chapter for the thickness of bottom and side shell plating, thickness and width of sheerstrake, plate keel, garboard strakes, as well as the requirements for the minimum structural thicknesses of these members and construction of openings therein. The requirements are applicable to all regions over the ship's length and depth unless additional requirements for shell plating thickness are put forward.

2.2.1.2 Symbols.

p_{st} = design static pressure according to 1.3.2.1;

p_w = design pressure due to the motion of ship hull about wave contour according to 1.3.2.2;

p_c = design pressure from carried liquid cargo, ballast or oil fuel according to 1.3.4.2.1.

2.2.2 Construction.

2.2.2.1 No openings are to be cut in the upper edge of sheerstrake or in the side shell plating if the distance between the upper edge of opening and the strength deck is less than half the opening depth. All other cases are to be specially considered by the Register.

Rectangular openings cut in the side shell plating are to have their corners rounded with the radius equal to 0,1 of the opening depth or width, whichever is less, but not less than 50 mm.

In all cases when the openings may result in considerable reduction of longitudinal or local strength of the ship, provision is to be made for reinforcement of such areas.

Reinforcement by means of thickened insert plates is required for openings located within 0,35L from the midship region, the distance from their upper edge to the strength deck being less than the depth of opening. The minimum width of thickened insert plates, as measured from the upper or lower edge of opening, is to be equal to 0,25 of the depth or length of the opening, whichever is less; the total width measured outside the opening is to be greater than the minimum thickness by at least 0,25 of the depth or length of the opening, whichever is less. The minimum distance from the end of the thickened insert plate to the nearest edge of opening, as measured along the length, of the ship shall be equal to at least 0,35 of the depth or length of opening, whichever is less. The corners of the thickened insert plate are to be rounded. The thickness of the thickened insert plate is not to be less than:

1,5s when $s < 20$ mm;

30 mm when $20 \leqslant s \leqslant 24$ mm;

1,25s when $s > 24$ mm

where s = thickness of shell plating in way of the opening.

A thicknened insert plate may be fitted around the perimeter of the opening.

2.2.2.2 The area of transition from sheerstrake to deck stringer may be rounded. In this case, the radius of curvature of sheerstrake is not to be less than 15 times the sheerstrake thickness. No openings are permitted in the rounded area.

2.2.3 Loading on shell plating.

The external pressure p, in kPa, on the bottom and side shell plating is determined by the formula

$$p = p_{st} + p_w. \qquad (2.2.3\text{-}1)$$

For ships with double bottom and double skin side construction intended for liquid ballast and for tankers with neither double bottom nor double skin side construction, the internal pressure $p = p_c$ shall be determined additionally from the Formulae (1.3.4.2.1). Where $p_{st} > p_w$, counterpressure shall be considered:

$$p = p_c - (p_{st} - p_w). \qquad (2.2.3\text{-}2)$$

For ships with double bottom and double skin side construction, p_{st} and p_w shall be determined in accordance with 1.3.2 as in the case of the ballasted ships.

As the design pressure, both external and internal pressure may be adopted, whichever is the greater.

The pressure p_w above the summer load waterline is not to be less than $p_{\min}$, in kPa, determined by the formula

$$p_{\min} = 0{,}03L + 5. \qquad (2.2.3\text{-}3)$$

Where $L > 250$ m, L is to be taken equal to 250 m.

For ships of restricted area of navigation, the value of $p_{\min}$ may be reduced by multiplying by the factor φ_r obtained from Table 1.3.1.5.

2.2.4 Scantlings of plate structures of shell plating.

2.2.4.1 The thickness of bottom and side shell plating is not to be less than determined by the Formula (1.6.4.4) taking:

$$m = 15{,}8;$$

for bottom shell plating

$k_\sigma = 0{,}3k_B \leqslant 0{,}6$ in the midship region for $L \geqslant 65$ m and transverse framing system;

$k_\sigma = 0{,}6$ in the midship region for $L = 12$ m and transverse framing system.

Where $12 < L < 65$, k_σ is to be determined by linear interpolation taking $k_\sigma = 0{,}45$ for $L = 65$ m;

$k_\sigma = 0{,}6$ in the midship region for longitudinal framing system;

$k_\sigma = 0{,}7$ at the ends of the ship within 0,1L from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation;

for side shell plating in way of $(0{,}4 - 0{,}5)D$ from the base line

$k_\sigma = 0{,}6$ in the midship region;

$k_\sigma = 0{,}7$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation.

For region below $0{,}4D$ from the base line, k_σ is determined by linear interpolation between the values of k_σ for bottom shell plating and those for side shell plating in way of $(0{,}4-0{,}5)D$ from the base line.

For region above $0{,}5D$ from the base line, k_σ is determined by linear interpolation between k_σ for upper deck level and k_σ for side shell plating in way of $(0{,}4-0{,}5)D$ from the base line.

k_σ for upper deck level is determined in the same way as k_σ for bottom shell plating, parameter k_D being substituted for parameter k_B.

$$k_B = W_B^F/\eta W\ ;\ k_D = W_D^F/\eta W \qquad (2.2.4.1)$$

where W = Rules' hull section modulus amidships in accordance with 1.4.6 and assuming $\eta = 1$;

W_B^F and W_D^F = actual section moduli for bottom and deck amidships according to 1.4.8;

η = factor indicating application of the steel mechanical properties for the member for which K_σ is determined, to be established on the basis of 1.1.4.3.

2.2.4.2 The buckling strength of bottom plating, strake above bilge, sheerstrake and strake below in the midship region of ships over 65 m in length is to be verified in accordance with 1.6.5.

2.2.4.3 The thickness of bilge strake is to be adopted equal to that of bottom or side shell plating, whichever is the greater.

2.2.4.4 The width of plate keel b_k, in mm, is not to be less than:

$$b_k = 800 + 5L; \qquad (2.2.4.4)$$

in this case, b_k need not exceed 2000 mm.

The thickness of plate keel is to be 2 mm greater than that of bottom shell plating.

2.2.4.5 The sheerstrake width b_s, in mm, is not to be less than determined by the Formula (2.2.4.4) taking b_s not greater than 2000 mm.

The sheerstrake thickness amidships is not to be less than that of adjoining strakes of side shell or deck plating (stringer plate), whichever is the greater. At ends, the sheerstrake thickness may be equal to that of side shell plating in this region.

2.2.4.6 The shell plates adjoining the sternframe, as well as the plates to which the arms of propeller shaft brackets are attached, are to have a thickness s, in mm, of not less than:

$$s = 0{,}1L + 4{,}4 \text{ for } L < 80 \text{ m};$$
$$s = 0{,}055L + 8 \text{ for } L \geqslant 80 \text{ m}. \qquad (2.2.4.6)$$

Where $L > 200$ m, L is to be taken equal to 200 m.

The aforesaid thickness is to be ensured after hot bending, if applied.

2.2.4.7 The thickness of garboard strakes directly adjoining the bar keel is not to be less than that required for the plate keel, and their width is not to be less than half the width required for the plate keel in accordance with 2.2.4.4.

2.2.4.8 In any case, the thickness of shell plating s, in mm, is not to be less than:

$$s_{\min} = 3{,}1 + 0{,}12L \text{ for } L < 30 \text{ m};$$
$$s_{\min} = (5{,}5 + 0{,}04L)\sqrt{\eta} \text{ for } L \geqslant 30 \text{ m} \qquad (2.2.4.8)$$

where for η, see 1.1.4.3.

Where $L > 300$ m, L is to be taken equal to 300 m.

Where the adopted spacing is less than the standard one (see 1.1.3) for ships of unrestricted area of navigation and limited area of navigation I, a reduction of minimum thickness of shell-plating is permitted in proportion to the ratio of adopted spacing to standard spacing but not more than 10 per cent.

2.2.5 Special requirements.

2.2.5.1 The grade of steel used for the sheerstrake shall be the same as that used for the strength deck. The upper edge of sheerstrake shall be smooth, and their corners shall be well rounded in the transverse direction.

2.2.5.2 For ships of 65 m and above, within $0{,}6L$ amidships no parts shall be welded to the upper edge of sheerstrake or to the sheerstrake rounding.

2.2.5.3 Bilge keels shall be attached to the shell plating by means of an intermediate member, i.e. a flat bar welded to the shell plating with an all-round continuous fillet weld. Connection of the bilge keel to this member shall be weaker than that of the member to the shell plating. However, the connection shall be strong enough to keep the bilge keels under the ordinary operating conditions of the ship. The intermediate member shall be made continuous over the length of bilge keel. Bilge keels shall terminate in the stiffened area of shell plating and shall be gradually tapered at ends.

The bilge keel and the intermediate member shall be of the same steel grade as the shell plating in this region.

2.2.5.4 In bottom-and-side fittings, the welded branch wall thickness is not to be less than that of shell plating determined according to 2.2.4.8, or 12 mm, whichever is the greater.

2.3 SINGLE BOTTOM

2.3.1 General and symbols.

2.3.1.1 Requirements are given in this Chapter for the bottom framing of ships having no double bottom and in way where it is omitted, as well as for the floors, centre girder, bottom longitudinals and the brackets by which they are connected.

2.3.1.2 Symbols:

L_1 = length of the compartment concerned (hold, tank, machinery space, etc.), in m;

B_1 = breadth of the compartment concerned, in m;

B_x = breadth of ship in m, in way of considered section at the level of summer load waterline.

2.3.2 Construction.

2.3.2.1 In tankers of 80 m and above, longitudinal framing is to be provided for single bottom.

2.3.2.2 The structure of centre girder is to satisfy the following requirements:

.1 the centre girder is to extend throughout the ship's length as far as practicable. In ships greater than 65 m in length, a continuous centre girder is recommended between transverse bulkheads;

.2 when the bottom is framed longitudinally, the centre girder is to be stiffened on both sides with flanged brackets fitted between the bottom transverses and between bottom transverse and transverse bulkhead. The distance between brackets, between bracket and bottom transverse or between bracket and transverse bulkhead is not to exceed 1,2 m.

The brackets shall be carried to the face plate of the centre girder if the web of the latter is stiffened vertically or to the second horizontal stiffener from below if the centre girder web is stiffened horizontally.

In way of bottom plating, the brackets are to extend to the nearest bottom longitudinal and are to be welded thereto.

2.3.2.3 When the bottom is framed transversely, floors are generally to be fitted at every frame.

Where the floors are cut at the centre girder, their face plates are to be butt-welded to the face plate of the centre girder. If the actual section modulus of floors exceeds the value required by 2.3.4.1.2 less than 1,5 times, the width of their face plates is to be doubled, where attached to the centre girder face plate, or horizontal brackets of adequate size are to be fitted.

The floor face plates may be replaced by flanges.

Flanged floors are not permitted in way of machinery space, in the after peak, and in ships of 30 m and above; they are not permitted within 0,25L from the fore perpendicular, either.

2.3.2.4 When the bottom is framed longitudinally, brackets are to be fitted in line with the bottom transverse web on both sides of the centre girder where the girder is higher than the bottom transverse at the place of their connection. A bracket shall be welded to bottom transverse face plate and to centre girder web and face plate. The free edge of the bracket shall be stiffened with a face plate, and the angle of its inclination to bottom transverse face plate is not to exceed 45°.

Similar requirements apply to the connections of the stringer to bottom transverse where the stringer is higher than the bottom transverse at the place of connection.

2.3.2.5 When the bottom is framed longitudinally, the spacing of side girders and the distance from the centre girder or ship's side to the side girder is not to exceed 2,2 m.

The side girder plates are to be cut at floors and welded thereto.

The face plates of side girders are to be welded to those of floors.

2.3.2.6 In tankers, the side girders, if fitted, are to form a ring system together with vertical stiffeners of transverse bulkheads and deck girders.

Deep side girders having the same depth as the centre girder, as well as conventional side girders having the same depth as bottom transverses, are to run continuous from one transverse bulkhead to another with $L_1/B_1 < 1$.

2.3.2.7 In the machinery space, the centre girder may be omitted if the longitudinal girders under engine seating extend from the fore to the after bulkhead of the engine room and terminate with brackets beyond the bulkhead according to 2.3.5.1.

2.3.2.8 In ships having a length of 65 m and more, the buckling strength of centre girder and side girders in the midship region is to be ensured in accordance with 1.6.5.

The webs of centre girder, side girders and floors are to be stiffened in accordance with 1.7.3.

2.3.2.9 Connections of bottom longitudinals to transverse bulkheads shall be such that the effective sectional area of the longitudinals is maintained.

2.3.3 Single bottom loading.

2.3.3.1 The design pressure on single bottom structures of dry cargo ships is the external pressure determined by the Formula (2.2.3-1) for a ship in the ballast condition. When determining p_{st} in the Formula (2.2.3-1), the ballast draught may be taken as 0,6 of the summer draught.

If a dry cargo ship is designed to operate in a fully loaded condition with some holds empty the static pressure p_{st} in the Formula (2.2.3-1) for these holds is to be determined at summer draught.

2.3.3.2 As the design pressure on single bottom structures of tankers, external pressure determined by the Formula (2.2.3-1) at summer draught is adopted, or the total pressure determined by the Formula (2.2.3-2), whichever is the greater.

2.3.4 Scantlings of single bottom members.

2.3.4.1 The bottom with transverse framing is to satisfy the following requirements:

.1 the depth of floors at the centreline is not to be less than 0,055B_1. In any case, B_1 is not to be taken less than 0,6B_x. Allowable reduction of floor depth is not to be more than 10 per cent, the required floor section modulus being maintained.

In the machinery space, the height of floor web between longitudinal girders under the seating is not to be less than 0,65 of the required depth at the centreline.

A reduction of floor section modulus by more than 10 per cent as compared to that required by 2.3.4.1.2 is not permitted.

At a distance of $^3/_8B_x$ from the centreline, the depth of floors is not to be less than 50 per cent of the required depth of the centreline floors;

.2 at the centreline, the section modulus of floors is not to be less than determined according to 1.6.4.1 and 1.6.4.2 taking:

$m = 13$;

$k_\sigma = 0{,}6$;

$l = B_1$, but not less than $0{,}6B_x$;

for p, see 2.3.3.1, but it is not to be less than 35 kPa for dry cargo ships and not less than 85 kPa for tankers.

On portions equal to $0{,}05B_x$ from ship's side, the floor web sectional area is not to be less than determined according to 1.6.4.3 taking:

$N_{\max} = 0{,}4pal$;

$k_\tau = 0{,}6$.

When determining p and l, the above limitations shall be used;

.3 in accordance with 2.3.4.1.2, the section modulus of centre girder is to be at least 1,6 times greater than the section modulus of a floor at the centreline. The depth of centre girder is to be equal to that of a floor at the place of their connection;

.4 the section modulus of a side girder is not to be less than the section modulus of a floor at the centreline in accordance with 2.3.4.1.2. The depth of side girder is to be equal to that of the floor at the place of their connection.

2.3.4.2 If longitudinal system of framing is adopted, the bottom members in way of the cargo tanks in tankers are to satisfy the following requirements:

.1 the section modulus of bottom longitudinals is not to be less than determined in accordance with 1.6.4.1 and 1.6.4.2 taking:

p = as defined in 2.3.3.2;

l = span, in m, equal to the distance between bottom transverses or between bottom transverse and transverse bulkhead;

$m = 12$;

$k_\sigma = 0{,}45k_B \leqslant 0{,}65$ in the midship region;

$k_\sigma = 0{,}65$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation.

k_B is to be determined by the Formula (2.2.4.1);

.2 the section modulus of a bottom transverse is not to be less than determined from 1.6.4.1 and 1.6.4.2. Bottom transverse web sectional area, excluding openings, is not to be less than stipulated under 1.6.4.3 taking:

p = as defined in 2.3.3.2;

$l = B_1$;

$k_\sigma = k_\tau = 0{,}6$;

for a wing tank

$m = 18$;

$N_{\max} = 0{,}35pal$;

for a centre tank,

$m = m_{b.t}$;

$N_{\max} = 0{,}7n_{b.t}pal$;

$m_{b.t}$ and $n_{b.t}$ are to be obtained from Table 2.3.4.2.2 depending upon the parameter μ and the number of bottom transverses within a tank;

Table 2.3.4.2.2

μ	Number of transverses within a tank															
	2	3	4	5	2	3	4	5	2	3	4	5	2	3	4	5
	$m_{b.t}$				$m_{c.g}$				$n_{b.t}$				$n_{c.g}$			
0,01	96,0	95,9	95,9	95,8	27,3	21,7	25,5	23,3	0,253	0,255	0,256	0,257	0,329	0,370	0,393	0,409
0,02	95,8	95,6	95,4	95,1	27,6	22,1	26,0	23,9	0,256	0,260	0,261	0,264	0,326	0,367	0,387	0,401
0,04	95,4	95,4	93,9	92,7	28,3	22,8	27,1	25,0	0,261	0,269	0,271	0,277	0,318	0,355	0,375	0,387
0,06	94,7	92,7	91,8	89,3	28,9	23,5	28,1	26,2	0,267	0,277	0,281	0,289	0,311	0,346	0,364	0,374
0,08	93,9	90,5	89,2	85,5	29,6	24,3	29,1	27,4	0,272	0,286	0,290	0,301	0,304	0,337	0,354	0,363
0,1	92,9	88,1	86,3	81,5	30,2	25,0	30,2	28,6	0,276	0,293	0,298	0,311	0,298	0,329	0,344	0,352
0,2	86,5	75,1	72,1	64,0	33,4	28,9	35,5	34,7	0,298	0,326	0,333	0,352	0,269	0,294	0,304	0,307
0,3	79,6	64,0	61,1	52,3	36,6	32,8	40,9	41,0	0,316	0,352	0,359	0,382	0,246	0,266	0,273	0,274
0,4	73,3	55,7	53,1	44,7	39,8	36,9	46,5	47,6	0,330	0,373	0,380	0,404	0,226	0,243	0,249	0,249
0,6	63,2	44,9	43,3	36,1	46,2	45,4	58,0	61,6	0,354	0,404	0,409	0,436	0,195	0,206	0,213	0,214
0,8	56,1	38,5	37,6	31,5	52,6	54,4	70,1	76,6	0,371	0,426	0,429	0,457	0,171	0,184	0,188	0,189
1,0	51,0	34,4	34,0	28,6	59,0	64,0	82,8	93,1	0,386	0,443	0,445	0,471	0,153	0,165	0,170	0,171
1,2	47,2	31,6	31,6	26,9	65,4	74,2	96,6	110,8	0,397	0,456	0,456	0,482	0,138	0,150	0,155	0,158
1,5	43,1	28,8	29,1	25,0	75,0	90,7	117,0	141,1	0,410	0,471	0,469	0,492	0,120	0,132	0,139	0,142

$\mu = \alpha^{4/3}(L_1/B_1)^3$;

$\alpha = W_{b.t}/W_{c.g}$;

$W_{b.t}$ = bottom transverse section modulus satisfying the present requirements;

$W_{c.g}$ = centre girder section modulus satisfying the requirements of 2.3.4.2.3.

The value of the parameter α is optional, but is not to exceed 0,6; the value of the parameter μ is not to exceed 1,5.

Bottom transverse section modulus is not to be less than $\alpha W_{c.g}$;

.3 centre girder section modulus is not to be less than determined from 1.6.4.1 and 1.6.4.2. The sectional area of centre girder web is not to be less than stipulated under 1.6.4.3 taking:

p = as defined in 2.3.3.2;

$l = L_1$;

$m = m_{c.g}$;

$N_{\max} = 0{,}7 n_{c.g} pal$;

$m_{c.g}$ and $n_{c.g}$ are to be obtained from Table 2.3.4.2.2 depending upon the parameter μ and the number of floors within a tank; μ is to be determined in accordance with 2.3.4.2.2;

$k_\sigma = 0{,}35 k_B \leqslant 0{,}6$ in the midship region;

$k_\sigma = 0{,}6$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation;

$k_\tau = 0{,}6$;

k_B is to be determined by the Formula (2.2.4.1).

The section modulus of centre girder is not to be less than $W_{b.t}/\alpha$ where $W_{b.t}$ is bottom transverse section modulus satisfying the requirements of 2.3.4.2.2; α shall be as stipulated under 2.3.4.2.2;

.4 in ships of 200 m and above, provision is to be made for side girders midway between longitudinal bulkhead and centre girder, as well as between longitudinal bulkhead and ship's side, in centre and wing tanks.

The section modulus of deep side girders, when fitted in accordance with 2.3.2.6, is not to be less than 0,5 of centre girder section modulus. The centre girder section moduli may be reduced in conformity with 2.3.4.2.3 and those of bottom transverse, in conformity with 2.3.4.2.2 by 15 per cent.

The section modulus of conventional side girders, when fitted in accordance with 2.3.2.6, is not to be less than bottom transverse section modulus;

.5 alternatively to the requirements of 2.3.4.2.2 to 2.3.4.2.4, the scantlings of bottom transverses, centre girder and side girders may be selected proceeding from the calculation of bottom grillage, using beam models. In this case, design loads are to be chosen in accordance with 2.3.3.2, permissible stress factors, in accordance with 2.3.4.2.2 and 2.3.4.2.3, boundary conditions, proceeding from cargo distribution over the length and breadth of the ship and the type of structures adjoining the calculated one. The effect of brackets is to be considered;

.6 in the machinery space, the bottom transverse and side girder web thickness is not to be less than the centre girder web thickness.

If a girder acts as the vertical plate of engine seating, the girder thickness is not to be less than the vertical plate thickness as required by 2.11.3. The depth of bottom transverse is to be increased in proportion to the height at which engine seatings are fitted.

2.3.4.3 The thickness, in mm, of single bottom members is not to be less than:

$s_{\min} = 5{,}3 + 0{,}04L$ for $L < 80$ m;

$s_{\min} = 6{,}5 + 0{,}025L$ for $L \geqslant 80$ m.

Where $L > 250$ m, L is to be taken equal to 250 m.

For the centre girder, $s_{\min}$ is to be increased by 1,5 mm, but is not to exceed the plate keel thickness; floor web thickness need not exceed the bottom shell plating thickness.

In tankers, the minimum thickness of single bottom members is also to satisfy the requirements of 3.5.4, whichever is the greater.

2.3.5 Special requirements.

2.3.5.1 End attachments of bottom members and deep member web stiffening are to satisfy the following requirements:

.1 centre girder and side girders should be attached to transverse bulkheads by brackets. For size of brackets, see 1.7.2.3;

.2 in dry cargo ships, the height of brackets may be reduced to half the centre girder depth if the face plate of centre girder is welded to the transverse bulkhead. In case the centre girder face plate is widened to at least twice the normal value in way of abutting upon the transverse bulkhead, the brackets need not be fitted. If the centre girder is not fitted in the machinery space, then at discontinuities beyond bulkheads it is to be terminated in gradually tapered brackets of a length equal to twice the centre girder depth, but not less than three spacings;

.3 in tankers, the bottom transverses are to be attached to side transverses and/or vertical webs of longitudinal bulkheads by brackets. For size of brackets, see 1.7.2.3.

2.3.5.2 If transverse system of framing is adopted, the holes cut in floors are to have a diameter not exceeding half the floor depth in this location. The distance between the hole edge and floor face plate is not to be less than 0,25 times the floor depth in this location. The distance between the edges of adjacent holes is not to be less than the floor depth. Floor plates provided with holes are to be strengthened with vertical stiffeners.

2.3.5.3 The webs of side girders and floors are to be provided with drain holes.

2.4 DOUBLE BOTTOM

2.4.1 General.

Requirements are given in this Chapter for double bottom structures including bottom framing up to the top of bilge rounding, inner bottom plating and framing, centre girder and duct keel, side girders and half-height girders, margin plate with stiffeners, brackets, knees and intermediate vertical stiffeners in the double bottom space, sea chests and drain wells.

Additional requirements for double bottoms are given in 1.1.6.3 (passenger ships), 1.1.6.4 (cargo ships, other than tankers), 3.1 (container ships), 3.3 (bulk carriers and oil/bulk dry cargo carriers), 3.4 (ore carriers and ore/oil carriers), 3.11 (icebreakers).

2.4.2 Construction.

2.4.2.1 In tankers of 80 m in length, bulk carriers and ore carriers, as well as in oil/bulk dry cargo carriers and ore/oil carriers, the double bottom is to be framed longitudinally.

2.4.2.2 The centre girder is to extend fore and aft as far as practicable to the stem and sternframe and is to be attached to them whenever possible. The centre girder is generally to be continuous within at least 0,6*L* amidships. Where longitudinal framing is adopted in the double bottom, brackets are to be fitted on both sides of centre girder, which are to be spaced not more than 1,2 m apart, extended to the nearest longitudinal or ligthened side girder and welded thereto. The distance between brackets is not to exceed 1,2 m.

2.4.2.3 In lieu of centre girder, a duct keel may be fitted consisting of two plates arranged on both sides of the centreline. The duct keel is to be wide enough for the access to all its structures to be ensured. A duct keel of more than 1,9 m in width is subject to special consideration by the Register.

Transverse members with brackets are to be fitted at every frame in way of the bottom and inner bottom plating between the side plates of the duct keel.

If longitudinal system of framing is adopted, brackets are to be fitted at every frame on both sides of the duct keel, similar to those used for the centre girder.

Where the duct keel fitted only over a part of the ship's length terminates and is transformed into the centre girder, the duct keel and centre girder plates are to overlap over a length of at least one frame spacing and are to terminate in brackets with face plates. In this case, the length of the brackets is not to be less than three spacings if the transition areas lie within 0,6*L* amidships, and not less than two spacings elsewhere.

2.4.2.4 The design of side girders and margin plate is to satisfy the following requirements:

.1 the spacing of side girders and the distance between a side girder and centre girder or margin plate, as measured at the level of the double bottom plating, is not to exceed 4,2 m for transversely framed double bottom and 5,0 for longitudinally framed double bottom;

.2 if longitudinal framing is adopted in the double bottom, lightened side girders may be fitted on bottom and double bottom instead of longi-tudinals (for panels with large openings, see 2.4.2.7.2 and 2.4.2.7.4);

.3 where there are two tunnels symmetrical with regard to the centreline, their design is subject to special consideration by the Register;

.4 in the machinery space, the arrangement of side girders is to be consistent with that of the engine, boiler and thrust block seatings, so that at least one of the longitudinal girders under the seating is fitted in line with the side girder. In this case, an additional side girder is to be provided under the seating in line with the second longitudinal.

Where side girders cannot be arranged under the seatings in line with longitudinal girders, additional side girders are to be fitted under each longitudinal girder.

Additional side girders may be replaced by half height side girders welded to the inner bottom plating and floors only, if approved by the Register;

.5 inclined margin plate, if fitted, is to extend throughout the double bottom length.

2.4.2.5 The arrangement and design of floors are to satisfy the following requirements:

.1 if transverse framing is adopted in the double bottom, plate floors are to be fitted at every frame:

in engine and boiler rooms;

at the fore end within 0,25*L* from the fore perpendicular;

in the holds intended for the carriage of heavy cargo and ore, as well as in holds from which cargo is regularly discharged by grabs;

in ships which may happen to be aground due to the ebb-tide in ports.

In other regions, plate floors may be fitted five spacings or 3,6 m apart, whichever is less. In this case, provision is to be made for open floors (bracket or lightened).

Bracket floors consist of bottom and reverse frames connected with brackets at centre girder, side girders and margin plate (Fig. 2.4.2.5.1-1).

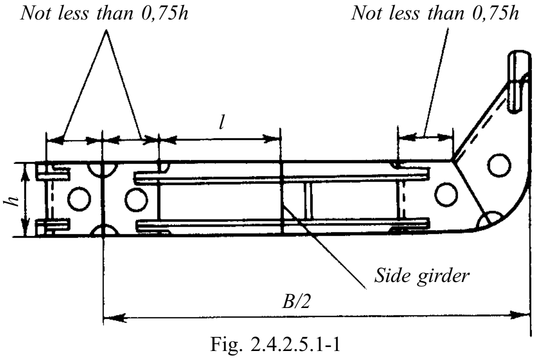


Fig. 2.4.2.5.1-1

Lightened floors consist of plate panels having large openings of a smooth shape between side girders (Fig. 2.4.2.5.1-2);

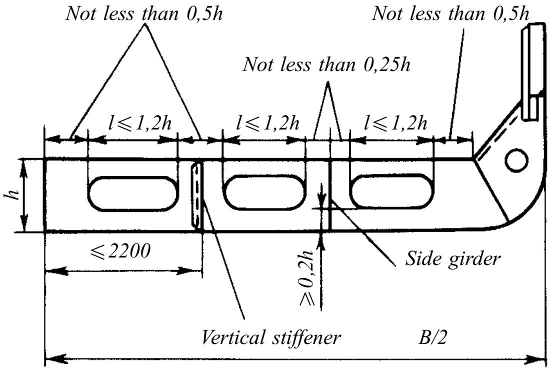


Fig. 2.4.2.5.1-2

.2 if longitudinal framing is adopted in the double bottom, plate floors are generally to be fitted at a distance not exceeding two spacings from each other:

in engine and boiler rooms;

at the fore end within 0,25L from the fore perpendicular;

in the holds intended for the carriage of heavy cargo and ore, as well as in holds from which cargo is regularly discharged by grabs;

in ships which may happen to be aground due to the ebb-tide in ports.

In other regions, plate floors may be fitted five spacings or 3,6 m apart, whichever is less. Where lightened side girders are fitted in lieu of bottom and double bottom longitudinals (see 2.4.2.4.2), the above spacing may be increased, but not more than twice.

When the ship's side is framed transversely and double bottom is framed longitudinally, brackets are to be fitted at every frame between plate floors to stiffen the margin plate, which are to be carried to the nearest bottom and inner bottom longitudinals or to the nearest additional side girder, and welded thereto (Fig. 2.4.2.5.2).

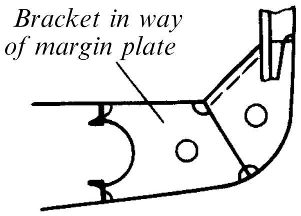


Fig. 2.4.2.5.2

Under the seating of main engine, plate floors are to be fitted at every frame and carried to the nearest side girder outside the main engine seating;

.3 irrespective of the requirements of 2.4.2.5.1 and 2.4.2.5.2, plate floors are to be fitted:

under pillars and ends of longitudinal partial bulkheads;

under bearers and boiler bearer ends;

under transverse bulkheads and sloping plates of low trapezoidal stools of corrugated bulkheads;

under bracket toes of deep tank bulkhead stiffeners in transversely framed double bottom;

under block bearing seatings.

In the above cases, the floors need not be fitted throughout the ship's breadth. Partial floors may be fitted and carried to the side girder nearest to the structure being stiffened.

2.4.2.6 Arrangement of stiffeners on centre girder and duct keel, side girders and floors is to satisfy the following requirements:

.1 stiffeners are to be provided where transverse system of framing is adopted and plate floors are more than 900 mm in depth. The spacing of stiffeners is not to exceed 1,5 m. The spacing of stiffeners of lightened floors is not to exceed 2,2 m.

If longitudinal system of framing is adopted, the stiffeners on plate floors are to be fitted in line with bottom and inner bottom longitudinals. The stiffeners are to be carried to the longitudinals and welded thereto.

The stiffeners are to be fitted under the pillars, at bracket toes of end stiffeners of longitudinal partial bulkheads, etc;

.2 watertight floors are to be fitted with vertical stiffeners spaced not more than 0,9 m apart.

2.4.2.7 Holes (manholes) are to satisfy the following requirements:

.1 an adequate number of holes (manholes) are to be provided in the inner bottom plating, side girders and floors for access to all portions of double bottom. The size of the holes, including lightening holes, is to satisfy the requirements of standards or other normative documents recognized by the Register. Air and drain holes, cut-outs for the passage of welded joints, see 1.7.5.12;

.2 the holes in centre girder, side girders and floors are to have a smooth rounded shape. The minimum allowable height of the plate adjoining bottom shell plating or inner bottom plating is indicated in Table 2.4.2.7.2. Besides, the minimum height of the plate in way of the hole is not to be less than $^{1}/_{8}$ of the length of the hole.

The plate height indicated in Table 2.4.2.7.2 may be reduced if suitable stiffening is provided. Besides, lightened side girder and floor plates are to satisfy the requirements of 2.4.4.5.5, and if the plate height h_0, in mm, exceeds $25s\sqrt{\eta}$ (where s is the web thickness, in mm, of a lightened side girder or floor), the free edge of the plate is to be stiffened;

Table 2.4.2.7.2

Member	Minimum allowable plate height (in parts of member height)
Centre girder	0,3
Side girders	0,25
Lightened side girders	0,15
Floors:	
plate	0,25
lightened	0,2

.3 the distance between the edges of adjacent openings in centre girder, side girders and plate floors is not to be less than half the length of the largest opening.

The distance of the edges of openings in the floors from longitudinal bulkheads, centre girder, side girders, inclined margin plate and inner edges of hopper side tanks is not to be less than half the centre girder depth in this region. The distance of the edge of opening in a lightened floor from the side girder is not to be less than one-quarter of centre girder depth.

In exceptional cases, deviation from the above requirements is permitted;

.4 one or more consecutive openings may be permitted in a lightened side girder web between adjacent floors or in a lightened floor web between adjacent side girders. In the latter case, vertical stiffeners are to be fitted between openings. The length of one opening is not to exceed 1,2 times the accepted depth of centre girder or 0,7 times the distance between floors (side girders) or between a floor (side girder) and vertical stiffener, whichever is less (see Fig. 2.4.2.5.1-2). The distance of the edges of openings in lightened side girders and floors from each other is not to be less than half the centre girder depth in this region;

.5 normally, openings are not permitted:

in centre girder over a length of 0,75L from the fore perpendicular;

in centre girder and side girders (lightened side girders) under pillars and in sections adjoining transverse bulkheads (between the bulkhead and extreme floor for double bottom with transverse framing and on a length equal to the depth of double bottom with longitudinal framing);

in floors under pillars and in way of partial longitudinal bulkheads;

in floors at the toes of brackets transversely supporting main machinery seatings;

in floors between the side (inner side) and the nearest lightened side girder, provided the spacing of floors is increased in accordance with 2.4.2.5.2.

In exceptional cases, openings are permitted in the above members provided the webs in way of the openings are suitably stiffened;

.6 circular lightening openings are permitted for brackets, having a diameter not greater than $^1/_3$ of the width or height of the bracket, whichever is less.

2.4.2.8 Where double skin side construction is provided, the inner bottom plating is to extend through the inner skin as far as the shell plating. A side girder is to be fitted in line with the inner skin. Festoon plates may be fitted in lieu of the inner bottom plating inside the double skin side or additional side girder in line with the inner skin.

2.4.2.9 Connections of bottom and inner bottom longitudinals to watertight floors shall be such that the effective sectional area of these members is maintained.

2.4.3 Double bottom loading.

2.4.3.1 The external pressure on double bottom structures is determined by the Formula (2.2.3-1).

For design ballast condition, the value of z_i in the Formula (1.3.2.1-2) is to be counted from the design ballast waterline.

2.4.3.2 Double bottom loading from inside:

.1 design pressure on the double bottom from general cargo is determined according to 1.3.4.1;

.2 design pressure on the double bottom from liquid cargo or ballast is determined according to 1.3.4.2;

.3 design pressure on the double bottom from bulk cargo is determined according to 1.3.4.3;

.4 test loads

$$p = 7{,}5h_p \tag{2.4.3.2.4}$$

where h_p = vertical distance, in m, from inner bottom plating to the top of air pipe;

.5 loads due to the emergency flooding of double bottom compartments

$$p = 10{,}5(d - h) \tag{2.4.3.2.5}$$

where h = actual depth of double bottom, in m.

2.4.3.3 The total design pressure on the double bottom is defined as a difference between the external pressure p and the cargo (ballast) pressure from inside p_c. In this case, the value of p_c is defined as the smallest value of counterpressures determined from 2.4.3.2.1 to 2.4.3.2.3 with $p > p_c$ and as the greatest of the above values with $p < p_c$.

If a hold may be empty during service, the external pressure p is to be taken as the design pressure.

2.4.4 Scantlings of double bottom members.

2.4.4.1 At centre girder, the depth of double bottom h, in m, is not to be less than:

$$h = \frac{L - 40}{570} + 0{,}04B + 3{,}5\frac{d}{L} \tag{2.4.4.1}$$

but not less than 0,65 m.

2.4.4.2 The centre girder and side girders are to satisfy the following requirements:

.1 the thickness, in mm, of centre girder (duct keel) is not to be less than:

$$s = \alpha_{c.g} h \frac{h}{h_a}\sqrt{\eta} + \Delta s \tag{2.4.4.2.1}$$

where h = height of centre girder, in m, required by 2.4.4.1;
h_a = actual height of centre girder, in m;
for η, see 1.1.4.3;
for Δs, see 1.1.5.1;
$\alpha_{c.g}$ = 0,03L+8,3, but not greater than 11,2.

In any case, the thickness of centre girder shall be 1 mm greater than that of a plate floor.

The thickness of side girders is not to be less than that of plate floors;

.2 the buckling strength of centre girder web and of side girders, as well as of longitudinal stiffeners fitted along them is to be ensured in accordance with 1.6.5;

.3 at ends within 0,1L from the fore and after perpendiculars, the centre girder web thickness may be 10 per cent less than that in the midship region, as determined for steel used at ends, but not less than the minimum thickness stipulated under 2.4.4.9.

The thickness of side plates of the duct keel is not to be less than 0,9 of that required for the centre girder in this region;

.4 the thickness of watertight sections of centre girder and side girders is not to be less than determined by the Formula (1.6.4.4) taking:

p = as determined by the Formulae (1.3.4.2-4) and (1.3.4.2-5) for the mid-depth of centre girder (side girder), whichever is the greater (where no safety valve is fitted, p_v is to be taken as zero);

$m = 15,8$;

if the centre girder (side girder) is stiffened with vertical brackets or stiffeners,

$k_\sigma = 0,6k_B \leqslant 0,75$ for $L \geqslant 65$ m in the midship region;

$k_\sigma = 0,75$ for $L = 12$ m.

For $12 < L < 65$ m, k_σ is to be determined by linear interpolation taking $k_\sigma = 0,68$ for $L = 65$ m;

if the centre girder (side girder) is stiffened with horizontal stiffeners, in the midship region

$k_\sigma = 0,75$;

at the ends of the ship within 0,1L from the fore or after perpendicular

$k_\sigma = 0,85$.

For regions between the midship region and above portions of ship's ends, k_σ is to be determined by linear interpolation.

For regions lying between the midship region and the above areas of ship ends, k_σ is to be determined by linear interpolation.

The thickness of the watertight sections of centre girder and side girders need not be greater than that of adjacent shell plating.

2.4.4.3 Floors are to satisfy the following requirements:

.1 the thickness, in mm, of watertight floors is not to be less than:

$$s = \alpha k a \sqrt{\eta} + \Delta s \qquad (2.4.4.3\text{-}1)$$

where $\alpha = 0,12L - 1,1$, but not greater than 6,5 for transversely framed double bottom;
$\alpha = 0,023L + 5,8$ for longitudinally framed double bottom;
$k = k_1 k_2$;
k_1, k_2 = coefficients given in Tables 2.4.4.3-1 and 2.4.4.3-2 respectively;
a = spacing, in m, of stiffeners, but not greater than the actual depth of double bottom;
for η, see 1.1.4.3;
for Δs, see 1.1.5.1;

Table 2.4.4.3-1

Coefficient k_1

Framing system	a_f/a				
	1	2	3	4	5
Transverse	1	1,15	1,20	1,25	1,30
Longitudinal	—	1,25	1,45	1,65	1,85

Symbols:
a_f = distance, in m, between plate floors;
a = spacing, in m.

Table 2.4.4.3-2

Coefficient k_2

Framing system	Number of girders per side			
	0	1	2	3 and above
Transverse	1	0,97	0,93	0,88
Longitudinal	1	0,93	0,86	0,80

.2 the floors are to be stiffened in accordance with 1.7.3.2.

Between the fore peak bulkhead and 0,25L from the forward perpendicular, in the machinery space and peaks, and in the holds of ships which may happen to be aground due to ebb-tide or from which cargo is regularly discharged by grabs, the thickness of plate floors $s_{\min}$, in mm, is not to be less than:

for transverse framing system

$$s_{\min} = 0,035L + 5; \qquad (2.4.4.3.2\text{-}1)$$

for longitudinal framing system

$$s_{\min} = 0,035L + 6; \qquad (2.4.4.3.2\text{-}2)$$

.3 the thickness of watertight floors is not to be less than determined by the Formula (1.6.4.4) taking:

p = as determined by the Formula (1.3.4.2-5) for the middepth of the floor;

$m = 15,8$;

$k_\sigma = 0,85$.

In any case, the thickness of watertight floors is not to be less than that required for plate floors in this region.

2.4.4.4 Inner bottom plating and margin plate are to satisfy the following requirements:

.1 the thickness of inner bottom plating, including margin plate, is not to be less than determined by the Formula (1.6.4.4) taking:

$m = 15{,}8$;

p = maximum design pressure as stipulated under 2.4.3.2;

$k_\sigma = 0{,}6k_B \leqslant 0{,}8$ in the midship region for $L \geqslant 65$ m and transverse framing system;

$k_\sigma = 0{,}8$ in the midship region for $L = 12$ m and transverse framing system.

Where $12 < L < 65$ m, k_σ is determined by linear interpolation taking $k_\sigma = 0{,}7$ for $L = 65$ m,

$k_\sigma = 0{,}8$ in the midship region for longitudinal framing system;

$k_\sigma = 0{,}9$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation.

k_B is to be determined by the Formula (2.2.4.1);

.2 in any case, the thickness of inner bottom plating $s_{\min}$, in mm, is not to be less than:

$$s_{\min} = (3{,}8 + 0{,}05L)\sqrt{\eta} \quad \text{for } L < 80 \text{ m};$$
$$s_{\min} = (5 + 0{,}035L)\sqrt{\eta} \quad \text{for } L \geqslant 80 \text{ m}, \qquad (2.4.4.4.2)$$

where η = as stated in Table 1.1.4.3.

Where $L > 260$ m, L is to be taken equal to 260 m.

Where the adopted spacing is less than the standard one (see 1.1.3) for ships of unrestricted area of navigation and limited area of navigation I, the minimum thickness of inner-bottom plating may be reduced in proportion to the ratio of adopted spacing to the standard spacing, but not more than by 10 per cent. In any case, the minimum thickness is not to be less than 5,5 mm.

The thickness of inner bottom plating in holds into which water ballast may be taken, as well as in the cargo (ballast) tanks of tankers is not to be less than stipulated under 3.5.4.

In the engine room and holds under cargo hatches where no wood sheathing is provided, $s_{\min}$ is to be increased by 2 mm.

In holds where no wood sheathing is provided and cargo is discharged by grabs, $s_{\min}$ is to be increased by 4 mm;

.3 in the midship region of ships of 65 m and greater in length, the buckling strength of inner bottom plating and margin plate is to be ensured in accordance with 1.6.5.

2.4.4.5 Primary members of bottom and inner bottom are to satisfy the following requirements:

.1 the section modulus of bottom and inner bottom longitudinals, as well as of the bottom and reverse frames of bracket floors and duct keel is not to be less than stipulated under 1.6.4.1 taking:

p = design pressure, in kPa, determined for bottom longitudinals and the bottom frames of bracket floors and duct keel in accordance with 2.4.3.1, and for inner bottom longitudinals and the reverse frames of bracket floors and duct keel, in accordance with 2.4.3.2;

$m = 12$;

l = design span, in m, of longitudinal, defined as the spacing of floors for bottom and inner bottom longitudinals, as the distance betwen bracket toes or between a bracket toe and side girder for the bottom and reverse frames of bracket floors, as the spacing of webs for duct keel;

for bottom longitudinals

$k_\sigma = 0{,}45k_B \leqslant 0{,}65$ in the midship region;

$k_\sigma = 0{,}65$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation;

for inner bottom longitudinals

$k_\sigma = 0{,}6k_B \leqslant 0{,}75$ in the midship region;

$k_\sigma = 0{,}75$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation;

for bottom frames of bracket floors and duct keel

$k_\sigma = 0{,}65$;

for reverse frames of bracket floors and duct keel

$k_\sigma = 0{,}75$;

k_B is to be determined by the Formula (2.2.4.1);

.2 if intermediate struts are fitted at mid-span between bottom and inner bottom longitudinals, the section modulus of such longitudinals may be reduced by 35 per cent;

.3 if the ratio of the span of a bottom or inner bottom longitudinal to its depth is less than 10, the sectional area of the longitudinal web is not to be less than determined by the Formula (1.6.4.3) taking $N_{\max} = 0{,}5pal$ (p, l = design pressure and design span of longitudinal as stipulated under 2.4.4.5.1), $k_\tau = k_\sigma$ where k_σ is as determined from 2.4.4.5.1 with $k_B = 1{,}25$;

.4 in the midship region of ships of 65 m in length and above, the buckling strength of bottom and inner bottom longitudinals is to be ensured in accordance with 1.6.5;

.5 at the centre of openings in lightened side girders and floors, the section modulus of the plate adjoining the shell plating or inner bottom plating is to comply with the requirements of 2.4.4.5.1 for bottom and inner bottom longitudinals and transverses respectively. In this case, the design span l is to be taken equal to the greatest opening length minus its rounding-off radius. The plate section is to include the effective flange of shell plating (inner bottom plating), as described under 1.6.3.2 and 1.6.3.3, as well as the flange or horizontal stiffener of the free edge of the plate, if these are fitted.

2.4.4.6 The stiffeners on the watertight sections of centre girder (duct keel), side girders and floors are to satisfy the following requirements:

.1 the section modulus of vertical stiffeners on the watertight sections of centre girder (duct keel), side girders and floors is not to be less than stipulated under 1.6.4.1 taking:

p = as determined by the Formula (1.3.4.2-5) for mid-height of vertical stiffener;

l = span, in m, of stiffener, defined as the spacing of longitudinals to which the stiffener is welded or as double bottom depth if the stiffener is not in line with bottom or inner bottom longitudinals;

$m = 8$ and 10 for stiffeners sniped at ends and welded to the bottom and inner bottom longitudinals respectively;

$k_\sigma = 0{,}75$;

.2 the section modulus of horizontal stiffeners on the centre girder (duct keel) and side girders is not to be less than stipulated under 1.6.4.1 taking:

p = as determined by the Formula (1.3.4.2-5) for the level of the horizontal stiffener considered;

l = distance, in m, between floors or between floors and brackets (see 2.4.2.2);

$m = 12$;

$k_\sigma = 0{,}5k_B \leqslant 0{,}75$ in the midship region;

$k_\sigma = 0{,}75$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation.

k_B is to be determined by the Formula (2.2.4.1);

.3 in the midship region of ships of unrestricted service and of restricted areas of navigation **I** and **II**, 65 m and greater in length, as well as of ships of restricted areas of navigation **IIСП**, **IIIСП** and **III**, 60 m and greater in length, the buckling strength of horizontal stiffeners on the centre girder (duct keel) and side girders is to be ensured in accordance with 1.6.5.

2.4.4.7 The intermediate struts between bottom and inner bottom longitudinals, as well as between bottom and reverse frames of bracket floors are to satisfy the following requirements:

.1 the sectional area f, in cm^2, of intermediate struts is not to be less than:

$$f = \frac{5pal}{k_\sigma \sigma_n} + 0{,}1h\Delta s \qquad (2.4.4.7.1)$$

where p = design pressure, in kPa, defined as the greater of the values of p or p_c according to 2.4.3.1 or 2.4.3.2, whichever is the greater;
l = design span, in m, of stiffened longitudinals;
k_σ = 0,6;
h = height, in cm, of the strut cross section;

.2 the inertia moment i, in cm^4, of intermediate struts is not to be less than:

$$i = 0{,}01fl^2\sigma_n \qquad (2.4.4.7.2)$$

where f = sectional area of intermediate struts as given in 2.4.4.7.1;
l = length, in m, of intermediate strut.

2.4.4.8 The thickness of brackets of centre girder (duct keel) and margin plate, as well as of the brackets of bracket floors and the brackets connecting bottom and inner bottom longitudinals to watertight floors, if the longitudinals are cut at the floors, is not to be less than the thickness of plate floors adopted in this region.

In way of centre girder and margin plate, the thickness of brackets fitted in line with the bracket floor is not to be less than 0,75 of the centre girder depth. The free edges of brackets are to be provided with flanges or face plates. The side girder fitted in line with the bracket floor shall be provided with a vertical stiffener whose profile is to be selected in the same way as that of the reverse frame of the floor.

The arm length of brackets connecting longitudinals on the bottom and inner bottom plating to watertight floors is not to be less than 2,5 times the bottom longitudinal depth (Fig. 2.4.4.8).

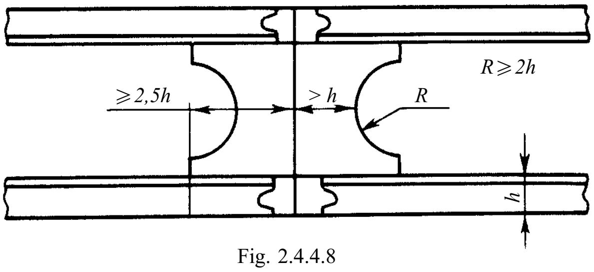


Fig. 2.4.4.8

The scantlings of knees by which bottom and reverse frames of the duct keel are secured are to be determined in accordance with 1.7.2.2.

2.4.4.9 Structural members inside the double bottom are to have a thickness $s_{\min}$, in mm, not less than:

$$\begin{aligned} s_{\min} &= 0{,}045L + 3{,}9 \text{ for } L < 80 \text{ m};\\ s_{\min} &= 0{,}025L + 5{,}5 \text{ for } L \geqslant 80 \text{ m}. \end{aligned} \qquad (2.4.4.9)$$

Where $L > 250$ m, L is to be taken equal to 250 m.

For centre girder, $s_{\min}$ is to be increased by 1,5 mm.

2.4.4.10 In way of holds designed for the carriage of heavy cargoes, the strength of double bottom structure shall be verified by the calculation of the bottom grillage strength using design loads stated in 2.4.3, as required by 3.3.4.1.1.

2.4.5 Special requirements.

2.4.5.1 Partial double bottom and stiffening in way of variable double bottom depth are to satisfy the following requirements:

.1 where the double bottom terminates, gradual transition from longitudinal members of double bottom to those beyond it is to be ensured.

The inner bottom plating is to be gradually tapered (on a length of at least three frame spaces) into the face plates of centre girder and side girders of single bottom. In way of the double bottom boundary, the width of these face plates is to be not less than half the distance between adjacent side girders.

The margin plate is to extend beyond the double bottom as a bracket with the height equal to the margin plate width and the length equal to at least three frame spaces, with a face plate or flange along its free edge;

.2 where the double bottom depth changes in the form of a knuckle, one end of the knuckle shall be in way of a transverse bulkhead and the other, on the fplate floor. However, both the knuckles may be arranged on plate floors in which case the structure is subject to special consideration by the Register;

.3 where the double bottom depth changes in the form of a step, the latter shall normally be arranged on a transverse bulkhead.

At the step, the inner bottom plating of the lower section should extend for a length of three frame spaces when $L \geqslant 80$ m and for two frame spaces when $L < 80$ m. Forward (or aft) of the end of the extension the general requirements for partial double bottom are to be complied with.

If the step is arranged beyond $0,5L$ amidships or if the height of the step is less than 660 mm, the double bottom structure in way of the extension is in each case subject the special consideration by the Register;

.4 continuity and reduction of stress concentrations should be ensured in way of the step where a variation of the depth of centre girder, side girders, margin plate and inner bottom longitudinals takes place (if longitudinal system of framing is adopted).

2.4.5.2 Bilge wells, sea chests and ice boxes are to satisfy the following requirements:

.1 in cargo ships, the bilge wells shall, as far as practicable, satisfy the requirements of 1.1.6.3.3.

The capacity of bilge wells is specified in Part VIII "Systems and Piping".

The thickness of the walls and bottom plates of a bilge well is to exceed that of watertight floors by not less than 2 mm;

.2 the thickness of the floors, side girders and inner bottom plating forming the walls of sea chests is to be 2 mm greater than that required by 2.4.4.2 to 2.4.4.4.

In any case, the thickness of sea chest and ice box walls is to be not less than that required by 2.2.4.1 for the shell plating in the region under consideration.

2.4.5.3 When oil fuel tanks are arranged in the double bottom, the manholes in the tank tops arranged within the engine and boiler rooms for access to the tanks are to be provided with coamings not less than 0,1 m in height, besides the general provisions for the arrangement of oil fuel tanks.

2.4.5.4 Where the bed plate of main engine and the thrust block are seated directly on the inner bottom plating, insert plates having a thickness not less than stipulated under 2.11.3.1 are to be welded to the plating under the supporting parts of bed plate and thrust block. The size of welded inserts shall be such as to ensure an adequate arrangement of supports and the attachment of machinery, and shall in any case be not less than that of the supporting parts of bed plate. Where the engine bed plate and thrust block are fitted on the inner bottom plating, two girders, or one girder and a half-height girder shall be provided in way of their arrangement along each welded insert plate. The upper part of the girder webs shall have the same thickness as the welded insert for at least 0,2 of the girder depth, or alternatively, the thickness of the webs throughout their depth shall be as required by 2.11.3 for the vertical plates of seatings.

Between the girders, a horizontal stiffener of the size required in the foregoing for the upper part of girder webs shall be fitted, account being taken of the holes for the holddown bolts of the bed plate.

On agreement with the Register, only one side girder may be fitted under the welded insert plate for small power engines.

2.4.5.5 The plating of the recess under the engine crankcase, as well as the side girders and floors by which it is confined, are to have a thickness 2 mm greater than that of the inner bottom plating in this region.

The minimum distance from the recess plating to the bottom shell plating is not to be less than 460 mm.

2.5 SIDE FRAMING

2.5.1 General and definitions.

2.5.1.1 Requirements are given in this Chapter for side frames, web frames (side transverses), side longitudinals, side stringers, cross ties connecting side transverses to vertical webs on longitudinal bulkheads in tankers, as well as for specific structures of double skin side.

2.5.1.2 By the double skin side construction, a side structure is meant which consists of watertight side shell plating and inner skin, both either strengthened with frames and longitudinals or not, and connected with plate structures perpendicular thereto: vertical (diaphragms) and/or horizontal (platforms). If no diaphragms or platforms are fitted, the inner skin together with framing is to be considered as longitudinal bulkhead and is to comply with the requirements of 2.7.

2.5.2 Construction.

2.5.2.1 When the ship's side is framed transversely, side stringers may be provided. In tankers with two or more longitudinal bulkheads, fitting of cross ties is recommended between the side stringers and horizontal girders of longitudinal bulkheads.

Web frames may be fitted if the ship's side is framed transversely, and they are to be fitted, if the ship's side is framed longitudinally. They are to be fitted in line with plate floors, as well as with deep beams, if any. In tankers with two or more longitudinal bulkheads, fitting of cross ties is recommended between side transverses and vertical webs of longitudinal bulkheads.

2.5.2.2 Structures of double skin side are to satisfy the following requirements:

.1 if the same framing system is adopted for side shell and inner skin, fitting of frames or longitudinals of both side shell and inner skin in line with each other is recommended. In this case, cross ties may be fitted between the frames or longitudinals of the side shell and inner skin, which are to be arranged at mid-span of relevant members;

.2 diaphragms or platforms are to be stiffened in accordance with 1.7.3.2. In this case, the shorter side, in mm, of panel of the diaphragm or platform being stiffened is not to exceed $100s\sqrt{\eta}$, where s is the thickness, in mm, of the diaphragm or platform;

.3 an appropriate number of openings (manholes) are to be provided in the diaphragms and platforms for access to all the structures of double skin side. The total breadth of openings in a diaphragm or platform section is not to exceed 0,6 of the double skin side breadth.

The edges of openings in diaphragms and platforms, arranged within $^1/_4$ of the span from their supports, are to be reinforced with collars or stiffeners. The distance between the edges of adjacent openings is not to be less than the length of the openings.

Normally, openings are not permitted, with the exception of air and drain holes:

in platforms on a length not less than three frame spaces or 1,5 times the double skin side breadth, whichever is less, from transverse bulkheads or partial bulkheads, which serve as platform supports;

in diaphragms on a length not less than 1,5 times the double skin side breadth from deck plating and/or double bottom, which serve as diaphragm supports.

2.5.2.3 In the machinery space, the side framing is to be strengthened by fitting of web frames and side stringers.

The web frames are to be fitted not more than 5 standard spacings or 3 m apart, whichever is the greater. The web frames are to be arranged taking into account the location of main engine, i.e. they are to be fitted at the extremities of the engine at least. In the machinery space, the web frames are to be carried to the nearest continuous platform. Deep beams are to be fitted in line with web frames.

In the machinery space, the side stringers are to be fitted so that the vertical distance between them, as well as between a side stringer and deck or tank top (upper edge of floor) at side does not exceed 2,5 m.

2.5.3 Side loading.

2.5.3.1 The design pressure on the side shell is to be determined in accordance with 2.2.3. In way of tanks, the pressure determined in accordance with 1.3.4.2 shall additionally be taken into consideration.

2.5.3.2 The design pressure on double skin side structures is to be determined as follows:

.1 the design pressure on the inner skin and framing is to be determined in accordance with 1.3.4.2 or 1.3.4.3 depending on the kind of cargo carried and on whether the double skin side space is used as tank space, but is not to be less than the design pressure on watertight bulkhead structures, as stipulated under 2.7.3.1;

.2 the scantlings of cross sections of diaphragms and platforms are determined using the design pressure specified in 2.2.3;

.3 the design pressure on the watertight sections of diaphragms and platforms bounding the tanks in the inter-skin space is to be determined in accordance with 1.3.4.2.

2.5.4 Member scantlings of side structures.

2.5.4.1 If transverse system of framing is adopted, the section modulus of hold frames in dry cargo ships and of side frames in tankers is not to be less than determined from 1.6.4.1 taking:

p = as defined in 2.5.3; the value of p for the side shell is not to be less than:

$$p_{\min} = 10z + 0{,}3L + 1 \text{ for } L < 60 \text{ m}; \qquad (2.5.4.1)$$
$$p_{\min} = 10z + 0{,}15L + 10 \text{ for } L \geqslant 60 \text{ m}$$

where z = distance, in m, from the mid-span of the frame to the summer load waterline;

l = span, in m, between adjacent supports, as measured in accordance with 1.6.3.1; unless expressly provided otherwise, the supports of a frame are bottom, deck or platform, side stringers;

$m = 12$ for single skin side construction when determining the section modulus of the supporting section of the frame taking into consideration the bracket, if any, included in the section, as well as for frames of the side shell and inner skin forming double skin side construction;

$m = 18$ for single skin side construction when determining the section modulus in the frame span;

$k_\sigma = 0{,}65$ for frames of the side shell;

$k_\sigma = 0{,}75$ for frames of the inner skin.

For ships of restricted area of navigation, the value of $p_{\min}$ may be reduced by multiplying by the factor φ_r obtained from Table 1.3.1.5.

2.5.4.2 The section modulus of 'tween deck frames is not to be less than determined from 1.6.4.1 taking:

p = design pressure, as stipulated under 2.5.3;

l = span, in m, between adjacent supports, as measured in accordance with 1.6.3.1; frame supports are decks and platforms;

$m = 10$ for single skin side frames;

$m = 12$ for frames of the side shell and inner skin forming double skin side construction;

$k_\sigma = 0{,}65$ for side shell frames;

$k_\sigma = 0{,}75$ for inner skin frames.

The above applies in case the lower end of 'tween deck frame is not stiffened by a bracket. If the lower end of the frame is stiffened by a bracket of a height not less than $0{,}1l$ and the section modulus of the frame in way of deck is not less than 1,75 of the section modulus determined above, taking the bracket into consideration, the section modulus of 'tween deck frame may be reduced by 30 per cent.

2.5.4.3 The section modulus of side longitudinals of all ships is not to be less than determined according to 1.6.4.1 taking:

p = as defined in 2.5.3;
a = spacing of longitudinals, in m;
l = average spacing of web frames or diaphragms, in m;
$m = 12$;

for side shell
$k_\sigma = 0{,}65$ within $(0{,}4-0{,}5)D$ from the base line.

For regions below $0{,}4D$ from the base line, k_σ is to be determined by linear interpolation between k_σ for bottom longitudinals in accordance with 2.4.4.5.1 and k_σ within $(0{,}4-0{,}5)D$ from the base line.

For regions above $0{,}5D$ from the base line, k_σ is to be determined by linear interpolation between k_σ for strength deck longitudinals in accordance with 2.6.4.2 and k_σ within $(0{,}4-0{,}5)D$ from the base line.

For the inner skin, k_σ is to be determined as in the case of horizontal stiffeners of longitudinal bulkheads in tankers in accordance with 2.7.4.2.

The buckling strength of three upper and three lower longitudinals in the midship region of ships 65 m and greater in length is to be ensured in accordance with 1.6.5.

2.5.4.4 In a transversely framed side, the section modulus of side stringers is not to be less than stipulated under 1.6.4.1 taking:

k_σ is determined in the same way as for side shell longitudinals mentioned under 2.5.4.3;
p = as defined in 2.5.3.1;
l = spacing, in m, of web frames and where these are not fitted, between transverse bulkheads, including end brackets;
a = spacing, in m, of side stringers;
$m = 18$ without cross ties;
$m = 27{,}5$ with cross ties.

The cross-sectional area, in cm^2, of a side stringer web is not to be less than determined according to 1.6.4.3 taking:

$N_{\max} = npal$;
$n = 0{,}5$ without cross ties;
$n = 0{,}4$ with one cross tie;
$n = 0{,}375$ with two cross ties;
$n = 0{,}35$ with three cross ties;
$k_\tau = 0{,}65$.

If web frames are fitted, the scantlings of side stringer section may be determined on the basis of the calculation of the side grillage using beam models. The design loads are to be determined in accordance with 2.5.3.1, permissible stress factors are to be selected in accordance with this paragraph. Where cross ties are fitted, the calculation shall consider the interaction between side grillage and grillage of the longitudinal bulkhead being connected with the cross ties.

2.5.4.5 The section modulus of web frames (side transverses) fitted in the holds and 'tween decks of dry cargo ships, as well as in the tanks of tankers, is not to be less than stipulated under 1.6.4.1 and 1.6.4.2 taking:

p = as defined in 2.5.3.1;
l = distance, in m, from the upper edge of a single bottom floor or from inner bottom plating to the lower edge of a deep beam;
a = spacing of web frames, in m;
$m = 10$ for 'tween deck frames;
$m = 11$ for holds and tanks without cross ties;
$m = 18$ with one or two cross ties;
$m = 27{,}5$ with three cross ties;
$k_\sigma = 0{,}65$.

The cross-sectional area, in cm^2, of a side transverse (web frame) web, excluding openings, is not to be less than stipulated under 1.6.4.3 taking:

$N_{\max} = npal$;
$n = 0{,}5$ without cross ties;
$n = 0{,}375$ with one cross tie;
$n = 0{,}35$ with two or more cross ties;
$k_\tau = 0{,}65$.

When the side is transversely framed, the scantlings of web frames may be determined on the basis of the side grillage calculation in accordance with the requirements of 2.5.4.4. In this case, the permissible stress factors are to be selected in accordance with the requirements of this paragraph.

In single-deck ships, the depth of web frame (side transverse) webs may be taken variable over the ship's depth with reducing at the top end and increasing at the bottom end. Variation of web depth is not to exceed 10 per cent of its mean value.

For stiffening of web frames (side transverses), see 1.7.3.

2.5.4.6 The sectional area f, in cm^2, of a cross tie fitted between deep members of side framing and of longitudinal bulkhead is not to be less than:

$$f = k\frac{10paa_i}{\sigma_{cr}} + 0{,}05\Sigma h_i\Delta s \qquad (2.5.4.6)$$

where p = design pressure, in kPa, at mid-length of a cross tie, as determined from 2.2.3 or 2.7.3.2, whichever is the greater;
a = spacing of web frames connected with cross ties, in m;
a_i = mean depth, in m, of side area supported by a cross tie;
Σh_i = perimeter of cross section, in cm, of a cross tie;
$k = 2{,}5$ — buckling strength margin;
σ_{cr} = critical stresses in accordance with 1.6.5.3 corresponding to the Euler stresses, in MPa, as determined by the formula

$$\sigma_e = \frac{206i}{fl^2}$$

where i = minimum moment of inertia, in cm^4, of a cross tie;
l = cross tie length, in m, as measured between the inner edges of deep members of side framing and of longitudinal bulkhead;
f = as determined by the Formula (2.5.4.6).

2.5.4.7 The side framing of the machinery space and tanks is to satisfy the following requirements:

.1 the scantlings of main frames in the machinery space are to be determined in accordance with 2.5.4.1 taking:

l = span measured between side stringers or between the lower side stringer and inner bottom plating (upper edge of floor), or between the upper side stringer and the lower edge of beam.

The scantlings of longitudinals are to be determined in accordance with 2.5.4.3.

The scantlings of web frames (side transverses) are to be determined in accordance with 2.5.4.5 taking:

l = span measured between inner bottom plating (upper edge of floor) and the lower edge of deep beam;

.2 in the machinery space of ships less than 30 m in length, the web frames and side stringers required by 2.5.2.3 may be omitted on condition that the main frame has a section modulus W, in cm^3, not less than:

$$W = 1{,}8W_1 \qquad (2.5.4.7.2)$$

where W_1 = section modulus of main frame, as stipulated under 2.5.4.7.1;

.3 in way of the ballast and fuel oil tanks of dry cargo ships 30 m and greater in length, the scantlings of side framing are to satisfy the requirements of 2.5.4.1, 2.5.4.3, 2.5.4.5 for side framing in way of tanks in tankers.

If transverse system of framing is adopted, the section modulus of side stringers is not to be less than determined according to 1.6.4.1 and 1.6.4.2 taking:

$k_\sigma = 0{,}65$;

$m = 10$.

In all other respects, the requirements of 2.5.4.4 are to be complied with;

.4 in the machinery space, the web frames are to have a depth not less than 0,1 of the span, and a web thickness not less than 0,01 of the web depth plus 3,5 mm;

.5 in the machinery space, the web depth of a side stringer is to be equal to that of a web frame.

The web thickness of a side stringer may be 1 mm less than that of a web frame. The side stringer face plate thickness is to be equal to the face plate thickness of a web frame.

2.5.4.8 The diaphragms and platforms of the double skin side are to satisfy the following requirements:

.1 the section moduli and cross-sectional areas of diaphragms and platforms are to satisfy the requirements for the section moduli and cross-sectional areas of side stringer webs, as specified in 2.5.4.4, and of web frames, as specified in 2.5.4.5, using the design pressure determined in accordance with 2.5.3.2.2.

In any case, the thickness, in mm, of diaphragm and platform is not to be less than:

$$s_{\min} = 0{,}018L + 6{,}2; \qquad (2.5.4.8.1)$$

.2 the stiffeners of diaphragms and platforms are to satisfy the requirements of 1.7.3.2.2;

.3 the platforms in the midship region and their continuous longitudinal stiffeners, if any, are to comply with the requirements for the buckling strength of longitudinal framing members, as specified in 1.6.5.2, within 0,25D above the base line and 0,25D below the strength deck;

.4 the thickness of watertight sections of diaphragms and platforms is not to be less than that determined by the Formula (1.6.4.4) taking:

p = as defined in 2.5.3.2.3;

$m = 15{,}8$;

$k_\sigma = 0{,}9$;

.5 the section modulus of stiffeners of the watertight sections of diaphragms and platforms is not to be less than determined from 1.6.4.1 taking:

p = as defined in 2.5.3.2.3;

l = span of stiffener, in m, equal to: the diaphragm spacing, for stiffeners parallel to the shell plating; the distance between the inner edges of primary members of side shell and inner skin if the stiffener is welded thereto, for stiffeners perpendicular to the shell plating; the double skin side breadth if the stiffener ends are sniped;

$m = 12$ for continuous stiffeners parallel to the side plating;

$m = 10$ for stiffeners perpendicular to the side plating and welded to primary framing members;

$m = 8$ elsewhere;

$k_\sigma = 0{,}75$.

2.5.4.9 If there are large openings (exceeding 0,7 times the ship's breadth in width) in the deck, stiffening of the diaphragms and frames of the side shell and inner skin may be required on agreement with the Register in connection with the upper deck pliability, which is to be determined by calculation (see also 3.1.4).

2.5.4.10 The thickness of inner skin is to comply with the requirements for the thickness of longitudinal bulkhead plating in tankers, as specified in 2.7.4.1, using the design pressure determined in accordance with 2.5.3.2.1. In any case, this thickness is not to be less than determined by the Formula (2.7.4.1-1).

2.5.4.11 The cross ties between frames and longitudinals of side shell and inner skin, as mentioned under 2.5.2.2.1, are to comply with the requirements for the intermediate struts of double bottom, as mentioned in 2.4.4.7 using the design pressure determined from 2.5.3.1 or 2.5.3.2.1, whichever is the greater.

If cross ties are fitted, the section modulus of frames complying with 2.5.4.1 and 2.5.4.2, as well as of longitudinals complying with 2.5.4.3, may be reduced by 35 per cent.

2.5.4.12 In the cargo and ballast tanks of tankers, in holds into which water ballast can be taken and in tanks, the thickness of structural members of side framing is not to be less than that required by 3.5.4.

2.5.5 Special requirements.

2.5.5.1 If transverse system of framing is adopted, efficient connection of lower ends of frames to bottom structures is to be ensured by means of bilge brackets or other structures of equivalent strength. The bilge brackets are to comply with the following requirements:

.1 the depth of bilge brackets is not to be less than that of the bilge as a whole. The free edge of a bilge bracket is to be flanged or stiffened with a face plate the dimensions of which are to be in compliance with 1.7.2.2.2.

The thickness of a bilge bracket is taken equal to that of plate floors in the hull region under consideration, but it need not exceed the frame web thickness more than 1,5 times.

Holes cut in bilge brackets are to be such that the width of plating outside the hole is nowhere less than $^1/_3$ of the bracket width.

In any case, the size of bilge brackets is not to be less than that required by 1.7.2.2;

.2 the end attachments of a frame to bilge bracket are to be designed so that at no section the section modulus is less than required for a frame;

.3 where an inclined margin plate is fitted in the double bottom, the bilge bracket is to be carried to the inner bottom plating, and its face plate (flange) is to be welded to the plating;

.4 where a horizontal margin plate is fitted in the double bottom or transverse system of framing is adopted in the single bottom, the width of bilge brackets is to be determined proceeding from the condition that their section moduli at the point of connection to the inner bottom plating or upper edge of floor shall be at least twice those of the frame.

The face plate (flange) of a bilge bracket may be welded to either the inner bottom plating or the face plate (flange) of a floor, or it may be sniped at ends. If the face plate (flange) is welded, the floor web is to be stiffened with a vertical stiffener or a bracket at the point of welding, also welded to the inner bottom plating or to the floor face plate (flange).

The depth of a bilge bracket is not to be less than its width;

.5 if longitudinal system of framing is adopted in the single bottom, the bilge bracket is to be carried at least to the bottom longitudinal nearest to the side and is to be welded thereto. The section modulus of the bracket at the section perpendicular to the shell plating where the bracket width is the greatest shall be at least twice the section modulus of the frame.

2.5.5.2 In all the spaces, the upper ends of frames are to be carried to the decks (platforms) with minimum gaps if they are cut at the decks (platforms). The beams of transversely framed decks (platforms) are to be carried to the inner edges of frames with minimum gaps.

The uppermost decks of ships (except for those secured alongside other ships at sea) may be designed with beams carried to the shell plating with minimum gaps, and frames carried to the beams.

The brackets by which the upper ends of frames are attached are to be sized in accordance with the requirements of 1.7.2.2. If the deck is framed longitudinally, the bracket shall be carried at least to the deck longitudinal nearest to the deck and welded to that longitudinal.

2.5.5.3 If the frame is cut at deck, its lower end is to be attached by a bracket complying with the requirements of 1.7.2.2 The bracket may be omitted if the ends of this frame are welded to the deck plating from above and below, and full penetration is ensured.

2.5.5.4 Side stringers are to be attached to web frames by brackets carried to the web frame face plate and welded thereto.

2.5.5.5 If cross ties are fitted in the wing tanks of tankers, the side transverse and side stringer webs in way of the cross tie attachments are to be provided with stiffeners which are to be an extension of the cross tie face plates. Cross tie attachments to side transverse (side stringer) shall comply with the requirements of 1.7.2.3.

2.6 DECKS AND PLATFORMS

2.6.1 General.

2.6.1.1 Requirements are given in this Chapter for the deck and platform structures of ships where the width of opening for a single cargo hatch does not exceed 0,7 times the ship's breadth abreast of the opening. Additional requirements for the decks and platforms of ships having greater width of openings and their length exceeding 0,7 times the spacing of centres of transverse deck strips between the openings, as well as for the decks and platforms of ships with twin or triple hatch openings, are specified in 3.1.

Requirements for cantilever beams are also to be found there.

For decks and platforms of ro-ro ships, see 3.2.

Requirements for the cargo hatch coamings of bulk carriers are given in 3.3.

Requirements of this Chapter cover plating and framing members of decks and platforms: deck longitudinals, beams, deck transverses, deck girders, hatch end beams, hatch side coamings and hatch end coamings, wash plate in the tanks of tankers.

Additional requirements for the areas of upper deck situated below the superstructures are given in 2.12.5.1 to 2.12.5.3.

2.6.2 Construction.

2.6.2.1 In tankers of 80 m and above, bulk carriers and ore carriers, as well as in oil/dry bulk cargo carriers, and ore/oil carriers, longitudinal system of framing is to be adopted for the strength deck in way of cargo holds (tanks).

Where longitudinal system of framing is adopted, the spacing of deck transverses is not to exceed that of bottom transverses.

2.6.2.2 Provision is to be made for the structural continuity of deck girders of the strength deck in the midship region. If the deck girders are cut at transverse bulkheads, their web plates are to be welded to the transverse bulkheads and attached thereto by brackets.

The web plates of hatch end coamings, deck transverses, hatch end beams and wash plates are to be strengthened by stiffeners and brackets (see 1.7.3).

The face plates of deck girders shall be connected to the face plates of hatch end beams by means of diamond plates (see 1.7.4.5) whose thickness is to be equal to the greater face plate thickness.

2.6.2.3 On the strength deck, the ends of side coamings at the corners of hatchways are to be either bent along the line of hatch corner rounding and butt-welded to the hatch end coaming or extended, in the form of a bracket, beyond the corner of the hatchway. Provision is to be made for a gradual termination of the bracket above the deck girder web.

The upper edges of coamings acting as deck girders should be stiffened with face plates and the lower edges of the coamings are to be rounded.

The upper edge of hatch side coaming shall be smooth and their corners shall be well rounded in the transverse direction.

2.6.2.4 The deck girders and deck transverses in way of pillars are to be strengthened by stiffeners or tripping brackets.

Where deck girders are connected to deck transverses and their web height is different, the deck girder web is to be strengthened by brackets fitted in line with the deck transverse. The brackets shall be welded to the face plate of deck transverse, to the web and face plate of deck girder.

Where deck girders are attached to conventional beams, the web of deck girder shall be strengthened by vertical stiffeners.

2.6.2.5 In the case of connection of deck longitudinals to transverse bulkheads, the effective sectional area of the longitudinals is to be maintained.

2.6.2.6 In tankers with two effective longitudinal bulkheads, provision is to be made for a wash plate at the centreline.

2.6.3 Deck loading.

2.6.3.1 The design pressure on the weather deck is not to be less than:

$$p = 0{,}7p_w \geqslant p_{\min} \qquad (2.6.3.1)$$

where p_w = wave load at the deck level, as defined in 1.3.2.2;

$p_{\min}$ = $0{,}1L + 7$ at the fore end within $0{,}2L$ from the forward perpendicular;

$p_{\min}$ = $0{,}015L + 7$ in the midship region and aft of the midship region; for regions between the fore end and the midship region, $p_{\min}$ is to be determined by linear interpolation.

For ships of restricted area of navigation the value of $p_{\min}$ may be reduced by multiplying by the factor φ_r obtained from Table 1.3.1.5.

2.6.3.2 For weather decks intended to carry deck cargo (except timber and coke), the design pressure is to be taken equal to the cargo pressure p_c determined by the Formula (1.3.4.1). For weather decks intended to carry timber and coke, the value of h in the Formula (1.3.4.1) is to be taken equal to 0,7 times the stowage height of timber and coke on deck.

For lower decks and platforms, the design pressure shall be taken according to 1.3.4.1. For decks where cargo is suspended from beams or deck longitudinals, the design pressure value is to be suitably increased.

For decks and platforms intended for the crew, passengers and equipment, the design pressure is to be determined by the Formula (1.3.4.1) while the product $h\rho_c g$ is not to be less than 3,5 kPa.

For platforms in the machinery space, the minimum design pressure should be 18 kPa.

Watertight lower decks and platforms are to be additionally calculated using the test loads, in kPa, as follows:

$$p = 7{,}5h_t \qquad (2.6.3.2)$$

where h_t = vertical distance, in m, from deck (platform) plating to air pipe top.

2.6.3.3 The design pressure on the structures of decks and platforms forming boundaries of compartments intended for the carriage of liquids is to be determined in accordance with 1.3.4.2.

2.6.4 Scantlings of deck members.

2.6.4.1 Thickness of deck plating.

2.6.4.1.1 The thickness of strength deck plating outside the line of hatch openings, taking deck longitudinals into account, is to be that necessary to give the hull section modulus for strength deck, as required by 1.4.6.

The adopted thickness of strength deck plating within midship region is to be in accordance with the requirements for buckling strength (see 1.6.5).

2.6.4.1.2 The plating thickness for decks and platforms is not to be less than determined by the Formula (1.6.4.4) taking:

$m = 15{,}8$;

p = as defined in 2.6.3;

for strength deck

$k_\sigma = 0{,}3k_D \leqslant 0{,}6$ in the midship region for $L \geqslant 65$ m and transverse framing system;

k_D = as determined by the Formula (2.2.4.1);

$k_\sigma = 0{,}6$ in the midship region for $L = 12$ m and the deck is transverse framing system.

Where $12 < L < 65$ m, k_σ is to be determined by linear interpolation taking $k_\sigma = 0{,}45$ for $L = 65$ m;

$k_\sigma = 0{,}6$ in the midship region for longitudinal framing system;

$k_\sigma = 0{,}7$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation;

for the second continuous deck situated above $0{,}75D$ from the base line

$k_\sigma = 0{,}65k_D \leqslant 0{,}8$ in the midship region for $L \geqslant 65$ m and transverse framing system;

k_D is to be determined by the Formula (2.2.4.1),

$k_\sigma = 0{,}8$ in the midship region for $L = 12$ m and transverse framing system.

Where $12 < L < 65$ m, k_σ is to be determined by linear interpolation taking $k_\sigma = 0{,}73$ for $L = 65$ m;

$k_\sigma = 0{,}8$ in the midship region for longitudinal framing system;

$k_\sigma = 0{,}9$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation;

for other lower decks and platforms, $k_\sigma = 0{,}9$.

2.6.4.1.3 If the machinery space is located aft, the plating thickness and the scantlings of deck longitudinals, at the poop (aft deckhouse) front are to be maintained abaft the poop (deckhouse) front for a length of at least the width of machinery casing opening.

If the distance from the fore edge of casing opening to the poop (deckhouse) front is less than the width of the opening, additional strengthening of deck may be required in this region.

2.6.4.1.4 If the thickness of strength deck plating is taken less than the side plating thickness, a deck stringer plate is to be provided. The width b, in mm, of the strength deck stringer plate is not to be less than:

$$b = 5L + 800 \leqslant 1800, \qquad (2.6.4.1.4)$$

and the thickness of stringer plate is not to be less than that of side shell plating.

2.6.4.1.5 The thickness $s_{\min}$, in mm, of deck plating and platforms is not to be less than:

for upper deck between the ship's side and line of large openings (tank decks of tankers) in the midship region

$$s_{\min} = (4 + 0{,}05L)\sqrt{\eta} \text{ for } L < 100 \text{ m;}$$
$$s_{\min} = (7 + 0{,}02L)\sqrt{\eta} \text{ for } L \geqslant 100 \text{ m;}$$

for upper deck at the ends of the ship and inside the line of large openings, as well as for the second deck

$$s_{\min} = (4 + 0{,}04L)\sqrt{\eta} \text{ for } L < 100 \text{ m;}$$
$$s_{\min} = (7 + 0{,}01L)\sqrt{\eta} \text{ for } L \geqslant 100 \text{ m;}$$

for the third deck and other lower decks and platforms

$$s_{\min} = (5 + 0{,}01L)\sqrt{\eta}$$

where η = as defined in 1.1.4.3.

Where $L > 300$ m, L is to be taken equal to 300 m.

Where the adopted spacing is less than the standard one (see 1.1.3) for ships of unrestricted area of navigation and limited area of navigation I, the minimum deck plating and platform thickness may be reduced in proportion to the ratio of adopted spacing to the standard spacing, but not more than by 10 per cent.

In any case, the minimum thickness is not to be less than 5,5 mm.

In way of compartments intended for the carriage of liquids, the thickness of plating and deck structural members (including perforated members) is not to be less than required by 3.5.4 for tankers and not less than determined by the Formula (2.7.4.1-2) for other ship types.

2.6.4.2 The section modulus of deck longitudinals is not to be less than determined according to 1.6.4.1 and 1.6.4.2 taking:

p = as defined in 2.6.3;

$m = 12$;

for weather deck

$k_\sigma = 0{,}45k_D \leqslant 0{,}65$ in the midship region;

$k_\sigma = 0{,}65$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation;

for other decks

$k_\sigma = 0{,}75$.

k_D is to be determined by the Formula (2.2.4.1).

2.6.4.3 When the decks are framed transversely, the scantlings of beams are to satisfy the following requirements:

.1 the section modulus of beams is not to be less than that determined from 1.6.4.1 taking:

p = as defined in 2.6.3;

$m = 10$;

$k_\sigma = 0{,}65$;

.2 the inertia moment i_b, in cm^4, of weather deck beams in the midship region of ships 65 m and greater in length is to be determined on the basis of a buckling strength calculation of deck grillage using beam models in accordance with 1.6.5.

For beams having two or more intermediate rigid supports, the required inertia moment may be determined, alternatively to the grillage calculation, by the following formula:

$$i_b = 6{,}33(s/a)^3 l^4 \varphi\chi \cdot 10^{-3} \qquad (2.6.4.3.2)$$

where l = beam span, in m, between supports;

$\varphi = 1$ where $\sigma_c \leqslant 0{,}5R_{eH}$;

$\varphi = 4\dfrac{\sigma_c}{R_{eH}}\left(1 - \dfrac{\sigma_c}{R_{eH}}\right)$ where $\sigma_c > 0{,}5R_{eH}$;

$\chi = \lambda^2/(4 - 1{,}5\lambda^4)$;

$\lambda = 4\dfrac{\sigma_c}{\varphi}(a/s)^2$, but not more than 1;

σ_c = compressive stresses as determined according to 1.6.5.1;

s = actual deck plating thickness, in mm.

2.6.4.4 The scantlings of deck framing members, such as deck transverses, deck girders, hatch coamings and hatch end beams, are to be determined on the basis of deck grillage calculation using beam models, except for cases mentioned under 2.6.4.5 to 2.6.4.8. Design loads shall be chosen in accordance with 2.6.3. Where pillars are fitted, the interaction between deck grillage and upper and/or lower structures shall be considered with regard for the arrangement of pillars.

Permissible stress factors shall be taken as follows:

strength deck

for deck girders and hatch side coamings which are arranged in line with the deck girders

$k_\sigma = 0{,}35k_D \leqslant 0{,}65$ in the midship region for $L \geqslant 65$ m;

k_D is to be determined by the Formula (2.2.4.1);

$k_\sigma = 0{,}65$ in the midship region for $L = 12$ m.

Where $12 < L < 65$ m, k_σ is to be determined by linear interpolation taking $k_\sigma = 0{,}5$ for $L = 65$ m;

$k_\sigma = 0{,}65$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation;

for deck transverses and half beams, hatch coamings, which are not arranged in line with the deck girders and hatch end beams

$k_\sigma = 0{,}65$;

for deep members, which are calculated using the shear stresses

$k_\tau = 0{,}65$;

for deep members of other decks and platforms

$k_\tau = k_\sigma = 0{,}7$.

The deep members of weather deck in the midship region are also to comply with the requirements of 2.6.4.9.

2.6.4.5 In tankers with two effective longitudinal bulkheads and with no deck girders, and where longitudinal system of framing is adopted, the scantlings of deck deep members in the centre tank are to comply with the following requirements:

.1 the section modulus of deck transverse is not to be less than determined according to 1.6.4.1 and 1.6.4.2, the sectional area of deck transverse web, excluding openings, is not to be less than determined from 1.6.4.3 taking:

p = as defined in 2.6.3;

k_σ and k_τ = as determined according to 2.6.4.4;

$l = B_1$; (B_1 = breadth, in m, of centre tank);

$m = m_{b.t}$;

$N_{\max} = 0{,}7n_{b.t}pal$;

$m_{b.t}$ and $n_{b.t}$ are to be determined from Table 2.3.4.2.2 depending upon the parameter μ and the number of deck transverses within the tank;

$\mu = \alpha^{4/3}(L_1/B_1)^3$;

$\alpha = W_{d.t}/W_{w.p.}$

where L_1 = tank length, in m;

$W_{d.t}$ = section modulus of deck transverse complying with the present requirements;

$W_{w.p.}$ = section modulus of wash plate complying with the present requirements.

The value of the parameter α is optional, but is not to be greater than 0,6; the value of the parameter μ shall not exceed 1,5.

The deck transverse section modulus is not to be less than $\alpha W_{w.p}$;

.2 the section modulus of wash plate is not to be less than stipulated under 1.6.4.1 and 1.6.4.2, the sectional area of wash plate web, excluding openings, is not to be less than stipulated under 1.6.4.3 taking:

p = as defined in 2.6.3;

k_σ and k_τ = as determined for deck girders in accordance with 2.6.4.4;

$l = L_1$;

a = distance, in m, between the wash plate and longitudinal bulkhead;

$m = m_{c.g}$;

$N_{\max} = 0{,}7n_{c.g}pal$;

$m_{c.g}$ and $n_{c.g}$ are to be obtained from Table 2.3.4.2.2 depending upon the parameter μ and the number of deck transverses within the tank; μ is to be determined in accordance with 2.6.4.5.1.

Besides, the section modulus of wash plate shall not be less than $W_{d.t}/\alpha$ where $W_{d.t}$ is the deck transverse section modulus complying with the requirements of 2.6.4.5.1; α shall be determined in accordance with 2.6.4.5.1.

Along the free edge, the wash plate is to be strengthened with a face plate the sectional area of which is not to be less than that of the deck transverse face plate.

2.6.4.6 The deck transverses of tankers having a single longitudinal bulkhead, tankers with two longitudinal bulkheads and no deck girders or strengthened longitudinals (in wing tanks only), as well as deep half beams, deep beams and hatch end coamings of dry cargo ships, which may be considered as members with rigid supports shall have a section modulus not less than stipulated under 1.6.4.1 and 1.6.4.2 and a web sectional area, excluding openings, not less than stipulated under 1.6.4.3 taking:

p = as defined in 2.6.3;

k_σ and k_τ = as defined in 2.6.4.4;

$m = 10$;

$N_{\max} = 0{,}5pal$.

2.6.4.7 Deck girders and hatch side coamings are to satisfy the following requirements:

.1 deck girders and hatch side coamings which may be considered as members with rigid supports shall have a section modulus not less than determined in accordance with 1.6.4.1 and 1.6.4.2, and a web sectional area, excluding openings, not less than stipulated under 1.6.4.3 taking:

p = as defined in 2.6.3;

k_σ and k_τ = as defined in 2.6.4.4;

$N_{\max} = 0{,}5pal$;

$m = 10$ for intercostal deck girders and hatch side coamings;

$m = 12$ for continuous deck girders and hatch side coamings when determining the section modulus at supporting section taking into account the bracket, if any, included in this section;

$m = 18$ for continuous deck girders and hatch side coamings when determining the section modulus in the span of a deck girder, hatch side coaming;

.2 for ships less than 30 m in length, the deck girder web thickness need not be taken greater than the deck plating thickness, and the hatch coaming web thickness is to be 1 mm greater than the thickness of deck plating;

.3 if the side coamings of strength deck hatches terminate in brackets, the length l_b, in m, of these brackets on the deck shall be:

$$l_b \geqslant 0{,}75h_b \text{ at } R_{eH} \leqslant 315 \text{ MPa}; \qquad (2.6.4.7.3)$$
$$l_b \geqslant 1{,}5h_b \text{ at } R_{eH} = 390 \text{ MPa}$$

where h_b = height of coaming above deck, in m.

For the intermediate values of R_{eH}, the bracket length is to be determined by linear interpolation;

.4 if containers or other cargo are stowed on cargo hatch covers, the scantlings of stiffeners for vertical coaming plates are to be so chosen as to consider both the horizontal and vertical components of inertia forces acting upon the stiffeners in the event of rolling.

2.6.4.8 If deck deep member can be considered separately from others, its section modulus is not to be less than stipulated under 1.6.4.1 and 1.6.4.2 using the design loads and factor k_σ determined from 2.6.4.4 and with $m = 10$.

The sectional area of such member is not to be less than determined by the Formula (1.6.4.3) taking:

k_σ = as stipulated under 2.6.4.4;

$N_{\max} = 0{,}5pal$;

p = as defined in 2.6.3.

2.6.4.9 In the midship region of a ship 65 m and greater in length, the deep member scantlings of the weather deck are to comply with the buckling strength requirements of 1.6.5, the buckling strength values to be determined by calculation of the deck grillage using beam models.

Where deck is framed longitudinally and no deck girders are fitted, or deck girders serve as rigid supports for deck transverses, the required moment of inertia I, in cm^4, of deck transverses may be determined by the following formula, as an alternative to grillage calculation:

$$I_{d.t} = 0{,}76(l/c)^3 \frac{l}{a_1} i\varphi\chi \qquad (2.6.4.9)$$

where l = span of deck transverse between supports, in m;
c = distance, in m, between deck transverses;
a_1 = spacing of deck longitudinals, in m;
i = actual inertia moment, in cm^4, of deck longitudinal provided with a face plate;
φ = 1 where $1{,}15\sigma_c \leqslant 0{,}5R_{eH}$;
φ = $4{,}6(1 - 1{,}15\sigma_c/R_{eH})$ where $1{,}15\sigma_c > 0{,}5R_{eH}$;
χ is determined by the Formula (2.6.4.3) taking $\lambda = 1{,}15\dfrac{\sigma_c}{\varphi\sigma_e}$;
σ_c = compressive stress as defined in 1.6.5.1;
σ_e = actual Euler stresses in deck longitudinals, determined in accordance with 1.6.5.4.

2.6.5 Special requirements.

2.6.5.1 The requirements for hatch openings as given below apply to single hatches whose scantlings do not exceed those stipulated under 2.6.1.1.

The openings are supposed to be arranged in the fore-and-aft direction with their greater side. Otherwise, the corner design of openings will be subject to special consideration by the Register.

2.6.5.1.1 For the strength deck within 0,6L amidships, if $L \geqslant 65$ m, and 0,5L, if $40 \leqslant L < 65$ m, the corner radii of openings in cargo hatches and engine and boiler casings are to comply with the following requirements:

when the corners are rounded along the circumferential arc with a radius r, in m,

$$r \geqslant 0{,}1ab_1; \qquad (2.6.5.1\text{-}1)$$

when the corners are rounded along the elliptical arc with the ratio of the length of longitudinal half-axis d_1, in m, to the length of transverse half-axis c_1, in m, being equal to 2,

$$c_1 \geqslant 0{,}07ab_1 \qquad (2.6.5.1\text{-}2)$$

where a = 1, if the corners of openings are not reinforced by thickened insert plates;
a = 0,7, if the corners of openings are reinforced by thickened insert plates;
$b_1 = c$ when $c \leqslant c_0$, for adjacent edges of successive openings;
$b_1 = b$ when $c > c_0$, for adjacent edges of successive openings and in all other cases;
c = distance, in m, between adjacent edges of successive openings (length of landing between openings);
b = breadth, in m, of opening;
$c_0 = B\dfrac{b}{l}\left(\dfrac{2}{\sqrt{b/B}} - 1\right)$;
l = length of opening, in m.

The size of thickened insert plates by which the corners of openings are reinforced shall be in compliance with Fig. 2.6.5.1.1 or with the requirements of 2.6.5.1.5 where r is to be determined by the Formula (2.6.5.1-1) if the rounding is made along the circumferential arc; $r = c_1$ for the transverse dimensions of the insert plate, and $r = d_1$ for its longitudinal dimensions if the rounding is made along the elliptical arc, and c_1 is to be determined by the Formula (2.6.5.1-2).

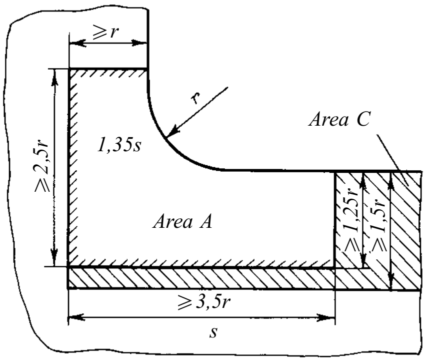


Fig. 2.6.5.1.1

2.6.5.1.2 For the strength deck outside the area indicated in 2.6.5.1.1 and for the second continuous deck situated above 0,75D from the base line, the corner radii of openings, as required by 2.6.5.1.1, may, in accordance with 1.1.3, be reduced by half in the midship region. The minimum radius is not to be taken less than 0,2 m.

For other regions, other decks and platforms, as well as for ships less than 40 m in length, the minimum corner radius of openings in cargo hatches and engine and boiler casings may be taken equal to 0,15 m.

2.6.5.1.3 At corners of openings in the cargo hatches of decks (irrespective of their location over the length and depth of the hull) exposed to low temperatures, the radii of curvature shall comply with the requirements for similar structures of the strength deck, situated in the midship region (see 2.6.5.1.1).

2.6.5.1.4 In the area A (see Fig. 2.6.5.1.1), butts of deck plating and coaming plates, butt welds of primary and deep longitudinal members, openings welding of shackles, frames, etc., as well as mounting parts, to deck plating are not permitted.

In the area C (see Fig. 2.6.5.1.1), only small openings generally of a round or elliptical shape with a minimum size not exceeding 20s (s = deck plating thickness, in mm) are permitted. Penetration of welds to longitudinal edges of openings shall be avoided as far as practicable.

If the deck plating is terminated at a hatch coaming (or engine casing) and welded thereto, full penetration welds are to be used. Where the deck plating extends inside a hatch coaming, the free edges of plating are to be smooth within the hatch and free of weld attachments.

If the hatch side coaming terminates in a bracket, the bracket the is not to coincide with the butt joint of the deck plating.

2.6.5.1.5 If the lost cross-sectional area of deck is to be compensated in way of an isolated opening, reinforcement should be applied as shown in Fig. 2.6.5.1.5. The value of factor k is to be selected proceeding from the relationship between the deck plating thickness s, insert plate thickness s_1 and opening width b, but is not to be taken less than $k = 0,35s/s_1$;

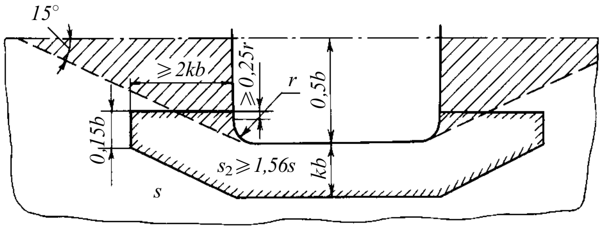


Fig. 2.6.5.1.5

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2.6.5.1.6 The deck plating thickness between transverse edges of adjacent successive openings in cargo hatches and engine casings (see 2.6.5.1.1) within their width except for the transverse dimensions of rounding is not to be less than stipulated under 2.6.4.2.

The thickness s_{min} is permitted in way of transverse edges of isolated openings in the area shown in Fig. 2.6.5.1.6.

If longitudinal system of framing is adopted, the deck plating between hatch end coamings shall be additionally strengthened by fitting of transverse intercostal stiffeners at every frame.

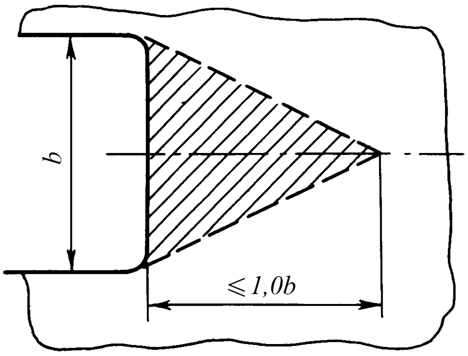


Fig. 2.6.5.1.6

2.6.5.1.7 Single openings in the strength deck and in the second continuous deck situated above 0,75D from the base line, in areas within the midship region, as mentioned in 2.6.5.1.1 and 2.6.5.1.2, and between the ship's side and the line of hatch openings in ships of 40 m and greater in length shall be as small as practicable and be arranged well clear of the corners of openings in cargo hatches and engine and boiler casings, as well as of the ends of superstructures.

Rectangular and circular openings in the above areas need not be reinforced, if their width (diameter) is less than 20 times the deck plating thickness in way of the opening, or 300 mm, whichever is less.

No openings are permitted in the thickened insert plates by which the corners of cargo hatches and engine and boiler casings are reinforced, as well as in the thickened deck stringer plates at the ends of superstructures and at the toes of brackets in which side coamings terminate.

Openings (including rectangular ones) are not to be reinforced when located inside the line of large hatchway openings not more than 0,25b from the centreline and 0,5b from the transverse edges of a cargo hatchway opening (where b is the width of cargo hatch, in m).

For isolated openings in the area indicated in Fig. 2.6.5.1.6, reinforcement is not required.

If the distance between the edge of an opening in the strength deck and ship's side (or a hatch side coaming) is less than twice the opening width, appropriate reinforcement is to be provided irrespective of the width and shape of opening. The aforesaid distance is not to be less than 75 mm.

The corners of rectangular openings are to be rounded with a radius. In general, $r_{min} = 0,1b$ (where b is the width of opening, in m). In any case, the minimum radius of curvature is not to be taken less than twice the plating thickness in way of the opening or 50 mm, whichever is the greater.

2.6.5.2 The thickness s, in mm, of the coamings of ventilators (ventilating tubing, ducts, trunks, etc.) on the freeboard deck and quarter deck, as well as on the open decks of superstructures within 0,25L from the forward perpendicular is not to be less than:

$$s = 0{,}01d_c + 5 \qquad (2.6.5.2\text{-}1)$$

where d_c = internal diameter or length of the greater side of a coaming section, in mm.

The thickness s is not to be less than 7 mm, but it need not be greater than 10 mm.

In ships of restricted areas of navigation **II**, **IIСП**, **IIIСП** and **III**, less than 24 m in length, the thickness s, in mm, of ventilator coamings is not to be less than:

$$s = 0{,}01d + 4 \qquad (2.6.5.2\text{-}2)$$

or

$$s = s_d + 1 \qquad (2.6.5.2\text{-}3)$$

where d = internal diameter or length of the greater side of a coaming section, in mm;

s_d = thickness of deck plating, in mm,

whichever is the greater.

The thickness of coamings on decks of the first tier superstructures situated outside 0,25L from the forward perpendicular may be reduced by 10 per cent as compared to that required for coamings on freeboard deck and raised quarter deck.

Where the thickness of deck plating is less than 10 mm, a welded insert or doubling plate shall be fitted in way of the coaming, having a thickness equal to at least 10 mm, length and breadth not less than twice the diameter or twice the length of the greater side of the coaming section.

In case of an efficient connection of the coaming to the deck framing, fitting of welded insert or doubling plate is not required.

Where the height of a ventilator coaming is greater than 0,9 m and the coaming is not supported by adjacent hull structures, brackets are to be fitted to attach the coaming to the deck.

The height of ventilator coamings shall be determined in accordance with 7.8, Part III "Equipment, Arrangements and Outfit".

The structure of companionway and skylight coamings are to have strength equivalent to that of cargo hatches, whereas the thickness of the coamings is not to be taken less than 7 mm, but need not exceed the thickness of deck plating in way of the coaming.

2.7 BULKHEADS, PROPELLER SHAFT TUNNEL

2.7.1 General and definitions.

2.7.1.1 Requirements are given in this Chapter for various types of bulkheads, propeller shaft tunnel and cofferdams. Requirements for cofferdam bulkheads are to be found under 3.3.

2.7.1.2 Definitions.

Tight bulkhead is a bulkhead proof against water and other liquids.

Cofferdam bulkhead is a bulkhead having two parallel tight platings, either strengthened with vertical or horizontal stiffeners or not, which are connected to each other by plate structures perpendicular to the platings: vertical structures (diaphragms) and/or horizontal structures (platforms). If no diaphragms and platforms are fitted, the structure should be considered as two bulkheads bounding the cofferdam.

Watertight (emergency) bulkhead is a bulkhead restricting the flow of water through ship spaces in the case of emergency.

Tank/cargo tank bulkhead is a bulkhead bounding a ballast, fuel or other tank, as well as a cargo tank of tanker.

Wash bulkhead is a bulkhead with openings, fitted inside a compartment in order to reduce impact pressure due to the movement of liquid therein.

Partial bulkhead is a bulkhead fitted in a compartment or part thereof, which is to ensure additional support for deck structures.

2.7.1.3 The total number of transverse watertight bulkheads, including fore and after peak bulkheads, is not to be less than specified in Table 2.7.1.3. These requirements apply to cargo ships only and are minimum.

Table 2.7.1.3

Length of the ship, in m	Total number of bulkheads	
	Machinery amidships	Machinery aft[1]
Up to 65	4	3
65 to 85	4	4
85 to 105	5	5
105 to 125	6	6
125 to 145	7	6
145 to 165	8	7
165 to 185	9	8
Above 185	On agreement with the Register	

[1] With after peak bulkhead forming after boundary of the machinery space.

Where compliance with subdivision requirements is to be ensured, the number and disposition of watertight bulkheads (and of partial watertight bulkheads) shall be determined proceeding from the requirements of Part V "Subdivision".

In special cases, a reduction in number of bulkheads may be permitted by the Register.

In this case, two adjacent watertight bulkheads should be spaced not more than 30 m apart. Increase of this distance shall be a matter of the special consideration of the Register in each case.

All the transverse watertight bulkheads located between fore and after peak bulkheads are generally to be carried to the freeboard deck.

2.7.1.4 Peak and machinery space bulkheads, shaft tunnels are also to comply with the requirements of 1.1.6.1 or 1.1.6.2.

2.7.1.5 Compartments intended for the carriage of liquid cargoes and ballast, for which $l > 0{,}13L$ and/or $b > 0{,}6B$ (l and b are the length and breadth, in m, of a compartment, as measured in the middle of its height), are subject to special consideration by the Register.

2.7.2 Construction.

2.7.2.1 Tight bulkheads may be either plane or corrugated. Wash bulkheads with openings shall be plane bulkheads.

For the construction of longitudinal tight bulkheads, as well as for the tight bulkheads of log and depth sounder wells, escape trunks, propeller shaft tunnel, etc., the same requirements apply as for transverse tight bulkheads.

In bulkheads, watertight steps and recesses are permitted.

In tankers, the longitudinal bulkheads shall be tight throughout the cargo tank region (including pump rooms and cofferdams) with the exception of the third bulkhead at the centreline which may be constructed as a wash bulkhead.

At intersections of longitudinal and transverse bulkheads, structural continuity of longitudinal bulkheads shall be ensured. The termination of longitudinal bulkheads shall be smooth.

Partial bulkheads shall be plane bulkheads.

2.7.2.2 In corrugated longitudinal bulkheads, the corrugations shall generally be arranged horizontally, while in transverse bulkheads the arrangement of corrugations may be both horizontal and vertical.

Plane bulkheads are to be strengthened by vertical or horizontal stiffeners. The vertical and horizontal stiffeners of plane bulkheads as well as the vertical and horizontal corrugations of corrugated bulkheads may be supported by horizontal girders or vertical webs respectively.

The horizontal girders and vertical webs are to be stiffened in accordance with the requirements of 1.7.3.

Partial bulkheads are to be strengthened by vertical webs.

2.7.2.3 The end attachments of bulkhead framing members shall comply with the following requirements:

.1 the ends of vertical webs and horizontal stiffeners of bulkheads are generally to be attached by brackets complying with the requirements of 1.7.2.2. Bracket attachments are required for the ends of main framing of forepeak bulkhead below the freeboard deck;

.2 if transverse system of framing is adopted, the brackets by which the vertical webs of transverse bulkheads are attached to deck plating and inner bottom plating (bottom plating) shall be carried to the beam or floor nearest to the bulkhead and welded thereto.

Where transverse framing system is adopted, the brackets by which the horizontal stiffeners of bulkheads are attached to the side or other bulkhead shall be carried to the frame or vertical stiffener nearest to the bulkhead and welded thereto;

.3 when the vertical stiffeners of bulkheads are cut at decks, platforms or horizontal girders and no brackets are fitted, the stiffener ends shall be welded to deck or platform plating, to horizontal girder web, or sniped at ends;

.4 the end attachments of vertical webs and horizontal girders shall comply with the requirements of 1.7.2.3.

Where there are no horizontal girders on longitudinal bulkheads and/or side stringers at the level of the horizontal girder brackets of transverse bulkheads, the brackets shall be carried to the nearest vertical web on longitudinal bulkhead and/or the nearest frame and welded thereto.

If the vertical web on a transverse bulkhead is not in line with the centre girder or side girder, a bracket shall be fitted in the double bottom under the bracket by which the lower end of the vertical web is attached.

2.7.2.4 The attachments of corrugated bulkheads shall comply with the following requirements:

.1 where a horizontally corrugated bulkhead is attached to deck and bottom (inner bottom) or a vertically corrugated bulkhead is attached to ship's sides and longitudinal bulkheads, provision is to be made for flat transition areas whose structure, thickness and stiffening shall be in compliance with the requirements for plane bulkheads;

.2 attachment of corrugation ends shall be effected by welding them directly to the inner bottom plating (bottom plating), side plating, deck plating, etc. In so doing, attention shall be given to eliminating hard spots (see 1.7.1.4) in the above structures;

.3 requirements for the attachments of corrugated bulkheads in bulk carriers are given in 3.3.2.

2.7.3 Bulkhead loading.

2.7.3.1 The design pressure p, in kPa, on watertight bulkhead structures and propeller shaft tunnel is to be taken equal to:

$$p = \alpha z_b \tag{2.7.3.1}$$

where $\alpha = 10$ for forepeak bulkhead structures;
$\alpha = 7{,}5$ elsewhere;
z_b = distance, in m, as measured at the centreline, from the point of design load application to its upper level; the upper load level is: the bulkhead deck for watertight bulkheads and propeller shaft tunnel, the upper edge of forepeak bulkhead for the forepeak bulkhead.
If partial watertight bulkheads are fitted on the bulkhead deck in line with the watertight bulkheads or in close vicinity to them, z_b is to be measured to the upper edge of the watertight partial bulkheads.

In any case, the design pressure is to be not less than 12 kPa for watertight bulkhead structures and not less than 16 kPa for forepeak bulkhead structures.

2.7.3.2 The design pressure on the bulkheads of tanks, cargo tanks and water ballast holds is to be determined in accordance with 1.3.4.2.

The design pressure on the wash bulkheads and plates should be determined by the Formulae (1.3.4.2-6) and (1.3.4.2-7), but is not to be less than $p_{\min} = 25$ kPa.

The design pressure on bulkheads bounding heavy bulk cargo holds is to be determined in accordance with 1.3.4.3.

2.7.4 Scantlings of bulkhead members.

2.7.4.1 The thickness of bulkhead plating is to be not less than determined by the Formula (1.6.4.4) taking:

p = as defined in 2.7.3;

$m = 15{,}8$;

for the longitudinal bulkheads of tankers 65 m or greater in length, with transverse framing in the midship region

$k_\sigma = 0{,}55k_B \leqslant 0{,}8$ at the level of base line;

k_B is to be determined by the Formula (2.2.4.1);

$k_\sigma = 0{,}55k_D \leqslant 0{,}8$ at the upper deck level;

k_D is to be determined by the Formula (2.2.4.1);

$k_\sigma = 0{,}8$ in way of $(0{,}4 - 0{,}5)D$ from the base line.

For intermediate regions over the ship's depth, k_σ is to be determined by linear interpolation;

$k_\sigma = 0{,}8$ for $L = 12$ m.

Where $12 < L < 65$ m, k_σ is to be determined by linear interpolation taking $k_\sigma = 0{,}68$ for $L = 65$ m at the level of base line and upper deck;

$k_\sigma = 0{,}9$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation;

$k_\sigma = 0{,}9$ for other bulkheads.

In ships of 50 m in length, the thickness of watertight bulkhead plating may be reduced by 0,5 mm, and in ships of 40 m in length or below, by 1 mm. For intermediate ship lengths, the reduction in thickness is to be determined by linear interpolation.

In tankers, the thickness of top and bottom strakes of longitudinal bulkheads is to comply with the requirements for side plating, as given in 2.2.4, with regard for the liquid cargo pressure.

The plating thickness $s_{\min}$, in mm, of watertight bulkheads and bulkheads of lubricating oil tanks is not to be less than:

$$s_{\min} = 4 + 0{,}02L. \qquad (2.7.4.1\text{-}1)$$

Where $L > 150$ m, L is to be taken equal to 150 m.

The thickness of bottom plates of bulkheads is to exceed the above value by 1 mm, but is not to be less than 6 mm.

For tank bulkheads (except lubricating oil tanks), the thickness $s_{\min}$, in mm, of plating, face plates and webs of framing members is not to be less than:

$$s_{\min} = 5 + 0{,}015L; \qquad (2.7.4.1\text{-}2)$$

$$6{,}0 \leqslant s_{\min} \leqslant 7{,}5 \text{ mm}.$$

In tankers, the minimum bulkhead plating thickness in way of cargo and ballast tanks is not to be less than that required by 3.5.4.

Bulkhead plating may have a thickness not exceeding that of relevant shell plating strakes and deck plating, where the spans and yield stress values are identical. The same applies to the thickness relationship of bulkhead bottom plating and inner bottom plating (bottom plating).

The breadth of top and bottom strakes of bulkheads is to be determined in accordance with 2.7.5.1.

Where sterntubes penetrate through bulkhead plating, the thickness of the latter shall be doubled.

The thickness of corrugated bulkheads is to be determined in accordance with 1.6.4.5 with regard for the requirements for the section moduli of vertical and horizontal stiffeners, as specified in 2.7.4.2.

2.7.4.2 The section modulus of vertical and horizontal stiffeners of bulkheads is not to be less than stipulated under 1.6.4.1 and 1.6.4.2 taking:

p = as defined in 2.7.3;

m = as obtained from Table 2.7.4.2;

Table 2.7.4.2

Framing members	m
Single span vertical stiffeners:	
both ends sniped	8
upper end sniped, lower end welded to supporting structure	9
both ends welded to supporting structure	10
upper end welded to supporting structure, lower end bracketed[1]	14
both ends bracketed[1]	18
Multispan vertical stiffeners:	
within span	18
within intermediate supporting section, where stiffener is continuous through supporting structure[2]	12
Horizontal stiffeners	12

[1] Additionally, strength in the supporting section is to be verified, considering the bracket as part of the section, with $m = 12$.

[2] With regard for a bracket, if fitted, in the supporting section.

for horizontal stiffeners of longitudinal bulkheads fitted in the midship region of tankers 65 m and greater in length

$k_\sigma = 0{,}55k_B \leqslant 0{,}75$ at the level of base line;

k_B is to be determined by the Formula (2.2.4.1);

$k_\sigma = 0{,}55k_B \leqslant 0{,}75$ at the upper deck level;

k_D is to be determined by the Formula (2.2.4.1);

$k_\sigma = 0{,}75$ within $(0{,}4 - 0{,}5)D$ from the base line.

For intermediate regions over the ship's depth, k_σ is to be determined by linear interpolation;

$k_\sigma = 0{,}75$ for $L = 12$ m;

Where $12 < L < 65$ m, k_σ is to be determined by linear interpolation, taking $k_\sigma = 0{,}65$ for $L = 65$ m at the base line and upper deck level.

$k_\sigma = 0{,}75$ at the ends of the ship within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation;

$k_\sigma = 0{,}75$ for other girders of bulkhead framing.

$m = 10$ for corrugations;

$m = 13$ for vertical corrugations of bulkheads whose top and bottom ends are attached to deck and bottom or to inner bottom by transverse members of rectangular or trapezoidal section and by supports of trapezoidal section complying with 3.3, respectively.

Horizontal stiffeners of longitudinal bulkheads fitted at a distance of $0{,}15D$ from deck and bottom are to comply with the buckling strength requirements of 1.6.5.

For tank bulkheads (except lubricating oil tanks), the thickness of member webs and face plates as well as of their stiffening brackets is not to be less than required by the Formula (2.7.4.1-2), and for the bulkheads of tankers in way of cargo and ballast tanks it is not to be less than stipulated under 3.5.4.

2.7.4.3 Bulkhead vertical webs and horizontal girders are to satisfy the following requirements:

.1 the section modulus and web sectional area, excluding openings, of the vertical webs of bulkheads whose structure does not include horizontal girders, and of the horizontal girders of bulkheads whose structure does not include vertical webs, are not to be less than stipulated under 1.6.4.1 to 1.6.4.3 taking:

$N_{\max} = npal$;

$p =$ as defined in 2.7.3;

m and n for the longitudinal bulkheads of tankers are to be determined from Table 2.7.4.3-1 depending upon the number of cross ties fitted in wing tanks between deep members of bulkhead and of ship's side; for other bulkheads for which vertical webs are provided, but horizontal girders are omitted, or vice versa, the values of m and n should be obtained from Table 2.7.4.3-2;

$l =$ span, including the brackets, in m;

k_σ is determined for horizontal girders of longi-tudinal bulkheads in tankers in the same way as for the horizontal stiffeners of those bulkheads in accordance with 2.7.4.2; for other webs and girders, $k_\sigma = 0{,}75$;

$k_\tau = 0{,}75$;

.2 where the bulkhead structure incorporates both vertical webs and horizontal girders, the scantlings of those members are to be determined on the basis of grillage calculation using beam models, with design loads as stipulated under 2.7.3 and permissible stress factors as stipulated under 2.7.4.3.1;

.3 for the girders and webs of corrugated bulkheads, the lowest cross section is to be adopted as the design cross section; the face plate width is to be determined in accordance with 1.6.3.6;

.4 for tank bulkheads (except lubricating oil tanks), the web and face plate thickness of girders and of their brackets and stiffeners is not to be less than required by the Formula (2.7.4.1-2); for tanker bulkheads in way of cargo and ballast tanks, this thickness is not to be less than that required by 3.5.4.

Table 2.7.4.3-1

Member	Parameter	Number of cross ties			
		0	1	2	3
Vertical web	m	11	24	24	24
	n	0,5	0,325	0,3	0,275
Horizontal girder	m	18	36	36	36
	n	0,5	0,35	0,3	0,3

Table 2.7.4.3-2

Member	m	n
Vertical web:		
in holds or tanks	11	0,5
in 'tween decks	10	0,5
Horizontal girder:		
in tanks	10	0,5
in wing tanks	18	0,5

2.7.4.4 In compartments intended for the carriage of liquid cargoes and ballast, the scantlings of members of wash bulkheads and wash plates are to comply with the following additional requirements:

.1 in the wash bulkheads, the total area of openings is not to be greater than 10 per cent of the bulkhead area as a whole. The number and size of openings in the top and bottom strakes shall be as small as possible.

The thickness and breadth of the top and bottom plates of wash bulkheads are to comply with the requirements for the bulkhead plating of tanks or cargo (ballast) tanks proceeding from the purpose;

.2 a wash plate is to be stiffened by framing complying with the requirements for wash bulkhead framing.

The free edge of the wash plate is to be stiffened by a horizontal stiffener or a face plate. Their section modulus is to comply with the requirements for the primary members of wash bulkheads.

Where a wash plate serves as the undeck girder, it is to comply with the requirements of 2.6.

2.7.4.5 The scantlings of partial bulkhead members are to comply with the following requirements:

.1 the thickness of partial bulkhead plating is not to be less than that required by the Formula (2.7.4.1-1);

.2 partial bulkhead stiffeners supporting deck transverses and hatch end beams are to be in accordance with the requirements for relevant pillars (see 2.9).

In any case, the Euler stresses, in MPa, in a stiffener, to be determined in accordance with 2.9.4.1, shall not be less than:

$$\sigma_e = 200\eta. \qquad (2.7.4.5.2)$$

The moment of inertia and sectional area of the stiffener on the basis of which the Euler stresses therein are determined shall be calculated with regard for the face plate of partial bulkhead plating equal in width to half the distance between the stiffeners;

.3 if the partial bulkhead takes up the load directly from cargo, the scantlings of its members are to comply with the requirements for hold bulkheads with regard for the particular cargo.

2.7.4.6 The scantlings of shaft tunnel members, its recess included, and those of the tight bulkheads of log and depth sounder wells, escape trunks, etc. shall comply with the requirements for the scantlings of watertight bulkhead members.

If the shaft tunnel passes through a compartment intended for the carriage of liquid cargo or ballast, the scantlings of its members shall comply with the requirements for the scantlings of the members of tight bulkheads bounding the compartment.

If the top plating is well curved, the thickness may be reduced by 10 per cent.

Under hatchways the top plating thickness is to be increased by 2 mm.

2.7.5 Special requirements.

2.7.5.1 The breadth of the bottom strake of bulkhead, as measured from inner bottom plating, or, where double bottom is omitted, from the bottom shell, shall be not less than 0,9 m for ships of 40 m and greater in length, and not less than 0,4 m for ships of 12 m in length. For intermediate ship lengths, the breadth of this strake is to be determined by linear interpolation. If the double bottom extends to the bulkhead on one side only, the bottom strake of bulkhead plating is to extend for at least 0,3 m above the inner bottom plating.

In the boiler room, the bottom strake of the bulkhead is to extend for at least 0,6 m above the flooring.

The upper edge of bottom strake of transverse bulkheads in the cargo tanks of tankers shall be at least 100 mm above the upper toes of brackets of bottom longitudinals. The top and bottom strake breadth of longitudinal bulkhead plating is not to be less than 0,1D, but need not exceed 1,8 m.

2.7.5.2 Cofferdams and the bulkheads forming their boundaries are to comply with the following requirements:

.1 unless expressly provided otherwise in the other Parts of the Rules, the breadth of vertical cofferdams stipulated under 2.1.12 and 2.4.7, Part VI "Fire Protection", and under 13.7.5, 14.5.2, 17.3, Part VIII "Systems and Piping" shall be equal to one spacing,but not less than 0,6 m, and the height of horizontal cofferdams shall not be less than 0,7 m.

In any case, cofferdam dimensions should be so selected as to make the cofferdams accessible for inspection and repair.

Instead of cofferdams, cofferdam bulkheads may be fitted in accordance with 3.3 unless expressly provided otherwise by the Rules;

.2 cofferdams adjoining cargo tanks and fuel tanks must be watertight.

Bulkheads separating cofferdams from tanks are to comply with the requirements for the bulkheads of those tanks.

The bulkheads of cofferdams filled with water are to comply with the requirements for tank bulkheads.

The bulkheads of cofferdams which are to ensure tightness, but which are not filled with water, shall comply with the requirements for watertight bulkheads.

The bulkheads of cofferdams which are non-tight shall comply with the requirements for partial bulkheads as stipulated under 2.7.4.5, except the requirement for vertical webs supporting deck transverses and hatch end beams. They may have openings provided the corners of the openings are rounded and the edges are suitably reinforced. Such openings are not generally to be arranged in the top and bottom strakes of longitudinal bulkheads.

2.8 FORE AND AFTER ENDS

2.8.1 General and symbols.

2.8.1.1 Requirements are given in this Chapter for the following structures: fore peak and bulb (if any), bottom within 0,25L aft of the fore perpendicular, side within 0,15L aft of the fore perpendicular, structures located aft of the after peak bulkhead, as well as strengthening of bottom and side forward in the region of impact pressure.

It is assumed in this Chapter that the upper boundary of the fore and after peak is formed by a tight deck or platform arranged directly above the summer load waterline.

2.8.1.2 Symbols:

d_f = minimum design draught, in m, in way of forward perpendicular;

α_x = angle, in deg., between a vertical and the straight line connecting the intersection points of summer load waterline and weather deck with the ship's side at a cross section within 0,05L from the forward perpendicular (Fig. 2.8.1.2-1);

β_x = angle, in deg., between a tangent to the waterline at vertical mid-distance between the summer load waterline and weather deck on forward perpendicular, and a line parallel to the centreline at a cross section within 0,05L from the forward perpendicular (Fig. 2.8.1.2-2).

2.8.2 Construction.

2.8.2.1 The following framing systems are adopted at ends:

transverse system of framing for bottom in peaks;

transverse or longitudinal system of framing for other structures.

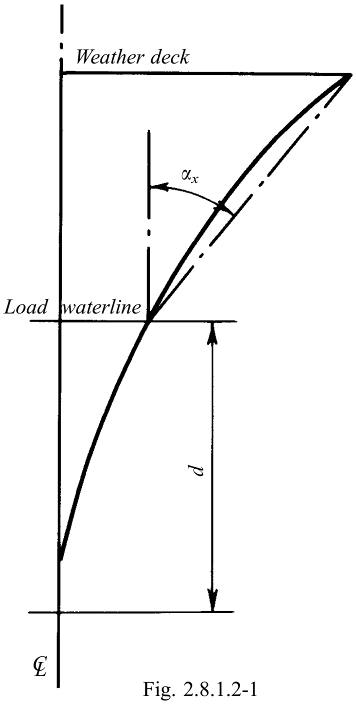


Fig. 2.8.1.2-1
Determination of angle α_x

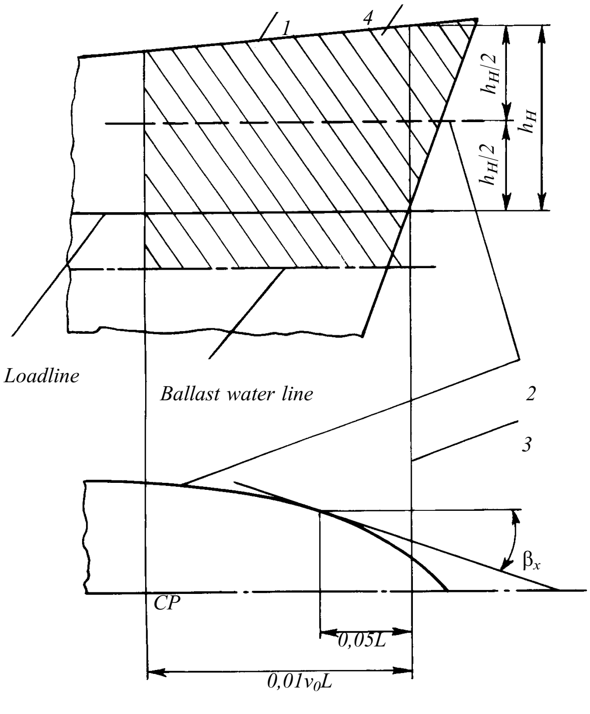


Fig. 2.8.1.2-2
Diagram for determining the angle and the area (lined) to which the move impact pressure is applied:
1 — open upper deck;
2 — water line for determining the angle;
3 — forward perpendicular;
4 — impact pressure area;
h_N — vertical distance between the loadline and the open upper deck at forward perpendicular

2.8.2.2 Fore peak floors are to be fitted at every frame. Their height is not to be less than stipulated under 2.4.4.1, but need not exceed 2,25 m, and the thickness is not to be less than required by the Formula (2.4.4.3-2) at $k = 1$ and $a = 0{,}6$ m; however, they need not be thicker than the bottom shell plating in this region. Floor webs shall be strengthened with vertical stiffeners to be spaced not more than 0,6 m apart.

Floor face plates are to have a thickness not less than the floor thickness and a breadth required by 1.7.3.1.

At the centreline an intercostal side girder with a face plate is to be fitted as an extension of centre girder in way of the holds. The height and thickness of girder plates as well as the thickness and width of girder face plate are to be equal to those of the floors.

Where the webs of the girder cannot be arranged, the floor face plates are to be interconnected at the centreline by an angle, tee section, etc. the flanges of which have the same width and thickness as the floor face plates.

2.8.2.3 If transverse system of framing is adopted in the fore peak side, the side stringers shall be fitted at least up to the deck directly above the summer load waterline. Side stringers must be so fitted that the distance measured vertically between them does not, in general, exceed 2 m.

Side stringers shall be supported by panting beams fitted at alternate frames and shall, where possible, be supported at the centreline by a longitudinal bulkhead.

The free edge of the side stringers is to be stiffened by a face plate having a thickness not less than that of a stringer web and a breadth in accordance with 1.7.3.1. At every frame, the stringer web is to be stiffened by brackets having the side dimensions not less than half the stringer web height, and where panting beams are fitted, these are to be not less than required by 1.7.2.2 The thickness of brackets is not to be less than that of the stringer web.

Instead of panting beams, the side stringers may be supported by web frames spaced not more than 3 m apart.

It is recommended that non-tight platforms be fitted instead of side stringers with panting beams or web frames. In this case, the distance between the platforms may be increased to 2,5 m. The beams of non-tight platforms shall be fitted at every frame.

If in the structure with panting beams or web frames the distance from the base line to the nearest deck or platform exceeds 9 m, a non-tight platform is to be fitted at the middle of this length, in which the total area of openings is not to exceed 10 per cent of its area.

With longitudinally framed fore peak side, the spacing of web frames is not to exceed 2,4 m. Deck transverses are to be fitted in way of the web frames passage through or attachment to decks and platforms.

Floors without web frames fitted in line with them are to be attached to the nearest side longitudinals by brackets.

2.8.2.4 The bulb must be strengthened by platforms spaced not more than 2 m apart. Beams of the platform are to be fitted at every frame.

If the length of the bulb forward of the forward perpendicular exceeds 0,03L, a non-tight bulkhead shall be fitted at the centreline, with stiffeners arranged at every frame.

If the length of the bulb is less than 0,03L, the bulb may be strengthened by a girder fitted at the centre line in continuation of the centre girder.

The construction of the fore end shall provide for the anchor to be lowered freely past the bulb with the ship listed 5 degrees either side.

In way of eventual touching of the bulb, the shell plating thickness is to be increased and intermediate frames fitted.

2.8.2.5 In ships with single bottom, the bottom structure in way of the fore end outside the fore peak is to comply with the requirements of 2.3.2, 2.3.4 and those given below.

2.8.2.5.1 If transverse system of framing is adopted, the spacing of side girders, as well as the distance from the centre girder or the ship's side to a side girder, is not to exceed 1,1 m within 0,25L from the forward perpendicular.

If longitudinal system of framing is adopted and minimum draught is less than 0,035L in way of the forward perpendicular, in cargo tanks of tankers an additional transverse with a face plate along its free edge shall be fitted midway between the bottom transverses. The depth of this transverse shall not be less than that of bottom longitudinals.

2.8.2.5.2 Forward of cargo tanks:

if transverse system of framing is adopted, intercostal side girders with face plates along their free edges are to be fitted in continuation of every second bottom longitudinal, extending forward as far as practicable. The depth and thickness of the side girder webs, as well as the scantlings of the face plates, shall be taken the same as for the floors;

if longitudinal system of framing is adopted, the spacing of floors shall not exceed 2,8 m. An intercostal side girder having the same scantlings as the floors is to be fitted on either side of the ship between the centre girder and longitudinal bulkhead.

2.8.2.6 In way of the fore end, the double bottom structure outside the fore peak is to comply with the requirements of 2.4.2 and those given below.

Within 0,25L from the forward perpendicular the distance between side girders is not to exceed 2,2 m. If transverse system of framing is adopted, in this region half-height side girders shall be fitted additionally and welded to the bottom and floors. The distance between side girders and half-height girders is not to exceed 1,1 m. These half-height girders are to be extended as far forward as practicable, whereas their free edges are to be reinforced with flanges or face plates.

If longitudinal system of framing is adopted, the floors are to be strengthened with stiffeners in line with each half-height side girder and each bottom longitudinal.

In ships greater than 80 m in length with a minimum draught less than 0,025L in way of the forward perpendicular, the edges of openings in floor, side girder and centre girder webs are to be stiffened within 0,25L from the forward perpendicular.

2.8.2.7 If transverse framing system is adopted, intercostal side stringers shall be fitted within 0,15L from the forward perpendicular, outside the fore peak, at the level of the fore peak side stringers. The depth and thickness of a stringer plate are to be equal to those of the frame. The intercostal brackets fitted as stringer plates shall be welded to the webs of frames at both ends and to the shell plating. On the free edge of a stringer, a face plate is to be fitted with the thickness not less than that of the web and the breadth in accordance with 1.7.3.1.

The intercostal side stringer may be of the same profile as the frames.

The stringer face plate (flange) shall not be welded to the face plate of frame.

Intercostal stringers are to be attached to the bulkheads by brackets.

The face plates (flanges) of intercostal stringers may be omitted where the spacing of frames does not exceed their double depth. In this case, their thickness s, in mm, is not to be less than $s = l/4s + \Delta s$ or $s = 0{,}05h$, whichever is the greater, where l is the length of the free edge of stringer between frames, in mm; h is the stringer depth, in mm.

In ships having the characteristic $(v_0/\sqrt{L}) > 1{,}5$ or a large bow flare, provision is to be made for web frames and side stringers supported thereby. The spacing of web frames is not to exceed 5 frame spaces.

Where longitudinal framing is adopted in the ship's side forward outside the fore peak, the spacing of side transverses is not to exceed 3 m. In the holds of any ship, as well as in 'tween decks and superstructures of ships with the characteristic $(v_0/\sqrt{L}) > 1{,}5$ or with a large bow flare, provision is to be made for a vertical intercostal member having the same scantlings as side longitudinals, to be fitted between side transverses. The structure of the member shall be similar to that of the intercostal side stringers required by transverse framing system. The intercostal member can terminate at the upper and lower side longitudinals of the hold, 'tween decks and superstructure. Every second side longitudinal must be attached to the side transverses by brackets extended to the frame face plate.

2.8.2.8 Within 0,1L from the forward perpendicular, the span of weather deck transverses is not to exceed 3 m, and the deck girder span is not to exceed 3,6 m.

Within 0,2L from the forward perpendicular, the section modulus of weather deck transverses is not to be less than required for deck girders with equal spans and spacing of members.

2.8.2.9 The structure located aft of the after peak bulkhead must be sufficiently rigid in the vertical and horizontal plane. For this purpose, fitting of additional longitudinal bulkheads or platforms, thickening of deck plating and shell plating, as well as connection of bottom and upper deck longitudinals with pillars or struts may be required. If the stern overhang is large or the after peak width exceeds 20 m at any section, fitting of additional longitudinal non-tight bulkheads is recommended port or starboard.

Where there is a flat of the bottom, additional strengthening may be required to take up the loads due to impact pressure.

2.8.2.10 Floors in the after peak are to comply with the requirements of 2.8.2.2.

In single screw ships, the floors shall be extended above the sterntube, but in any case to a height of not less than 0,8 m. If this is impracticable, tie plates with face plates on both edges shall be fitted transversely at every frame above the sterntube. The thickness of the tie plates is not to be less than that of the floor. Tie plate exceeding 1,5 m in length is to be provided with a stiffener fitted in the middle of its length.

Floors with flanged edges are not permitted.

In ships greater than 200 m in length, floors are to be extended to the platform located above the sterntube. Longitudinally, the floors shall be stiffened with brackets fitted at the centreline and, if practicable, supporting the floor for a full depth. Brackets above the sterntube are necessary. The brackets shall be carried to the propeller post. They need not be fitted where a wash plate is located above the floors, with its lower edge extending at least 0,8 m below the face plates of the floors.

The opening in floors for the sterntube is to be reinforced with face plate along the edges. Below the sterntube, the openings shall be reinforced with face plates or stiffeners.

2.8.2.11 If transverse framing is adopted in the after peak side, panting beams and side stringers, beam knees, frame to side stringer attachments, arrangement and structure of web frames and non-tight platforms are to comply with the requirements of 2.8.2.3. The vertical distance between side stringers is not to exceed 2,5 m, and the frame span, as measured on the side plating, is not to exceed 3,5 m.

In 'twin- and multi-screw ships having a cruiser or transom stern, the distance between stringers, as measured on the side plating, is not to exceed 2 m, with one of the stringers being fitted in way of the top edge of propeller shaft bossing or in line with the shaft bracket. Where web frames are fitted, their spacing is not to exceed 2,4 m.

If longitudinal framing is adopted in the after peak side, relevant requirements of 2.8.2.3 are to be complied with.

2.8.2.12 The ends of after peak members (including deck, platform and bulkhead framing), as well as the ends of horizontal and, where practicable, vertical stiffeners of floors are to be secured (see 1.7.1.4).

The face plates of the after peak floors and deck transverses are to be sniped in way of their attachments to longitudinal bulkheads. Bulkhead stiffeners shall be attached to the floor face plates by brackets fitted on either side of the bulkhead.

This also applies to deck girder and side girder attachments to transverse bulkheads.

2.8.2.13 The spacing of ordinary and bevel frames may be the same as in the midship region, but is not to exceed 750 mm. A side girder of the same depth as that of floors is to be fitted at the centreline. In case of transom stern and/or flat of the bottom, the side girders are to be spaced not more than 2 m apart.

In full cruiser sterns and where the frame span from the upper edge of floors to the nearest deck exceeds 2,5 m, additional strengthening is to be provided by means of web frames and a side stringer.

2.8.2.14 If peaks are used as tanks, fitting of a wash bulkhead is recommended at the centreline.

2.8.3 Loading on structures at ends.

2.8.3.1 The design pressure on the structures at ends is determined using the design loads specified in 2.2 to 2.7 and the extreme loads specified in 2.8.3.2 and 2.8.3.3.

The scantlings of fore end members subject to impact pressure shall be verified by applying extreme loads:

in accordance with 2.8.3.2 for ships greater than 65 m in length with a minimum draught of 0,045L in way of the forward perpendicular;

in accordance with 2.8.3.3 for ships having the characteristic $(v_0/\sqrt{L}) > 1{,}5$ or a considerable bow flare.

2.8.3.2 Under the wave impact upon the bottom of the fore end, the extreme values of the design hydrodynamic pressure p_{SL}, in kPa, are to be determined using the formula

$$p = 5{,}5 C_1 C_2 \varphi_r \frac{b_x}{B}(1 - 5d_f/L)(1 - x_1/l_b)\cdot 10^3 \qquad (2.8.3.2\text{-}1)$$

where $C_1 = \sqrt{L}$ for $L \leqslant 200$ m;

$C_1 = 5\sqrt{10 - 0{,}01L}$ for $L > 200$ m;

$C_2 = 0{,}134 v_0 (1 - 17{,}1 d_f/L)/\sqrt{L}$;

$l_b = (0{,}22 + 1{,}5C_2)L$;

for v_0, see 1.1.3;

$\varphi_r =$ as obtained from 1.3.1.5 ($\varphi_r = 1$ for ships of unrestricted service);

$b_x =$ ship breadth, in m, in the considered cross section at the level of 0,04B above the base line, but not greater than 0,8B;

$x_1 =$ distance, in m, from the considered cross section to the forward perpendicular, but not greater than l_b.

The Formula (2.8.3.2-1) is used for derivation of p values in a number of sections within the portion l_b, from which the maximum value of p (hereinafter — symbol

p_m) and the value of x_1(hereinafter — symbol x_m) corresponding to p_m are chosen. The design pressure p_{SL} (Fig. 2.8.3.2) is determined by the formula

$$\begin{aligned}&p_{SL} = p_f + (p_m - p_f)x_1/(x_m - 0{,}05L)\\ &\text{when } 0 \leqslant x_1 < x_m - 0{,}05L;\\ &p_{SL} = p_m\\ &\text{when } x_m - 0{,}05L \leqslant x_1 \leqslant x_m + 0{,}05L;\\ &p_{SL} = p_m(0{,}5L - x_1)/(0{,}45L - x_m)\\ &\text{when } x_m + 0{,}05L \leqslant x_1 \leqslant 0{,}5L\end{aligned} \qquad (2.8.3.2\text{-}2)$$

where $p_f = 0{,}5p_m$ with bulb;
$p_f =$ 0 without bulb.

The hydrodynamic pressure as determined by the Formula (2.8.3.2-2) is distributed over a height of 0,04B above the base line.

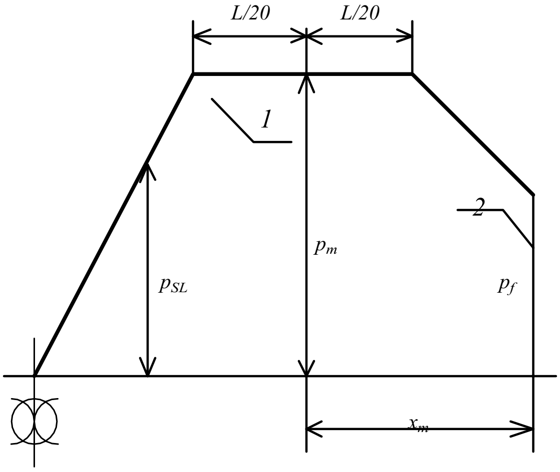


Fig. 2.8.3.2 Determination of design pressure p_{SL}:
1 — value of p determined by the Formula (2.8.3.2-1);
2 — forward perpendicular

2.8.3.3 Under the wave impact upon the side at the fore end, the extreme values of the design hydrodynamic pressure p_{SL}, in kPa, are to be determined by the formula

$$p_{SL} = 0{,}9C_3C_4^2 \qquad (2.8.3.3)$$

where $C_3 = 2{,}2 + 1{,}5\,\mathrm{tg}\,\alpha_x$;
$C_4 = v_0(0{,}6 - 20/L)(1{,}2 - 0{,}2\beta_x/60)\sin\beta_x + 0{,}6\sqrt{L}$;
for v_0, see 1.1.3;
α_x and β_x = as defined in 2.8.1.2.

Depthwise the impact pressure is distributed over the part of the side above the ballast waterline, and lengthwise — over the part of the side extending as far aft as the cross section at 0,01v_0L from the forward perpendicular and as far forward as the intersection of the upper deck with the stem (see Fig. 2.8.1.2-2).

2.8.4 Scantlings of structural members at ends.

2.8.4.1 The shell plating thickness, scantlings of single bottom and double bottom members and of side framing are to comply with the requirements of 2.2.4, 2.3.4, 2.4.4, 2.5.4 using the service loads given in 2.2, 2.3, 2.4, 2.5. Besides, when determining the scantlings of fore and after peak members, the following requirements are to be satisfied:

.1 the section modulus of frames is to be determined by the Formulae (1.6.4.1-1) and (1.6.4.1-2) taking:
$m = 12$;
l = spacing of side stringers, as measured along the shell plating;

.2 scantlings of panting beams are to comply with the requirements of 2.9.4.1;

.3 in calculating the section modulus and cross-sectional area of web frames,
$m = 10$;

$$N_{\max} = 0{,}5pal \qquad (2.8.4.1.3)$$

where p = design pressure, in kPa, according to 2.5.3;
a = spacing of web frames, in m;
l = span of web frame, in m, as measured between the upper edge of floor and the deck (platform) bounding the fore peak (after peak) or the non-tight platform, if any, nearest to the bottom, or between non-tight platforms, the deck and non-tight platform less the height of deck transverse of the relevant deck (platform);

.4 plating thickness and framing of non-tight platform are to satisfy the requirements of 2.6.4 for platforms at ends. When determining the design load by the Formula (1.3.4.1), the product $h\rho_cg$ is not to be less than 3,5 kPa.

The thickness of non-tight platform plating, in mm, is not to be less than:

$$s_{\min} = (5 + 0{,}02L)\sqrt{\eta}, \qquad (2.8.4.1.4)$$

but not less than 5 mm.

Where $L > 300$ m, L is to be taken equal to 300 m;

.5 if the fore peak (after peak) is used as tanks, the scantlings of their members are also to comply with the requirements for the structural members of tanks.

2.8.4.2 Where exposed to extreme loads to be determined in accordance with 2.8.3.2, the scantlings of bottom framing members at the fore end are to comply with the requirements of 2.2.4, 2.3.4 and 2.4.4, as well as with the following additional requirements:

.1 the thickness of shell plating is to be determined by the Formula (1.6.4.4) taking:

$$p = 0{,}4p_{SL} \qquad (2.8.4.2.1)$$

where p_{SL} = as derived from the Formula (2.8.3.2-2);

$m = 15{,}8$;
$k_\sigma = 0{,}7$;

.2 the section modulus, in cm^3, of a primary member is not to be less than:

$$W = 0{,}75\,\frac{pal^2}{mk_\sigma\sigma_n}\,\omega_c \cdot 10^3 \qquad (2.8.4.2.2)$$

where $p =$ as derived from the Formula (2.8.4.2.1);
$k_\sigma =$ 0,65;
m = 16, if the members are continuous through the webs of supporting structures;
m = 8, if the members are cut at supports;
m = 28, if the supporting sections of the member are reinforced with brackets on both sides of the supporting structure; the depth and length of brackets are not less than 1,5 of the member depth;
for ω_c, see 1.1.5.3;

.3 the cross-sectional area, in cm^2, of a primary member or of welds by which intercostal members are connected to supporting structures is not to be less than:

$$f = 5pa\frac{l-0{,}5a}{k_\tau\tau_n} + 0{,}05\Sigma h_i\Delta s \qquad (2.8.4.2.3)$$

where $p =$ as derived from the Formula (2.8.4.2.1);
$k_\tau =$ 0,65;
$\Sigma h_i =$ length of member section perimeter, in cm;
$\Delta s =$ as determined from 1.1.5.1.

The cross-sectional area of a member includes the web area, as well as the portion of the sectional area of shell plating, having a breadth $b_1 = 3s$ (where s is the thickness, in mm, of shell plating). If the member is of bulb profile, the whole of its face plate is included in the cross-sectional area. In the case of member of T-section, a portion of its breadth $b_2 = 3s_{f.p}$ is included in the cross-sectional area (where $s_{f.p}$ is the face plate thickness of the member, in mm);

.4 the web thickness s, in mm, of floor, side girder and centre girder is not to be less than:

$$s = 0{,}75\frac{pab}{k_\tau\tau_n h} + \Delta s \qquad (2.8.4.2.4)$$

where $p =$ as derived from the Formula (2.8.4.2.1);
a and $b =$ average spacing of floors and girders accordingly (centre girder and side girder); when determining b, half-height side girders are to be disregarded;
$k_\tau =$ 0,65;
$h =$ depth, in m, of floor, side girder or centre girder accordingly;
$\Delta s =$ as determined from 1.1.5.1.

2.8.4.3 Where exposed to extreme loads to be determined in accordance with 2.8.3.3, the scantlings of side framing members at the fore end are to comply with the requirements of 2.2.4 and 2.5.4, as well as with the following additional requirements:

.1 the thickness of shell plating is to be determined by the Formula (1.6.4.4) taking:

$$p = 0{,}5p_{SL} \qquad (2.8.4.3.1)$$

where $p_{SL} =$ as derived from the Formula (2.8.3.3);

$m = 15{,}8$;
$k_\sigma = 0{,}7$;

.2 the section modulus of a primary member is to comply with the requirements of 2.8.4.2.2 using the design load determined by the Formula (2.8.4.3.1);

.3 the cross-sectional area of a primary member is to comply with the requirements of 2.8.4.2.3 using the design load determined by the Formula (2.8.4.3.1).

2.8.4.4 Within the area of the stern counter, the scantlings of frames are to be not less than those of the after peak frames, unless their span exceeds 2,5 m. With a greater span, the frame scantlings shall be increased accordingly. The thickness of floors and side girders is not to be less than required by 2.8.4.5.

2.8.4.5 The side stringers of fore and after peaks are to have a web sectional area f_s, in cm^2, not less than:

$$f_s = 12 + 0{,}45L. \qquad (2.8.4.5\text{-}1)$$

The side stringer width b, in m, is not to be less than:

$$b = 0{,}24 + 0{,}005L \text{ for } L \leqslant 80 \text{ m}; \qquad (2.8.4.5\text{-}2)$$
$$b = 0{,}4 + 0{,}003L \text{ for } L > 80 \text{ m}.$$

The web thickness, in mm, of a side stringer is not to be less than:

$$s_{\min} = (5 + 0{,}02L)\sqrt{\eta}\,, \qquad (2.8.4.5\text{-}3)$$

but not less than 5 mm.

Where $L > 300$ m, L is to be taken equal to 300 m.

2.8.4.6 The thickness of shell plating in way of the bulb is not to be less than $0{,}08L + 6$, but it need not be taken greater than 25 mm. In this case, the shell plating thickness at the lower part of the bulb is not to be less than stipulated under 2.8.4.2.1 for the hull section in way of the forward perpendicular.

2.8.5 Special requirements.

2.8.5.1 Visor-type bow doors.

2.8.5.1.1 The present requirements apply to the construction of visor-type bow doors which form a component part of the fore end of the ship, being mechanically connected with the side and deck structures and capable of moving in the vertical direction to provide access for motor vehicles and/or other transport means.

2.8.5.1.2 The thickness of visor-type bow door plating is not to be less than that required by 2.8.4 for the appropriate sections of shell plating.

2.8.5.1.3 The section modulus of primary members is not to be less than that required by 2.8.4 for the appropriate fore end regions. In this case, the design load, in kPa, is not to be less than:

$$p_{\min} = 0{,}8(1{,}5v_0 + 0{,}6\sqrt{L})^2. \qquad (2.8.5.1.3\text{-}1)$$

The sectional area of member web is not to be less than determined by the Formula (1.6.4.3) taking:

$$N_{\max} = 0{,}5pal \qquad (2.8.5.1.3\text{-}2)$$

where $p =$ design load in accordance with 1.3.2.2 or 2.8.3.3, whichever is the greater, but not less than $p_{\min}$, in kPa, as determined by the Formula (2.8.5.1).

$k_\tau = 0{,}7$.

2.8.5.1.4 Structural measures are to be taken to ensure rigid attachment of primary members and support members of bow doors.

2.8.5.1.5 The scantlings of support members are to be obtained by strength calculation using the design loads given in 1.3.2.2 or 2.8.3.3, whichever is the greater, but not less than $p_{\min}$ determined by the Formula (2.8.5.1), as well as the permissible stress factors $k_\sigma = k_\tau = 0,6$.

2.8.5.1.6 The construction of support members is to comply with the requirements of 1.7.3.

2.8.5.2 In ships provided with fixed propeller nozzles, transverse bulkheads or support members are to be fitted in way of the nozzle attachment to the hull.

2.8.5.3 In hull curvilinear sections (deadrise, flare), it is recommended that the framing be fitted at an angle of approximately 90° to the shell plating.

2.8.5.4 In multi-screw ships, the structural strength and rigidity in way of sterntube, shaft bracket and shaft bossing attachments are subject to special consideration by the Register.

2.9 PILLARS AND PANTING BEAMS

2.9.1 General and symbols.

2.9.1.1 Requirements are given in this Chapter for the scantlings of pillars fitted in the hull, superstructures and deckhouses and for the panting beams in peaks.

2.9.1.2 Symbols:

l = length of pillar (panting beam), in m, measured: for the pillar — between the face plate of the deck girder (or the deck transverse, if the latter is supported by the pillar) and the deck plating (or the inner bottom plating); for the panting beam — between the inner edges of the starboard and port frames or from the inner edge of the frame to a strong support at the centerline;

f = sectional area of the pillar (panting beam), in cm^2;

i = the least moment of inertia of the pillar (panting beam), in cm^4;

d_0 = outer diameter of the pillar, in mm.

2.9.2 Construction.

2.9.2.1 The pillar axes in 'tween deck spaces and holds are generally to be fitted in the same vertical line, the heads and heels of the pillars are to be bracketed.

Where the heel of a tubular pillar with the load $P < 250$ kN has no brackets, the deck (inner bottom) plating under the heel is to be strengthened with doubling or insert plates (P = as determined from 2.9.3.1).

The web of a framing member to which the head of a pillar is attached is to be strengthened with brackets to transmit the load to the pillar.

The pillars are to be fitted on plate floors and side girders which are to be strengthened with vertical brackets. Openings in floors and side girders under the pillars are not permitted.

With the load $P > 250$ kN (P = as defined in 2.9.3.1), the pillars are to be fitted at the intersection of plate floors and side girders, otherwise the plate floor (side girder) is to be strengthened with vertical brackets attached to the adjacent floors (side girders).

2.9.2.2 The pillars are to be attached at their heads and heels by brackets or other arrangements approved by the Register, in order to effectively transmit the loads to the hull structures below:

in the holds of ships of ice categories **ЛУ9**, **ЛУ8**, **ЛУ7**, **ЛУ6**, **ЛУ5**;

in the tanks under watertight platforms, deckhouses, ends of superstructures, windlasses, winches, capstans, etc.;

at the fore end of ships with the specified speed $v_0 > 1{,}5\sqrt{L}$ or large bow flare.

2.9.3 Design loads.

2.9.3.1 Loading on the pillar P, in kN, is determined by the formula

$$P = pl_m b_m + \sum_i (pl_m b_m)_i \qquad (2.9.3.1)$$

where p = design pressure on the above deck specified in 2.6.3, in kPa;

l_m = distance measured along the deck girders between mid-points of their spans, in m;

b_m = mean breadth of deck area (including the hatchways in the region concerned) supported by the pillar, in m;

$\sum_i (pl_m b_m)_i$ = sum of loads from the pillars fitted above, determined having regard to 2.6.3, which may be transmitted to the pillar considered, in kN.

2.9.3.2 Loading on the panting beam P, in kN, is determined by the formula

$$P = pac \qquad (2.9.3.2)$$

where $p = p_{st} + p_w$ — design pressure on the ship's side in way of installation of the panting beam, determined from 1.3.2.1 and 1.3.2.2, in kPa;

a = spacing of frames on which panting beams are fitted, in m;

c = half-sum of frame spans measured vertically above and under the beam considered, in m.

2.9.4 Scantlings of pillars and panting beams.

2.9.4.1 The sectional area of pillalrs and panting beams f, in cm^2, is not to be less than determined by the iterative method according to the formula

$$f = 10kP/\sigma_{cr} + \Delta f \qquad (2.9.4.1)$$

where P = as determined in accordance with 2.9.3;

$k = 2$ — buckling strength margin;

σ_{cr} = critical stress according to 1.6.5.3 at Euler stress determined by the formula

$$\sigma_e = \frac{206i}{fl^2};$$

Δf = wear allowances, in cm^2, determined by the following formulae:

for tubular pillars

$\Delta f = 0{,}03 d_0 \Delta s$;

for box-shaped pillars

$\Delta f = 0{,}1 \Sigma h_i \Delta s$,

where Σh_i = perimeter length of cross section, in cm;

for built-up pillars and panting beams (I-beams, made of channels, etc.);

$\Delta f = 0{,}05 \Sigma h_i \Delta s$.

2.9.4.2 The wall thickness s, in mm, of tubular pillars is not to be taken less than:

$$s = (d_0/50)+3{,}5. \qquad (2.9.4.2\text{-}1)$$

The wall thickness of built-up pillars (box-shaped, made of channels or I-beams, etc.) s, in mm, is not to be less than:

$$s = h_p/50 \qquad (2.9.4.2\text{-}2)$$

where h_p = width of the pillar wall, in mm.

The wall thickness of a pillar, in general, is not to be taken less than 6 mm.

In small ships the thickness of the pillar walls may, on agreement with the Register, be reduced to 5 mm, provided the required sectional area of the pillar is maintained.

2.10 STEMS, STERNFRAMES, KEELS, RUDDER HORN, PROPELLER SHAFT BRACKETS, FIXED NOZZLES OF PROPELLERS

2.10.1 General.

2.10.1.1 Requirements are given in this Chapter for the construction and scantlings of the stem, sternframe (rudder post, propeller post), solepiece of the sternframe, rudder horn of semi-spade rudders, propeller shaft brackets, bar keel, fixed nozzles of propellers.

2.10.2 Construction.

2.10.2.1 It is recommended to use a bar or plate type welded stem. The lower part of the stem is to be efficiently connected to the bar or plate keel and, whenever possible, to the centre girder.

The welded stem plates are to be stiffened with transverse brackets. Arrangement of transverse brackets of the stem shall, as far as possible, be consistent with the hull framing. Transverse brackets stiffening the stem plate are fitted not more than 1 m apart below and not more than 1,5 m above the summer load line. The brackets are to overlap the joints of the stem with the shell plating and are to be extended and welded to the nearest frames.

The brackets which cannot be extended to the framing, except for the brackets in way of ice belt in ships with ice categories, shall have their rear edge made along a smooth curve.

In case where the radius of curvature of the stem is sufficiently large, it is recommended to fit a centerline girder with a face plate.

2.10.2.2 The construction of sternframe of a single screw ship is to comply with the following requirements:

.1 the sternframe is to have such dimensions as to provide the clearances between sternframe and propeller, and between propeller and rudder (Fig. 2.10.2.2) not less than indicated in Table 2.10.2.2;

Table 2.10.2.2

Dimensions	a	b	c	d	e
Clearances, in mm	0,2R_p	0,42R_p	0,36R_p	0,08R_p	200 — 250
R_p — radius of propeller, in mm.					

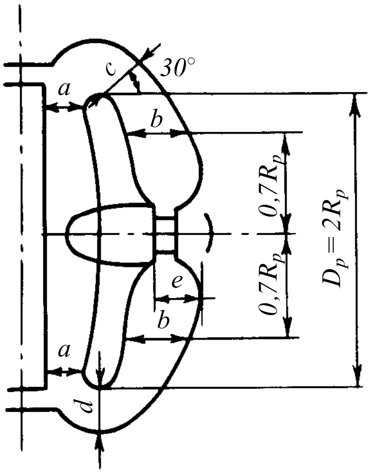


Fig. 2.10.2.2

.2 the solepiece shall be made with a smooth rise in the aft direction;

.3 the propeller post is to be provided with transverse brackets in the case of welded sternframe and webs in the case of cast sternframe. The brackets and webs are to be spaced at least 1 m apart; their arrangement is to be consistent with the hull framing;

.4 the sternframe is to be efficiently attached to the hull.

The lower part of the sternframe shall be extended forward from the propeller post and shall be attached by its brackets (webs) to at least three floors in ships with a length $L > 120$ m and at least two floors in ships with a length $L \leqslant 120$ m. In small ships the sternframe may be attached to one floor only.

The rudder post is to extend over the counter to a height sufficient for its attachment to the transom floor.

In ships of 80 m and above and in ships with cruiser stern, the propeller post is also to be extended upwards to a distance sufficient for its attachment to the additional transom floor.

The thickness of transom floor and additional transom floor shall be increased as compared to that of the floors in the after peak. In general, the above floors are to be extended to the nearest deck or platform.

2.10.2.3 The sternframe in twin screw ships is to comply with the requirements for the sternframe in single screw ships, as specified in 2.10.2.2. The lower part of the sternframe to be extended forward, may be attached to at least two main floors.

2.10.2.4 The sternframe of triple screw ships is to comply with the requirements for the sternframe of single screw ships, as specified in 2.10.2.2 and 2.10.4.2.

2.10.2.5 The rudder horn of semi-spade rudder is to be efficiently connected to the respective floors of the after peak and its centreline wash bulkhead.

The welded rudder horn is to be provided inside with transverse brackets; its main supporting structures are to be extended to the nearest deck or platform; the thickness of the floors to which the rudder horn is connected is to be increased as compared to that of the floors in the after peak.

2.10.2.6 The struts of two-strut shaft brackets are to form an angle of approximately 90° to each other. Their axes are to intersect at the axis of the propeller shaft.

The construction of propeller shaft brackets with struts arranged at an angle less than 80° and greater than 100°, additional strengthening of the hull within the region of shaft brackets are subject to special consideration by the Register.

The propeller shaft brackets are to be so arranged in relation to the ship's hull that the clearance between the blade tip and the ship's hull is as large as possible and, but, not less than 25 per cent of the propeller diameter.

2.10.2.7 The outer and inner plating of propeller nozzle is to be strengthened by stiffeners whose arrangement and size as well as connection with outer and inner plating of the propeller nozzle are to be determined according to 2.4.2.2, Part III "Equipment, Arrangements and Outfit".

In general, the transverse web plates are to be arranged in line with the floors of the after peak.

In way of attachment of the nozzle to the hull smooth transition from the nozzle to the ship's hull is to be provided. The bottom part of the nozzle is to be connected to the hull. If the propeller nozzle is attached to the hull by shaft brackets, provision is to be made for an efficient connection of the brackets with the framing in the aft region of the hull and the framing inside the nozzle. The construction of shaft brackets is to satisfy the requirements of 2.10.2.6. Drain plugs of non-corrosive material are to be fitted in the top and bottom parts of outer plating.

2.10.3 Design loading.

Design loading for the structures of the solepiece and rudder horn of semi-spade rudders is taken equal to the reaction force of lower support of the rudder R_4 according to 2.2.4.12, Part III "Equipment, Arrangements and Outfit". In the Formulae (2.2.4.7-2) to (2.2.4.7-4) the coefficient α_4 shall be taken equal to zero.

2.10.4 Scantlings of stem, sternframe, rudder horn and propeller shaft brackets, bar keel and fixed nozzle of propeller.

2.10.4.1 The stem is to satisfy the following requirements:

.1 the sectional area f, in cm^2, of a bar stem from the keel to the summer load waterline is not to be less than:

$$f = 1{,}3L - 4. \qquad (2.10.4.1.1)$$

The sectional area may be reduced for ships of restricted areas of navigation:

II and **IIСП** — by 10 per cent;
IIIСП and **III** — by 20 per cent.

Above the summer load waterline the sectional area may be gradually reduced to 70 per cent of the area stated above;

.2 the plate thickness s, in mm, of welded stem is not to be less than:

$$s = (0{,}085L + 5{,}5)\sqrt{\eta}, \qquad (2.10.4.1.2)$$

where η = as determined from 1.1.4.3,

but not less than 7 mm.

Where $L > 220$ m, L is to be taken equal to 200 m.

The plate thickness of the stem may be reduced for ships of restricted areas of navigation:

II and **IIСП** — by 5 per cent;
IIIСП and **III** — by 10 per cent.

The plate thickness of the stem above the summer load waterline may be gradually reduced to that of shell plates adjoining the stem.

The thickness and width of the stem plates in way of attachment to the plate keel is not to be less than the thickness and width of the latter.

When the distance between the brackets strengthening the stem is reduced by 0,5 m, as compared to that required by 2.10.2.1, the reduction of plate thickness of stem by 20 per cent may be permitted. If the reduction of the distance between the brackets is less than 0,5 m, the permissible reduction of plate thickness is to be determined by linear interpolation;

.3 the thickness of brackets strengthening the stem is not to be less than that of shell plating adjoining the stem.

The thickness of web and face plate of the girder stiffening the stem at the centreline is not to be less than that of the brackets.

2.10.4.2 The sternframe of a single screw ship is to satisfy the following requirements:

.1 the length l_s and width b_s, in mm, of rectangular solid propeller post section, from the keel to the counter, are not to be less than:

$$l_s = 1{,}30L + 95; \quad b_s = 1{,}60L + 20 \quad \text{for } L < 120 \text{ m};$$
$$l_s = 1{,}15L + 110; \quad b_s = 0{,}675L + 130 \quad \text{for } L \geqslant 120 \text{ m}.$$

The scantlings of the propeller post may be reduced for ships of restricted areas of navigation:

II and **IIСП** — by 5 per cent,
IIIСП and **III** — by 10 per cent.

Above the counter the sectional area of sternframe may be gradually reduced. And nowhere its sectional area is to be less than 40 per cent of the required area of the propeller post, corresponding to the scantlings stated above;

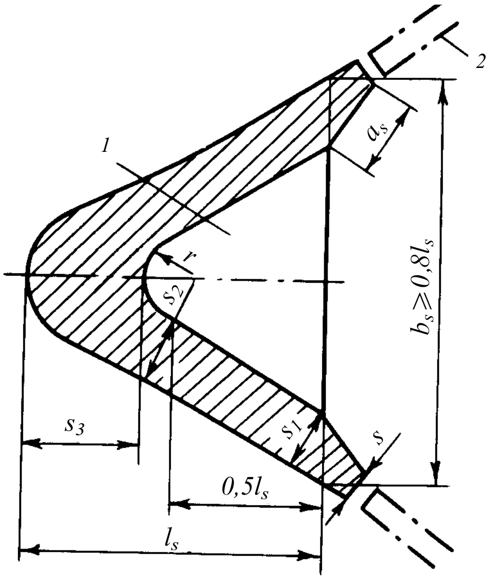


Fig. 2.10.4.2-1:
1 — web; 2 — adjoining plate of shell;
$s_1 = 1,5s_0$; $s_2 = 2,5s_0$; $s_3 = 3,5s_0$;
$l_s \geqslant 1,9L + 135$ mm for $L < 200$ m;
$l_s \geqslant 1,4L + 235$ mm for $L \geqslant 200$ m;
r — cast radius

.2 the scantlings of the propeller post cross section of a cast sternframe with the rudder having top and bottom supports are to be established in accordance with Fig. 2.10.4.2-1 depending on the value s_0, in mm, determined by the following formulae:

$$s_0 = 0,1L + 4,4 \quad \text{for } L < 200 \text{ m};$$
$$s_0 = 0,06L + 12,4 \text{ for } L \geqslant 200 \text{ m}.$$

The thickness of webs is to be at least 50 per cent greater than that of the shell plating adjoining the sternframe;

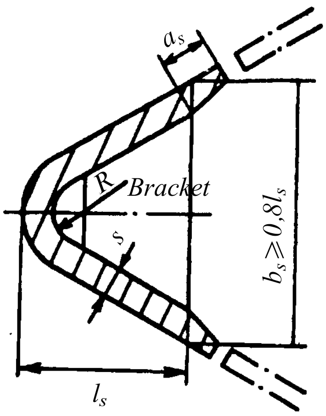


Fig. 2.10.4.2-2:
$s = 1,6s_0$ at $L < 150$ m; $s = 1,5s_0$ for $L \geqslant 150$ m;
$l_s = 2,5L + 180$ mm for $L < 200$ m;
$l_s = 1,4L + 400$ mm for $L \geqslant 200$ m;
R — bending radius

.3 the scantlings of the propeller post cross section of a welded sternframe with the rudder having top and bottom supports are to be established according to Fig. 2.10.4.2-2 where s_0 is to be determined in accordance with 2.10.4.2.2. The thickness of transverse brackets is to be at least 20 per cent greater than that of the shell plating adjoining the sternframe.

Welded propeller post of other construction may be used, provided that its strength is equivalent to that of the abovementioned construction;

.4 the finished thickness of propeller boss is to be not less than 30 per cent of the shaft diameter;

.5 the section modulus W_s, in cm^3, of the solepiece about the vertical axis is not to be less than:

$$W_s = 8\alpha R_4 x_s \eta \qquad (2.10.4.2.5\text{-}1)$$

The section modulus $W_{r.p}$, in cm^3, of the rudder post about the horizontal longitudinal axis is not to be less than:

$$W_{r.p} = 8(1 - \alpha)R_4 l_s \eta \qquad (2.10.4.2.5\text{-}2)$$

where $\alpha = 0,85$ if there is a rudder post;
$\alpha = 1$ if there is no rudder post or a bolted rudder post is fitted;
$R_4 =$ as determined according to 2.10.3;
$x_s =$ distance from the solepiece section concerned to the centre of the rudder stock (x_s should not be taken less than $0,5l_s$ and more than l_s);
$l_s =$ span of the solepiece, measured from the centre of the rudder stock to the beginning of rounding of the propeller post, in m;
$l_{r.p} =$ span of the rudder post, measured vertically from the mid-thickness of solepiece at the centre of the rudder stock to the beginning of rounding in the upper part of the rudder post, in m;
$\eta =$ as determined according to 1.1.4.3.

The section modulus of the solepiece about the horizontal transverse axis is not to be less than $0,5W_s$ where W_s is to be determined by the Formula (2.10.4.2-1). The section modulus of the rudder post about the horizontal transverse axis is not to be less than $0,5W_{r.p}$ where $W_{r.p}$ is to be determined by the Formula (2.10.4.2-2);

.6 the scantlings of the sternframe structural members may be determined on the basis of direct strength calculation taking the permissible stress factor $k_\sigma = 0,55$ and external loads according to 2.2, Part III "Equipment, Arrangements and Outfit".

2.10.4.3 The scantlings of the sternframe of twin screw ships are to satisfy requirements for the scantlings of propeller post in single screw ships as given in 2.10.4.2 with the following amendments:

.1 the section width of the sternframe of a solid rectangular cross section may be reduced by 50 per cent as compared with that required by 2.10.4.2.1;

.2 the scantlings of the cast or welded sternframe may be reduced as compared with those required by 2.10.4.2.2 and 2.10.4.2.3 respectively, so that their section moduli about the horizontal longitudinal and transverse axes, are reduced by not more than 50 per cent. The thickness of the sternframe wall is to be at least 7 mm.

2.10.4.4 For semi-spade rudders with one gudgeon upon the horn, the section modulus, in cm^3, of the rudder horn about the horizontal longitudinal axis is not to be less than:

$$W = 12R_4 z_s \eta \qquad (2.10.4.4)$$

where R_4 = as defined in to 2.10.3;

z_s = vertical distance for the mid-thickness of the horn gudgeon to the section concerned, in m (z_s is not to be taken less than $0{,}5l_h$ and more than l_h);

l_h = horn span measured vertically from the mid-thickness of the horn gudgeon to the point of intersection of the horn axis with shell plating, in m;

η = as determined according to 1.1.4.3.

Where the rudder horn is welded of plates, the thickness of the plates, in all cases, is to be at least 7 mm.

The scantlings of the rudder horn may be determined on the basis of direct strength calculation taking the permissible stress factor $k_\sigma = 0{,}35$ and external loads according to 2.2, Part III "Equipment, Arrangements and Outfit".

2.10.4.5 The sectional area of either strut of two-strut shaft brackets is to be equal to not less than 60 per cent of the propeller shaft section in the bracket plane, the strut thickness — to not less than 45 per cent, and the boss thickness — to not less than 35 per cent of the propeller shaft diameter. The length of the boss is to be in accordance with 5.6.1, Part VII "Machinery Installations".

The strength of the welded shaft brackets is not to be less than that specified above. The plate thickness is not to be less than 7 mm.

The weld area of rivets attaching each strut to the hull is not to be less than 25 per cent of the propeller shaft sectional area. Where the struts are attachhed by means of flanges, the thickness of the latter is to be not less than 25 per cent of the propeller shaft diameter.

2.10.4.6 The height h_s and width b_s, in mm, of the bar keel cross section are not to be less than:

$$h_s = 1{,}3L + 100;$$
$$b_s = 0{,}7L + 8 \text{ for } L < 60 \text{ m}; \qquad (2.10.4.6)$$
$$b_s = 0{,}4L + 26 \text{ for } L \geqslant 60 \text{ m}.$$

The height and width of the bar keel cross section may be reduced for ships of restricted areas of navigation:

II and **IICП** — by 5 per cent;

IIICП and **III** — by 10 per cent.

2.10.4.7 The thickness of outer and inner plating of fixed propeller nozzle is to comply with the requirements of 2.4.2, Part III "Equipment, Arrangements and Outfit" taking the following into consideration:

width of middle belt of inner plating is to be not less than the distance from $0{,}03D_o$ forward of the propeller blade tips and $0{,}07D_o$ aft of the propeller blade tips where D_o is the internal diameter of propeller nozzle;

thickness of forward part of the inner and outer plating is to be not less than required for side shell plating (see 2.2.4.1 for transverse framing system).

The width of attachment is to be at least $0{,}15D_o$.

The cross-sectional area of the joint is to be not less than required by 2.10.4.2.5 for the solepiece. If the solepiece serves as support of the rudder, the connection of the nozzle to the solepiece is subject to special consideration by the Register.

For twin screw ships when the propeller nozzle is not attached to the hull at its bottom part, the width of attachment at the top part is to be not less than $0{,}3D_o$.

If the propeller nozzle is attached to the hull by shaft brackets, their strength is to comply with the requirements of 2.10.4.5.

In way of attachment of the nozzle to the hull the thickness of framing members is not to be less than required by the Formula (2.4.2.2-2), Part III "Equipment, Arrangements and Outfit".

2.11 SEATINGS OF MACHINERY AND BOILERS

2.11.1 General.

2.11.1.1 Requirements are given in this Chapter for the construction and dimensions of the seatings intended for main machinery and boilers, deck machinery, fishing installations, cargo handling gear, auxiliary machinery, etc.

2.11.1.2 The requirements laid down in this Chapter are minimum. Requirements concerning construction and dimensions of structural components of a seating, which are contained in the technical documentation of the machinery, unit or device to be installed on the seating concerned, are also to be complied with.

2.11.2 Construction of seatings.

2.11.2.1 The construction of seatings is to satisfy the following requirements:

.1 the seating is to be of substantial construction to ensure efficient attachment of machinery, gear or device and transmission of forces to the hull framing, which is to be sufficiently strong. If necessary, the framing may be strengthened;

.2 the seating is to be so constructed that the resonance vibration of the seating as a whole and of its structural components can be avoided under all specified running conditions;

.3 where the seating in ships with a length $L > 65$ m is installed on the continuous longitudinals of strength deck and double bottom (bottom) within $0{,}5L$ amidships, the height of the vertical plates of the seating at the ends is to be gradually reduced. If the length of the vertical plate is more than six times its height, the vertical plate and its top plate are to be made of the same steel grade as the deck or double bottom (bottom) structural member on which it is installed. The structural components of the seating are not to terminate at the unsupported portions of plating. Attachment of the seating to the upper edge of sheerstrake is subject to special consideration by the Register;

.4 the seating is to be so designed that the plating beneath is accessible for inspection. Measures shall be taken to prevent water from accumulating under the seating.

In particular cases agreed with the Register, a hermetic construction of the seating is permitted, the inner space of the seating being filled with some chemically neutral material with good adhesion properties.

2.11.2.2 In general, a seating of main machinery and boilers shall comprise two vertical plates (girder webs) (for medium-speed and high power engines — four vertical plates (two — either side of the engine)) and horizontal face plates (top plates) to which the machinery (boiler) is to be attached directly. The vertical plates are to be strengthened with brackets (knees) having face plates (flanges) along the free edges.

Where the seating comprises four vertical plates, the top plate is attached to two vertical plates fitted on one side of the machinery; the outer plates are to have openings to provide access into the seating. In the case of medium-speed engines, such openings are not to extend to the top plate. The outer plates may be made sloped.

All the vertical plates are to be fitted in line with the main or additional side girders.

2.11.2.3 Machinery and equipment may be installed on shell plating of the hull, tight bulkheads, decks and platforms (including tank bulkheads and crown), inner bottom and shaft-tunnel platings on condition they are attached to the framing members and stiffeners (see 1.7.1.4), or on cantilevers connected to framing members or stiffeners.

Attachment of small-sized machinery and equipment directly to the above-mentioned structure with the help of welded pads is not permitted.

2.11.3 Dimensions of structures of seatings.

2.11.3.1 The thickness s, in mm, of structural components of a seating of main machinery or boiler is not to be less than:

$$s = k_0\sqrt[3]{Q} + k_1 \qquad (2.11.3.1)$$

where Q = mass of machinery (boiler) in working condition, in t;
k_0 = factor given in Table 2.11.3.1-1;
k_1 = factor given in Table 2.11.3.1-2.

2.11.3.2 The thickness s, in mm, of structural components of a seating of main internal combustion engine is not to be less than:

$$s = k_2\sqrt[3]{N} + k_3 \qquad (2.11.3.2)$$

where N = specified power of the engine, in kW;
k_2, k_3 = factors given in Table 2.11.3.2,

but not less than required by 2.11.3.1.

Table 2.11.3.1-1

Seating of machinery (boiler)	k_0		
	Top plates	Vertical plates[1]	Brackets, knees
Main internal combustion engine	4,65	3,0	2,5
Main geared turbine set, main diesel generator and electric propelling motor	4,15	2,7	2,7
Boiler	3,65	2,4	2,4

[1] In a seating with four vertical plates the thickness of the plates may be taken equal to the thickness of brackets and knees.

Table 2.11.3.1-2

Mass of machinery (boiler), in t	$\leqslant 20$	>20 $\leqslant 50$	>50 $\leqslant 100$	>100 $\leqslant 200$	>200
k_1	4	3	2	1	0

Table 2.11.3.2

N, in kW	Number of vertical plates	Factor	Top plates	Vertical plates	Brackets, knees
$\leqslant 1000$	2	k_2	1,7	1,1	0,9
		k_3	6	4	3
	4	k_2	1,4	0,9	0,9
		k_3	5	3	3
>1000	2	k_2	1,0	1,0	0,7
		k_3	13	5	5
	4	k_2	0,8	0,7	0,7
		k_3	11	5	5

2.12 SUPERSTRUCTURES, DECKHOUSES AND QUARTER DECKS

2.12.1 General provisions, definitions and symbols.

2.12.1.1 Requirements are given in this Chapter for short and long bridges extending from side to side of the ship as well as to short bridges which do not extend to the sides of the ship, forecastle, poop, long forecastle and poop extending to ship's sides, short deckhouses and quarter decks.

The applicability of the requirements contained in this Chapter to long superstructures not extending from side to side of the ship as well as to long deckhouses are to be specially agreed with the Register.

2.12.1.2 Definitions.

Long deckhouse is a deckhouse of a length not less than that determined by the Formula (2.12.1.2-1), but not less than 0,20L, having no expansion or sliding joints.

Long bridge is a superstructure having a length not less than:

$$l_1 = 2l_e, \qquad (2.12.1.2\text{-}1)$$

but not less than $0{,}15L$.

Quarter deck is the after part of upper deck stepped up to a portion of 'tween deck height.

Short deckhouse is any deckhouse which is not a long deckhouse. Deckhouses of ships less than 65 m in length are considered as short deckhouses.

Short bridge is any bridge which is not a long bridge. Superstructures of ships less than 65 m in length are considered as short superstructures.

Ends of superstructures and deckhouses are the ends of the length measured from the end bulkheads, in m:

$$l_e = 1{,}5(B_2/2 + h). \qquad (2.12.1.2\text{-}2)$$

Transition area of quarter deck is an area measured from the forward edge of break to the after edge of upper deck plating and extending below the quarter deck.

Long forecastle (poop) is a forecastle (poop) having a length not less than:

$$l_1 = 0{,}1L + l_e, \qquad (2.12.1.2\text{-}3)$$

in ships of 65 m and greater in length.

2.12.1.3 Symbols:

B_2 = breadth of superstructure deck measured at its mid-length, excluding the breadth of openings of cargo hatches, machinery casings, if any, in m;

h = height of the first tier of superstructure or deckhouse, in m;

l_1 = length of superstructure (deckhouse) measured between the end bulkheads; the length of forecastle (poop) measured from the fore or after perpendicular to the end bulkhead of the forecastle (poop), in m;

B_x = ship's breadth at the level of the upper deck at the section considered, in m;

b = breadth of the deckhouse, in m.

2.12.2 Construction.

2.12.2.1 For the first tier of long bridge outside the end portions, long forecastle (poop) outside the end portion, the requirements of 2.6 for the upper deck and the requirements of 2.2 and 2.5 for the ship's side in way of the upper 'tween deck space are to be complied with.

2.12.2.2 For the buttom strake of side plating and longitudinal bulkhead plating of short bridge, the ends of 1st tier long bridges and long forecastle (poop), the bottom strake of side plating of steel short deckhouses and the ends of steel long deckhouses fitted on the strength deck, grade of steel and yield stress are to be the same as required for the strength deck in this region. The width of the bottom strake is not to be less than $0{,}5h$.

2.12.2.3 Whenever practicable, the end bulkheads of superstructures and deckhouses are to be situated in line with the hull transverse bulkheads or as close to the latter as possible.

Web frames or vertical webs, bulkheads or partial bulkheads are to be fitted in superstructures and deckhouses in such a way as to be in line with girder webs or bulkheads of hull structures located below. The vertical webs of end bulkheads are to be fitted in line with the vertical webs of hull bulkheads.

2.12.2.4 The lower ends of vertical stiffeners of the end bulkheads of the 1st tier superstructures and deckhouses are to be welded to the deck. The lower ends of side vertical stiffeners of 1st tier houses are to be attached to the deck by brackets.

2.12.2.5 Adequate strengthening is to be provided for the structures of deckhouses and superstructures where launching and recovery appliances for survival craft and rescue boats are fitted.

2.12.3 Design loading.

2.12.3.1 The design loading on the superstructure sides and on the superstructure and deckhouse decks is to satisfy the following requirements:

.1 design pressure on the superstructure sides is determined according to 2.2.3;

.2 design pressure on weather areas of the superstructure and deckhouse decks is to be determined by the formula

$$p = \alpha p_w \qquad (2.12.3.1.2)$$

where p_w = wave load at the deck level according to 1.3.2.2;

α = 0,9 for forecastle deck, long forecastle deck or part of long bridge deck within $0{,}2L$ from the fore perpendicular;

α = 0,8 for poop deck, long poop deck or part of long bridge deck within $0{,}2L$ from the after perpendicular;

α = 0,7 for short bridge and deckhouse decks, long superstructure and deckhouse decks, long forecastle and poop decks within the midship region. For areas of long bridge and deckhouse decks, long forecastle and poop decks outside the midship region and outside areas situated at $0{,}2L$ from the fore or after perpendicular, α is to be determined by linear interpolation,

but not less than $p_{\min}$.

For the 1st tier superstructure and deckhouse decks, $p_{\min}$, in kPa, is to be determined by the following formulae:

for forecastle, long forecastle decks or part of long bridge deck within $0{,}2L$ from the fore perpendicular

$$p_{\min} = 0{,}1L + 7;$$

for poop, long poop deck or part of long bridge deck within $0{,}2L$ from the after perpendicular

$p_{\min} = 0{,}015L + 4$ for $L \leqslant 80$ m;
$p_{\min} = 0{,}03L + 2{,}8$ for $L > 80$ m;

for bridge and deckhouse decks, long forecastle and poop decks within the midship region

$$p_{\min} = 0{,}015L + 4;$$

for areas of bridge and deckhouse decks, long forecastle and poop decks outside the midship region and outside areas situated at $0{,}2L$ from the fore or after perpendicular, $p_{\min}$ is to be determined by linear interpolation.

For decks of the superstructures and deckhouses of the 2nd and upper tiers

$$p_{\min} = 2 \text{ kPa}.$$

For ships greater than 250 m in length, $p_{\min}$ is determined taking $L = 250$ m.

For ships of restricted area of navigation, $p_{\min}$ may be reduced by multiplying by the factor φ_r obtained from Table 1.3.1.5.

2.12.3.2 Pressure on the end bulkheads of superstructures and deckhouses as well as on sides of deckhouses p, in kPa, is determined by the formula

$$p = 5{,}1nc_2(kz_0 - z_1) \qquad (2.12.3.2)$$

where n = factor determined from Table 2.12.3.2-1;

c_2 = $0{,}3 + 0{,}7b/B_x$, in this case, $c_2 \geqslant 0{,}5$;

k = $1{,}0 + \left(\frac{x_1/L - 0{,}45}{C_b + 0{,}2}\right)^2$ when $x_1/L \leqslant 0{,}45$;

k = $1{,}0 + 1{,}5\left(\frac{x_1/L - 0{,}45}{C_b + 0{,}5}\right)^2$ when $x_1/L > 0{,}45$;

for the sides of deckhouses the factor k is assumed to vary for the length of bulkhead. For this purpose the deckhouse is subdivided into parts of approximately equal length not exceeding $0{,}15L$ each, and x_1 is taken as the distance between the after perpendicular and the middle of the part considered;

C_b is to be taken as not less than 0,6, nor greater than 0,8; for the aft end bulkheads forward of amidships $C_b = 0{,}8$;

z_0 = as given in Table 2.12.3.2-2;

z_1 = vertical distance, in m, from the summer load waterline to the mid-point of the plate panel considered or the mid-point of span of the bulkhead stiffener.

Table 2.12.3.2-1

Bulkhead	Structure		n
Front	Unprotected	1st tier	$2 + L_0/120$
		2nd tier	$1 + L_0/120$
		3rd tier	$0{,}5 + L_0/150$[1]
	Protected		
Aft end	Aft of amidships		$0{,}7 + L_0/1000 - 0{,}8x_1/L$
	Forward of amidships		$0{,}5 + L_0/1000 - 0{,}4x_1/L$

L_0 = length of ship, in m (to be taken not greater than 300 m for the purpose of calculation);

x_1 = distance, in m, between the after perpendicular and the bulkhead under consideration.

[1] Formula is also used for the deckhhouses sides.

Table 2.12.3.2-2

L, in m	z_0, in m	L, in m	z_0, in m
20	0,87	180	9,85
40	2,59	200	10,25
60	4,07	220	10,55
80	5,42	240	10,77
100	6,6	260	10,92
120	7,69	280	11,0
140	8,63	300	11,03
160	9,35	350	11,05

The above-stated valus of factor n apply to a ship having the freeboard equal to minimum tabular freeboard of Type "B" ships, and a standard height of superstructures according to Section 4 of Load Line Rules for Sea-Going Ships. If the deck of the tier considered is situated higher than the standard position due to an increase of freeboard, as against the tabular value, then the appropriate factor n may be determined by linear interpolation between the values of that factor for superstructures with standard and actual positions of decks under the superstructures.

In any case, the design pressure is not to be taken less than indicated in Table 2.12.3.2-3.

For ships of restricted area of navigation the design pressure may be reduced by multiplying by the factor φ_r obtained from Table 1.3.1.5.

Table 2.12.3.2-3

L, in m	Design pressure p, in kPa	
	for 1st tier unprotected fronts	elsewhere
$\leqslant 50$	15,6	7,8
$50 < L < 250$	$13 + 0{,}052L$	$6{,}5 + 0{,}026L$
$\geqslant 250$	26	13

2.12.4 Scantlings of structures of superstructures, deckhouses and quarter decks.

2.12.4.1 The thickness of side plating of short and long bridges, forecastle and poop, long forecastle and poop is to be determined according to 2.2.4.1 using the deisgn loads given in 2.12.3.1.1. For short bridges, forecastle and poop, $k_\sigma = 0{,}7$.

For long bridge, long forecastle and poop outside the end portions, k_σ is determined according to 2.2.4.1; at sections in way of end bulkheads $k_\sigma = 0{,}7$; within the end portions k_σ is to be determined by linear interpolation.

The thickness of side plating of long bridges, long forecastle and poop is to satisfy the requirements of 2.2.4.8.

In any case, the thickness $s_{\min}$, in mm, of side plating of short bridges, forecastle and poop is not to be less than:

for superstructures of the lowest tier

$$s_{\min}=(4,5+0,025L)\sqrt{\eta} ;$$

for superstructures of other tiers

$$s_{\min}=(4 +0,02L)\sqrt{\eta}$$

where η is obtained from Table 1.1.4.3.

Where $L>300$ mm, L is to be taken equal to 300 m.

For ships of unrestricted service and ships of restricted area of navigation I, the reduction of minimal thickness, but not more than 10 per cent, is permitted in proportion to the ratio of adopted spacing to standard spacing, where the adopted spacing is less than the standard one (see 1.1.3). In any case, for ships of 30 m and greater in length the minimum thickness is to be not less than 5 mm.

2.12.4.2 The thickness of deck plating of short and long bridges, forecastle and poop, long forecastle and poop, short and long deckhouses is to be determined according to 2.6.4.1.1 and 2.6.4.1.2 using the design loads stated in 2.12.3.1.2. For short bridges, forecastle, poop and short deckhouses, $k_\sigma=0,7$.

For long bridge, long forecastle and poop outside the end portions, k_σ is determined as for the strength deck according to 2.6.4.1.2; at sections in way of end bulkheads k_σ is to be determined by linear interpolation.

The thickness of deck plating of long bridges, long forecastle and poop, long deckhouses is to satisfy the requirements of 2.6.4.1.5 for the upper deck between the side and the line of large openings.

In any case, the thickness $s_{\min}$ in mm, of deck plating of short bridges, forecastle and poop, short deckhouses is not to be less than:

for open forecastle deck

$s_{\min}=(4+0,04L)\sqrt{\eta}$ for $L<100$ m;

$s_{\min}=(7+0,01L)\sqrt{\eta}$ for $L\geqslant 100$ m;

for other decks of superstructures and deckhouses of the lowest tier

$$s_{\min}=(5+0,01L)\sqrt{\eta} ;$$

for superstructure and deckhouse decks of other tiers

$$s_{\min}=(4+0,01L)\sqrt{\eta}$$

where η is obtained from 1.1.4.3.

Where $L>300$ m, L is to be taken equal to 300 m.

For ships of unrestricted service and ships of restricted area of navigation I, the reduction of minimal thickness, but not more than 10 per cent, is permitted in proportion to the ratio of adopted spacing to standard spacing, where the adopted spacing is less than the standard one (see 1.1.3). In any case, the minimum thickness may be reduced to 4 mm for ships of length $L\geqslant 50$ m and to 3 mm for ships of length $L<20$ m, subject to agreement with the Register.

2.12.4.3 The plate thickness of the end bulkheads of superstructures, sides and end bulkheads of deckhouses is not to be less than that determined by the Formula (1.6.4.4) taking:

$m=15,8$;

$k_\sigma=0,6$

$\Delta s=0$,

$p=$ as defined in 2.12.3.2.

The thickness of side plating of deckhouses may be not less than that of superstructures as stated in 2.12.4.1, provided they are arranged similarly over the ship's length and depth.

The thickness of bottom plates of end bulkheads in superstructures (deckhouses) of 1st tier is to be increased by 1 mm as compared with the design thickness. The width of bottom plate is to be not less than 0,5 mm.

If the deckhouse front extends in a fair convex form beyond the intersection with the deckhouse sides, the thickness of plating may be taken 0,5 mm less as compared with the design value.

2.12.4.4 In any case, the plate thickness $s_{\min}$, in mm, of superstructure end bulkheads, sides and end bulkheads of deckhouses is not to be less than:

for the lowest tier

$$s_{\min}=(5+0,01L)\sqrt{\eta} ;$$

for other tiers

$$s_{\min}=(4+0,01L)\sqrt{\eta}$$

where η is obtained from 1.1.4.3.

Where $L>300$ m, L is to be taken equal to 300 m.

In any case, the minimum thickness is not to be less than 5 mm for ships of length $L\geqslant 50$ m. The minimum thickness may be reduced to 4 mm for ships of length $L<20$ m and to 3 mm for ships of length $L<20$ m, subject to an agreement with the Register. Reduction of the minimum thickness is not permitted for fronts of bridge and unprotected front of poop in ships of length $L\geqslant 20$ m.

2.12.4.5 Framing of the sides, decks and end bulkheads of the forecastle, poop and bridge, quarter deck and deckhouse is to satisfy the following requirements:

.1 side framing of the superstructure is to comply with the requirements for side framing in 'tween deck space as specified in 2.5.4.2 to 2.5.4.5 using the design loads given in 2.12.3.1.1. For longitudinals and side stringers of short bridge, forecastle and poop, $k_\sigma=0,65$;

For longitudinals and side stringers of long bridge, long forecastle and poop outside the end portions, k_σ is determined according to 2.5.4.3 and 2.5.4.4; at sections in way of the end bulkheads $k_\sigma = 0{,}65$; within the end portions k_σ is to be determined by linear interpolation;

.2 underdeck framing of the superstructure and deckhouse is to satisfy the requirements of 2.6.4.2-2.6.4.9 using the design loads stated in 2.12.3.1.2. For longitudinals and deck girders of short bridge, forecastle and poop, $k_\sigma = 0{,}65$.

For longitudinals and deck girders of long bridge, long forecastle and poop outside the end portions, k_σ is determined in accordance with 2.6.4.2 and 2.6.4.4; at sections in way of the end bulkheads $k_\sigma = 0{,}65$; within the end portions k_σ is to be deter-mined by linear interpolation;

.3 the section modulus of vertical stiffeners of the end bulkheads of superstructures, deckhouse sides and end bulkheads is not to be less than that determined according to 1.6.4.1 taking:

$k_\sigma = 0{,}6$;

$\omega_c = 1$;

$p =$ as defined in 2.12.3.2;

$m = 12$, if the lower end of the stiffener is attached to the deck by a bracket;

$m = 10$, if the lower end of the stiffener is welded to the deck;

$m = 8$, if the lower end of the stiffener is sniped.

The section modulus of stiffeners of deckhouse sides need not be greater than that of frames of superstructures as stated in 2.12.4.5.1, where arranged similarly over ship's length and depth.

2.12.4.6 The scantlings of members of bulkheads and partial bulkheads inside the superstructures and deckhouses are to satisfy the requirements of 2.7.4.5, unless stated otherwise.

2.12.5 Special requirements.

2.12.5.1 The upper deck areas situated under the long bridge, long forecastle and poop outside the end portions are to satisfy the requirements of 2.6 for the second deck. Requirements for the upper deck areas situated under the ends of long bridge, long forecastle and poop are determined by linear interpolation between the requirements for the upper deck and those for the second deck.

2.12.5.2 In way of the end bulkheads the following requirements are to be complied with:

.1 where the superstructure end bulkhead is not in line with the transverse bulkhead of the hull, partial bulkheads or pillars are to be fitted in spaces below the end bulkhead, or frames and beam knees are to be strengthened;

.2 where the end bulkhead of long deckhouse is not in line with the transverse bulkhead below, short deck girders are to be fitted in line with deckhouse sides under the house deck so as to extend further for three frame spaces forward and aft of the deckhouse end bulkhead;

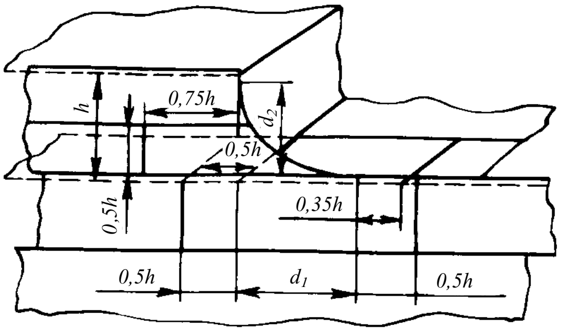
.3 at the section, where the end bulkheads of superstructures and deckhouses abut on the undeck longitudinal structures and the sides of deckhouses — on the transverse underdeck structures fitted below (bulkheads, partial bulkheads, undeck girders, deck transverses, etc.), the webs of these underdeck structures are to be stiffened with brackets.

2.12.5.3 The structure at the ends of superstructures is to satisfy the following requirements:

.1 at the ends of bridge, long forecastle and poop located within 0,6L midship region of a ship with a length $L \geqslant 60$ m the side plating is to be extended beyond the end bulkhead with smooth tapering to the ship's side on a length d_1, in m, (Fig. 2.12.5.3), determined by the formula

$$d_1 \geqslant 0{,}2(B_2/2 + h). \qquad (2.12.5.3)$$

On agreement with the Register, the value of d_1 may be reduced provided that the thickness of bottom strake of the superstructure side plating, sheerstrake and deck stringer plate within the region shown in Fig. 2.12.5.3 is increased;



$$0{,}5 \leqslant d_2 = 0{,}65 d_l \leqslant 0{,}75h$$

Fig. 2.12.5.3

.2 if the end of superstructure (forecastle, poop) is located within 0,1L from the fore or after perpendicular, as well as in ships of length $L < 65$ m, the value of d_1 in accordance with 2.12.5.3 may be reduced by half. If the end of a superstructure is located outside the above-mentioned regions and outside 0,6L amidships, the value of d_1 is to be determined by linear interpolation;

.3 the blunted ends of projecting side plates are to be machined flush with the deck.

The curved edge of side plating is to be stiffened by flat bar carried down for 50 mm from the edge. The ends of that bar are to be sniped.

Openings in side plating projecting beyond the ends of a superstructure are normally not permitted. The projecting plates are to be attached to the bulwark by means of flexible joints;

.4 at the ends of short bridge not extending from side to side of ship the attachment of the side to the deck shall be made similarly to the attachment required by 2.12.5.4 for deckhouses, otherwise gussets are to be used to provide smooth transition from the side to a short deck girder strengthening the deck under that side with simultaneous strengthening of the deck stringer plate within the region shown in Fig. 2.12.5.3.

2.12.5.4 Attachment of sides of the deckhouse to the end bulkhead arranged within 0,6L amidships of a ship with a length $L \geqslant 65$ m shall be performed by rounding with a radius r, in m, determined by the formula

$$r = \frac{l_1}{100}(1{,}5 + 0{,}1 l_1/b) \leqslant 1{,}4 \qquad (2.12.5.4)$$

where b = breadth of the deckhouse in way of the end bulkhead, in m.

2.12.5.5 Rectangular openings in outer sides and top plating of long deckhouses shall have their corners well rounded and shall be substantially framed. Door openings in the sides of a deckhouse, arranged within 0,6L amidships, shall be additionally reinforced with thickened plates as shown in Fig. 2.12.5.5. Rectangular openings are not permitted for a length not less than the height of the deckhouse counted from the end bulkhead, if the deckhouse is situated on the strength deck.

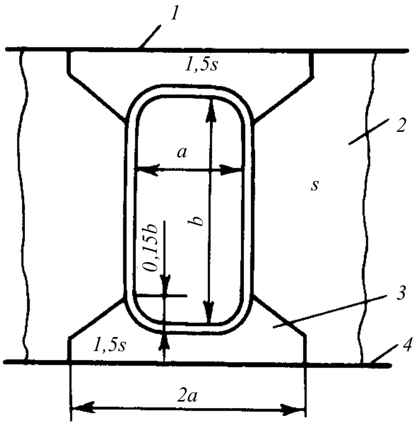


Fig. 2.12.5.5:
1 — deckhouse top; *2* — deckhouse side;
3 — thickened plate; *4* — strength deck

If door openings in sides are arranged outside the midship region or if the deckhouse is short, the thickened plates may be fitted only below the opening as shown in Fig. 2.12.5.5.

Where the distance between the expansion or sliding joints is less than a triple height of the deckhouse, it is sufficient to provide the rounding of the corners of openings. Openings for side scuttles shall have the upper and lower edges reinforced with horizontal stiffeners.

2.12.5.6 Requirements for quarter deck in ships greater than 90 m in length are subject to special consideration by the Register. The structures in way of the break at connection of the upper deck to quarter deck in ships of 90 m and under are to satisfy the following requirements:

.1 the upper deck plating in way of the break is to extend abaft the break for three frame spaces in ships of 60 m in length and above, and for two frame spaces in ships less than 60 m in length. The upper deck plating of ships less than 40 m in length need not extend abaft the break;

.2 the upper deck stringer plate is to extend abaft the steel plating for three frame spaces, where $L \geqslant 60$ m, and for two frame spaces, where $L < 60$ m.

The stringer plate so arranged shall be tapered from its full width to a width equal to the depth of frame to which it is welded;

.3 the stringer plate of quarter deck shall extend forward in the form of a bracket gradually tapered to ship's side on a length of three frame spaces. The quarter deck stringer plate projecting beyond the break is to be adequately stiffened and its free edge shall have a face plate or flange;

.4 the sheerstrake of quarter deck shall extend forward of the deck stringer plate projecting beyond the break bulkhead for at least 1,5 times the height of break and shall be smoothly tapered into the upper edge of ship's side sheerstrake. For other structural requirements, see 2.12.5.3;

.5 diaphragm plates spaced not more than 1,5 m apart are to be fitted over the ship's breadth between the overlapping decks in way of the break. The thickness of diaphragms is not to be less than the thickness of the break bulkhead plating.

The diaphragm plates are to be strengthened by vertical stiffeners.

Vertical stiffeners with effective flange are to have a moment of inertia not less than that obtained from the Formula (1.6.5.6-1).

Continuous welds are to be used to attach the horizontal edges of diaphragm plates to the decks, and the vertical edges to break bulkhead on one side, and on the other side to an extra supporting bulkhead made of continuous plate welded to the decks over the ship breadth. The plate thickness of that bulkhead is to be not less than the thickness of break bulkhead plating and may have openings between diaphragms;

.6 where a supporting bulkhead is fitted, the diaphragm plates shall be stiffened with brackets fitted to their ends (Fig. 2.12.5.6.6);

.7 where a raised quarter deck is adjoining the bridge, it shall extend into that superstructure for two frame spaces beyond the break, the extension being, in any case, not less than the elevation of superstructure above the quarter deck.

The quarter deck stringer plate shall extend forward for two frame spaces with the width gradually reduced as required by 2.12.5.6.2.

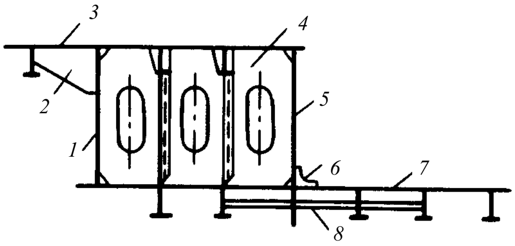


Fig. 2.12.5.6.6:
1 — supporting bulkhead; 2, 6 — brackets; 3 — quarter deck;
4 — diaphragm; 5 — break bulkhead; 7 — upper deck;
8 — stiffener in line with bracket

Strengthening of the overlapping decks in way of break is to comply with requirements of 2.12.5.6.5 and 2.12.5.6.6 depending on the location of the break along the length of the ship.

The superstructure side plates extending aft of the superstructure are to be smoothly tapered into the sheerstrake on a length of at least 1,5 times the height of break (see also 2.12.5.3.1);

.8 strengthening in case where the break bulkhead is located within 0,25*L* from the after perpendicular shall comply with the following requirements:

in ships greater than 60 m in length, the supporting bulkhead fitted over the breadth the ship may be omitted. The free edges of diaphragm plates are, in this case, to be stiffened with face plates or flanges of a width equal to at least ten thicknesses of the diaphragm plate;

in ships of 60 m in length and below, the upper deck plating need not extend aft of the break over the ship breadth, however, the upper deck stringer and the raised quarter deck stringer and sheerstrake shall be extended forward and aft as provided in 2.12.5.6.3 and 2.12.5.6.4.

2.12.5.7 The use of aluminium alloys for the construction of deckhouses is permitted. Decks of accommodation and service spaces situated above the machinery and cargo spaces shall be made of steel.

The scantlings of aluminium deckhouses shall be determined according to 1.6.6. The minimum scantlings are to be the same as those required for steel deckhouses.

The degree to which the deckhouse of aluminium alloys contributes to longitudinal bending of the hull and stresses in ship's hull and deckhouse shall be determined according to the procedure approved by the Register.

2.12.5.8 The helicopter deck members and supporting structures are to satisfy the following requirements:

.1 the helicopter deck members, depending on its location over the ship's length and depth, should satisfy the requirements for members of weather deck as specified in 2.6 or superstructure (deckhouse) decks, as specified in 2.12.4.2 and 2.12.4.5.2. In any case, the design pressure is not to be less than:

$$p_{\min} = 2 \text{ кPa}.$$

.2 the helicopter deck members shall satisfy the requirements for the members of decks intended for the carriage of cargo, as specified in 2.6. The design loading is determined according to 1.3.4.1 on the basis of the greatest mass of helicopters and equipment stowed on that deck during operation of the ship and the additional pressure of 0,5 kPa from snow cover or ice;

.3 the helicopter deck members shall satisfy the requirements for deck members of ro-ro ships, as specified in 3.2. The design loading under the helicopter landing conditions is determined on the basis of the following:

Q_0 = assumed load on the axle, taken to be equal to the maximum take off weight of helicopter, in kN;

$n_0 = 2$ — assumed number of wheels on the axle;

$n = 1$ — number of wheels forming a group;

$u \times v = 0,3 \times 0,3$ m^2 — size of tyre print;

$k_d = 1,5$ — dynamic amplification factor;

.4 if the helicopter deck is not a superstructure or deckhouse deck, its supporting structures shall satisfy the requirements for pillars as stated in 2.9 and/or partial bulkheads as specified in 2.7.4.5 using the design loads given in 2.12.5.8.1 to 2.12.5.8.3;

.5 if the helicopter deck has parts protruding beyond the side line, requirements for such a helicopter deck are subject to special consideration by the Register.

2.13 MACHINERY CASINGS

2.13.1 General.

2.13.1.1 Openings in decks and platforms over machinery spaces are to be protected by strong casings.

The casings may be omitted only in cases where the space on the deck or platform is a part of the machinery space.

2.13.2 Construction.

2.13.2.1 Where there are large openings in the deck in way of machinery space, additional pillars and deck transverses are to be fitted for strengthening of the deck in way of machinery casing.

2.13.2.2 For the lower strake of the casing longitudinal wall plating, adjoining the strength deck within the 0,6*L* midship region of ships with a length $L \geqslant 65$ m of steel grade and yield stress are to be the same as for the strength deck plating in this region.

2.13.2.3 Where the opening for machinery casing is arranged in the strength deck, the requirements of 2.6.5.1 regarding the design of corners and compensation for openings are to be complied with.

2.13.3 Scantlings of machinery casing structures.

2.13.3.1 The part of machinery casing located inside the enclosed spaces ('tween deck spaces, forecastle, poop, bridge, deckhouse) shall comply with the requirements of 2.7.4.5 for partial bulkheads. The spacing of stiffeners is not to exceed 0,9 m.

The thickness of plating of the part of machinery casing located inside the poop, bridge or deckhouse may be 0,5 mm less than specified.

2.13.3.2 The part of machinery casing located below the bulkhead deck shall comply with the requirements of 2.7.2.3, 2.7.4.1 to 2.7.4.3 for waterlight bulkheads where it is included in subdivision calculation as watertight construction.

2.13.3.3 The part of machinery casing located above weather deck shall comply with the requirements of 2.12 for deckhouses situated in the same region of the ship. In calculating the design loading by the Formula (2.12.3.2) c_2 is to be taken equal to 1.

2.14 BULWARKS

2.14.1 General.

Bulwarks of strong construction are to be provided in places specified in 8.6, Part III "Equipment, Arrangements and Outfit".

The construction of bulwarks in the midship region of ships of 65 m and above shall be such that the bulwark contributes to longitudinal bending of the hull.

2.14.2 Construction.

2.14.2.1 The height of the bulwark as measured from the upper edge of the deck plating or from that of planking, if any, to the upper edge of the rail section is to comply with the requirements of 8.6.2, Part III "Equipment, Arrangements and Outfit".

2.14.2.2 The bulwark plating within the 0,6*L* midship region of ships of 65 m and above shall be welded to the upper edge of sheerstrake. Outside the above-mentioned region as well as in ships less than 65 m in length, the openings cut in bulwarks shall be so designed as to ensure a smooth transition (with a radius not less than 100 mm) from the bulwark plate to the sheerstrake.

Within 0,07*L* from the fore perpendicular the welding of bulwark plating to the sheerstrake is necessary.

2.14.2.3 The bulwark is to be supported by stays spaced not more than 1,8 m apart. In the region of uprights for timber deck cargo, fastening to bulwarks, as well as at the fore end within 0,07*L* from the fore perpendicular, the spacing of stays is to be not more than 1,2 m. In the ships with large flare of sides and in ships with minimum assigned freeboard, stays may be required to be fitted at every frame within the region considered.

2.14.2.4 The stays are to be fitted in line with deck beams, brackets and other structures and are to be welded to the rail section, bulwark plate and deck. The attachment of stays to bulwark shall be ensured on a length not less than half the height of the bulwark.

In welding the stays to the deck, holes sufficient in size to allow free passage of water to the scuppers are to be provided in the stays. The welded connection of the beam (bracket) to deck plating under the stay shall not be weaker than the attachment of stay to deck.

Directly under the lower ends of stays no cut-outs in the deck beams and no gaps between frame ends and deck are permitted.

The dimensions of lightening holes in stays are not to exceed half the stay width in any section of the stay.

The free edges of stays are to be stiffened with face plates or flanges.

In general, the flanges (face plates) of stays are not to be welded to deck plating and rail section.

The flanges (face plates) on the outer edge of the stay are not to be welded to horizontal stiffener (flange) of lower edge of the bulwark in way of continuous cut-out.

2.14.2.5 The rail section shall have a flange (face plate) or shall be of bulb profile.

The lower edge of bulwark shall be stiffened with horizontal stiffener or flange in way of continuous cut-out.

Bulwarks are to be adequately strengthened in way of mooring pipes, fairleads and eyeplates for cargo gear.

2.14.2.6 Requirements for the design of freeing ports in bulwarks are given in 1.1.6.5.

2.14.3 Loading on bulwarks.

The external pressure determined by the Formula (1.3.2.2-2) is the design pressure p, in kPa, acting on the bulwark. The design pressure is to be taken not less than:

$$p_{\min} = 0{,}02L + 14, \qquad (2.14.3)$$

but not less than 15 kPa.

Where $L > 300$ m L is to be taken equal to 300 m.

For ships of restricted area of navigation the value of $p_{\min}$ may be reduced by multiplying by the factor φ_r obtained from Table 1.3.1.5.

2.14.4 Scantlings of bulwark structures.

2.14.4.1 The thickness of the bulwark plating is not to be less than: $s = 0{,}065L + 1{,}75$ for $L \leqslant 60$ m and $s = 0{,}025L + 4{,}0$ for $L > 60$ m, but not less than 3,0, nor greater than 8,5 mm.

The thickness of bulwark plating of a superstructure located beyond $^1/_4$ of the ship's length from the fore perpendicular, as well as that of bulwark plating of 2nd tier deckhouses or superstructures may be reduced by 1 mm.

For 3rd and above tiers of the deckhouses the thickness of the bulwark plating need not exceed the thickness required for the plating of sides of 3rd tier deckhouse.

2.14.4.2 The section modulus of bulwark stay adjoining the deck plating is not to be less than determined according to 1.6.4.1 taking:

p = as defined in 2.14.3;

$m = 2$;

$k_\sigma = 0{,}65$.

Where the bulwarks are cut to form a gangway or provision is made for expansion joints, the section modulus of stay at the ends of the openings or expansion joints is to be increased by 25 per cent.

The width of stay at the upper end is to be equal to that of the rail section.

2.14.4.3 Where the deck cargo effect on the bulwark is contemplated, the scantlings of the bulwark stays are to be determined by strength calculation involving effect of the said cargo, with regard for heel of the ship determined by the Formula (1.3.3.1-5) and acceleration in the horizontal-transverse direction, determined by the Formulae (1.3.3.1-2); the permissible stress factor is determined according to 2.14.4.2.

3 REQUIREMENTS FOR STRUCTURES OF SHIPS OF SPECIAL DESIGN

3.1 SHIPS WITH LARGE DECK OPENINGS

3.1.1 General and symbols.

3.1.1.1 The requirements of this Chapter are additional to those of Sections 1 and 2.

3.1.1.2 The requirements for deck structure, exclusive of those for cantilever beams, apply to ships with single, twin and triple cargo hatchways which are considered to form a large deck opening meeting the following conditions:

$$b/B \geqslant 0{,}7;\ l/l_m \geqslant 0{,}7.$$

The requirements of this Chapter are to be applicable throughout the entire cargo hatch region, including the engine room, provided it is located between the cargo holds.

3.1.1.3 The requirements for container securing arrangements and hull structures, which take up forces exerted by the said arrangements, apply to container ships.

3.1.1.4 The cantilever beam is a short deep half beam for which the supporting effect of the side hatch coaming is disregarded in the strength and buckling strength calculation to be made for deck grillage in accordance with 2.6.4.4 and 2.6.4.9 respectively.

3.1.1.5 Symbols:

b = breadth of deck opening determined as the distance between the outer longitudinal edges of hatchway openings at ship's sides, in m;

l = length of hatchway opening, in m;

l_m = distance between centres of transverse deck strips at each end of opening, in m;

c = distance between trasverse edges of adjoining openings, in m;

n = total number of 20-ft containers carried by the ship.

3.1.2 Construction.

3.1.2.1 For ships with a length $L \geqslant 80$ m longitudinal framing system is provided for the deck and bottom.

3.1.2.2 Upper deck and side longitudinals are to be continuous within the region stated in 3.1.1.2.

3.1.2.3 Ends of cargo hatch continuous side coamings are to be attached as required by 1.7 and 2.6.2. It is not recommended that continuous side coamings be attached to the front bulkhead of the aft superstructure and the aft bulkhead of the forecastle.

3.1.2.4 Abrupt changes of cross section and shape of members referred to in 3.1.2.2 over the length of the ship is generally not permitted. Where such changes are necessary, arrangements are to be such as to minimize the creation of stress concentration and attention is to be paid to provision of buckling strength.

3.1.2.5 The attachment of the forward end of the longitudinal strip to the deck where there is a cargo hatch single opening forward of the attachment is to be specially considered by the Register.

3.1.2.6 It is recommended that transverse and longitudinal deck strips have a box-shaped cross-section.

3.1.2.7 Transverse deck strips are to be efficiently attached to the underdeck framing members and web frames in line with which they are fitted. Where the plating of the deck strips is arranged in line with the upper flanges of continuous hatch side coamings, the attachment of deck strips to the deck and side shell is to be specially considered by the Register.

3.1.2.8 Openings in the deck plating in immediate proximity to the attachments of transverse and longitudinal deck strips are not permitted.

3.1.2.9 Large deck openings.

3.1.2.9.1 Adjacent corners of hatch openings in the upper deck arranged in one line are to be rounded with a radius r, in m, (Fig. 3.1.2.9) not less than:

$$r = kb \qquad (3.1.2.9.1)$$

where $k = 0{,}025$ when $c/b \leqslant 0{,}04$;
$k = 0{,}050$ when $c/b \geqslant 0{,}2$; the intermediate values of k are to be obtained by linear interpolation.

In way of longitudinal deck strips the value of r may be reduced by 40 per cent.

Given below are minimum radii of rounding of opening corners:

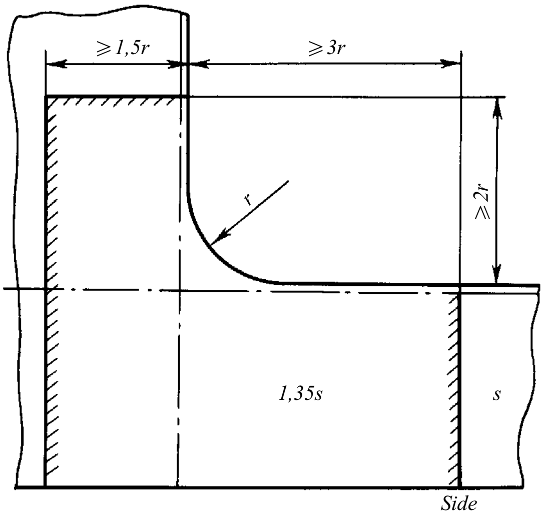


Fig. 3.1.2.9

$r_{\min} = 300$ mm in way of deck stringer plate;

$r_{\min} = 250$ mm in way of longitudinal deck strips.

Thickened insert plates are required at hatch corners (see Fig. 3.1.2.9).

3.1.2.9.2 In way of conjugations of open and enclosed parts of the hull (adjacent to the engine room, bow, etc.) the corner radius of hatch openings is not to be less than:

$$r = 0{,}07b\ . \qquad (3.1.2.9.2)$$

3.1.2.9.3 Hatch corners in the areas where cargo hatchways arranged abreast change in number are to be specially considered by the Register.

3.1.2.9.4 For general requirements regarding deck openings, see 2.6.5.1.

3.1.2.10 The cantilever beams are to be fitted in line with web frames. Their connection is to satisfy the requirements of 1.7.2.3.

The cantilever beams are to be fitted with minimum stiffeners as shown in Fig. 3.1.2.10.

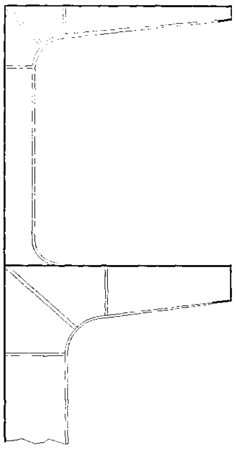


Fig. 3.1.2.10
Stiffening of cantilever beams

3.1.2.11 Stiffeners, brackets or deep members are to be fitted under the vertical guides or corner fittings of containers in double bottom of container ships. The inner bottom plating in these locations is to be increased in thickness or the corner fitting sockets are to be welded therein.

The above also applies to lashing pots.

Similar increase in the plating thickness and stiffening in way of container corner fitting pockets and lashing pots shall be provided in deck structure.

3.1.3 Design loads.

3.1.3.1 The design still water bending moment is to be determined in accordance with 1.4.3.

3.1.3.2 The vertical wave bending moment is to be determined in accordance with 1.4.4.

3.1.3.3 The design horizontal wave bending moment M_h, in kN/m, is determined by the formula

$$M_h = 250 k_h c_w B L^2 C_b \alpha_h 10^{-3} \qquad (3.1.3.3)$$

where $k_h = æ(d/b + 0{,}3)$;

$æ = 1 - 4d/L$;

for c_w, see 1.3.4.1;

$\alpha_h = 0{,}5(1 - \cos\frac{2\pi x}{L})$;

x = distance between the considered section and the after perpendicular, in m.

3.1.3.4 The design components of a wave torque, in kN/m, are determined by the formulae:

$$M_{tw_1} = 63 k_1 c_w B L^2 \alpha_{t_1} \cdot 10^{-3}; \qquad (3.1.3.4\text{-}1)$$

$$M_{tw_2} = 63 k_2 c_w B L^2 C_b \alpha_{t_2} \cdot 10^{-3}\ ; \qquad (3.1.3.4\text{-}2)$$

$$M_{tw_3} = 126 k_2 c_w B L^2 C_b \alpha_{t_3} \cdot 10^{-3}\ . \qquad (3.1.3.4\text{-}3)$$

where $k_1 = 2æ\chi_0[1 + 3{,}6(C_{WL} - 0{,}7)]B/L$;

$k_2 = 10\,æ\,\frac{d}{L}\,\frac{e}{B}$;

$æ_1 = 1 - 8d/L$;

$\chi_0 = 1 - 4C_{WL}B/L$;

C_{WL} = water plane area coefficient for summer load waterline;

for $æ$, see 3.1.3.3;

e = vertical distance from the torque centre to a point at $0{,}6d$ above the base line; the torque centre position is to be determined in accordance with the procedure approved by the Register;

$\alpha_{t_1} = 0{,}5(1 - \cos\frac{2\pi x}{L})$;

$\alpha_{t_2} = \sin\frac{3\pi x}{L}$;

$\alpha_{t_3} = \sin\frac{2\pi x}{L}$;

for x, see 3.1.3.3.

3.1.3.5 For container ships, the design statical torque M_{ts}, in kN/m, is determined by the formula

$$M_{ts} = 30\sqrt{n}B \qquad (3.1.3.5)$$

where n = total number of 20-ft containers carried by ship.

3.1.3.6 For ships of restricted area of navigation, the horizontal wave bending moment (see 3.1.3.3) and the components of a wave torque (see 3.1.3.4) are to be multiplied by the reduction factor φ determined in accordance with Table 1.4.4.3.

3.1.3.7 The design loads for cantilever beams are determined in accordance with 2.6.3.

3.1.3.8 The design loads on container securing arrangements are determined with due regard for the inertia forces caused by ship's accelerations at motions in accordance with 1.3.3.1. The design mass value of ISO series 1 containers is:

24,0 t for 20-ft containers,

30,5 t for 40-ft containers.

When calculating strength of container securing arrangements fitted on weather deck, account shall be taken of loads from the wind in the direction perpendicular to the centreline of the ship. The design value of wind pressure is:

$$p = 1,0 \text{ kPa}.$$

3.1.4 Scantlings of structural members.

3.1.4.1 The combined stresses σ_Σ, in MPa, in strength deck longitudinals, determined by the Formula (3.1.4.1-1) are not to exceed 190/η in any section

$$\sigma_\Sigma = \sigma_{sw} + \sigma_{ts} + k_\Sigma \sigma_w \qquad (3.1.4.1\text{-}1)$$

where σ_{sw} = normal stresses, in MPa, in the section considered due to still water bending moment, determined by the formula

$$\sigma_{sw} = \frac{M_{sw}}{W_d^a} \cdot 10^3; \qquad (3.1.4.1\text{-}2)$$

for M_{sw}, in kN/m, see 1.4.3;

W_d^a = actual hull section modulus in way of deck, as defined in 1.4.8;

σ_{ts} = normal stresses, in MPa, in the section considered due to the static torque M_{ts} (see 3.1.3.5), determined by the formula

$$\sigma_{ts} = \frac{B_{ts}\overline{\omega}}{I_W \cdot 10^3} \qquad (3.1.4.1\text{-}3)$$

B_{ts} = biomoment in considered section along the length of open part of the ship under the effect of the static torque M_{ts}, in kN/m^2;

$\overline{\omega}$ = main sectional area at the considered section point, in m^2;

$\overline{I}_w$ = main sectional moment of inertia, in m^6;

B_{ts}, $\overline{\omega}$, I_W are determined according to the procedure approved by the Register;

σ_w = normal stresses, in MPa, in considered section due to vertical wave bending moment, determined by the formula

$$\sigma_w = \frac{M_w}{W_d^a} \cdot 10^3;$$

for M_w, see 1.4.4;

k_Σ = factor by which vertical bend stresses are increased taking the horizontal bending and torque into account. It is determined by the formula

$$k_\Sigma = \sqrt{1 + 0{,}15(0{,}85 + L/600)^2(\overline{\sigma}_h + \overline{\sigma}_{tw})^2}\ ;$$

$\overline{\sigma}_h = \sigma_h/\sigma_W$;

σ_h = normal stresses, in MPa, in considered section due to design horizontal wave bending moment, determined by the formula

$$\sigma_h = \frac{M_h}{W_{dz}^a} \cdot 10^3; \qquad (3.1.4.1\text{-}4)$$

for M_h, see 3.1.3.3;

W_{dz}^a = actual hull section modulus about the vertical axis through the centreline of the ship, in cm^3, determined by the formula

$$W_{dz}^a = \frac{I_z}{y} \cdot 10^2,$$

I_z = actual inertia moment of the hull about the vertical axis, in cm^2/m^2;

y = half the ship's breadth in the considered section, in m;

$\overline{\sigma}_{tw} = \sigma_{tw}/\sigma_w$;

σ_{tw} = total warping stresses, in MPa, under the effects of the torques M_{tw_1}, M_{tw_2}, M_{tw_3}, determined by the formula

$$\sigma_{tw} = \sqrt{(\sigma_{tw_1} - \sigma_{tw_2})^2 + \sigma_{tw_3}^2}\ ; \qquad (3.1.4.1\text{-}5)$$

σ_{tw_1} = normal warping stresses, in MPa, under the effects of the torques M_{tw_1}, M_{tw_2}, M_{tw_3} (see 3.1.3.4), determined by the formula

$$\sigma_{tw_1} = \frac{B_i\,\overline{\omega}}{I_W \cdot 10^3}\ ; \qquad (3.1.4.1\text{-}6)$$

B_i = biomoments in considered section along the length of the open part of the ship under the effects of M_{tw_1}, M_{tw_2}, M_{tw_3} respectively, in kN/m^2. The biomoments are determined by the procedure approved by the Register.

3.1.4.2 Kinematic parameters of warping are to be determined.

The elongation of hatch opening diagonal under the effect of hull warping is not to exceed 35 mm. Where such elongation obtained by calculation is in excess of 35 mm, measures specially agreed with the Register are to be taken for opening edge reinforcements. The calculation is to be made in accordance with the procedure approved by the Register.

3.1.4.3 Adequate buckling strength of the longitudinal deck strip between the supports as well as that of its items as regards the compressive stresses due to longitudinal bending are to be ensured.

3.1.4.4 Where the ratio of the length of the hatch opening to the width of the deck portion from the side shell to the longitudinal edge of the nearest hatch opening exceeds 10, calculation of shape deformation of the deck portion concerned in the horizontal plane in accordance with the procedure approved by the Register and use of the results obtained in assessment of the deck stressed state, design of hatch covers and side framing may be required.

3.1.4.5 The scantlings of cantilever beams and adjoining web frames are to satisfy the following requirements:

.1 the section modulus, in cm^3, of cantilever beam at a section in way of the end of a beam knee is not to be less than:

$$W = \left(\frac{1}{2}\,pal + Q\right)\frac{l}{k_\sigma \sigma_n}\ \omega_c \cdot 10^3 \qquad (3.1.4.5.1)$$

where p = intensity of design loading, in kPa, on the deck plating supported by the cantilever beam, as required by 3.1.3.7;

a = distance between adjacent cantilever beams, in m;

l = span, in m, of a cantilever beam, measured from the section at the end of a beam knee to the hatch side coaming supported;

Q = design load, in kN, transmitted from hatch cover to the cantilever beam:

$$Q = \frac{1}{2}\,p_1 a b_1;$$

p_1 = intensity of design loading, in kPa, on the cover of hatch adjoining the cantilever beam as required by 3.1.3.7;

b_1 = width, in m, of opening for a hatch adjoining the cantilever beam;

k_σ = 0,6;

ω_c = as defined in 1.1.5.3.

The sectional area of the web of cantilever beam is not to be less than that determined according to 1.6.4.3 taking:

$k_\sigma = 0{,}6$;

$N_{\max} = \text{pal} + Q$ for the section at the end of the beam bracket;

$N_{\max} = Q$ for the section in way of the hatch side coaming adjoining the cantilever beam;

.2 the section modulus of the web frame connected to the upper deck cantilever beam at the section in way of the end of the beam bracket is not to be less than that determined by the Formula (3.1.4.5.1).

The section modulus of the web frame connected to the cantilever beam of the lower deck and fitted below that deck at the section in way of the end of the beam bracket is to comply with the same requirement but may be reduced by the value of section modulus of the web frame fitted above that deck, at the section in way of the end of the bracket adjoining the deck.

3.1.4.6 The scantlings of container securing arrangements are to be determined on the basis of strength calculations using the design loads complying with the requirements of 3.1.3.8, and the resulting stresses are not to exceed the permissible ones determined using the permissible stress factors $k_\sigma = k_\tau = 0{,}75$.

The strength of hull structures taking up forces from the container securing arrangements is to be verified by calculation of the effects produced by these forces, and the resulting stresses are not to exceed the permissible ones specified in Section 2 for the appropriate structures.

3.2 ROLL-ON/ROLL-OFF SHIPS

3.2.1 General and symbols.

3.2.1.1 The requirements of this Chapter apply to ro-ro ships, ro-ro passenger ships and are supplementary to those of Sections 1 and 2.

These requirements also apply to decks and double bottoms of ships carrying wheeled vehicles for use in cargo handling.

3.2.1.2 Symbols.

Q_0 = static load on the axle of the wheeled vehicle, in kN;

n_0 = number of wheels on an axle;

n = number of wheels forming a design load spot (for a single wheel $n = 1$);

u = size of a tyre print normal to the axis of rotation, in m;

v = size of a tyre print parallel to the axis of rotation, in m;

e = spacing between adjacent tyre prints, in m;

l_a = design load spot dimension parallel to the smaller side of the panel (directed across framing members) , in m;

l_b = design load spot dimension parallel to the larger side of the panel (directed along framing members), in m;

a, b = smaller and larger sides of panel, respectively, in m;

l = span of the considered girder between supports, in m (see 1.6.3.1).

3.2.2 Construction.

3.2.2.1 Vehicle decks and double bottoms of ro-ro ships and car ferries are, in general, to be longitudinally framed. If framed otherwise, the above structures are subject to a special consideration by the Register.

3.2.2.2 Movable decks fitted temporarily for the carriage of vehicles are to be so fixed as to prevent these decks from taking up longitudinal forces under the hull longitudinal bending.

The Rules provide for movable deck structure consisting of a top decking with a web structure and longitudinals welded thereto. Other forms of movable deck construction will be specially considered by the Register.

3.2.3 Loads from wheeled vehicles.

3.2.3.1 The design loads are to be based on specification details of vehicles carried on board the ship and used for cargo handling. The design documentation submitted to the Register for the consideration is to include statical load on vehicle axle, number of wheels on the axle, wheel spacing, tyre print dimensions and tyre type.

Where wheel print details are not initially available, the requirements of 3.2.3.5 are to be applied.

3.2.3.2 The design load spot dimensions l_a and l_b are to be chosen as the overall dimensions of the print of a wheel group consisting of a maximum number of wheels and complying with the following conditions:

when determining the required plating thickness, the prints of all the wheels in a group are to be arranged within the panel surface (i.e. $l_a \leqslant a$ and $l_b \leqslant b$, see Table 3.2.3.2);

when determining the section modulus and cross section of a main framing girder, the prints of all the wheels of a group are to be fully arranged within the surfaces of two panels adjacent to the girder under consideration (i.e. $l_a \leqslant 2a$ and $l_b \leqslant l$, see Fig. 3.2.3.2).

The wheels may be united in a group irrespective of the distance between prints provided the overall dimensions of the group are in accordance with the above limitations.

Where two positions of the design load spot are possible (along and across main framing), $l_b \geqslant l_a$ is to be adopted as the design case (i.e. the spot positioned with its larger side along main framing).

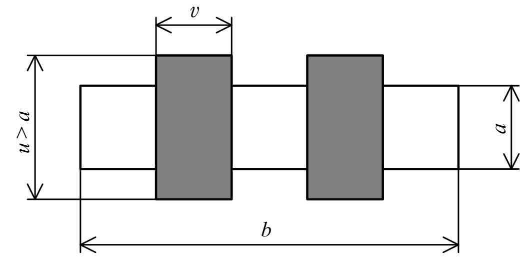
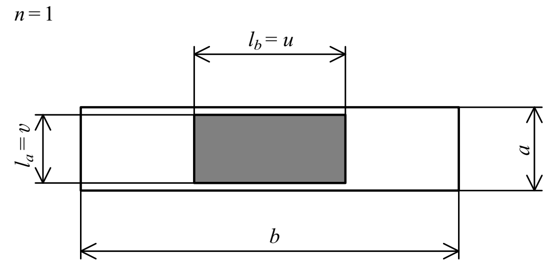
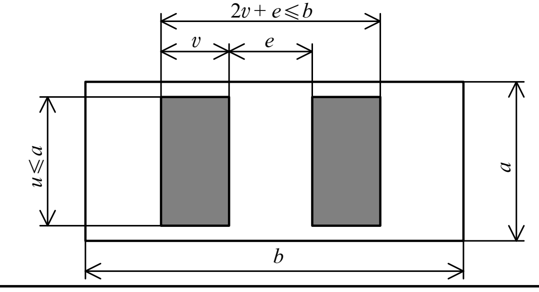
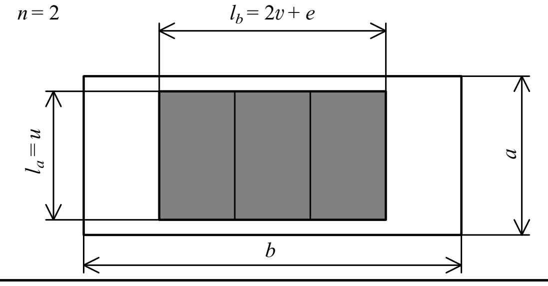
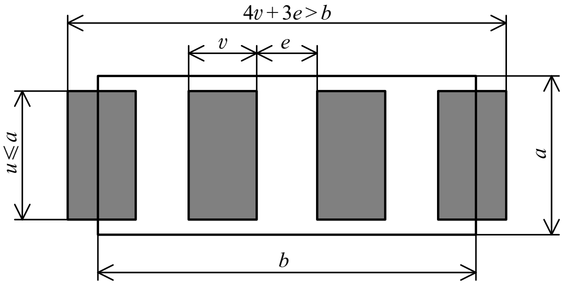
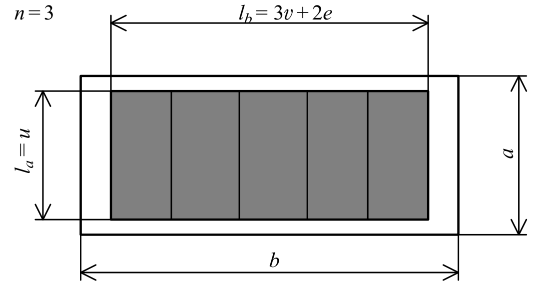
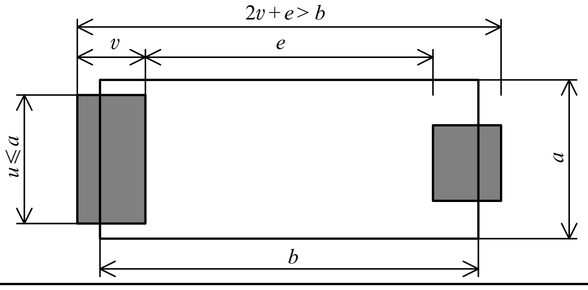
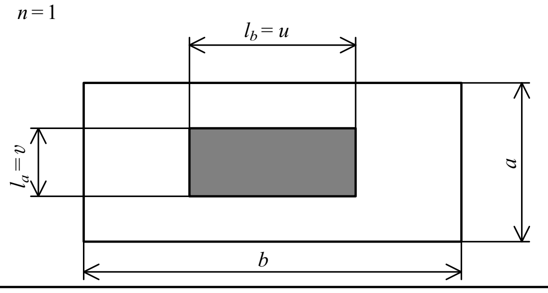
3.2.3.3 To be considered are the loads resulting from the operation of vehicles during cargo handling operations and from stowage of vehicles on the deck under conditions of the ship motions.

3.2.3.4 The design load Q, in kN, is to be determined by the formula

$$Q = k_d Q_0 \frac{n}{n_0} \qquad (3.2.3.4)$$

Table 3.2.3.2

Procedures for Choosing Design Load Spot Dimensions When Establishing Deck Plating Thickness

Wheel prints	Design load spot
	
	
	
	

where $k_d=\alpha_1\alpha_2$ — dynamic coefficient in the process of operation of vehicles used for cargo handling operations;

$\alpha_1=$ factor equal to: 1,10 and 1,05 for vehicles (except fork lift trucks) having an axle load less than 50 kN and 50 kN and more, respectively; 1,0 for fork lift trucks;

$\alpha_2=$ factor equal to: 1,03 and 1,15 for pneumatic and cast-rubber tyres, respectively; 1,25 for wheels with a steel rim;

$k_d=1+a_z/g$ — dynamic factor characterizing the ship motions;

$a_z=$ acceleration in the ship section under consideration in accordance with 1.3.3.1.

Where distribution of the load between wheeled vehicle axles is not uniform, the maximum axle load is to be taken as the design load. For fork lift trucks it is assumed that the total load is applied to the forward axle.

3.2.3.5 Where specifications on tyre print dimensions are not available, the tyre print dimension normal to the wheel axle u, in m, is to be determined by the formulae:

for wheels with cast tyres

$$u=0{,}01Q_0/n_0 \quad \text{where } Q_0/n_0\leqslant 15 \text{ kH};$$

(3.2.3.5-1)

$$u=0{,}15+0{,}001(Q_0/n_0-15) \text{ where } Q_0/n_0>15 \text{ kH};$$

for wheels with pneumatic tyres

$$u=0{,}15+0{,}0025Q_0/n_0 \text{ where } Q_0/n_0\leqslant 100 \text{ kH};$$

(3.2.3.5-2)

$$u=0{,}4+0{,}002(Q_0/n_0-100) \text{ where } Q_0/n_0>100 \text{ kH}.$$

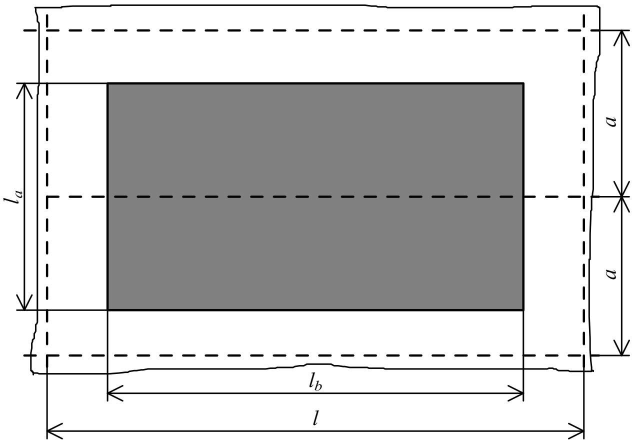


Fig. 3.2.3.2
Design loaded spots for main framing

The tyre print dimension of a wheel parallel to the wheel axle v, in m, is to be determined by the formula

$$v = \frac{Q_0}{n_0 u p_k} \qquad (3.2.3.5\text{-}3)$$

where p_k — static specific pressure, in kPa, to be adopted from Table 3.2.3.5.

Table 3.2.3.5

Vehicle	p_k	
	Pneumatic tyres	Cast tyres
Cars	200	—
Lorries, motor vans	800	—
Trailers	800	1500
Fork lift trucks	800 (where $n = 1$) 600 (where $n \geqslant 2$)	1500 1500

3.2.3.6 If the size of wheel prints is adopted in accordance with 3.2.3.5, the design load Q shall be increased by 15 per cent.

3.2.3.7 The design load for train rails Q, in kN, is to be determined by the formula

$$Q = 0{,}5 k_d Q_0 n_1 \qquad (3.2.3.7)$$

where $k_d = 1{,}1$ if the vehicle moves about during cargo-handling operations;
$k_d = 1 + a_z/g$ in case of the ship motions;
a_z = acceleration in considered ship section in accordance with 1.3.3.1;
n_1 = number of vehicle wheels arranged within the design span of framing member supporting railways.

3.2.3.8 The design loads for side shell and permanent deck primary members are to be those to satisfy the most severe stowage arrangement of all cargoes carried on deck (including package cargo, containers, wheeled vehicles, etc.) and to allow for statical and inertia forces resulting from the ship motions. Accelerations are to be determined in accordance with 1.3.3.1.

3.2.3.9 The design load Q, in kN, for the transverses and girders of movable decks is to be determined by the formula

$$Q = k_d(p_c + p_d)a_2 l \qquad (3.2.3.9)$$

where k_d = as defined in 3.2.3.4;
p_c = static deck loading from the cargo carried , in kPa;
p_d = static deck loading from deck own mass, in kPa;
a_2 = mean spacing of transverses and girders , in m.

The value of $(p_c + p_d)$ is not to be taken less than 2,5 kPa.

3.2.4 Scantlings of deck and side shell structures.

3.2.4.1 The thickness of plating s, in mm, is not to be less than

$$s = \left(\frac{17 Q k_0}{l_a l_b R_{eH} k_1 k_2 k_3}\right)^{0{,}6} + 2 \qquad (3.2.4.1)$$

where Q = as defined under 3.2.3;
k_0 = factor accounting for the effects of total hull bend:
$k_0 = \frac{1}{1{,}4 - 0{,}8W/W_d^f} \geqslant 1$ — for the upper (strength) deck amidships with loads acting at sea;
k_0 = 1 elsewhere;
$k_1 = 0{,}83/\sqrt{a}$;
$k_2 = 0{,}84/\sqrt{l_a} - 0{,}185$;
$k_3 = 0{,}18/l_b + 0{,}38$;
W_d^f = actual hull section modulus for deck in accordance with 1.4.8.

3.2.4.2 The section modulus W of longitudinals and beams, in cm^3, is not to be less than determined from 1.6.4.1 with

Q = as defined in 3.2.3;

$$m = \frac{5{,}84}{[1 - 0{,}57 l_b/l]k_a};$$

$k_a = 1 - 0{,}204(l_a/a)^2 + 0{,}045(l_a/a)^3$;
$k_\sigma = 0{,}8/k_0$ — for cargo handling operations in port;
$k_\sigma = 0{,}7/k_0$ — with loads applied at sea;
k_0 = factor defined in 3.2.4.1.

3.2.4.3 The web cross-sectional area f_c, in cm^2, of beams and longitudinals is not to be less than determined in accordance with 1.6.4.3 with

$$N_{\max} = Q k_a(1 - 0{,}47 l_b/l); \qquad (3.2.4.3)$$

$k_\tau = k_\sigma$

where Q = as defined in 3.2.3;
k_a; k_σ = factors defined in 3.2.4.2.

3.2.4.4 The plating thickness, section modulus and cross-sectional area of beams and longitudinals of movable decks are to be determined in accordance with 3.2.4.1, 3.2.4.2 and 3.2.4.3. Where beams and longitudinals are freely supported by girders and transverses, the factor m shall be determined by the formula

$$m = \frac{8}{k_a(2 - l_b/l)} \qquad (3.2.4.4)$$

where k_a = factor defined in 3.2.4.2;

Otherwise, the factor m is to be determined as for beams and longitudinals of permanent cargo decks according to 3.2.4.2.

3.2.4.5 The section modulus of longitudinals W, in cm^3, supporting fixed rails is not to be less than determined in 1.6.4.1 with

Q = as defined in 3.2.3.7;

m to be determined by the formula

$$m = \frac{5{,}85}{1 - k_5 e_2 / l} \qquad (3.2.4.5)$$

where $k_5 = 0$ with $n_1 = 1$

$k_5 = 0{,}5n_1$ with $n_1 \geqslant 2$;

for n_1,see 3.2.3.7;

e_2 = mean spacing of centres of wheels arranged within the design member span, in m;

k_σ = $0{,}7/k_0$;

k_0 = factor determined by 3.2.4.1.

3.2.4.6 The scantlings of deep members of sides and permanent cargo decks, as well as of pillars are to be derived by direct calculation using the procedures approved by the Register.

3.2.4.7 The section modulus of the girders and transverses of movable decks W, in cm^3, is not to be less than determined by 1.6.4.1 with

Q = as defined in 3.2.3.9;

$m = 12$ for fixed members;

$m = 8$ for freely supported members;

$k_\sigma = 0{,}7$.

3.2.5 Special requirements.

3.2.5.1 A side fender protecting the ship side and stern from damage during mooring operations is to be fitted at the lower cargo deck level of ferries.

3.2.5.2 A longitudinal is to be fitted under each rail on the cargo decks of train ferries.

3.2.5.3 Where train decks with rails which are flush with the deck plating are provided on ships carrying railway carriages, the actual section modulus and sectional area of deck transverses are to be determined for the section located in the rail recess. Structural continuity of the effective flange of the deck transverse, where it intersects the rail, is to be ensured. In any case, the intersections of the fixed rails with deck transverses is to be specially agreed with the Register.

3.2.5.4 Where rails for the transport of railway carriages are welded to the deck plating throughout the entire length, the rail butts are to be welded with full penetration.

3.3 BULK CARRIERS AND OIL OR BULK DRY CARGO CARRIERS

3.3.1 General.

3.3.1.1 The requirements of this Chapter apply to ships designed for the carriage of bulk dry cargoes and to ships designed both for the carriage of bulk dry cargoes and crude oil (oil products) in bulk.

3.3.1.2 The scantlings of structural members bounding the cargo region are to be determined as required by Sections 1 and 2 on assumption of the carriage of bulk or liquid cargo (water ballast) in the holds primarily designed for the purpose concerned. The value to be adopted is the greater of the appropriate strength characteristics of the item.

3.3.1.3 The requirements for the structures not mentioned in this Chapter are to be as given in Sections 1 and 2.

In any case, the requirements for the hull and its structures are not to be less stringent than those stated in Sections 1 and 2.

3.3.1.4 The basic structural type of ships is considered to be a single-deck ship with machinery aft, having a flat (or nearly a flat) double bottom in the holds (permissible slope of the inner bottom from the side to the centreline is not over 3°), hopper side and topside tanks, single or double skin sides, transverse hold bulkheads of plane, corrugated or cofferdam type, which is primarily intended for balk cargoes.

3.3.1.5 In combination carrier the length of the holds is not to exceed $0{,}1L$. Holds of a greater length require special consideration by the Register in each case.

It is assumed that when carrying heavy bulk cargo, certain holds remain empty, their numbers are to be indicated in line "Other characteristics" in Classification Certificate as stated in 2.3, Part I "Classification".

3.3.1.6 Descriptive notation and distinguishing mark “(ESP)”.

3.3.1.6.1 The descriptive notation “BULK CARRIER” and the distinguishing mark “(ESP)” shall be assigned to sea going self-propelled single deck ships with a double bottom, hopper side tanks and topside tanks and with single or double skin side construction intended for carriage of dry cargoes in bulk. Typical midship sections are given in Fig. 3.3.1.6.1.

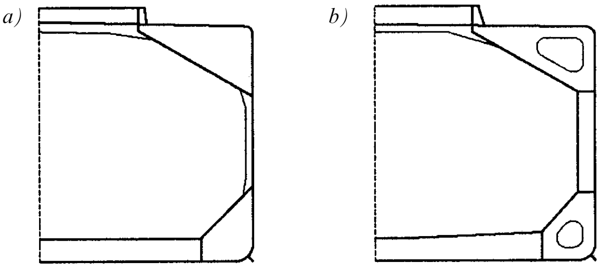


Fig. 3.3.1.6.1

Bulk carrier of single skin side construction means a bulk carrier where one or more cargo holds are bound by the side shell only or by two watertight boundaries, one of which is the side shell, which are:

less than 760 mm apart in bulk carriers, the keels of which are laid or which are at a similar stage of construction before 1 January 2000;

less than 1000 mm apart in bulk carriers, the keels of which are laid or which are at a similar stage of construction on or after 1 January 2000.

3.3.1.6.2 The descriptive notation "OIL/BULK/ORE CARRIER" and the distinguishing mark "(ESP)" shall be assigned to single deck ships of double skin side construction, with a double bottom, hopper side tanks and topside tanks fitted below the upper deck intended for the carriage of oil or dry cargoes, including ore, in bulk. A typical midship section is given in Fig. 3.3.1.6.1, *b*.

3.3.2 Construction.

3.3.2.1 Longitudinal framing is to be adopted for the deck, the side shell in way of topside tanks and the sloped bulkheads of topside tanks. The deck plating between end coamings of adjacent cargo hatches is to be additionally strengthened with intercostal transverse stiffeners fitted at every frame.

The double bottom is to be longitudinally framed. The double bottom structure in which all bottom and inner bottom longitudinals are replaced by side girders may be permitted (see 2.4.2.4.2).

The single skin side between topside and hopper side tanks is to be transversely framed.

Longitudinal or transverse framing may be adopted for the double skin side and in the hopper side tanks.

The transverse watertight bulkheads may be plane with vertical stiffeners, corrugated with vertical corrugations or of a cofferdam type.

3.3.2.2 A hatch side coaming is to be fitted with horizontal stiffeners. At every alternate frame the coaming is to be stiffened with vertical brackets fitted between the coaming flange and the deck.

3.3.2.3 The slope angle of topside tank walls to the horizontal axis is not to be less than 30°.

Inside topside tanks, in line with hold transverse bulkheads, diaphragms are to be fitted, the plating of which may generally have drain and access holes of minimum size. The plating of transverse bulkheads inside topside tanks is to be strengthened with stiffeners. The ends of vertical stiffeners are to be bracketed.

In topside tanks transverse beams are to be fitted in line with deck transverses.

To stiffen the plates of the tank vertical walls which are in line with the hatch side coaming, brackets are to be placed inside the tanks in line with every stay of side coaming. These brackets are to be extended to the deck and tank sloped bulkhead longitudinals nearest to the centreline.

At every frame, in the lower corner of the tank, brackets are to be fitted in line with the brackets attaching the hold frame to the sloped bulkhead of the tank. These brackets are to be carried to the ship's side and tank sloped bulkhead longitudinals nearest to the lower corner of the tanks and welded to them so as to extend beyond the brackets of frames.

3.3.2.4 The slope angle of hopper side tank walls to the horizontal is not to be less than 45°. The extension of the tank over the ship breadth at the inner bottom level is generally not to be less than 0,125*B* on one side.

Transverse diaphragms are to be fitted in line with transverse bulkheads and every alternate plate floor. The diaphragms may have drains and access holes. The total height of openings at the section of diaphragm, in the direction along the normal to the tank plating, from a line drawn through the opening centre perpendicularly to that normal, to the plating is not to exceed 0,5 of the height of that section anywhere. The opening edges are to be reinforced with face plates or stiffeners. The diaphragm plating is to be stiffened as required by 1.7.3.2 for the floor stiffeners.

Inside longitudinally framed tank, brackets are to be fitted in line with every frame. These brackets are to be carried to the sloped bulkhead and side longitudinals and welded to them so as to extend beyond the brackets of frames.

At the outboard side girder forming transversely framed hopper side tank wall, brackets are to be fitted in line with every frame. These brackets are to be carried to the nearest bottom and inner bottom longitudinals and welded to them.

3.3.2.5 Within the cargo area, the single-side structure is to comply with the following requirements:

.1 the scantlings of side hold frames immediately adjacent to the collision bulkhead are to be increased in order to prevent excessive imposed deformation on the shell plating. As an alternative, supporting structures are to be fitted which maintain the continuity of fore peak stringers within the foremost hold;

.2 frame ends should be attached with brackets. The vertical dimension of the lower and upper brackets, as measured at shell plating, is not to be less than 0,125 of the frame span. On the level of the frame adjoining the bilge and underdeck tank, the breadth of the lower and upper brackets is not to be less than half the web height;

.3 frames are to be fabricated symmetrical sections with integral upper and lower brackets and are to be arranged with soft toes. The end brackets adjoining the underdeck and bilge tanks are to be blunted, and the flange ends are to be sniped. The side frame flange is to be curved at the connection with the end brackets. The radius of curvature is not to be less than r, in mm, determined by the formula

$$r = 0{,}4b_{br}^2\,/s_{br} \qquad (3.3.2.5.3)$$

where b_{br} = the flange width, in mm;
s_{br} = the thickness of brackets, in mm;

.4 in ships below 190 m in length, normal steel frames may be asymmetric. The face plates or flanges of brackets are to be sniped at both ends. The brackets are to be arranged with soft toes;

.5 where, a frame being connected to an underdeck tank, the frame or its bracket overlaps with a horizontal section of an inclined wall, provision shall be made for the bracket to go over the bent section, and the angle between the plane of the face plate (bracket) and the inclined tank wall is not to be less than 30°;

.6 the web depth to thickness ratio of frames is not to exceed the following values:

$60\sqrt{\eta}$ for symmetrically flanged frames;

$50\sqrt{\eta}$ for asymmetrically flanged frames;

.7 the outstanding flange is not to exceed $10\sqrt{\eta}$ times the flange thickness;

.8 in way of the foremost hold, side frames of asymmetrical section are to be fitted with tripping brackets which shall be welded to shell plating, webs and face plates of frames;

.9 double continuous welding is to be adopted for the connections of frames and brackets to side shell, hopper wing tank plating and web to face plates. For this purpose, the strength factor α for a weld (see 1.7.5.1) is adopted equal to:

0,44 where frame webs are to be welded to shell plating on lengths equal to 0,25 of the frame span as measured from the upper and lower frame end, and where bracket webs are to be welded to the plating of underdeck and bilge tanks;

0,4 where frame webs are to be welded to shell plating outside the above end sections.

Where the hull form is such as to prohibit an effective fillet weld, edge preparation of the web of frame and bracket may be required, in order to ensure the same efficiency as the weld connection stated above.

3.3.2.6 The ends of plane bulkhead stiffeners are to be bracketed to the inner bottom plating and to deck structures.

3.3.2.7 The cofferdam bulkheads are to satisfy the following requirements:

.1 the construction of cofferdam bulkheads, as stipulated under 2.7.1.2, should consist of two tight platings, diaphragms and/or platforms. To stiffen the plating, vertical or horizontal stiffeners may be fitted;

.2 the vertical or horizontal stiffeners of both platings are to be identical, form a ring structure and pass continuous through the platforms or, accordingly, diaphragms. The vertical stiffeners of both platings are to be fitted in the same plane parallel to the centreline of the ship; the horizontal stiffeners are to be fitted in the same plane parallel to the base line of the ship.

Cross ties are permitted between the vertical or horizontal stiffeners of both platings, at the mid-span thereof;

.3 the diaphragms or platforms are to be stiffened in accordance with 1.7.3.2. The smaller side, in mm, of the panel of diaphragm or platform to be stiffened is not to exceed $100s\sqrt{\eta}$, where s is the thickness of diaphragm or platform, in mm;

.4 for access to all parts of the cofferdam bulkhead an adequate number of openings (manholes) is to be provided in the diaphragms and platforms. The total width of openings in one section of the diaphragm or platform is not to exceed 0,6 of the cofferdam bulkhead thickness.

Openings other than the air and drain scuppers are generally not permitted:

in the platforms, at a distance not less than 1,5 times the cofferdam bulkhead thickness from the longitudinal bulkheads or side, which act as the platform supports;

in the diaphragms, at the same distance from the inner bottom plating or the upper point of the bulkhead bottom trapezoidal stool, if any, and the upper deck plating or the lower point of the horizontal underdeck stiffener of rectangular or trapezoidal section, being the bulkhead top stool, if any, which act as the diaphragm supports.

Edges of the openings cut in the diaphragms and platforms located within $^1/_4$ of the span from their supports are to be reinforced with face plates or stiffeners. The distance between the edges of adjacent openings is to be not less than the length of these openings.

3.3.2.8 Transverse bulkheads with vertical corrugations are to have plane areas at ship's sides not less than $0{,}08B$ in width. The upper ends of these bulkheads are to be attached to the deck by horizontal stiffeners of rectangular or trapezoidal section, complying with the requirements of 3.3.2.11, while the lower ends are to be attached directly to the inner bottom plating or to the stools of trapezoidal section fitted on the inner bottom, complying with the requirements of 3.3.2.10. The bulkheads in heavy cargo holds are to be supported by trapezoidal stools.

At lower end of corrugations there shall be fitted vertical and sloped plates so as to cover the concave portion of corrugations on each side of the corrugated bulkhead. The height of the covering plates in oil or bulk dry cargo carriers is not to be less than 0,1 of the corrugation span, and their thickness is to be not less than the lower strake thickness of the corrugation.

3.3.2.9 Where lower ends of vertical corrugations are attached directly to the inner bottom plating, floors the thickness of which is to be not less than that of the bottom strake of the corrugated bulkheads are to be aligned with transverse faces (those directed athwart the ship).

In this case, web plates (those directed along the ship) of rectangular corrugations are to be in line with inner bottom longitudinals or side girders. Side faces of trapezoidal corrugations are to be arranged so that in way of their intersection with inner bottom longitudinals hard spots are avoided.

3.3.2.10 The construction of the transverse bulkhead bottom trapezoidal stool is to comply with the following requirements:

.1 the stool is fitted on the inner bottom athwart the ship under the bulkhead. It should consist of a top horizontal plate having a width not less than the height of the bulkhead corrugations and two sloped plates resting upon the plate floors. The height of the stool is not to exceed 0,15*D*. Stools of greater height are subject to special consideration by the Register;

.2 inner bottom longitudinals are to be cut at the floors giving support to the sloped plates of the bottom stools and to be attached to them by brackets. Brackets having a thickness not less than that of the floors, reinforced with stiffeners are to be fitted between the floors in line with the inner bottom longitudinals;

.3 diaphragms are to be fitted inside the bottom stools in line with the centre girder and side girders. Drain and access holes may be cut in the diaphragms. Size of the openings, their runforcement as well as stiffening of diaphragms should comply with similar requirements for the diaphragms of hopper side tanks, as specified in 3.3.2.4;

.4 the horizontal and sloped plates inside the bottom stool are to be stiffened to form a ring structure, fitted in line with the inner bottom longitudinals.

3.3.2.11 The construction of the corrugated bulkhead top stool of rectangular or trapezoidal section is to comply with the following requirements:

.1 the top stool is to be fitted under the deck athwart the ship, over the bulkhead. It shall consist of a bottom horizontal plate having a width not less than the height of the bulkhead corrugations and two vertical or sloped plates. The height of the top stool is to be approximately equal to 0,1 of the distance between the topside tanks. The dimensions of the top stool are to be such as to provide access into that stool;

.2 the horizontal and vertical (sloped) plates inside the stool are to be stiffened.

The stiffeners may be fitted in line with the deck longitudinals forming ring structures with them.

Horizontal stiffeners may be fitted. In this case, webs giving intermediate support to these stiffeners as well as brackets ensuring efficient end attachment of corrugations are to be provided inside the top stool;

.3 where an angle between the sloped plate of the top stool and a vertical axis exceeds 30°, brackets ensuring efficient upper end attachment of corrugations are to be fitted inside the top stool in line with plane faces of trapezoidal corrugations.

3.3.3 Design loads.

3.3.3.1 The design loads on the inner bottom members, sides and transverse bulkheads are to be calculated as required by 2.2.3, 2.4.3, 2.5.3 and 2.7.3 respectively, taking account of the heaviest of the anticipated bulk cargoes, liquid cargo (water ballast) or empty holds, whichever is appropriate.

3.3.3.2 The design pressure on the plating and framing of the hopper side tank sloped sides and of the plates of the transverse bulkhead bottom stools is to be determined as required by 1.3.4.3 for the heaviest of the anticipated bulk cargoes and as required by 1.3.4.2 for liquid cargo, whichever is appropriate. In any case, the design pressure need not be taken less than that determined by the Formula (1.3.4.2-4) and for the trapezoidal stools also in accordance with 2.7.3.1.

3.3.3.3 The design pressure on the plating and framing of the topside tank longitudinal bulkheads and of the plates of the transverse bulkhead top stools of rectangular or trapezoidal section is to be determined as required by 1.3.4.2 for the holds filled with liquid cargo (water ballast). In any case, the design pressure need not be taken less than that determined by the Formula (1.3.4.2-4) and for the top stools also in accordance with 2.7.3.1.

3.3.3.4 Where the hopper side and/or topside tanks, transverse bulkhead bottom and/or top stools, space inside the cofferdam bulkheads and/or inter-skin space are used as tanks, the design pressure is to be determined with regard for the pressure from the inside as required by 1.3.4.2.

3.3.4 Scantlings of structural members.

3.3.4.1 The scantlings of double bottom members are to satisfy the following requirements:

.1 the scantlings of centre girder, side girders and floors are to be determined on the basis of strength calculation made for bottom grillages using design pressure stated in 3.3.3 and the following permissible stress factors:

for centre girder and side girders

$k_\sigma = 0,3k_B \leqslant 0,6$ in the midship region, when determining the shell plating stresses;

$k_\sigma = 0,35k_B \leqslant 0,6$ in the midship region, when determining the inner bottom plating stresses;

$k_\sigma = 0,6$ at the ship's ends within 0,1*L* from the fore or after perpendicular.

For regions between the midship region and the above portions of ship's ends, k_σ is to be determined by linear interpolation;

for floors

$k_\sigma = 0,6$;

when the strength is verified using the shear stresses,

$k_\tau = 0,6$;

k_B is to be obtained from the Formula (2.2.4.1).

Where combinations of empty and loaded holds are envisaged, this shall be accounted for in the strength calculation made for the bottom grillage when determining the root flexibility factor of the centre girder and side girders on the bearing contour line of the grillage. Account may be taken of the end root flexibility of floors owing to rotational stiffness of the hopper side tanks. The grillage is to be treated as a system of cross members (structural idealization using beam models).

For ships of 150 m in length and more, intended to carry cargoes having bulk density of 1,0 t/m^3 and more, the strength of double-bottom structural components shall be additionally verified in accordance with a special procedure, described in Annex 2, for the case of each of the holds being flooded;

.2 the section modulus of the bottom primary members is to be determined in accordance with 2.4.4.5 taking the following permissible stress factors:

for longitudinals

$k_\sigma = 0{,}4k_B \leqslant 0{,}65$ in the midship region;

$k_\sigma = 0{,}65$ at the ship's ends within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of the ship's ends, k_σ is to be determined by linear interpolation;

for transverse members

$k_\sigma = 0{,}65$;

k_B is to be determined by the Formula (2.2.4.1);

.3 the section modulus of inner bottom primary members is to be determined in accordance with 2.4.4.5 at the design pressure in accordance with 3.3.3 and the following permissible stress factors:

for longitudinals

$k_\sigma = 0{,}5k_B \leqslant 0{,}75$ in the midship region;

$k_\sigma = 0{,}75$ at the ship's ends within $0{,}1L$ from the fore or after perpendicular.

For regions between the midship region and the above portions of the ship's ends, k_σ is to be determined by linear interpolation;

for transverse members

$k_\sigma = 0{,}75$

k_B is to be determined by the Formula (2.2.4.1).

3.3.4.2 the scantlings of the hopper side tank members are to comply with the following requirements:

.1 the thickness of the sloped bulkhead plating is not to be less than that determined by the Formula (1.6.4.4) taking:

$m = 15{,}8$;

p = design pressure as defined in 3.3.3;

k_σ is to be taken as for the longitudinal bulkhead plating of tankers as required by 2.7.4.1, but not more than for the inner bottom plating in accordance with 2.4.4.4.1.

The bottom strake thickness of the tank sloped bulkhead is not to be less than that of the inner bottom plate adjacent to it. The thickness of other strakes, in mm, is not to be less than:

$$s_{\min} = (7 + 0{,}035L)\sqrt{\eta}\ , \tag{3.3.4.2}$$

but not greater than the bottom strake thickness, where η is to be obtained from Table 1.1.4.3.

If $L > 260$ m, $L = 260$ m shall be adopted.

Where the hold and/or tank is used for the carriage of oil, oil products or water ballast, the thickness is not to be less than required by 3.5.4;

.2 the section modulus of primary members of the sloped bulkhead is not to be less than that determined in accordance with 1.6.4.1 and 1.6.4.2 taking:

p = design pressure as defined in 3.3.3;

$m = 10$ for transverse stiffeners;

$m = 12$ for longitudinal stiffeners;

k_σ is to be taken as for the bulkhead stiffeners of tankers as specified in 2.7.4.2, but not more than for the inner bottom primary members in accordance with 3.3.4.1.3.

The longitudinal stiffeners are to comply with buckling strength requirements, as specified in 1.6.5.2;

.3 the thickness of the diaphragm plating is not to be less than that of the abutting plate floors. Stiffening of the diaphragms with openings is to comply with the requirements for stiffeners of the floors, as specified in 1.7.3.1.

The thickness of plating and the scantlings of the stiffening framing members of the watertight diaphragms are to comply with the requirements for the tank bulkheads as specified in 2.7.4.1 and 2.7.4.2.

3.3.4.3 Where the frame ends are attached directly to the sloped bulkheads of tanks (without transition horizontal area), the section modulus at support section W_{sup}, in cm^3, is to be not less than:

$$W_{sup} = W_0/\cos^2\alpha \tag{3.3.4.3}$$

where W_0 = section modulus at the frame support section as required by 2.5.5.1, in cm^3;
α = slope angle of the tank bulkhead to the base line, in deg.

3.3.4.4 The scantlings of the frames are to be in accordance with the requirements of 2.5.4.1 and with those given below:

см.Б1 **.1** the thickness of frame webs $s_{w\ \min}$, in mm, is not to be less than:

$$s_{w\ \min} = k(7 + 0{,}03L) \tag{3.3.4.4}$$

where $k = 1{,}15$ for frame webs in way of the foremost hold;
$k = 1{,}0$ for frame webs in way of other holds.

Where $L > 200$ m, L is to be taken equal to 200 m;

.2 the thickness of the bracket connecting the lower end of frame to the bilge tank is not to be less than that of the frame web or $s_{w\ min} + 2$ mm, whichever is greater. The thickness of the bracket connecting the upper end of frame to the underdeck tank is not to be less than that of the frame web;

.3 the section modulus of the frame and bracket or integral bracket, and associated shell plating, is not to be less than twice the section modulus required for the frame midspan area.

3.3.4.5 The scantlings of the topside tank members are to comply with the following requirements:

.1 the plating thickness of the vertical and sloped bulkheads of the topside tank is not to be less than determined by the Formula (1.6.4.4) taking:

$m = 15{,}8$;

p = design pressure as defined in 3.3.3;

k_σ is to be taken as for the longitudinal bulkhead plating of tankers as specified in 2.7.4.1.

The thickness, in mm, of the vertical bulkhead plating and of the adjoining sloped bulkhead plate is not to be less than:

$$s_{\min} = 10 + 0{,}025L . \qquad (3.3.4.5)$$

Where $L > 200$ mm, L is to be taken equal to 200 m.

The thickness of other sloped bulkhead plates is to be not less than that determined by the Formula (2.7.4.1-2). Where the hold and/or tank is used for the carriage of oil, oil products or water ballast, the thickness is to be not less than that required by 3.5.4;

.2 the section modulus of longitudinal stiffeners of the vertical and sloped bulkheads is not to be less than that determined according to 1.6.4.1 and 1.6.4.2 taking:

p = design pressure as defined in 3.3.3, but not less than 25 kPa;

$m = 12$;

k_σ is to be taken as for horizontal stiffeners of longitudinal bulkheads of tankers as specified in 2.7.4.2.

The longitudinal stiffeners of the vertical and sloped bulkheads are to comply with buckling strength requirements of 1.6.5.2;

.3 the section modulus of the transverse web of the sloped bulkhead is to be not less than that determinated in 1.6.4.1 and 1.6.4.2, and the sectional area of the web plate is not to be less than that determined in accordance with 1.6.4.3 taking:

$N_{\max} = 0{,}5pal$;

p = design loading as defined in 3.3.3, but not less than 25 kPa;

$m = 10$;

$k_\sigma = k_\tau = 0{,}75$;

.4 the section modulus and sectional area of the deck transverse web inside the tank is to comply with the requirements of 2.6.4.6.

The section modulus and sectional area of the side transverse web inside the tank is to comply with the requirements of 2.5.4.5 at $m = 10$.

The section modulus and sectional area of vertical web plate of the tank vertical bulkhead is to be calculated as the mean of these values for the deck transverse and transverse web of the sloped bulkhead;

.5 the plate thickness of bulkheads inside the tanks fitted in line with the hold transverse bulkheads is not to be less than that of the latter at the same distance from the inner bottom plating. Stiffening of bulkhead plating is to comply with the requirements of 2.7.4.2 for the tank primary members;

.6 the thickness of brackets stiffening the tank vertical bulkhead and of brackets fitted at the lower corner of the tank is not to be less than 10 mm.

3.3.4.6 In any case, the hold bulkhead plating and corrugations are to have a thickness not less than 10 mm.

The height of top rectangular (trapezoidal) stool, bottom trapezoidal stool and of double bottom is not included in the span of the hold bulkhead vertical corrugations.

3.3.4.7 The scantlings of the transverse bulkhead lower trapezoidal stool members are to comply with the following requirements:

.1 the thickness of the horizontal and sloped plate is not to be less than that determined by the Formula (1.6.4.4) taking:

$m = 15{,}8$;

p = design pressure as defined in 3.3.3;

$k_\sigma = 0{,}9$.

The thickness of horizontal plate and top strake of the sloped plate is not to be less than that of the corrugation adjoining the stool. The thickness of the bottom strake of the sloped plate is not to be less than that of the inner bottom plating. The thickness of other stakes of the sloped plate is not to be less than that determined by the Formula (3.3.4.2). Where the hold and/or stool is used for the carriage of oil, oil products or water ballast, the thickness is to be not less than that required by 3.5.4;

.2 the section modulus of the sloped plate stiffeners is not to be less than that determined in accordance with 1.6.4.1 and 1.6.4.2 taking:

p = design pressure as defined in 3.3.3;

$m = 10$;

$k_\sigma = 0{,}75$.

The section modulus of the horizontal plate stiffeners is not to be less than that of the sloped plate stiffeners;

.3 the thickness of diaphragm is not to be less than that of side girders. Size of the openings cut in diaphragms and their reinforcement are to comply with the requirements for openings and reinforcement of the hopper side tank diaphragms as specified in 3.3.4.2.3.

3.3.4.8 The scantlings of the transverse bulkhead top rectangular or trapezoidal stool members are to comply with the following requirements:

.1 the thickness of the horizontal and vertical (or sloped) plates is not to be less than that determined by the Formula (1.6.4.4) taking:

$m = 15{,}8$;

p = design pressure as defined in 3.3.3;

$k_\sigma = 0{,}9$.

The thickness of the horizontal plate and bottom strake of the vertical (sloped) plate is not to be less than that of the corrugation adjoining the top stool. Where the vertical plate is fitted in line with the hatch end coaming, its thickness is not to be less than that of this coaming as required by 3.3.4.11. The top strake of the sloped plate is to have the same thickness provided that its upper edge is at a distance of less than 0,4 m from the hatch end coaming. In any case, the thickness of the vertical or sloped plate is not to be less than that determined by the Formula (2.7.4.1-2). Where the hold and/or interior of the top stool is used for the carriage of oil, oil products or water ballast, the thickness is not to be less than that required by 3.5.4;

.2 the section modulus of the stiffeners of vertical or sloped plate is not to be less than that determined according to 1.6.4.1 and 1.6.4.2 taking:

p = design pressure as defined in 3.3.3, but not less than 25 kPa.

$m = 12$ for horizontal stiffeners;

$m = 10$ for other stiffeners;

$k_\sigma = 0,75$.

The section modulus of the stiffeners of hori-zontal plate is not to be less than that of the stiffeners of vertical or sloped plate;

.3 the section modulus of the vertical or sloped plate web to be fitted where horizontal stiffeners are provided, as stated in 3.3.2.11.2, is not to be less than that determined from 1.6.4.1 and 1.6.4.2, while the sectional area of the web plate is not to be less than determined according to 1.6.4.3 taking:

$N_{\max} = 0,5pal$;

p = design loading as defined in 3.3.3, but not less than 25 kPa;

$m = 10$;

$k_\sigma = k_\tau = 0,75$.

The section scantlings of webs fitted on the horizontal plate and under the deck are not to be less than those required for the vertical (sloped) plate web;

.4 the thickness of the brackets fitted inside the top stool to ensure efficient upper end attachment of corrugations is not to be less than that of these corrugations in the upper part of the bulkhead.

3.3.4.9 The scantlings of the cofferdam bulkhead members are to comply with the following requirements:

.1 the thickness of the cofferdam bulkhead plating is not to be less than that determined by the Formula (1.6.4.4) taking:

$m = 15,8$;

p = design pressure as defined in 3.3.3;

$k_\sigma = 0,9$.

The plating thickness is not to be less than that determined from the Formula (2.7.4.1-2) or according to 3.3.4.6, whichever is the greater. Where the hold or interior of the cofferdam bulkhead is used for the carriage of oil, oil products or water ballast, the plating thickness is to be not less than that required by 3.5.4;

.2 the section modulus of primary members stiffening the plating of cofferdam bulkheads is not to be less than that determined from 1.6.4.1 and 1.6.4.2 taking:

p = design pressure as defined in 3.3.3 but not less than 25 kPa;

$m = 12$;

$k_\sigma = 0,75$;

.3 where the construction of the cofferdam bulkhead incorporates only diaphragms or only platforms, their section modulus is not to be less than that determined from 1.6.4.1 and 1.6.4.2, and the sectional area is not less than that determined from 1.6.4.3 taking:

$N_{\max} = 0,5pal$ for platforms,

$N_{\max} = 0,65pal$ for diaphragms;

p = design loading as defined in 3.3.3, but not less than 25 kPa;

l = span, in m, equal to:

for diaphragms — the distance between the deck plating and inner bottom plating, at the centreline;

for platforms — the ship's breadth in way of construction bulkhead for ships having single skin side construction, the distance between the inner skins for ships having double skin side construction;

$m = 10$;

$k_\sigma = k_\tau = 0,75$;

.4 where the construction of the cofferdam bulkhead consists both the diaphragms and platforms, their thickness is to be determined on the basis of the calculation of the grillage as a system using beam models, with the loading specified in 3.3.3 but not less than 25 kPa and the permissible stress factors $k_\sigma = k_\tau = 0,75$;

.5 in any case, the thickness of the cofferdam bulkhead diaphragms and platforms is not to be less than that determined by the Formula (2.5.4.8). Where the interior of the cofferdam bulkhead is used as a fuel oil or ballast tank, the thickness of the diaphragms and platforms is not to be less than that required by 3.5.4;

.6 stiffening of the diaphragms and platforms is to comply with the requirements of 1.7.3.2.2;

.7 the thickness of tight portions of the diaphragms and platforms and their stiffeners are to comply with the requirements of 2.7.4.1 and 2.7.4.2 for tank bulkheads;

.8 cross ties between the primary members strengthening the cofferdam bulkhead plating are to comply with the requirements for the double bottom intermediate struts, as specified in 2.4.4.7 with the design pressure determined according to 3.3.3, but not less than 25 kPa.

Where cross ties are fitted, the section modulus of the primary members, as specified in 3.3.4.9.2, may be reduced by 35 per cent.

3.3.4.10 For ships of 150 m in length and more, intended to carry cargoes having bulk density of 1,0 t/m^3 and more, the strength of transverse, watertight, vertically corrugated bulkheads should be additionally verified in accordance with a special procedure, described in Annex 2, for the case of each of the holds being flooded.

3.3.4.11 The thickness of the hatch coamings is not to be less than that determined by the Formula (3.3.4.4).

The thickness of the hatch side coamings, in mm, is not to be less than:

$$s = 17a \tag{3.3.4.11}$$

where a = vertical distance between horizontal stiffeners on coaming plate or between the lower stiffener and the deck plating, in m.

Stiffening of the coaming plates is to comply with the requirements of 1.7.3.2. The thickness of coaming plate stiffeners and brackets is not to be less than 10 mm.

The width of the coaming face plate is to comply with the requirements of 1.7.3.1.

3.3.4.12 The thickness of single-side shell plating located between hopper and upper wing tanks is not to be less than $s_{\min}$, in mm, determined by the formula

$$s_{\min} = \sqrt{L}. \tag{3.3.4.12}$$

3.3.5 Special requirements.

3.3.5.1 Provision is to be made for an efficient corrosion protection coating (epoxy coating or equivalent) for all internal surfaces of the cargo holds, excluding the flat tank top areas and the hopper tanks sloping plating, approximately 300 mm below the toe of frame brackets and for all internal and external surfaces of hatch coamings and hatch covers. In the selection of coating due consideration is to be given to intended cargo conditions expected in service.

см.Б1 **3.3.5.2** The longitudinal strength of ships of 150 m in length and more, intended to carry cargoes having bulk density of 1,0 t/m^3 and more, is to be verified for the case of each cargo hold being flooded as a result of hull damage, in each of the cargo and ballast conditions considered in the intact longitudinal strength calculations. The verification may not be carried out in the following cases:

for ships, which keel was laid, or being at a similar stage of construction before 1 July 1999 and having double sides in way of cargo holds;

for ships, which keel was laid, or being at a similar stage of construction before 1 July 2000 and having double sides at least 760 mm broad in way of cargo holds;

for ships, which keel was laid, or being at a similar stage of construction on 1 July 2000 or after this date and having double sides at least 1000 mm broad in way of cargo holds.

The breadth of double sides shall be measured perpendicularly to the shell plating.

The actual hull girder bending stress σ_{fld}, in MPa, is determined by the formula

$$\sigma_{fld} = \frac{M_{sw}^{fld} + 0{,}8M_w}{W} 10^3 \tag{3.3.5.2-1}$$

where M_{sw}^{fld} = still water bending moment, in kN m, in the flooded conditions for the section under consideration;

M_w = wave bending moment, in kN m, in accordance with 1.4.4.1 for the section under consideration;

W = actual section modulus, in cm^3, for the corresponding location in the hull girder.

The actual hull girder shear stress τ_{fld}, in MPa, is determined by the formula

$$\tau_{fld} = \frac{N_{sw}^{fld} + 0{,}8N_w}{2s} \frac{S}{I} 10^3 \tag{3.3.5.2-2}$$

where N_{sw}^{fld} = still water shear force, in kN, in flooded condition for the section under consideration;

N_w = wave shear force, in kN, in accordance with 1.4.4.2 for the section under consideration;

I, S = as defined in 1.4.2;

s = thickness of plating, in mm.

The ship strength analysis in damaged condition is to demonstrate that the actual hull girder bending stresses do not exceed 175/η, in MPa, and the actual shear stresses do not exceed 110/η, MPa.

To carry out an analysis of damaged ship strength, the following assumptions are to be made:

the damaged structure is assumed to remain fully effective in resisting the applied loading;

each cargo hold is to be considered individually flooded up to the equilibrium waterline. Position of the waterline and the volume of ingressed water are determined on the basis of damaged trim calculations which are to be made in accordance with a program approved by the Register;

"permeability" for solid bulk cargo means the ratio of the floodable volume between the particles, granules or any larger pieces of the cargo, to the gross volume of the bulk cargo;

the permeability of empty cargo spaces and volume left in loaded cargo spaces above any cargo is to be taken as 0,95;

appropriate permeabilities and bulk densities are to be used for any cargo carried. For iron ore, a minimum permeability of 0,3 with a corresponding bulk density of 3,0 t/m^3 is to be used. For cement, a minimum permeability of 0,3 with a corresponding bulk density of 1,3 t/m^3 is to be used;

for packed cargo conditions (such as steel mill products), the actual density of the cargo shall be used with a permeability of zero. см.Б1-добавлено

3.3.6 Strength control during ship loading.

3.3.6.1 Bulk carriers, ore carriers and combination carriers of 150 m length and more are to be provided with an approved loading manual and the Register-approved loading instrument of an approved type.

3.3.6.2 Loading manual is a document approved by the Register, which describes:

the loading conditions on which the design of the ship has been based, including permissible limits of still water bending moments and shear forces;

the results of the calculations of still water bending moments, shear forces and where applicable, limitations due to torsional loads;

envelope results and permissible limits of still water bending moments and shear forces in the hold flooded condition according to 3.3.5.2;

the cargo holds or combination of cargo holds that might be empty at full draught. If no cargo hold is allowed to be empty at full draught, this is to be clearly stated in the loading manual;

maximum allowable and minimum required mass of cargo and double bottom contents of each hold as a function of the draught at mid-hold position;

maximum allowable and minimum required mass of cargo and double bottom contents of any two adjacent holds as a function of the mean draught in way of these holds. This mean draught may be calculated by averaging the draught of the two mid-hold positions;

maximum allowable tank top loading together with specification of the nature of the cargo (density or stowage factor) for cargoes other than bulk cargoes;

maximum allowable load on deck and hatch covers. If the ship is not approved to carry load on deck or hatch covers, this is to be clearly stated in the loading manual;

the maximum rate of ballast change together with the advice that a load plan is to be agreed with the terminal on the basis of the achievable rates of change of ballast.

In addition to the requirements given in 1.4.3.1.1, the following conditions, subdivided into departure and arrival conditions as appropriate, are to be included in the loading manual:

alternate light and heavy cargo loading conditions at maximum draught, where applicable;

homogeneous light and heavy cargo loading conditions at maximum draught;

ballast conditions. For ships having ballast holds adjacent to topside wing, hopper and double bottom tanks, it shall be strengthwise acceptable that the ballast holds are filled when the topside wing, hopper and double bottom tanks are empty;

short voyage conditions where the vessel is to be loaded to maximum draught but with limited amount of bunkers;

multiple port loading/unloading conditions;

deck cargo conditions, where applicable;

typical loading sequences where the vessel is loaded from commencement of cargo loading to reaching full deadweight capacity, for homogeneous conditions, relevant part load conditions and alternate conditions where applicable. Typical unloading sequences for these conditions shall also be included. The typical loading/unloading sequences shall also be developed to not exceed applicable strength limitations. The typical loading sequences shall also be developed paying due attention to loading rate and the deballasting capability;

typical sequences for change of ballast at sea, where applicable.

3.3.6.3 A loading instrument is an approved digital system as defined in 1.4.9.4. In addition to the requirements in 1.4.9.4, it shall ascertain as applicable that:

the mass of cargo and double bottom contents in way of each hold as a function of the draught at mid-hold position;

the mass of cargo and double bottom contents of any two adjacent holds as a function of the mean draught in way of these holds;

the still water bending moment and shear forces in the hold flooded conditions according to 3.3.5.2;

are within permissible values.

Conditions of approval of loading instruments, as stated in 1.4.9.4, are to include the following:

acceptance of hull girder bending moment limits for all read-out points;

acceptance of hull girder shear force limits for all read-out points;

acceptance of limits for mass of cargo and double bottom contents of each hold as a function of draught;

acceptance of limits for mass of cargo and double bottom contents in any two adjacent holds as a function of draught.

3.4 ORE CARRIERS AND ORE OR OIL CARRIERS

3.4.1 General.

3.4.1.1 The requirements of this Chapter apply to ships for the carriage of ore and other bulk cargoes, as well as to combination carriers for transportation of ore and oil (petroleum products).

3.4.1.2 The requirements for structures not mentioned in this Chapter are to be as stated in Sections 1 and 2, having regard to those contained in 3.3 as regards structures exposed to the loads from heavy dry bulk and liquid cargoes.

In any case, the requirements for the hull and its structures are not to be less stringent as those of Sections 1 and 2.

3.4.1.3 The basic structural type of a ship is considered to be a single deck ship, with machinery aft, having longitudinal bulkheads separating the centre ore compartment from the wing tanks and a double bottom throughout the entire breadth of the ship or the centre part between the longitudinal bulkheads.

3.4.1.4 Descriptive notation and distinguishing mark "(ESP)".

3.4.1.4.1 The descriptive notation "ORE CARRIER" and the distinguishing mark "(ESP)" shall be assigned to sea-going self-propelled single deck ships having two longitudinal bulkheads and a double bottom throughout the cargo region and intended for the carriage of ore cargoes in the center holds only. A typical midship section is given in Fig. 3.4.1.4.1.

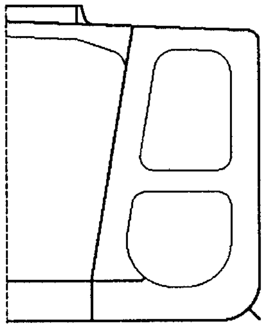


Fig. 3.4.1.4.1

3.4.1.4.2 "COMBINATION CARRIER" is a general term applied to ships intended for the carriage of both oil and dry cargoes in bulk; these cargoes are not carried simultaneously, with the exception of oil retained in slop tanks.

3.4.1.4.3 The descriptive notation "ORE/OIL CARRIER" and the distinguishing mark "(ESP)" shall be assigned to sea-going self-propelled single deck ships having two longitudinal bulkheads and a double bottom throughout the cargo region and intended for the carriage of ore cargoes in the centre holds or of oil cargoes in centre holds and wing tanks. Typical midship sections are given in Fig. 3.4.1.4.3.

3.4.2 Construction.

3.4.2.1 The deck and bottom (double bottom) are to be longitudinally framed. The side shell and longitudinal bulkheads may, in general, be framed either longitudinally or transversely. Deck plating between end coamings of adjacent cargo hatches is to be strengthened by transverse stiffeners as required by 3.3.2.1.

Transverse bulkheads may be plane with stiffeners arranged vertically, corrugated with vertical corrugations or of a cofferdam type.

3.4.2.2 Floors in the centre hold and in the wing tanks are to be aligned and to form, in conjunction with side transverses, vertical webs of longitudinal bulkheads and deck transverses, a single transverse ring structure.

3.4.2.3 Where transverse bulkheads in the wing tanks are not aligned with centre hold bulkheads, transverse ring structures are to be fitted in line with the latter bulkheads.

In this case, provision is to be made in the wing tanks for a smooth tapering of the sloped bulkheads of trapezoidal stools fitted under centre hold bulkheads.

3.4.2.4 Longitudinal bulkheads are, in general, to be plane with horizontal or vertical stiffening.

Longitudinal bulkheads may be slightly sloped or to have a knuckle.

3.4.2.5 Where a double bottom in wing tanks is omitted, floors are to be backed by substantial knees or brackets fitted in line with the inner bottom plating of the centre hold.

3.4.2.6 Diaphragms shall be fitted in line with the longitudinal bulkheads inside the bottom trapezoidal stools and top stools of rectangular or trapezoidal sections. The diaphragms of the bottom stools are to comply with the requirements of 3.3.2.10.3, the diaphragms of the top stools — with the requirements for the topside tank bulkheads as specified in 3.3.2.3.

3.4.3 Design loads.

3.4.3.1 The design pressure on the centre hold boundary structures is to be determined according to 1.3.4.3 assuming that the centre hold is loaded with ore or other heavy bulk cargo.

3.4.3.2 Structures which are likely to be subjected to one-sided pressure of a liquid cargo (ballast water) are to be examined for the design pressure of the liquid cargo as required by 1.3.4.2.

3.4.4 Scantlings of structural members.

3.4.4.1 The scantlings of structural members of the cargo spaces intended only for the carriage of bulk cargoes or bulk cargoes and oil, oil products or water ballast are to comply with the requirements of Section 2 and 3.3.4.

The scantlings of structural members of the cargo spaces intended only for the carriage of oil, oil products or water ballast are to comply with the requirements of Section 2 and 3.5.4.

3.4.4.2 The scantlings of longitudinal bulkhead members are to comply with the requirements of 2.7.4 at the design pressure defined in 3.4.3.

In any case, the thickness of longitudinal bulkhead plating is not to be less than that required by the Formula (3.3.4.5) or, where oil, oil products or water

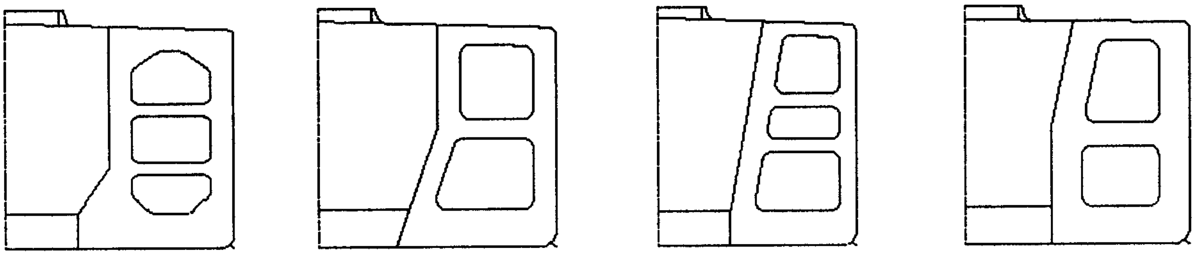


Fig. 3.4.1.4.3

ballast is carried in any compartment bounded by that bulkhead, it is to be not less than that required by 3.5.4, whichever is the greater.

3.4.4.3 The scantlings of structural items of diaphragnis of transverse bulkhead bottom trapezoidal stool, fitted in line with the longitudinal bulkheads, are to comply with the requirements of 3.3.4.7.3.

3.4.4.4 The scantlings of structural items of diaphragms of transverse bulkhead top stool, fitted in line with longitudinal bulkheads, are to comply with the requirements of 3.3.4.5.5 for the transverse bulkheads inside the topside tanks.

см.Б1

3.5 TANKERS

3.5.1 General.

3.5.1.1 The requirements of this Chapter apply to tankers, chemical tankers, as well as to oil recovery ships and gas carriers, as applicable, with machinery aft, having a single or a double bottom arrangement and one, two or three longitudinal bulkheads. Hull structural members of tankers not covered by this Chapter are to comply with the requirements of Sections 1 and 2.

3.5.1.2 Descriptive notation and distinguishing mark "(ESP)".

3.5.1.2.1 The descriptive notation "OIL TANKER" and the distinguishing mark "(ESP)" shall be assigned to sea-going self-propelled ships having integral tanks and intended for the carriage of oil in bulk. The above mentioned descriptive notation and distinguishing mark shall be assigned to tankers of both single and double skin side construction, as well as tankers with alternative structural arrangements, e.g. mid-deck designs. Typical midship sections are given in Fig. 3.5.1.2.1.

3.5.1.2.2 The descriptive notation "CHEMICAL TANKER" and the distinguishing mark "(ESP)" shall be assigned to sea-going self-propelled ships having integral tanks intended for the carriage of chemicals in bulk. This descriptive notation shall be assigned to tankers of both single or double skin side construction, as well as tankers with alternative structural arrangements. Typical midship sections are given in Fig. 3.5.1.2.2.

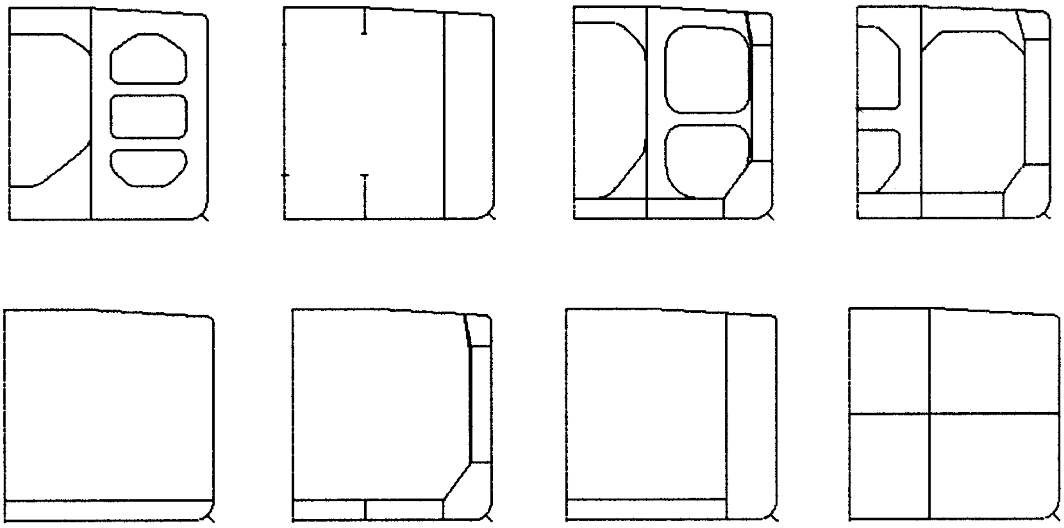


Fig. 3.5.1.2.1

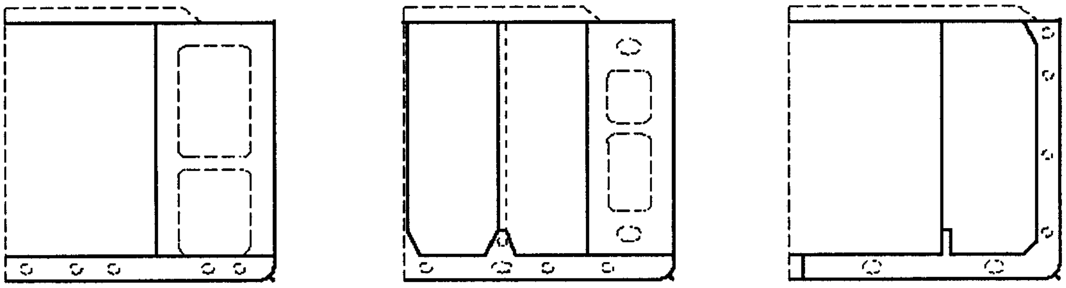


Fig. 3.5.1.2.2

3.5.2 Structural configuration.

3.5.2.1 The scantlings of the cofferdams are to be determined according to 2.7.5.2.

3.5.2.2 Longitudinal corrugated bulkheads are permitted in ships under 180 m in length.

Longitudinal corrugated bulkheads are to have horizontally arranged corrugations, and their upper and lower strakes for 0,1D from the deck and bottom, respectively, are to be plane.

In way of connections between longitudinal and transverse bulkheads, continuity of strength is to be maintained at the top and bottom strakes of the longitudinal bulkheads.

3.5.2.3 The deck and bottom in the cargo tank region are to be framed longitudinally, for the side shell and longitudinal bulkheads, longitudinal or transverse framing may be adopted. The deck and bottom of ships under 80 m in length may be transversely framed. It is recommended that longitudinal framing be used for side shell and longitudinal bulkheads of ships over 180 m in length. Where the longitudinal framing is adopted, spacing of transverse members is to correspond to that of bottom transverses (see 2.3.2.4 and 2.4.2.5).

3.5.2.4 The longitudinal scantlings of deck, bottom, side shell and longitudinal bulkheads within the midship portion of the ship are not to vary. Structural continuity of the above longitudinals is to be ensured within 0,1D from deck and bottom.

In ships of 150 m in length and more, the above longitudinals are to pass through the transverse bulkheads without cutting.

3.5.2.5 The primary supporting members (bottom centreline girder, side girders, vertical webs on bulkheads, deck centreline girder, continuous deck girders, side and bottom transverses, side stringers and bulkhead horizontal girders) in way of cargo tanks are to form a transverse ring structure, whenever possible.

3.5.2.6 Hull structural members are to be interconnected as required by 1.7.2. The webs of primary supporting members are to be supported by horizontal or vertical stiffeners in accordance with 1.7.3.2. The inertia moment of stiffeners is to comply with 1.6.5.6.

3.5.3 Design loads.

Unless provided otherwise in this Chapter, the design loads on hull structures of tankers are to be taken according to 1.3 and relevant chapters of Section 2.

3.5.4 Scantlings of structural members.

The scantlings of structural members of tankers are to be determined in compliance with Section 2, having regard to the provisions of this Chapter.

The thickness $s_{\min}$, in mm, of structural members, forming the boundaries of cargo and ballast tanks as well as members fitted inside these tanks is not to be less than:

$$s_{\min} = 5{,}5 + 0{,}035L \text{ for } L < 80 \text{ m}; \qquad (3.5.4)$$
$$s_{\min} = 6{,}7 + 0{,}02L \text{ for } L \geqslant 80 \text{ m}.$$

Where $L > 290$ m, L is to be taken as equal to 290 m. In this case, the minimum thickness of the primary members need not exceed 11,5 mm.

3.5.5 Special requirements.

3.5.5.1 The number of openings for access to cofferdams, pump rooms, cargo and ballast tanks is to be kept to the minimum required. They are to be as far distant as practicable from end bulkheads of superstructures. Hatches to wing tanks in line with a centre tank hatch in the athwart direction are not permitted.

Hatch openings are to be either circular or elliptical in shape, the elliptical openings having the major axis fore and aft. Structural continuity of deck girders and longitudinals is to be maintained. The thickness of cargo hatch coamings less than 750 mm high is to be 10 mm, while coamings 750 mm and more in height are to have a thickness equal to 12 mm. Coamings more than 750 mm in height, provided they are more than 1,25 m long, are to be stiffened.

3.5.5.2 Guard rails, bulwark, gangway or an equivalent arrangement are to be fitted in compliance with 8.6, Part III "Equipment, Arrangements and Outfit".

The gangway, if fitted, is not to contribute to hull longitudinal bending.

3.6 VESSELS OF DREDGING FLEET

3.6.1 General.

3.6.1.1 The requirements of this Chapter apply to the hulls of the vessels of dredging fleet and floating cranes. Areas where such ships operate and/or transport spoil are called work areas. The transfer of the ship from one work area to another is called a voyage.

3.6.1.2 As to their purpose, vessels of dredging fleet are to be defined as follows:

Dredgers are self-propelled or non-self-propelled ships designed to operate for the purpose of raising the soil (silt, sand, gravel, clay, etc.) using any dredging gear (buckets, suction pipes, grabs, etc.) and having no spaces where the soil may be stored or transported.

Hopper dredgers are self-propelled ships having dredging gear for raising the soil and one or two hoppers where the spoil may be stored or transported.

Hopper barges are self-propelled or non-propelled ships designed only for transportation of the soil, but having no dredging gear. They can be single-hulled or double-hulled capable of opening.

Floating cranes and crane ships — see the definitions in 1.1, Part I "Classification".

3.6.1.3 The basic structural configuration of a vessel of dredging fleet, considered in this Chapter, is a single-deck vessel with ordinary ship lines or of a pontoon shape, having a ladder well or other hull cut-outs.

The pontoon hull shape may be used only in vessels of restricted service **II**, **IIСП**, **IIIСП** and **III** according to Part I "Classification".

Use of a pontoon hull in vessels of restricted service **I** and of unrestricted service is to be specially considered by the Register.

3.6.1.4 The requirements of this Chapter apply to dredgers, single-hulled and opening double-hulled hopper dredgers and hopper barges, floating cranes and crane ships.

3.6.1.5 In opening hopper dredgers and hopper barges, subject to the Register's supervision are deck and deckhouse hinges, hydraulic presses and their hull connections as well as longitudinal and transverse structures between the hulls and deckhouses.

3.6.1.6 Symbols:

d_1 = maximum dredging draught, in m, at which the vessel is designed to operate;

d_2 = draught during sea voyage, in m;

Δ = displacement at the draught d_1 or d_2, in t;

Δ_l = light-ship displacement without spoil mixture, in m;

Ω = mid-section area corresponding to the draught d_1 or d_2, in m^2;

l_h = full length of the hopper, in m;

$h_{l.cr}$ = depth of a hopper lower cross-member, in m;

$l_{l.cr}$ = hopper lower cross-member span measured at mid-depth between longitudinal bulkheads of the hopper, in m;

H_1 = distance from the mid-depth of the hopper lower cross-member to the deck at side, in m;

H_2 = distance from the base line to the upper edge of the coaming, in m;

h_c = coaming height above the deck line at side, in m;

B_2 = distance between the side shell and the longitudinal bulkhead at mid-depth of a hopper lower cross-member, in m;

B_3 = distance between the side shell and the longitudinal bulkhead at the deck level, in m;

Q_s = maximum mass of the spoil mixture in the hopper, in t;

ρ_s = density of spoil mixture, defined as a ratio of the spoil mass in the hopper at the maximum draught d_1 to the hopper volume up to the level of overflow or to the upper edge of the hopper coaming where there is no overflow, in t/m^3; it is not to be taken more than 1,8;

$A_{b.k}$, $A_{l.cr}$ = areas enveloped in the contour of the centre line box keel, hopper lower cross-member, respectively, in m^2; where the centre line keel and/or a hopper lower cross-member are an ordinary girder (web with a face plate), it is assumed that $A_{b.k} = A_{l.cr} = 0$;

$b_{b.k}$ = centre line box keel width at lower portion, in m;

b_b = bottom breadth from the side shell to the point of intersection of the hopper longitudinal bulkhead with the bottom, in m;

$b_{f.p}$ = width of the coaming upper face plate, in m;

a = spacing of frames, hopper side stiffeners, longitudinals, in m;

b = spacing of transverse ring structures, in m;

l_1, l_2 = length of the upper and lower face plate of the hopper lower cross-member, measured from the hopper longitudinal bulkhead to the centre line box keel, in m;

$R_{up.cr}$, $R_{l.cr}$ = axial force acting on the hopper upper and lower cross-member, respectively, in kN;

N = design axial force, in kN.

Δs = corrosion allowance, in mm, for plate thickness (see 1.1.5.1);

ω_k = factor taking corrosion allowance into account with regard to the section modulus of members (see 1.1.5.3).

Some of the symbols are shown in Fig. 3.6.1.6.

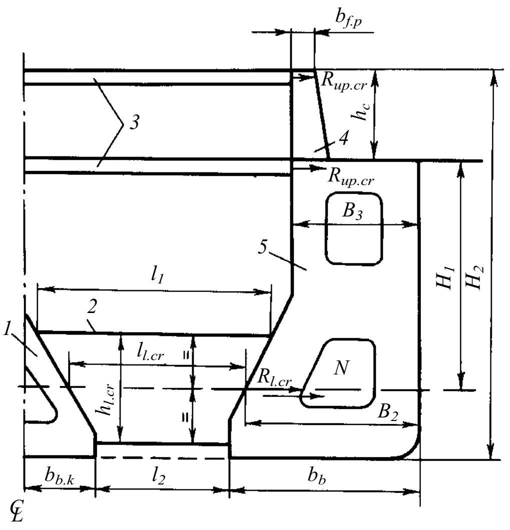


Fig. 3.6.1.6:
1 — centre line box keel; *2* — hopper lower cross member;
3 — hopper upper cross member;
4 — stay of coaming; *5* — diaphragm

3.6.2 Construction.

3.6.2.1 Main hull structures are to comply with the requirements of Section 2, having regard to the provisions and additions given in this Chapter.

Referred to the particular structures of vessels of dredging fleet are:

hopper longitudinal and transverse bulkheads;

hopper lower and upper cross-members;

centre line box keels, hopper coamings;

diaphragms and transverse ring structures in buoyancy spaces (see 3.6.2.11).

For floating cranes strengthening is to be provided of the pontoon hull beneath the fixed crane tower supporting the upper crane structure, this strengthening including the crane tub, the bulkhead cross and the bearing contour (Fig. 3.6.2.1). Other construction of the pontoon

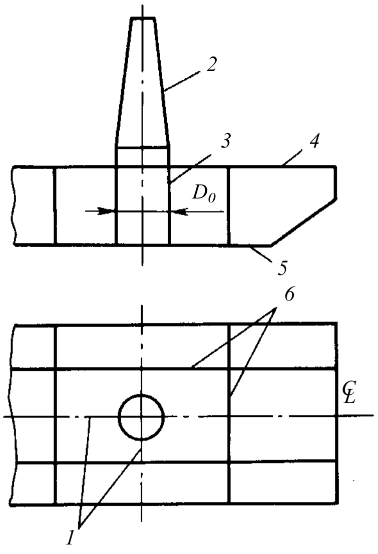


Fig. 3.6.2.1:
1 — bulkhead of the cross; *2* — fixed crane tower; *3* — tub;
4 — upper deck; *5* — bottom;
6 — bulkheads of the bearing contour

strengthening in way of the tower is to be specially considered by the Register.

3.6.2.2 Shell plating.

3.6.2.2.1 Corners of hopper and well openings in the bottom plating are to be rounded and insert plates, the dimensions of which are to be approved by the Register, are to be fitted at the corners.

3.6.2.2.2 The cutting of overflow discharge trunk openings in the sheerstrake is to be avoided wherever practicable. Where such openings cannot be dispensed with, their upper edge is not to be within 800 mm of the deck line at side. They are to have corner radii of not less than 150 mm.

3.6.2.2.3 Angular connection of the side shell plating or longitudinal bulkhead of the well with the bottom plating is to be made by means of section steel (rod, bar).

3.6.2.3 Single bottom.

3.6.2.3.1 The bottom centre girder in way of the hopper and well of hopper dredgers is not to be fitted.

3.6.2.3.2 The depth of floors abreast of hoppers in hopper dredgers and barges with transverse framing and abreast of dredging wells in hopper dredgers is not to be less than ${}^{1}/_{18}B_1$.

The breadth B_1 is taken:

in way of the hopper, equal to the breadth of the vessel after deducting the breadth of the hopper at bottom, but not less than $0{,}6B$;

in way of the well, equal to the breadth of the vessel after deducting the breadth of the well.

3.6.2.3.3 Side girders are to be fitted in side buoyancy tanks of hopper dredgers and hopper barges where the tank width between the vessel's side and the longitudinal bulkhead exceeds 3,5 m in transversely framed vessels, and 4 m in longitudinally framed vessels.

Side girders in opening hopper barges may be omitted.

3.6.2.3.4 In the pump rooms of hopper dredgers, the bottom framing should be identical to that of the engine room.

In the area where soil pumps are located, the depth of floors and side girders may be reduced with the required section modulus and web area being maintained. Otherwise a calculation proving the strength of the bottom grillage in the region concerned is to be submitted to the Register.

3.6.2.3.5 In floating cranes plate floors are to be fitted at every frame within $0{,}2L$ from the forward perpendicular over the entire breadth of the hull and additional bottom transverses or longitudinals spaced not more than 0,35 m apart are to be fitted.

3.6.2.4 Double bottom.

3.6.2.4.1 In lieu of the bottom centre girder, two side girders may be fitted on each side of ship's centre line at a distance not exceeding 1 m from each other and passing into the webs of the centre line box keel or into the well sides (Fig. 3.6.2.4.1).

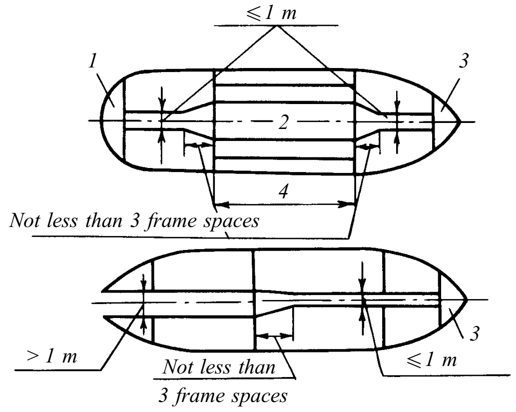


Fig. 3.6.2.4.1:
1 — after peak; *2* — centre line box keel;
3 — fore peak; *4* — hopper space

3.6.2.4.2 Additional side girders extending over a distance of not less than three spacings from the end of the bracket are to be fitted in the double bottom under the lower brackets of longitudinal bulkheads of the hopper space or the well and under the brackets of the centre line box keel.

3.6.2.5 Side framing:

3.6.2.5.1 In floating cranes, hopper dredgers designed to work in conjunction with hopper barges, and in hopper barges, the side framing is to be reinforced as follows:

two rows of efficient fenders, one fitted at the deck level or 200 mm below it, the other 200 to 300 mm above the lowest operating waterline amidships;

the upper and lower fenders in hopper dredgers are to be connected by vertical fenders fitted in line with frames;

it is recommended that a side stringer required by 2.5.4.4 which is to be taken into account in determining the scantlings of the frames or an intercostal side stringer be fitted at a level of the lower fenders.

3.6.2.5.2 In floating cranes the strengthening of the side framing within 0,2*L* from the forward perpendicular is to comply with the requirements of 3.6.2.8. Web frames are to be spaced not more than four spacings apart.

3.6.2.5.3 In floating cranes, intermediate frames of the same scantlings as the main frames are to be fitted in the fore peak and in areas extending forward for 0,1*L* from the stern transom and inboard for 0,1*B* over the entire depth.

The extension and end attachments of intermediate frames are to comply with the requirements of 3.10.

3.6.2.6 Decks and platforms.

3.6.2.6.1 Corners of openings in the deck plating in way of the hopper and the well are to be rounded. Insert plates, the dimensions of which are to be approved by the Register, are to be fitted at the corners.

3.6.2.6.2 In hopper side buoyancy spaces, the hopper lower cross members are to be fitted in line with the web frames unless partial bulkheads are fitted.

3.6.2.7 Watertight bulkheads.

3.6.2.7.1 Bulkheads forming the ends of the hopper are to extend from side to side.

3.6.2.7.2 In bucket dredgers, protective bulkheads are to be provided parallel to the well sides at a distance of not less than 600 mm from them.

The extension of protective bulkheads is to be such as to prevent the ship from flooding in case of damage to the shell plating by objects brought up in the dredge buckets.

A protective bulkhead is to be also provided at the end of the well. The scantlings of framing members and the plating thickness of the protective bulkheads are to be determined as for permanent watertight bulkheads of dry cargo ships. The framing inside the cofferdam formed by the well side and the protective bulkhead may consist of brackets with openings cut therein. Cofferdams are to have access openings for maintenance.

3.6.2.7.3 Bulkheads forming the ladder well in hopper dredgers are to be protected against possible damage by the ladder when moved.

3.6.2.7.4 Longitudinal bulkheads of the hopper and well sides are to terminate at deck and bottom in brackets. The length of the arms of the brackets is not to be less than 0,25*D* and their thickness is not to be less than the plating thickness of the longitudinal bulkhead. The brackets are to be strengthened with stiffeners and to have a face plate over the free edge. The top bracket is to be extended by a deck girder, the bottom bracket by a side girder for at least three spacings beyond the bracket end.

3.6.2.7.5 In floating cranes the bulkheads forming the cross are to be rigidly connected with the bulkheads forming the bearing contour. These bulkheads are to be carried to the nearest transverse and longitudinal bulkheads (sides, transoms).

3.6.2.8 In ships with a pontoon shape of the forward and after ends, the following structural requirements are to be fulfilled:

.1 the fore and after peak bulkheads are to be fitted at a distance of 0,1*L* from the forward and after transoms, but not less than one spacing from the line connecting the raked part and flat of the bottom;

.2 frame spacing in peaks is to be not more than 550 mm;

.3 the bottom framing within 0,15*L* from the forward and after perpendiculars is to consist of plate floors fitted at every frame, with side girder spaced not more than 1 m apart.

The scantlings of floors and side girders are to be determined as for the midship region;

.4 the side framing within 0,2*L* from the forward and after perpendiculars is to be strengthened with web frames and side stringers.

The web frames are to be fitted not more than three or four spacings.

The side stringers are to be fitted so that the distance between the side stringers measured over the vessel's side in way of the floor nearest to the fore peak bulkhead, the distance from the side stringer to the upper edge of the floor, as well as from the side stringer to the deck is not more than 2 m.

The scantlings of main frames fitted between the web frames are to comply with the requirements of 3.6.4.7 as for the midship region where side stringers are not provided.

The side stringers are to have the same scantlings as the web frames and to terminate at the bulkhead or at the web frame (see 2.5.4.7.2).

Construction and end attachments of the web frames are to comply with the requirements of 2.5.5;

.5 the transom bulkheads are to be strengthened with vertical stiffeners spaced not more than 0,5 m apart, and with horizontal girders arranged at the side stringer level.

Vertical webs are to be fitted in line with side girders. The scantlings of the vertical webs and horizontal girders are to be the same as those of web frames and side stringers in the fore peak. The scantlings of vertical stiffeners are to be the same as those of the frames. The attachments of stiffener ends with brackets are to comply with the requirements of 2.7.2 for watertight bulkheads.

3.6.2.9 Structural requirements for hull members of opening vessels.

3.6.2.9.1 Opening vessels consist of two separate semihulls with asymmetrical lines, connected by hinges positioned above the deck at the ends of the hopper. When discharging the spoil, the semi-hulls are opened about a common longitudinal axis on the centre line of the ship by means of hydraulic devices.

The structure of each semi-hull is to comply with the requirements of Section 2 with due regard for 3.6.2; transverse or longitudinal or both framing systems may be adopted. In hopper side buoyancy tanks transverse ring structures spaced as required by 3.6.2.11.1 are to be fitted.

3.6.2.9.2 Where hinges are installed in opening hopper dredgers and hopper barges, deck plating and framing are to be strengthened. Hinge eyes are to pierce the decks.

3.6.2.9.3 Stops are to be fitted in the opening vessels between semi-hulls forward and aft from the hopper space. The stops are to be arranged at the levels of the bottom and the deck and are to prevent the hulls from displacement relative to one another.

3.6.2.9.4 Scantlings of brackets connecting framing members of each semi-hull are to comply with the requirements of 3.6.2.11.3.

3.6.2.9.5 Longitudinal bulkheads and coamings of the hopper are to be extended with brackets as required by 3.6.2.7.4 and 3.6.2.11.7.

3.6.2.10 Fixing of dredging gear.

3.6.2.10.1 Hull framing is to be strengthened in way of the main and ladder gallows.

The stanchions of the ladder gallows may terminate at the deck. In such case, pillars, vertical webs or other equivalent structures are to be provided under the stanchions or longitudinal and transverse bulkheads are to be fitted.

The stanchions of the main gallows are to extend to the bottom and be efficiently connected with longi-tudinal and transverse framing, otherwise transverse bulkheads are to be fitted under the stanchions.

3.6.2.10.2 In way of grab crane, spuds and other dredging gear adequate strengthening is to be provided.

3.6.2.11 Specific structures.

3.6.2.11.1 Whatever the hull framing of single-hull hopper dredgers and barges in way of the hopper is adopted, transverse ring structures consisting of the following items are to be fitted:

solid platforms or ring structures in the side buoyancy spaces and centre line box keel;

a lower cross member in the bottom part of the hopper, connecting the centre line box keel with longitudinal bulkheads of the hopper;

an upper cross member inside the hopper at a level of the main deck and upper edge of the coaming where its height more than 0,2 m (where the requirements of 3.6.4.11.10 are complied with, upper cross members need not be fitted);

vertical webs on the hopper coaming.

The maximum distance between transverse ring structures is not to be less than $b = (0{,}012L + 2{,}9)$ m.

3.6.2.11.2 The construction of diaphragms is to comply with the requirements of 2.5.2.2. Diaphragms which are more than 1 m in width are to be strengthened by vertical and horizontal stiffeners. Where longitudinal framing is adopted, horizontal stiffeners are to be fitted in line with side and bulkhead longitudinals. In lieu of the diaphragms watertight (non-tight) bulkheads complying with the requirements of 2.7.2 may be used.

3.6.2.11.3 The transverse ring structure in the side buoyancy space, fitted in lieu of the diaphragm, is to consist of side shell, bulkhead, bottom and deck transverses. The longitudinal bulkhead and side shell transverses are to be connected by means of cross ties which are to be so positioned that the distance between them, between a cross tie and a bottom or deck transverse is not more than 3 m. In lieu of the cross ties, use may be made of braces connecting a bulkhead transverse with a bilge or deck transverse bracket. Where platforms are fitted in side buoyancy spaces at the same distance as cross ties, cross ties and braces may be omitted.

The brackets connecting transverse ring structure items in the side buoyancy space are to have the length of the arms not less than one-twelfth of the greater span of the connected members. The free edge of the bracket is to have a face plate of the same width as that of the face plate of the greater member connected. The bracket thickness is to be equal to the web thickness of the greater member connected.

3.6.2.11.4 Hopper lower cross members may consist of a web with openings and face plates provided on the upper and lower edges or may take the form of a hollow box, generally of triangular cross-section.

The web thickness of the hopper lower cross member is to be taken equal to the plating thickness of the hopper longitudinal bulkheads at the corresponding level.

A cross member web is to be strengthened with stiffeners spaced 900 mm apart.

The upper face plate of the hopper lower cross member is to be made of a tube, section, round or flat bar, the lower face plate is to be fabricated of a flat bar having a thickness not less than that of the bottom plating.

The hopper lower cross members are to be connected with the hopper longitudinal bulkhead and centre line box keel by brackets having length of the arms equal to one-tenth of the length of the cross member upper face plate. The thickness of brackets is to be taken equal to the thickness of the cross member web. Where the depth of the cross member and centre line box keel is the same, brackets on the centre keel need not be fitted. The structure of box-type cross members is similar to that of the centre box keel. Where cross members are of a box shape, their lower and upper face plates are to be welded to the plating of the buoyancy spaces and centre line box keel.

3.6.2.11.5 The centre line box keel fitted in the hopper is generally fabricated as a closed box structure. The plating thickness of the sides is to be equal to that of hopper longitudinal bulkheads at the corresponding level, but not less than 8 mm for vessels of 60 m in length and less than 10 mm for vessels of more than 60 m in length. The thickness of the centre line keel bottom strake is to be not less than that of the plate keel. Where the transverse framing is adopted, the stiffeners in the upper part of the centre line box keel are to be connected with brackets, the thickness of which is to be not less than that of the floor and height not less than 2,5 times the depth of the stiffener web.

Where the breadth of the centre line box keel at bottom exceeds 1 m, but not more than 2 m, a bottom longitudinal is to be fitted on centre line box keel bottom, the depth of which is to be equal to half the floor depth. Where the breadth of the centre line keel is more than 2 m, an intercostal side girder having the same scantlings as the floor is to be fitted in lieu of the above longitudinal. The scantlings of floors are assumed the same as those of floors fitted in correspondingly framed buoyancy spaces.

On the top, the centre line box keel is to terminate in a bar, or an angle, or a cover plate, the thickness of which is to be equal to that of the centre line box keel.

The centre line box keel sides are to extend beyond the hopper transverse bulkheads by brackets, the arm lengths of which are to be equal to the depth of the centre line box keel, and the thickness equal to that of the centre line box keel side.

3.6.2.11.6 The upper cross members of the hopper space may consist of a web with openings and face plates on the upper and lower edges or be fabricated in the form of a hollow box generally of a triangular or another cross-section.

It is recommended that the upper cross members be attached to the hopper longitudinal bulkhead by brackets the arm lengths of which are to be equal to the depth of the upper cross member, and the thickness to its web thickness.

The upper cross members are to be connected to the centre line box keel by pillars, where such a keel is fitted.

3.6.2.11.7 The hopper coaming may be transversely or longitudinally framed. The upper edge of the coaming is to be stiffened with a face plate having a width not less than one-tenth of the coaming height and a thickness not less than a coaming thickness.

In case of longitudinal framing, the coaming is to be strengthened by longitudinals spaced not more than 900 mm apart.

In case of transverse framing, vertical stiffeners are to be fitted between stays at every frame.

The hopper side coamings are to be extended beyond the hopper ends by the brackets for a distance equal to 1,5 times the coaming height. Deck girders extending not less than three frame spaces from a bracket end are to be fitted under the brackets.

3.6.2.11.8 In floating cranes, the tub plating is not to be cut at the upper deck. No horizontal welds are permitted in the tub plating within the area extending for 0,2h up and down from the upper deck (where h is the distance between the bottom and the upper deck in way of the tub position).

3.6.2.11.9 Diaphragms are to be fitted inside the crane tub in line with the upper deck and platform.

3.6.2.11.10 For outer plating of specific structures 20 mm and more in thickness in way of the hopper steel of not lower than grade D is to be utilized. Use of plates having a thickness 50 mm and more is subject to special consideration by the Register.

3.6.3 Design loads.

3.6.3.1 Design loads on the main hull structures are to be determined in compliance with Sections 1 and 2 at draughts d_1 and d_2 and the wave coefficient c_w under dredging conditions and during voyage. For dredging conditions, the wave coefficient c_w is not to be taken greater than $2(D + h_c - d_1)$.

3.6.3.2 The maximum value of the design load for vessel's extremities during voyages is to be obtained as required by 2.8.3 using the draught at the section 0,1L from the forward perpendicular. For the transom bulkhead angles $\alpha_x = 0$ and $\beta_x = 90°$ are assumed.

3.6.3.3 The design bending moments and shear forces in vessels of dredging fleet having $L \geqslant 60$ m are to be determined for voyage and for dredging conditions.

For voyage the hopper space is considered to be filled with water up to the effective waterline (or empty if such case is possible), stores and outfit are taken as 100 per cent, all gear being stowed for sea.

For the case of dredging operations, the hopper space is considered to be filled with homogeneous soil up to the upper overflow level (coaming), there are no stores on board, the draught is equal to d_1, gear being stowed for sea.

Wave bending moments and shear forces are to be determined as required by 1.4.4.

3.6.3.4 Opening vessels.

3.6.3.4.1 In opening vessels, still water and wave bending moment is created both by vertical and horizontal forces. Bending moments are calculated first in vGu coordinate system and then re-calculated for the basic inertia axes x and y of each semi-hull (Fig. 3.6.3.4.1). A fully loaded hopper space at the maximum draught of the vessel is taken as a design case. Bending of each semi-hull hopper is considered separately. Deck hinges and hydraulic cylinders are assumed to be supports located at the hopper ends.

Besides, the following cases are considered:

sailing in the work area with soil in the hopper, dredging gear stowed for sea;

voyage with water in the hopper space or in the ballast condition (the hopper is empty, wherever practicable). Stores and outfit are taken in full, all gear stowed for sea.

3.6.3.4.2 The type of supporting structures and the clearance between two semi-hulls in the fore and aft ends

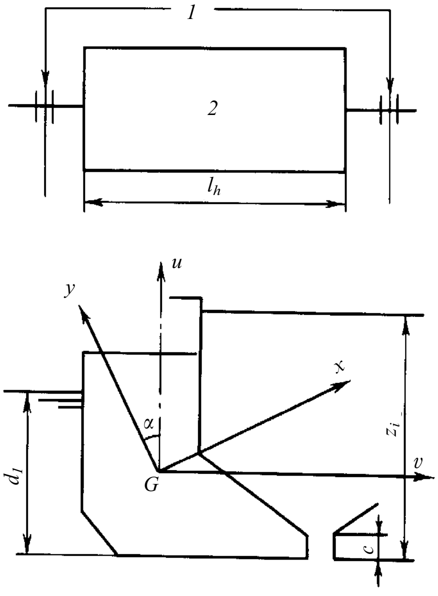


Fig. 3.6.3.4.1:
1 — hinges; *2* — hopper space

of the hopper space determine the conditions of horizontal moments calculation.

Where supporting structures fitted at the deck or bottom level forward or aft of the hopper space provide the absence of any clearance between the semi-hulls, and the length of the supporting structures creates adequate fixing against the horizontal forces acting athwart the hopper space, the horizontal force calculation is made assuming that a semi-hull is rigidly restrained at each hopper end.

Otherwise a semi-hull is considered to be freely supported.

3.6.3.4.3 Vertical loads.

The vertical bending moment at any section M_v, in kN·m, acting on each semi-hull is to be determined by the formula

$$M_v = 0{,}5(M_{swx} + M_{wx}) \qquad (3.6.3.4.3)$$

where M_{swx} = still water bending moment to be obtained by load integration of the vessel with connected hulls for loading conditions referred to in 3.6.3.4.1, in kN·m;

M_{wx} = wave bending moment for the vessel with connected hulls, to be determined as required by 1.4.4., in kN·m.

Vertical moments are considered positive in case of hogging and negative in case of sagging.

3.6.3.4.4 Horizontal loads.

The horizontal bending moment M_{hi}, in kN/m, acting on each semi-hull at the sections taken in the middle and at ends of the hopper space is to be determined by the formula

$$M_{hi} = M_{sw_{hi}} + M_{w_{hi}} \qquad (3.6.3.4.4\text{-}1)$$

where $M_{sw_{hi}}$ and $M_{w_{hi}}$ = horizontal still water and wave bending moments at the section under consideration, respectively, in kN·m.

Horizontal moments are considered positive where the outer side of one semi-hull is subjected to tensile stresses.

The horizontal moment acting on a semi-hull depends on the fixing used at the ends of the hopper space.

Where a semi-hull is considered rigidly fixed at the ends of the hopper space, the horizontal moment is to be determined using the following formulae:

in still water

at the section taken in the middle of the hopper space

$$M_{swh} = 0{,}10pl_h^2; \qquad (3.6.3.4.4\text{-}2)$$

at the hopper end sections

$$M'_{swh} = -0{,}10pl_h^2 \qquad (3.6.3.4.4\text{-}3)$$

where $p = 0{,}5g(\rho_s H_2^2 — \rho d_1^2)$ kN/m;

in waves

at the section taken in the middle of the hopper space

$$M_{wh} = M_{wx}\frac{d_1}{B}(\psi_1 + \psi_2\frac{E}{d_1}); \qquad (3.6.3.4.4\text{-}4)$$

at the hopper end sections

$$M'_{wh} = — M_{wx}\frac{d_1}{B}(\psi_3 + \psi_4\frac{E}{d_1}); \qquad (3.6.3.4.4\text{-}5)$$

where $\psi_1 = 0{,}61l_h/L — 0{,}103$;

$\psi_2 = 0{,}50l_h/L — 0{,}100$;

$\psi_3 = 0{,}85l_h/L — 0{,}112$;

$\psi_4 = 0{,}37l_h/L — 0{,}050$;

$E = \varkappa(C_b + 0{,}7)[1{,}38 — 0{,}128(\frac{300 — L}{100})^{3/2}]$;

$\varkappa = 1{,}35L/100 — 0{,}215$.

Where the semi-hull is not fixed at the hopper ends, the horizontal moment at the section at the middle of the hopper space is to be determined by the following formulae:

in still water

$$M_{sw} = 0{,}15pl_h^2; \qquad (3.6.3.4.4\text{-}6)$$

in waves

$$M_{wh} = M_{wx}\frac{d_1}{B}(1 + \psi_5\frac{E}{d_1}) \qquad (3.6.3.4.4\text{-}7)$$

where $\psi_5 = 1{,}23(l_h/L - 0{,}5)$.

The still water and wave horizontal bending moments at the hopper end sections are equal to zero.

The sign of M_{wx} is to be taken into account in determination of M_{wh} and M'_{wh}.

It is assumed that M_{swh} and M'_{swh} are equal to zero during voyage whatever the fixing conditions are.

3.6.3.5 Bending moments acting on the hull of the floating crane are to be determined for operating conditions in the work area and a voyage.

For the operation in the work area the design vertical bending moment M_{op}, in kN m, is to be determined by the formula

$$M_{op} = M_{sw} + M_g + M_w \qquad (3.6.3.5)$$

where M_{sw} = still water bending moment according to 1.4.3, in kN·m;
M_g = bending moment due to the weight of the load suspended on the crane hook, in kN·m;
For a voyage M_g is assumed to be equal to zero.
M_w = wave bending moment for work areas and a voyage to be determined using a procedure approved by the Register for a specified length and height of the wave.

3.6.3.6 The design pressure p_s, in kPa, on the bulkheads bounding the hopper space, on the structures of the enclosed watertight centre line box keel is to be determined using the formula

$$p_s = \rho_s g z_i \qquad (3.6.3.6)$$

where z_i = distance of the load application point from the upper weir level (upper edge of the coaming), in m.

3.6.3.7 The design load p_1, in kPa, on a partial bulkhead (diaphragm) or a transverse ring structure of the side buoyancy space at a level of the mid-height of the hopper lower cross member due to soil pressure, having regard to the outer counterpressure, is to be determined by the formula

$$p_1 = g(0{,}8\rho_s H_1 - 1{,}5\rho_s h_c - 0{,}1\rho H_1 \varepsilon) \qquad (3.6.3.7)$$

where $\varepsilon = 0$ for $D \leqslant 4$ m;
$\left.\begin{array}{l} \varepsilon = 0{,}2D - 0{,}8 \text{ when } d_1/D \leqslant 0{,}75 \\ \varepsilon = 0{,}4D - 1{,}6 \text{ when } d_1/D > 0{,}75 \end{array}\right\}$ for $D > 4$ m.

3.6.3.8 The vertical design load p_2, in kPa, due to soil pressure, having regard to the counterpressure of the water on the lower cross member of the hopper space is to be determined using the formula

$$p_2 = g[\rho_s H_2 - (\rho d_1 + 0{,}5\rho c_w) - \\ - \frac{\rho_s(l_{l.cr} - b_{b.k})A_{l.cr}}{bl_{l.cr}} - \frac{1{,}5\rho_s A_{b.k}}{l_{l.cr}}]. \qquad (3.6.3.8)$$

3.6.3.9 The horizontal design load p_3, in kPa, due to the dredged spoil pressure on face plates of the hopper lower cross member is to be obtained from the formulae:

for the upper face plate

$$p'_3 = \frac{1}{6} g\rho_s h_{l.cr}; \qquad (3.6.3.9\text{-}1)$$

for the lower face plate

$$p''_3 = \frac{1}{3} g\rho_s h_{l.cr}. \qquad (3.6.3.9\text{-}2)$$

3.6.3.10 The design load p_4, in kPa, on the framing members and on the plating of the hopper coaming is to be determined using the formula

$$p_4 = g\rho_s h_c. \qquad (3.6.3.10)$$

The value p_4 is to be taken not less than 15 kPa.

3.6.3.11 The design axial force N, in kN, acting at the mid-height level of the hopper lower cross member on a diaphragm or a transverse ring structure of the side buoyancy space is to be determined by the formula

$$N = gbH_1[0{,}40\rho_s H_1 + 0{,}63\rho_s h_c - 0{,}03\rho H_1 m] \qquad (3.6.3.11)$$

where $m = 0$ for $D \leqslant 3{,}5$ m;
$m = 1$ for $D > 3{,}5$ m, $d_1/D \leqslant 0{,}75$;
$m = (9D - 31{,}5)(d_1/D - 0{,}75)$ for $D > 3{,}5$ m, $d_1/D > 0{,}75$.

3.6.3.12 The design axial force $R_{l.cr}$, in kN, acting on the lower cross member of the hopper space is to be obtained from the formula

$$R_{l.cr} = 0{,}163\frac{b}{gH_1}[\rho_s H_2^2(3D - H_2) - \\ - \rho(d_1 - 0{,}5c_w)^2(3D - d_1 + 0{,}5c_w)]. \qquad (3.6.3.12)$$

3.6.3.13 The design axial force $R_{up.cr}$, in kN, acting on the upper cross members of the hopper space is to be determined using the following formulae:

.1 for the upper cross member fitted at the deck level

$$R_{up.cr} = R_1 — R_2 — R_3 — R_4 \qquad (3.6.3.13.1)$$

where R_1 = pressure of dredged soil on the upper cross member obtained as

$R_1 = g\rho_s \frac{0{,}082bH_2^2}{H_1}(2H_2 - 3h_{l.cr})$;

R_2 = external hydrostatic pressure on the upper cross member to be obtained as

$R_2 = g\rho \frac{0{,}082b(d_1 — 0{,}5c_w)^2}{H_1}(2d_1 - c_w - 3h_{l.cr})$;

R_3 = reaction due to supporting bending moment at the junction of the diaphragm with the lower cross member to be determined as

$R_3 = p_2 \frac{bl_{l.cr}^2}{12H_1}$;

R_4 = force resulting from supporting reactions of the hopper lower cross member determined from the formula

$R_4 = \frac{bl_{l.cr}b_2}{4H_1}(p_2 + \frac{g\rho_s 0{,}5A_{k.b}}{l_{l.cr}})$;

.2 for the upper cross member fitted at the upper face plate of the hopper coaming

$$R_{up.cr} = g\rho_s b h_c^2. \qquad (3.6.3.13.2)$$

3.6.3.14 The design load on deck is to be not less than 20 kPa.

3.6.3.15 The design loads on the structures of each semi-hull of opening vessels are to be determined in compliance with 3.6.3.1 to 3.6.3.14.

3.6.3.16 In opening hopper dredgers and hopper barges, for each hydraulic press, the horizontal statical force F_H, in kN, necessary to keep the hull closed is determined by the formula (see also Fig. 3.6.3.16)

$$F_H = \frac{1}{n_1 a_3}\left[-F_h a_1 + F_d a_2 + \frac{1}{2}\left(g\Delta b_1 - g\Delta_l b_2 - gQ_s b_3\right)\right] \quad (3.6.3.16\text{-}1)$$

where n_1 = number of hydraulic presses;

F_h = horizontal force of water pressure on the hull, determined by the formula

F_h = $0{,}5\rho g l_\mathrm{h}(d_1 - 0{,}5c)^2$;

F_d = horizontal force of dredged soil pressure on the hull, determined by the formula

F_d = $0{,}5\rho_s g l_\mathrm{h}(H_2 - c)^2$;

for c, see Fig.3.6.3.4.1;

a_1, a_2, a_3, b_1, b_2, b_3 = force arms, in m (see Fig. 3.6.3.16).

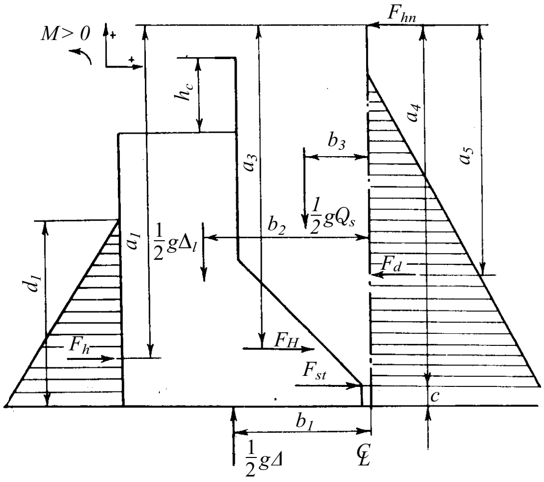


Fig. 3.6.3.16

For design force F_{des}, the maximum pressure value achieved by the hydraulic press is adopted, with $F_{des} \geqslant F_H$.

The horizontal static force in each hinge F_{hn}, in kN, is determined by the formula

$$F_{hn} = \frac{1}{2}\left[F_h + n_1 F_H - F_d - \frac{n_1 a_3}{a_4}\left(F_{des} - F_H\right)\right] \quad (3.6.3.16\text{-}2)$$

where a_4 = arm of the force acting upon the stop, in m.

The horizontal static force acting upon each stop is determined by the formula

$$F_{st} = \frac{n_1 a_3}{n_2 a_4}\left(F_{hn} - F_H\right) \quad (3.6.3.16\text{-}3)$$

where n_2 = number of stops.

The vertical components of static forces in hinges are assumed equal to zero.

3.6.3.17 The dynamic forces acting on hydraulic cylinders and deck hinges are to be determined by calculations of vessel's motions in a seaway, with various course angles, in light-ship and full-load conditions. Based on these calculations, maximum vertical and horizontal forces acting on the hydraulic presses are determined. The calculation is to be made using a procedure approved by the Register.

3.6.4 Scantlings of structural members.

3.6.4.1 Scantlings of structural members are to be determined in compliance with Sections 1 and 2, having regard to the provisions of this Chapter.

3.6.4.2 The required hull section modulus of a singlehull vessel of 60 m in length and over is to be determined as required by 1.4.6 for deck, bottom, upper edge of the hopper coaming, having regard to specified work areas and voyages. The greater value obtained for the work area or voyage (see 3.6.3.3 and 3.6.3.4) is to be taken.

For opening hopper dredgers and hopper barges the required section modulus is to be determined for the case when both semi-hulls are connected (see 3.6.3.4).

3.6.4.3 When calculating the actual section modulus of the hull in way of the hopper space as required by 1.4.8, account is to be taken of all continuous longitudinals, longitudinal bulkheads and the hopper space coamings with longitudinals, 85 per cent of the total area of centre line box keel longitudinal members, provided they are properly interconnected with the longitudinal framing members beyond the hopper and fitting of transverse members regulated by the Rules, inside the hopper.

The continuous deck plating longitudinally framed above the hopper space and a wash bulkhead in the hopper may be included in the actual section modulus calculation using a procedure approved by the Register.

3.6.4.4 Longitudinal strength of each semi-hull of opening hopper dredgers and hopper barges is to be checked for vertical and longitudinal bending moments in asymmetrical bending (see Fig. 3.6.3.4.1).

3.6.4.4.1 Normal stresses arising in cross-section points under conditions of asymmetrical bending are to be determined amidships and at the end bulkhead sections of the hopper space (from inside the hopper), provided the hulls at this position are rigidly restrained.

Stresses σ, in MPa, are to be determined by the formula

$$\sigma = \left(M_x \frac{y}{I_x} - M_y \frac{x}{I_y}\right) \cdot 10^{-3} \quad (3.6.4.4.1\text{-}1)$$

where $M_x = M_v \cos\alpha - M_h \sin\alpha$;

$M_y = M_v \sin\alpha + M_h \cos\alpha$;

for M_v and M_h, see 3.6.3.4.3 and 3.6.3.4.4;

α = rotation angle of main inertia axes (positive value of α — rotation Gu axis counter-clockwise), it is to be determined using the formula

$$\mathrm{tg}\,2\alpha = 2I_{uv}/(I_u - I_v); \qquad (3.6.4.4.1\text{-}2)$$

$I_{uv} = \sum_i u_i\, v_i\, dS_i$ = centrifugal inertia moment about axes *Gu, Gv* with no regard for wear allowance, in m^4;

u_i, v_i = distance of the centre of gravity of *i*-th member area from the axes *Gu, Gv*, in m;

dS_i = *i*-th member area, in m^2;

I_u, I_v = inertia moments of the semi-hull cross-section about axes *Gu, Gv* with no regard for wear allowance, in m^4;

x, y = coordinates of the section point under consideration about main axes *Gx, Gy* (see Fig. 3.6.3.4.1), in m;

I_x, I_y = inertia moments of the semi-hull cross-section about the main axes with no regard for wear allowance, in m^4.

3.6.4.4.2 Normal stresses acting in the semi-hull cross-section (for normal strength structural steel) are not to exceed:

150 MPa for the lower edge of the deck stringer;

145 MPa for the upper edge of the plate keel;

165 MPa in the face plate of the hopper coaming.

3.6.4.4.3 Permissible shear stresses for members made of normal strength structural steel and participating in the longitudinal bending are assumed equal to 115 MPa. Equivalent stresses $\sigma_{eq} = \sqrt{\sigma^2 + 3\tau^2}$ at the sections where substantial normal stresses and shear stresses (at the hopper ends) act are to be not more than 170 MPa.

3.6.4.4.4 Buckling strength of compressed members according to 1.6.5 is to be ensured.

3.6.4.5 Bottom framing.

3.6.4.5.1 When the bottom is transversely framed, the moment of inertia and scantlings of floors in side buoyancy spaces are to be determined as required by 2.3.4.1.1; in this case, to be taken as B_1 is doubled breadth of the buoyancy space over the bottom.

3.6.4.5.2 Where a single bottom is longitudinally framed, the section modulus of bottom longitudinals in buoyancy spaces is to be not less than that determined in compliance with 2.3.4.2.1. The floors are to be fitted in line with transverse ring structures, their section modulus and cross sectional area are to be not less than determined from 2.3.4.2.3 and 2.3.4.2.4. The section modulus and depth of a side girder are to be not less than those required for the floor.

The floor web depth is not to be less than $0{,}13B_1$ (see 3.6.4.5.1).

3.6.4.5.3 The scantlings of the bottom framing members in each semi-hull of opening vessels are to be determined as required by 2.3.4.2; to be taken as breadth B_1 is the breadth of one semi-hull at the section under consideration. There is no bottom centre girder in opening vessels.

3.6.4.5.4 The scantlings of double bottom members in way of the hopper space are determined as for dry cargo ships having double skin construction according to 2.4 with regard to 3.6.2.4; beyond the hopper as for dry cargo ships with single skin construction in compliance with the requirements of the same paragraphs.

The plate floor spacing is not to exceed the maximum spacing of transverse ring structures, specified in 3.6.2.11.1.

3.6.4.5.5 For floating cranes the section modulus of bottom transverses is to be as required by 2.3, and additional bottom longitudinals are to have the same section modulus as for main longitudinals.

3.6.4.5.6 In calculating the section modulus and the depth of floors in accordance with 2.3, B_1 is assumed to be the floor span between the side shell and the longitudinal bulkhead or between the longitudinal bulkheads, but not less than 0,4 of the full breadth of the ship.

3.6.4.5.7 In case of longitudinally framed bottom, the scantlings of floors and bottom longitudinals of floating cranes beyond the double bottom area are to be determined in accordance with 2.3.4.2.

3.6.4.6 Shell plating.

3.6.4.6.1 Shell plate scantlings are determined in accordance with 2.2.4.

The thickness of the bottom strakes to which hopper longitudinal bulkheads or well sides are connected is to be increased by 15 per cent as against that of the bottom plating. Where there is no centre line box keel, the thickness of the bottom strakes abutting on the hopper longitudinal bulkhead is to be increased by 50 per cent.

3.6.4.6.2 The side shell plating thickness at the hopper ends is not to be less than required by 1.4.7.

3.6.4.6.3 In vessels with pontoon hulls, the thickness of the bottom and side shell plating within $0{,}15L$ from the forward and after perpendiculars is not to be less than the plating thickness within the midship region.

3.6.4.6.4 The thickness of the well side plating is to be equal to the thickness of the side shell plating in area concerned, but not less than 8 mm.

3.6.4.6.5 In opening vessels the shell plating thickness is to be determined with regard for 3.6.4.4.

The thickness of the bottom strakes at the hopper longitudinal bulkhead need not be increased.

3.6.4.6.6 In floating cranes the thickness of the bottom plating within $0{,}2L$ from the forward perpendicular is to be increased over the entire breadth of the hull by 30 per cent as against the minimum thickness required by 2.2.4.8.

In the fore peak and the areas extending forward for $0{,}1L$ from the stern transom corners and inboard for $0{,}1B$, the thickness of the side shell plating is to be increased over the entire depth by 30 per cent as compared to the minimum thickness required by 2.2.4.8 (see also 3.6.2.5.2).

In other regions along the hull length, the minimum thickness of the shell plating is to be increased by 10 per cent as against that prescribed by 2.2.4.8.

3.6.4.6.7 The plating thickness of the bow and stern transoms in floating cranes is not to be less than required by 3.6.4.6.3.

3.6.4.7 Side framing.

The scantlings of the side framing members are to be determined in compliance with 2.5, having regard to 3.6.2.5, 3.6.2.11 and the requirements given below.

3.6.4.7.1 The section modulus of frames in transversely framed side buoyancy spaces is to be determined from 2.5.4.1 as for dry cargo ships.

Where a side stringer is fitted at a level of fenders, main frame span may be determined in compliance with 2.5.1.2 as for side transverses of tankers, provided the structure of the side stringer meets the requirements of 3.6.4.7.2. Where no transverse ring structures are fitted, braces may be provided in line with horizontal girders of longitudinal bulkheads.

3.6.4.7.2 The scantlings of side stringers are to be determined as required by 2.5.4.4 as for the case of fitting web frames. The width of the side stringer is not to be less than 0,08l (l = stringer span as measured between web frames or between those and tight transverse bulkheads) or 2,5 times the frame depth, whichever is the greater. Side stringers are to be aligned with cross ties of the transverse ring structures.

3.6.4.7.3 The section modulus of side longitudinals is to be determined as required by 2.5.4.3 with k_σ values taken as for dry cargo ships.

3.6.4.7.4 The section modulus and cross-sectional area of web frames which are a part of a transverse ring structure are to be not less than those required in 2.5.4.5 for side transverses of tankers.

A web frame span is to be measured between the inner edges of the floor and an inner edge of the beam.

The depth of the web frame is not to be less than 0,1l or 2,5 times the width of longitudinals (whichever is the greater) and may be assumed varying with reduction at the upper end and increase at the lower end by 10 per cent as against the average value.

3.6.4.7.5 The section modulus of well longitudinal bulkhead stiffeners is not to be less than required for side frames.

3.6.4.7.6 In floating cranes, the section modulus of main and intermediate frames in the fore peak is to be increased by 20 per cent as compared to that required by 2.8.4.2.2.

3.6.4.7.7 The section modulus of web frames in floating cranes W, in cm^3, within the region specified in 3.6.2.5.3 is not to be less than:

$$W = 0{,}95(300 + \frac{120}{\sigma_n} bpl^2)\omega_c \qquad (3.6.4.7.7)$$

where l = web frame span measured between the deck and the upper edge of the floor, in m;
p = as defined in 3.6.3, but not less than 0,5ρgl, in kPa.

3.6.4.7.8 The scantlings of the framing members of the bow and stern transoms are not to be less than required by 3.6.4.7.2 to 3.6.4.7.4 and 3.6.4.7.6.

3.6.4.8 Decks.

3.6.4.8.1 The plating thickness of the strength deck within the midship region is to be taken not less than the sheerstrake thickness.

The minimum thickness of the deck plating in vessels of dredging fleet is to be determined according to 2.6.4.2 as for the strength deck. For floating cranes the minimum thickness of the upper deck is to be increased by 10 per cent as against that prescribed by 2.6.4.2 as for the strength deck.

3.6.4.8.2 Compressive stresses in deck are to be determined under the action of bending moment components according to 3.6.3. The buckling strength requirements of 1.6.5 are to be met.

3.6.4.8.3 The depth of deck transverses in buoyancy spaces which form a part of the transverse ring structure is to be equal to two-thirds of the floor depth, while the thickness of the web plate and sizes of the face plate are to be equal to those of the vertical webs. The depth of the deck transverse is to be not less than 2,5 times the height of the deck longitudinal.

3.6.4.8.4 For floating cranes the section modulus of deck girders is to be determined as required by 1.6.4.1 with $k_\sigma = 0{,}6$ and $m = 12$.

3.6.4.8.5 The deck plating thickness under the seats of special arrangements fitted on the deck (cat cranes of suction tubes, transfer appliances, grab cranes, etc.) and where special metal structures pass through the deck (main and ladder gallows) is to be increased by 25 per cent.

3.6.4.9 The scantlings of side and deck framing members, the thicknesses of deck plating, bulkhead framing and plating, and coamings of opening vessels are to be determined with regard for 3.6.4.4.

Where vertical webs and web frames are connected by cross ties or braces, the scantlings of vertical webs, web frames and braces are to be submitted to the Register for consideration.

3.6.4.10 In vessels with pontoon hulls, the scantlings of side stringers at the forward end of the vessel are to be prescribed as required by 2.8.4.5, the height and thickness of vertical webs and web frames are to be the same as the width and thickness of the stringer.

3.6.4.11 Specific structures of vessels of dredging fleet:

3.6.4.11.1 The section modulus W, in cm^3, of the diaphragm of the buoyancy space after deduction of openings, or the total section modulus of a vertical web and a web frame of the transverse ring structure at the section of a mid-point of the hopper lower cross member depth is not to be less than:

$$W = \frac{10^3 bH_1^2}{mk_\sigma\sigma_n} p_1\omega_c \qquad (3.6.4.11.1)$$

where for H_1, see Fig. 3.6.1.6;
m = 12;
k_σ = 0,6;
p_1 = as defined in 3.6.3.7.

3.6.4.11.2 The cross-sectional area f, in cm^2, of the diaphragm, or the total sectional area of a vertical web and a web frame of the transverse ring structure at a level of a mid-point of the hopper lower cross member depth is to be not less than

$$f = \frac{10N}{k_\tau\tau_n} + 0{,}1\Delta f_i \qquad (3.6.4.11.2)$$

where N = as defined in 3.6.3.11;
k_τ = 0,65;
$\Delta f_i = \Delta s b_i$;
b_i = typical member scantlings (half-breadth of deck, web height of longitudinal, etc.), in cm.

The scantlings of the transverse ring structure members (bottom transverse, vertical web, side and deck transverses) are to be not less than required by the relevant paragraphs of this Chapter for such members.

3.6.4.11.3 The section modulus W, in cm^3, sectional area of the hopper lower cross member web f_w, in cm^2, after deducting openings, sectional area of the floor with face plates f_0, in cm^2, are not to be less than:

$$W = \frac{10^3 b l_{l.cr}^2}{m k_\sigma \sigma_n} p_2 \omega_c; \qquad (3.6.4.11.3\text{-}1)$$

$$f_w = 5 \frac{b l_{l.cr}}{k_\tau \tau_n} (p_2 + \frac{0{,}5 \rho_s g}{l_{l.cr}} A_{b.k}) + 0{,}1 \Delta f_i; \qquad (3.6.4.11.3\text{-}2)$$

$$f_0 = \frac{10 R_{l.cr}}{k_{\sigma_p} \sigma_n} + 0{,}1 \Delta f_i \qquad (3.6.4.11.3\text{-}3)$$

where m = 12;
k_σ = 0,45;
k_{σ_p} = 0,2;
k_τ = 0,45;
p_2 = as defined in 3.6.3.8;
$R_{l.cr}$ = as defined in 3.6.3.12;
for Δf_i, see 3.6.4.11.2.

3.6.4.11.4 The section modulus of the face plates of the hopper lower cross members W, in cm^3, about the horizontal axis and sectional area $f_{f.p}$, in cm^2, are not to be less than:

for the upper face plate

$$W = \frac{10^3 h_{l.cr} l_1^2}{m k_\sigma \sigma_n} [3 — \frac{(l_1 — l_2)^2}{l_1^2}] p_3' \omega_c; \qquad (3.6.4.11.4\text{-}1)$$

$$f_{f.p} = \frac{2{,}5 h_{l.cr} (l_1 + l_2)}{k_\tau \tau_n} p_3' + 0{,}1 \Delta f_i; \qquad (3.6.4.11.4\text{-}2)$$

for the lower face plate

$$W = \frac{10^3 h_{l.cr} l_2^2}{m_1 k_\sigma \sigma_n} 2 p_3'' \omega_c; \qquad (3.6.4.11.4\text{-}3)$$

$$f_{f.p} = 5 \frac{h_{l.cr} l_2}{k_\tau \tau_n} p_3'' + 0{,}1 \Delta f_i \qquad (3.6.4.11.4\text{-}4)$$

where for l_1 and l_2, see Fig. 3.6.1.6;
m = 24;
m_1 = 12;
k_σ = 0,6;
k_τ = 0,45;
p_3', p_3'' = as defined in 3.6.3.9;
Δf_i = as defined in 3.6.4.11.2.

3.6.4.11.5 The section modulus of bulkhead vertical webs, horizontal girders, vertical stiffeners and longitudinals of the hopper longitudinal bulkheads are to be determined as for side framing according to 3.6.4.7 with substitution of p according to 2.5.3 by p_s according to 3.6.3.6. For the longitudinal bulkhead stiffeners $m = 11$ and $k_\sigma = 0{,}75$.

The depth of the vertical web is to be not less than 0,12l and may be assumed varying with reduction at the upper end and increase at the lower end by 10 per cent as compared to the average value.

Two upper longitudinals are to be taken the same as the third longitudinal from the deck.

Besides, three upper and three lower longitudinals are to be checked according to 1.6.5.4.

The width of the horizontal girder is to be equal to that of the bulkhead vertical web.

3.6.4.11.6 The plating thickness of the hopper longitudinal and end bulkheads is to be determined as required by 1.6.4.4 assuming $p = p_s$ (where p_s is to be obtained from 3.6.3.6), $k_\sigma = 0{,}7$, $m = 15{,}8$.

The upper strake thickness of the hopper longitudinal bulkhead at 0,1D below the deck is not to be less than the sheerstrake thickness. The lower strake thickness of the longitudinal bulkhead at 0,1D from the base line is not to be less than the bottom plating thickness.

3.6.4.11.7 The minimum thickness of hopper bulkhead plating is to be equal to 8 mm for vessels having the length $L < 60$ m and 10 mm for vessels having the length $L \geqslant 80$ m. For intermediate values of L, the minimum thickness is to be determined by linear interpolation.

3.6.4.11.8 The section modulus W, in cm^3, of vertical stiffeners and stanchions of the hopper coaming is not to be less than determined by the formula[1]

$$W = \frac{10^3 a h_c^2 p_4}{m k_\sigma \sigma_n} \omega_c \qquad (3.6.4.11.8\text{-}1)$$

where p_4 = as defined in 3.6.3.10;
m = 15 for stanchions where upper cross members are fitted in line with transverse ring structures at the coaming top;
m = 6 for stanchions where no upper cross members are fitted at the coaming top;
m = 15,6 for vertical stiffeners where transverse framing is adopted;
k_σ = 0,6.

The section modulus W, in cm^3, of horizontal stiffeners and face plate of the coaming is not to be less than:

$$W = \frac{10^3 a b^2 p_4 z_i}{m k_\sigma \sigma_n h_c} \omega_c \qquad (3.6.4.11.8\text{-}2)$$

where z_i = distance between the coaming top and horizontal stiffeners, but not less than half the coaming height, in m;
m = 12;
k_σ = 0,2.

The sectional area f_{st} of the coaming stanchion, in cm^2, at deck is not to be less than:

$$f_{st} = 4 \frac{a h_c p_4}{k_\tau \tau_n} + 0{,}1 \Delta f_i; \qquad (3.6.4.11.8\text{-}3)$$

---

[1] For stanchions b is substituted for a.

where $k_\tau = 0{,}45$;
$\Delta f_i =$ as defined in 3.6.4.11.2.

The plate thickness of the side (end) coaming is to be determined as for the longitudinal (end) bulkhead of the hopper p_s according to 3.6.3.6 as measured at the deck level, but it is to be taken not less than the upper strake thickness of the longitudinal bulkhead.

The depth of the stanchion at deck is to be not less than $0{,}12h_c$ and the thickness not less than the coaming thickness.

The plate thickness of the coaming and moment of inertia of the horizontal stiffeners and face plate of the coaming are to meet the buckling strength requirements according to 1.6.5.

3.6.4.11.9 The sectional area of the upper cross members spanning hopper space at deck level and/or coaming level $f_{up.cr}$, in cm^2, is not to be less than:

$$f_{up.cr} = 0{,}085R_{up.cr} + 0{,}1\Delta f_i \qquad (3.6.4.11.9\text{-}1)$$

where $\Delta f_i =$ as defined in 3.6.4.11.2.

Where a load from bottom closing appliances is applied to the upper cross members, their strength is to be checked using the stress given below

$$\sigma_{eq} = \sqrt{\sigma^2_{\max} + 3\tau^2_{sh}} \leqslant 0{,}75\sigma_n \qquad (3.6.4.11.9\text{-}2)$$

where $\sigma_{\max} = 10R_{up.cr}/f_{up.cr} + (M_b/W)10^3$;
$\tau_{sh} = 10N_{sh}/f_w$;
M_b and N_{sh} = maximum bending moment, in kN.m, and shear force, in kN, due to transverse load;
$W =$ actual section modulus of the upper cross member, in cm^3;
$f_{up.cr}$, f_w = full sectional area of the upper cross member and sectional area of the cross member web, in cm^2.

3.6.4.11.10 Where no upper cross members are fitted at a deck level in line with transverse ring structures, a part of the coaming structure with the upper portion of the side buoyancy space located at $0{,}1D$ below the deck line (Fig. 3.6.4.11.10) is to have a section modulus W, in cm^3, about a horizontal axis not less than:

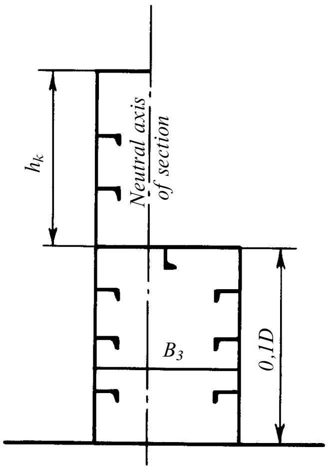


Fig. 3.6.4.11.10

$$W = \frac{550R_{up.cr}(l_h - b)^2}{b\sigma_n}\,\omega_c. \qquad (3.6.4.11.10\text{-}1)$$

The thickness of the deck plating s, in mm, is not to be less than:

$$s = \frac{1{,}11R_{up.cr}(l_h - b)}{bB_3\tau_n} + \Delta s \qquad (3.6.4.11.10\text{-}2)$$

where for B_3, see Fig. 3.6.4.11.10.

3.6.4.11.11 The scantlings of hull structural items in places where hinges and hydraulic presses are arranged are to be determined by direct calculation as regards the action of statical and dynamical forces in compliance with 3.6.3.16.

The calculations are to be submitted to the Register for consideration.

3.6.4.11.12 Hydraulic presses are to be positioned in special spaces at the hopper ends. The strength calculation of foundations and attachments of hydraulic presses is to be made as regards the action of forces determined in accordance with 3.6.4.11.11 and is subject to consideration by the Register.

3.6.4.12 Specific structures of floating cranes.

3.6.4.12.1 The diameter of the tub D_0, in m, at the upper deck beneath the fixed tower supporting the upper structure of the crane is not to be less than:

$$D_0 = 0{,}37M/P \qquad (3.6.4.12.1)$$

where $M =$ total bending moment due to load and weight of the movable upper structure of the crane, applied to the supporting tower, in kN.m;
$P =$ total vertical force due to load and weight of the movable upper structure of the crane, applied to the supporting tower, in kN.

3.6.4.12.2 The thickness of the tub plating, in cm, at the upper deck is to be determined by calculation based on the total bending moment according to 3.6.4.12.1 and a horizontal component of the load for the case when a design safe working load of the crane with the lifting height from the water level at the maximum outreach is used.

Permissible stresses for normal strength steel are not to be more than: $\sigma = 140$ MPa and $\tau_{cr} = 80$ MPa.

The buckling strength of the tub plating over its entire height is to be ensured to the value $\sigma_{cr} = 2{,}5R_{eH}$. The calculations are to be submitted to the Register for consideration.

3.6.4.12.3 The inertia moment $I_{\min}$, in cm^4, of the tub vertical stiffeners (if any) is not to be less than:

$$I_{\min} = (1{,}03l - 1{,}80y)s^3 \qquad (3.6.4.12.3)$$

where $l =$ stiffener span measured between the bottom and the platform or between the platform and the deck, whichever is the greater, in m. Where the platform is omitted, the distance between the bottom and the deck is measured;
$y =$ spacing of stiffeners, measured along the chord line, in m;
$s =$ tub plating thickness at the stiffener mid-span, in mm.

3.6.4.12.4 The plating thickness of the bulkheads forming a cross and the bearing contour is not to be less than determined according to 2.7.4.1, assuming $k_\sigma = 0{,}70$, $\Delta s > 4$ mm for bulkheads forming the cross and $\Delta s \geqslant 2$ mm for those forming the bearing contour.

For cranes having a safe working load more than 100 t, the stressed condition of framing members and plating of bulkheads forming the cross under the loads transferred from the fixed supporting tower in case of using the design safe working load at the maximum outreach is to be checked according to the procedure approved by the Register.

3.6.4.12.5 The plating thickness of the upper deck and the bottom s', in mm, in way of the crane tub is not to be less than:

$$s' = \alpha s \qquad (3.6.4.12.5)$$

where s = as defined in 3.6.4.12.2;
α = 0,6 and 0,4 for the upper deck plating and bottom plating, respectively.

The dimensions of the plates of increased thickness are to be taken in accordance with Fig. 3.6.4.12.5.

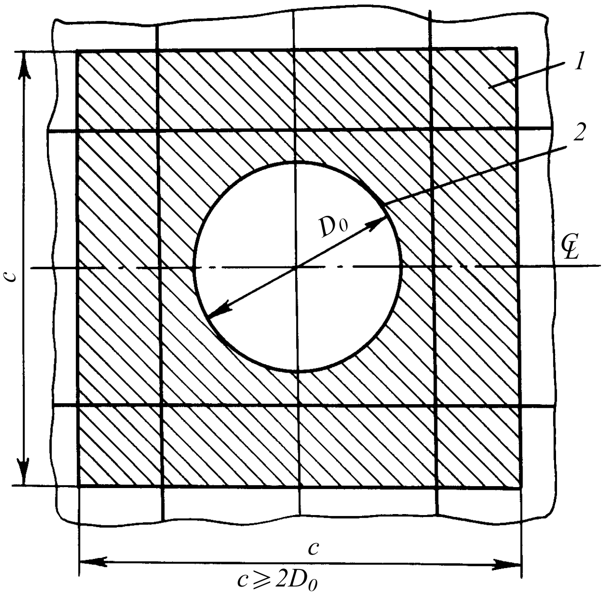


Fig. 3.6.4.12.5:
1 — thickened plate; *2* — tub

3.6.5 Special requirements.

3.6.5.1 Where vessels are intended to ground during the course of normal service, the bottom of such vessels is to be suitably strengthened.

3.6.5.1.1 The thickness of the bottom shell plating is to be increased by 20 per cent over the minimum requirement.

3.6.5.1.2 Where the double bottom is omitted and transverse framing system is adopted, the bottom shell plating between the bottom side girders is to be strengthened by horizontal stiffeners.

In line with horizontal stiffeners vertical stiffeners are to be fitted. The horizontal stiffeners are to pass through openings in the floors and to be welded to them.

3.6.5.1.3 Where double bottom is omitted and longitudinal framing system is adopted, the bottom shell plating is to be strengthened by additional floors, the depth of which is to be not less than 2,5 times the depth of the bottom longitudinal and a thickness equal to that of the main floors. The main floors are to be strengthened by vertical stiffeners fitted in line with bottom longitudinals. Side girders are not to be spaced more than 2,2 m apart. The scantlings of bilge longitudinals are not to be less than those required for the bottom.

3.6.5.1.4 In transversely framed double bottom plate floors are to be fitted at every frame, side girders are to be spaced not more than 2,5 m apart, they are to be also fitted inboard or from longitudinal bulkheads at a distance not exceeding 2,5 m. The bottom shell plating is to be strengthened by horizontal stiffeners fitted between the side girders. Vertical stiffeners are to be fitted in line with horizontal stiffeners at every floor and be welded to them.

In longitudinally framed double bottom floors are to be fitted at every second frame, and side girders are to be spaced 2,5 m apart.

3.6.5.1.5 In way of a recess for vertical girders of suction tubes, the following hull strengthening is to be provided:

side framing is to be reinforced by at least three web frames, the scantlings of which are to be the same as those required for the engine room, and by not less than three intercostal side stringers extending for three spacings from the extreme web frames which are to be fitted not less than 50 mm from the edge of the recess;

side shell plating in way of the recess is to be made of a curved welded-in plate, the vertical butt joint of this plate is to be not less than 100 mm from the edge of the recess;

the thickness of the deck stringer in way of the recess is to be increased by 60 per cent over the length equal to one spacing forward and abaft of web frames.

3.6.5.2 The requirements of 3.6.5.1 are not to apply to floating cranes for which deep sea service is specified and which are not likely to ground under any conditions of heel and trim.

3.6.5.3 The thickness of main structural items which are particularly subjected to abrasive wear due to the effect of spoil/water mixture (in particular, in case of special dredging methods used) is to be increased. These items may be made of special wear-resistant materials subject to special agreement with the Register.

3.6.5.4 Dredging pumps are to be located in special spaces bounded by watertight bulkheads.

3.6.5.5 The scantlings of deck framing members on deck portions where heavy dredging (cargo handling) gear is installed, as well as where large heavy cargoes may be carried on decks of floating cranes or hopper dredgers are to be determined by calculation for the following conditions:

beams are considered to be rigidly fixed to the supporting structure;

a load (concentrated, partially distributed, etc.) is to be taken into account;

equivalent stresses for items made of normal strength steel σ_{eq}, in MPa, are to comply with the condition

$$\sigma_{eq} = \sqrt{\sigma^2 + 3\tau^2} \leqslant 170 \qquad (3.6.5.5)$$

where σ and τ = normal and shear design stresses at the section under consideration.

The results of the calculation are to be specially considered by the Register.

3.7 FISHING VESSELS AND SPECIAL PURPOSE SHIPS USED FOR PROCESSING OF SEA LIVING RESOURCES

3.7.1 General and symbols.

3.7.1.1 The requirements of this Chapter apply to fishing vessels having a stern trawling arrangement or a side trawling arrangement and to special purpose ship intended for processing, storage and/or transportation of catch.

3.7.1.2 The requirements for hull structures not referred to in this Chapter are given in Sections 1 and 2. In no case shall the requirements for hull structures be less stringent than those contained in Sections 1 and 2.

3.7.1.3 Symbols:

b_{sr} = breadth of stern ramp, in m;

G_1 = greatest specified mass of catch which can be handled by a special wheeled device or another transport means, in t;

G_2 = mass of moving part of special wheeled device or another transport means, in t;

G = mass of processing equipment, in t;

S_d = factory deck area, in m^2;

a = spacing of framing members under consideration, in m;

l = span of member under consideration (see 1.6.3.1);

b = height of design load distribution on a member;

Δs = corrosion and wear allowance added to plate thickness, in mm (see 1.1.5.1);

ω_k = factor taking account of corrosion allowance to the section modulus of the to framing member (see 1.1.5.3).

3.7.1.4 The requirements for ships mooring at sea provide for a damping protection of the hull for which purpose pneumatic fenders or other equivalent damping arrangements may be used. These requirements are based on the assumption that ships would be moored at a sea state not above 6.

No side or superstructure strengthening are required when ships are moored at a sea force below 4, provided the above damping protection is used.

3.7.1.5 The regions of side strengthening of fishing vessels and special purpose ships mooring at sea.

3.7.1.5.1 Depth dimension:

region A lying between the line drawn lower than the ballast waterline by the value of h and the line drawn higher than the summer loadline by the value of h. The value of h is to be determined from Table 3.7.1.5-1;

Table 3.7.1.5.1

Sea force No.	h, in m
4	0,8
5	1,2
6	2,0

region B lying between the upper boundary of region A and upper deck;

region C lying between the upper deck and the first tier superstructure deck, forecastle and poop included.

3.7.1.5.2 Lengthwise, region A lies between sections in which the ship breadth at summer loadline level is equal to (B — 3 m).

In special purpose ships, region A is to extend for at least 0,36*L* forward and aft from the midship section.

3.7.1.5.3 For special purpose ships, one or more fender areas are to be additionally established the boundaries of which are formed by sections lying within 0,05*L* forward and aft of the forward and aft edges accordingly of a group of floating fenders providing one mooring place for all specified variants of mooring. The boundaries of fender areas are to be determined at extreme positions of fenders and for all specified variants of mooring.

3.7.1.6 Fishing vessels intended for systematic operation in ice conditions.

3.7.1.6.1 Fishing vessels intended for systematic operation in ice conditions are to have an ice category not lower than **ЛУ3** in accordance with the requirements of 3.10.

3.7.1.6.2 Fishing vessels intended for systematic operation in ice conditions, which have the ice category **ЛУ3**, are to comply with the requirements of 3.10, as well as with additional requirements contained in 3.7.1.6.4, 3.7.2.6, 3.7.3.4 and 3.7.4.5.

3.7.1.6.3 No additional requirements are put forward with regard to the ice strengthening of category **ЛУ4** or above.

3.7.1.6.4 If the loadline entrance of a fishing vessel of category **ЛУ3** exceeds 0,25*L*, an intermediate region of ice strengthening may be established the boundaries of which are to be determined as in the case of a category **ЛУ4** vessel.

3.7.2 Construction.

3.7.2.1 Stern ramp construction.

3.7.2.1.1 The after end structure of vessels having a stern ramp and/or stern trawling arrangements is to be strengthened by fitting additional longitudinal and transverse members (girders, transverses, cross ties, bulkheads and partial bulkheads).

The stern ramp is to be so constructed as to avoid flat of bottom in way of stern counter.

The connection of stern ramp sides to transom plating and of the ramp deck to bottom plating are to have a radius of rounding not less than 200 mm. This connection may be made by using a bar not less than 70 mm in diameter.

3.7.2.1.2 Stern ramp sides are, in general, to be carried downwards to the shell plating and forward to the after peak bulkhead and are to be smoothly tapered into deck girders and transverses.

3.7.2.1.3 Where the catch is dragged onto the deck, it is recommended that the stern ramp be longitudinally framed with transverses fitted at intervals not exceeding four frame spacings. The stern ramp longitudinals are to be spaced not more than 600 mm apart.

In vessels where special transport means are used to carry the catch onto the deck, the stern ramp is to be framed transversely.

3.7.2.2 The construction of ships having a side trawling arrangement.

3.7.2.2.1 It is recommended that vessels more than 30 m in length be fitted up with a forecastle.

3.7.2.2.2 Within the location of each gallow, determined as the distance between sections at three spacings forward and aft of the gallow ends, the strengthening shall be as follows:

intermediate frames are to be fitted extending from the upper deck down to a level not less than 0,5 m below the ballast waterline and having a section modulus not less than 75 per cent of that required by 2.5.4.2 for the frames in the 'tween deck space concerned;

the upper and lower ends of intermediate frames are to be secured to the decks, platforms and longitudinal intercostal members fitted between the main frames; longitudinal intercostal members are to have the same section as intermediate frames and be aligned with them; the upper longitudinal intercostal member is to be fitted not more than 350 mm below the upper deck;

bulwark stays are to be fitted at every frame.

3.7.2.3 Structures in processing shops.

3.7.2.3.1 Where the number of bulkheads in the processing shops located above the bulkhead deck is less than specified in 2.7.1.3 and where the distance between the bulkheads forming the boundaries of that space exceeds 30 m, partial bulkheads extending inboard for not less than 0,5 m of the 'tween deck height are to be fitted on the bulkhead deck at each side of the vessel in line with watertight bulkheads. The thickness of the partial bulkhead plating is to be not less than that of the top strake of the corresponding watertight bulkhead below the deck where the considered processing shop is located.

Partial bulkheads are to be strengthened with horizontal stiffeners in accordance with 1.7.3.2. Strengthening with vertical stiffeners is permitted with fitting the horizontal stiffeners between the side shell and the nearest vertical stiffener in compliance with 3.7.2.5.4.

Partial bulkheads are to be interconnected with deck transverses supported by pillars in a required number. Alternative structural arrangements may be used if approved by the Register as equivalent.

3.7.2.3.2 Where multi-tier deckhouses are arranged above the processing shops, the requirements of 2.12.5.2 for rigid members (bulkheads, partial bulkheads) to be fitted in such spaces are to be complied with.

3.7.2.4 In fishing vessels, bulwark stays are to be fitted at intervals equal to not more than two frame spacings.

3.7.2.5 Structural strengthening of ships mooring at sea.

3.7.2.5.1 In regions strengthened for mooring at sea, transverse framing is to be adopted for the vessel's sides. In single-deck ships, the deck and bottom in the above regions are also to be framed transversely. In multi-deck ships, transverse framing is to be adopted for the deck located on the fender level. Longitudinal framing of sides is permissible in the upper 'tween deck space only. In this case, the spacing of web frames is not to exceed three frame spacings or 2,4 m, whichever is less.

3.7.2.5.2 In the region A, intermediate frames are recommended through the region length in fishing vessels and within fender areas in special purpose ships.

3.7.2.5.3 In any case, it is recommended that symmetrical sections be used and the minimum possible web depth be ensured for the particular section modulus.

3.7.2.5.4 Between the ship's side and vertical stiffener nearest to it, transverse bulkheads are to have horizontal stiffeners with a section height not less than 75 per cent of the vertical stiffener height. In ships with $L \leqslant 80$ m, horizontal stiffeners are to be spaced not more than 600 mm apart, and with $L \geqslant 150$ m, not more than 800 mm apart. For ships of intermediate lengths, linear interpolation may be used to determine this distance. The ends of horizontal stiffeners are to be welded to vertical stiffeners and sniped at the ship's sides.

3.7.2.5.5 The bulwark is to be inclined towards the centre line of the ship at not less than one-tenth or be fitted inboard of the ship's side at not less than one-tenth of its height.

3.7.2.5.6 Bilge keels of ships with the length $L \leqslant 80$ m are to be, as far as practicable, so arranged that a tangent drawn to the frame and passing through the outer free edge of the bilge keel would form an angle of not less than 15 deg with the vertical axis. For ships with the length $L \geqslant 150$ m, this angle may be zero. For ships of intermediate lengths, the above angle is to be obtained by linear interpolation.

3.7.2.5.7 The lower end attachments of hold frames are to be as required by 2.5.5.1.

In 'tween decks, the attachments of frame lower ends are to comply with the requirements of 2.5.5.3. The frame ends are to be welded to the deck plating.

Upper ends of frames are to be carried to the deck plating and welded thereto. Beams are to be carried to the inner edges of frames with a minimal gap. Beam knees are to have a face plate or flange.

The ends of intermediate frames are to be attached to longitudinal intercostals, decks or platforms.

3.7.2.5.8 Side longitudinals are to be attached to transverse bulkheads with knees. The height and width of the knees are to comply with 1.7.2.2.

3.7.2.5.9 Bulwark stays welded to sheerstrake are to be so constructed as to prevent deck plating damage in case of bumping.

3.7.2.6 Besides the requirements of 3.10, the ice-strengthening structure of fishing vessels of category **ЛУ3** intended for systematic operation in ice conditions is to comply with the following requirements:

.1 for the case of transverse main framing, at least one load distributing side stringer shall be fitted in each grillage in way of region of ice strengthening AI, A1I, BI, CI;

.2 bulbous forebody is not recommended;

.3 in the forepeak, the spacing of stringers and their dimensions, as well as stem dimensions, are to be in accordance with the requirements of 3.10 for ships of category **ЛУ4**;

.4 in the afterbody, provision shall be made for an appendage (ice knife) aft of the rudder to protect the latter on the sternway.

3.7.3 Design loads.

3.7.3.1 Design loads on ramp structures.

3.7.3.1.1 The design pressure p, in kPa, on the ramp sides and deck in vessels where the catch is dragged in is to be determined using the formula

$$p = 6{,}5 b_{sr}. \qquad (3.7.3.1\text{-}1)$$

Where the breadth of the ramp varies along its length, the minimum breadth is to be taken as the design value.

3.7.3.1.2 In vessels equipped with a special wheeled catch-transport arrangement, the design load p, in kN, for ramp deck plating is to be determined from the formula

$$p = 27\,\frac{G_1 + G_2}{n_w} \qquad (3.7.3.1\text{-}2)$$

where n_w = number of the wheel axes of the arrangement.

3.7.3.2 For factory decks, the design pressure p, in kPa, is to be determined from the formula

$$p = 15\,\frac{G}{S_d}\,. \qquad (3.7.3.2)$$

3.7.3.3 The design pressure p, in kPa, on the sides and superstructure sides of ships moored at sea is to be obtained from the following formulae:

in the region A

$$p = \alpha_1\alpha_2(190 + 51\sqrt{\Delta z\cdot 10^{-3} - 0{,}464}); \qquad (3.7.3.3\text{-}1)$$

in the regions B and C

$$p = \alpha_1\alpha_2(129 + 59\sqrt{\Delta z\cdot 10^{-3} - 0{,}464}) \qquad (3.7.3.3\text{-}2)$$

where α_1 is to be adopted from Table 3.7.3.3-1 depending on the ship displacement and the sea conditions specified for mooring at sea;

α_2 is to be adopted from Table 3.7.3.3-2 depending on the ship purpose and the region of strengthening;

Δ = design ship displacement, in t. For a fishing vessel Δ — displacement to the summer loadline. For a special purpose ship Δ — displacement of the largest ship mooring alongside. In any case Δ is not to be taken greater than 7500 t and smaller than 464 t;

n = number of moorings, during a voyage, alongside the ship whose displacement has been adopted as the design value in the Formulae (3.7.3.3-1) and (3.7.3.3-2);

z = distance in m, from the mid-span of member calculated to the summer loadline.

Where a special purpose ship has the freeboard depth h_c greater than the freeboard depth h_p of the ship whose displacement has been adopted as the design value in the Formulae (3.7.3.3-1) and (3.7.3.3-2), the value of z is to be reduced by the difference of $(h_c - h_p)$.

In any case, $z \geqslant 1{,}0$; in the region A, $z = 1{,}0$.

Table 3.7.3.3-1

Factor α_1

Ship displacement, in t	Sea state No.		
	4	5	6
⩽2000	1,00	1,15	1,60
>2000	0,82	1,00	1,16

Table 3.7.3.3-2

Factor α_2

Region of strengthening	Fishing vessel	Special purpose ship
Region A	1,00	0,8
Region A within fender area	–	1,1
Region B	$\frac{1}{0{,}22z + 0{,}6}$	$\frac{1 + 0{,}05n^{1/3}}{0{,}22z + 0{,}6}$
Region C	$\frac{1}{0{,}12z + 1{,}28}$	$\frac{1 + 0{,}05n^{1/3}}{0{,}12z + 1{,}28}$

n — number of moorings, during a voyage, along the ship whose displacement is adopted for the design value in the Formulae (3.7.3.3-1) and (3.7.3.3-2).

Note. In the regions B and C of special purpose ships, α_2 is assumed between 1,1 and 1,4.

3.7.3.4 For fishing vessels of category **ЛУ3** which are intended for systematic operation in ice conditions, the ice load parameters are to be determined on the basis of the following provisions.

3.7.3.4.1 In the forward region of ice strengthening (A), the load parameters are to be determined in accordance with the requirements of 3.10 for the ice category **ЛУ3**. In the case of a bulbous forebody, the rake angle of frame is to be determined as stipulated in 3.10.3.2.1 for ships of category **ЛУ4**.

3.7.3.4.2 In the intermediate region of ice strengthening (A_I), the ice load parameters are to be taken equal to:

$$
\begin{aligned}
&p_{A_1 I} = 0{,}75 p_{AI} \\
&p_{A_1 II} = 0{,}75 p_{AII} \\
&b_{A_1} = b_A \\
&l^{H}_{A_1} = l^{H}_{A}
\end{aligned}
\qquad (3.7.3.4.2)
$$

where p_{A_I}; $p_{A_1 II}$; b_A; l^H_A = ice load parameters for the forward region (A), as determined in accordance with the requirements of 3.10, with due regard for para 3.7.3.4.1.

3.7.3.4.3 In the midship region of ice strengthening (B), the ice-load intensity, in kPa, is determined by the formula

$$p_{wI} = p^{\circ}_{BI} k_B \qquad (3.7.3.4.3)$$

where p°_{BI} = ice load intensity in midship region according to 3.10.3.2.3;

k_B = $2k_1$, but not less than 1;

$$k_1 = \frac{r^2}{\sqrt{\Delta/1000}}(l_k/L - 0{,}18);$$

$$r = \frac{17{,}4 P_b^{1/2}\ a^{1/2} - B_2}{57{,}3 P_b^{1/3}};$$

Δ = displacement, in t, to summer loadline;

P_b = shaft power, in kW, determined with due regard for power take-off in the trawling condition;

l_k = distance, in m, from forward perpendicular to a section aft where the reduction of summer loadline breadth begins.

The height and length (b_B and l^H_B) to which the midship region is covered by the ice load are to be determined in accordance with 3.10.3.3.3 and 3.10.3.4.3.

3.7.3.4.4 The ice load intensity, in kPa, in the aft region of ice strengthening (C) is determined by the formula

$$p_{CI} = p^{\circ}_{CI} k_c \qquad (3.7.3.4.4)$$

where p°_{CI} = ice pressure in the aft region according to 3.10.3.2.4;

k_c = $2{,}5k_1$, but not less than 1;

for k_1, see 3.7.3.4.3.

The height and length (b_B and l^H_B) to which the aft region is covered by the ice load are to be determined in accordance with 3.10.3.3.4 and 3.10.3.4.4.

3.7.4 Scantlings of structural members.

3.7.4.1 Requirements for the scantlings of stern ramp framing.

3.7.4.1.1 The section modulus of longitudinals, beams and deck transverses of the stern ramp is to be determined according to 1.6.4.1, taking:

p = as obtained from the Formulae (3.7.3.1-1) or (3.7.3.1-2);

m = as determined from Table 3.7.4.1.1 for vessels where the catch is dragged in;

$m = 9{,}3 l^2 \sqrt[4]{\frac{a}{l}}$ for vessels where the catch is carried onto the deck by a special wheeled arrangement;

k_σ = 0,6.

Table 3.7.4.1.1

Factor *m*

Stern ramp framing	Fishing vessels	Special purpose ship
Deck longitudinals	11,3	7,9
Beams and deck transverses	12,6	8,8

3.7.4.1.2 The section modulus, in cm^3, of stern ramp side stiffeners is not to be less than determined from 1.6.4.1 with the design load p as determined from the Formulae (3.7.3.1-1), $k_\sigma = 0{,}9$, $m = 17{,}0$, or 22,6 for fishing vessels and special purpose ships respectively. The stiffener span l is to be adopted equal to the maximum distance between the ramp deck and the nearest deck above or to the distance between two decks adjoining the ramp side, but is not to be less than 2,6 m.

In vessels engaged in pelagic fishing, the section modulus of ramp side stiffener, in cm^3, is not to be less than:

$$W = 45{,}5\,(1 - \frac{0{,}5}{l})(\frac{820}{\sigma_n} - \frac{l}{a})\omega_c. \qquad (3.7.4.1.2)$$

In no case shall the section modulus of stern ramp side stiffeners be less than required in 2.5.4.2 for the frames of upper 'tween deck and superstructure.

3.7.4.1.3 The length of thickened ramp deck plating sections along the ramp length shall equal:

the ramp width at least, if measured forward of the ramp edge, in way of bottom rounding;

double ramp width at least in way of top rounding.

3.7.4.1.4 Where the connection of the ramp side with transom plating is rounded, the thickness of the plating strake not less than 700 mm broad, if measured from the ramp deck plating, is not to be less than 20 mm. Doubling plates are also permitted.

If a welded half-round bar not less than 70 mm in diameter is fitted to the junction of the rounding and the flat part of the side, but not farther than 200 mm from the transom, the plating thickness may be adopted in accordance with the requirements of 3.7.4.1.6.

3.7.4.1.5 For vessels not engaged in pelagic fishing, the plating strakes of ramp sides are to be thickened, in way of connection with the transom and along the ramp deck, to a value not less than required under 3.7.4.1.6.

The thickened side plating strakes fitted along the ramp length shall have a breadth not less than 0,4 of the ramp breadth, or 1,0 m, whichever is greater. The lower edge of those strakes is to coincide with the ramp deck in vessels where the catch is dragged in and to be level with the catch stowage surface in vessels where the catch is carried onto the deck by a wheeled arrangement.

If measured forward of the rounding-to-flat-side-junction line, the length of thickened section of the side plating in way of transom is not to be less than 0,5 of the ramp breadth.

3.7.4.1.6 For vessels where the catch is dragged in, the plating thickness of ramp deck and sides, in mm, is

Table 3.7.4.1.6

Ramp structure	Location along ramp length	Fishing vessel		Special purpose ship	
		m	Δs, in mm	m	Δs, in mm
Deck	Bottom rounding and stern-counter plating	26,8	10,0	26,8	10,0
	Mid-region	26,8	5,5	26,8	5,5
	Top rounding	26,8	9,5	26,8	5,5
Sides	In way of friction	25,9	5,5	21,9	5,5
	Elsewhere on deck	25,9	4,5	21,9	4,5

not to be less than determined from the Formula (1.6.4.4), taking:

m, Δs = to be adopted from Table 3.7.4.1.6;

p = as determined from the Formula (3.7.3.1-1);

$k_\sigma = 0,8$;

$k = 1,0$.

3.7.4.1.7 Where doubling plates are fitted on the ramp deck in way of bottom rounding or top rounding or where devices to prevent excessive wear of stern ramp plating with wire ropes are installed, the plating thickness may be adopted as for the mid-portion.

3.7.4.1.8 In vessels engaged in pelagic fishing, the lower strake of the side having a width from the stern ramp plating to a point at least 100 mm above the upper half-round bar is to have a thickness s, in mm, not less than:

$$s = 2 \cdot 10^4 \frac{a_s}{\sigma_n} + 1 \qquad (3.7.4.1.8)$$

where a_s = distance, in m, between adjacent edges of half-round bars.

3.7.4.1.9 Whatever the mode of carrying the catch along the stern ramp, the thickness of ramp plating in vessels of all types is to be 2 mm greater than required by 2.2.4.8 for the shell plating. This thickness shall be maintained on the length from the stern ramp end to a line at least 600 mm above the bulkhead deck within the particular section of the vessel length. Forward of this region the thickness of stern ramp plating is to be 2 mm greater than required under 2.6.4.1.5 for the upper deck plating at ends.

3.7.4.1.10 On a length at least 1,0 m forward of the stern ramp edge and at least over the whole ramp breadth, the stern-counter plating shall be 1 mm thicker than stipulated under 2.2.4.1.

3.7.4.2 Requirements for the member scantlings of vessels having a side trawling arrangement.

3.7.4.2.1 In vessels over 30 m in length, the side plating and sheerstrake thickness between the gallows, determined as the distance between the section three spacings forward of the fore end of forward gallow and the section three spacings abaft the after end of after gallow, shall be 1 mm greater than stipulated under 2.2.4.1.

3.7.4.2.2 Within the location of each gallow, to be determined in accordance with 3.7.2.2.2, provision should be made for strengthening as follows:

sheerstrake thickness to be increased by 2 mm;

thickness of strake adjacent to sheerstrake to be increased to equal that of the sheerstrake between gallows;

deck stringer thickness to be increased by 3 mm as compared to that required by 2.6.4.1;

bulwark plate thickness to be increased by 2 mm as compared to that required by 2.14.4.1.

3.7.4.3 Requirements for member scantlings of holds and fish handling spaces.

3.7.4.3.1 The section modulus of factory deck beams and longitudinals is to be determined as required by 2.6.4 with the design pressure according to 3.7.3.2 where it exceeds that required by 2.6.3.

3.7.4.3.2 In holds and fish handling spaces in which non-packed salted catch or salt is stored or which are exposed to the detrimental effect of catch wastes and sea water, the plating thickness is to be increased by 1 mm as compared to that required by the relevant sections of the Rules. Where the structure is so influenced from both sides, relevant thickness is to be increased by 2 mm.

3.7.4.3.3 The vertical web plate thickness of coamings not acting as deck girders is not to be less than the deck plating thickness, or 7 mm, whichever is greater.

3.7.4.4 Requirements for member scantlings of ships mooring at sea.

3.7.4.4.1 The side plating and sheerstrake thickness of ships below 80 m in length shall be by 1 mm greater than required under 2.2.4.8.

3.7.4.4.2 In strengthened regions, the side plating and sheerstrake thickness, in mm, is not to be less than:

$$s = 21,7a\sqrt{\frac{p}{k_n R_{eH}} - 0,242} + \Delta s \qquad (3.7.4.4.2)$$

where a = frame spacing, in mm. If panting frames are provided, a is the distance between main and panting frames;

p = as defined under 3.7.3.3;

k_n = 1,1;

Δs = 4,0 mm for region A in case trawling is effected from the vessel side;

Δs = 1,2 mm for regions B and C;

Δs = 3,0 mm elsewhere.

3.7.4.4.3 In region A, the section modulus of frames, in cm^3, is not to be less than:

$$W = \frac{pab(2l - b)\omega_K}{mk_n R_{eH}} \cdot 10^3 \qquad (3.7.4.4.3)$$

where p = as determined from the Formula (3.7.3.3-1);

a = spacing, in m, of main frames;

b = 1,5 m;

$m = 20,4\ k_1 k_2(1 + k_3 k_4)$;

k_1, k_2 and k_3 should be adopted from Table 3.7.4.4.3 proceeding from the number of load distributing side stringers fitted;

k_4 = 0 where no panting frames are fitted;

k_4 = 0,69 if panting frame ends terminate at longitudinal intercostal members;

k_4 = 1,0 if the end attachments of main and panting frames are similar;

Table 3.7.4.4.3

Factor	No load distributing side stringers	One load distributing side stringer	Two load distributing side stringers or more
k_1	1,0	$1{,}12+0{,}038\,\frac{l}{a}\,\overline{\varpi}$	$1{,}27+0{,}039\,\frac{l}{a}\,\overline{\varpi}$
k_2	$1+6{,}8\sqrt{f/l(f/l+0{,}28)}-12{,}5f_1/l$	$1{,}0+7{,}0\,\frac{f}{l}-8{,}0\,\frac{f_1}{l}$	
k_3	1,0	0,75	0,65

$\overline{\varpi}=\frac{W_c}{W}=$ section modulus ratio of load distributing side stringer and frame;
$f=$ distance, in m, between a section at the lower support of frame and a tangent to the frame contour in way of the section at the upper support, as measured normal to the tangent (see Fig. 3.7.4.4.3);
$f_1=$ maximum deflection of frame according to Fig. 3.7.4.4.3, in m.

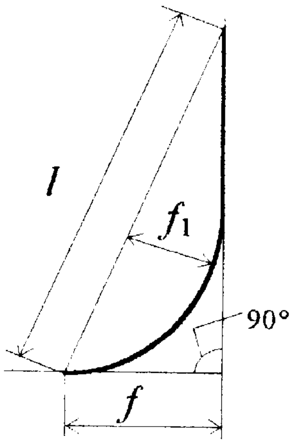


Fig. 3.7.4.4.3

$k_n=$ 1,1;
$l=$ frame span, in m, as measured along the chord between the upper edge of inner bottom plating or floor face plate and the lower edge of deck at side (side stringer where web frames are fitted).

3.7.4.4.4 In regions B and C, the section modulus of frames, in cm^3, is not to be less than determined from the Formula (3.7.4.4.3). The value of p shall be adopted from the Formula (3.7.3.3-2). Where the actual shell plating thickness is greater than 8 mm, p may be reduced by the value

$$\Delta p = \frac{2{,}9+l}{al}s^2R_{eH_{(0)}}\cdot 10^{-3} \qquad (3.7.4.4.4)$$

where $s=$ actual shell plating thickness, in mm, but not greater than 20 mm;
$l=$ frame span, in m;
$R_{eH(0)}=$ yield stress, in MPa, of shell plating material;
$a=$ main frame spacing, in m;
$b=$ 2,2 m;
$m=$ $25{,}0\,\frac{k_1k_2}{k_3}k_4$;
$k_1=$ 1,3 for region B of special purpose ships;
$k_1=$ 1 elsewhere;
$k_2=$ 1 where no load distributing stringers are fitted;
$k_2=1{,}12+\frac{2{,}46\,\overline{\varpi}}{a(8{,}6-l)}$ with one load distributing stringer;
$k_2=1{,}15+\frac{5{,}06\,\overline{\varpi}}{a(8{,}6-l)}$ with two load distributing stringers or more;
$\overline{\varpi}=\frac{W_c}{W}=$ section moduli ratio of load distributing stringer and frame;
$k_3=2a$ for the fender areas of special purpose ships and within (0 — 0,25)L of forward perpendicular in fishing vessels;
$k_3=2a-0{,}1$ within (0 — 0,20)L of aft perpendicular in fishing vessels;
$k_3=2a-0{,}2$ elsewhere;
$k_4=$ 1 where no pantig frames are fitted;
$k_4=$ $\frac{k'_3}{k_3}(1+0{,}5k_1k'_3)$ where panting frames are fitted;
the factor k'_3 is determined in the same way as k_3 with a equal to the spacing of main and panting frames;
$k_n=$ 1,1.

3.7.4.4.5 If longitudinal framing system is applied for 'tween deck spaces, the section modulus, in cm^3, of side longitudinals is not to be less than:

$$W = 24\,\frac{paa_p^2}{R_{eH}}\,\omega_c \qquad (3.7.4.4.5)$$

where $p=$ as determined from the Formula (3.7.3.3-2);
$a=$ spacing, in m, of longitudinals;
$a_p=$ web frame spacing, in m.

3.7.4.4.6 Where superstructure sides of ships mooring at sea are inclined to the centre line at not less than $^1/_{10}$ or fitted inboard at not less than $^1/_{10}$ of their height, no additional strengthening as per 3.7.4.4 is required.

Where the inclination of superstructure sides to the vessel side or the distance between those and the vessel side is less than specified above, the strengthening of their frames and shell plating shall be determined by linear interpolation proceeding from the requirements of 3.7.4.4, 2.2.4.1 and 2.5.4.2.

3.7.4.5 The member scantlings in the ice strengthened regions of fishing vessels of the ice category **ЛУ3** which are intended for systematic operation in ice conditions are to be determined in accordance with 3.10.4 where the ice load parameters are as stipulated in 3.7.3.4, bearing the following specification in mind. When determining shell plating thickness in the intermediate region of ice strengthening in accordance with 3.10.4.1, the annual average thickness reduction of shell plating as a result of corrosion wear and abrasion shall be adopted as $u=0{,}25$ mm/year.

3.7.5 Special requirements.

3.7.5.1 Stern ramp structure.

3.7.5.1.1 Transom plating should be protected from excessive wear with half-round steel bars of at least 70 mm in diameter, which are to be fitted inclined and secured by welding.

3.7.5.1.2 Half-round steel bars of at least 70 mm in diameter shall be welded along the junction line of rounding and flat side, but not farther than 200 mm from the transom.

3.7.5.1.3 In vessels engaged in pelagic fishing, stern ramp sides are to be stiffened with longitudinal half-round steel bars of at least 70 mm in diameter, welded to the sides and spaced not more than 200 mm apart. The edge of the upper bar is to be not less than 650 mm above the ramp deck plating.

3.7.5.1.4 Suitable devices are recommended to prevent excessive wear of ramp plating with wire ropes when dragging the catch. Where the rated winch pull exceeds 30 kN on each wire rope, such devices are compulsory.

Devices preventing excessive wear of plating may be substituted by doubling plates in the thickened areas of top and bottom rounding over the full breadth of the ramp, and doubling strips at least 400 mm wide may be fitted at the sides over the rest of the ramp length.

3.7.5.2 Within the location of each gallow complying with 3.7.2.2.2, bulwark, sheerstrake and shell plating above ballast waterline are to be protected with half-round steel bars fitted inclined and secured by welding.

3.7.5.3 In way of heavy items of machinery and equipment installed in fish handling spaces, extra strengthening of 'tween deck sides may be required by the Register where the 'tween deck height exceeds 3,5 m.

3.7.5.4 When determining the requirements for sternframe scantlings of ships having the length $L < 60$ m, the design length and width of a solid rectangular propeller post are to be those stipulated under 2.10.4.3, as increased by 10 per cent.

3.8 SUPPLY VESSELS

3.8.1 General.

3.8.1.1 The requirements of this Chapter apply to supply vessels. Structural items not covered by this Chapter are to comply with the requirements of Sections 1 and 2.

3.8.2 Construction.

3.8.2.1 Provision is to be made for longitudinal fenders. At the fore end sloped fenders are to be fitted between the longitudinal fenders.

3.8.2.2 Inner bulwarks (coamings) and other similar structures protecting deck cargoes are to be properly secured to deck framing members. The scantlings of the above structures are to be agreed with the Register.

3.8.2.3 Shell in way of stern rollers and in other high load areas is to be suitably reinforced.

3.8.2.4 In deck areas where concentrated loads are applied (e.g. drilling rig anchors), extra strengthening of decks is to be provided.

3.8.2.5 The sides of superstructures and the bulwark are to be inclined to the centre line of the vessel at not less than one-tenth or to be fitted inboard from the vessel's side at not less than one-tenth of their height.

3.8.2.6 The lower ends of stiffeners of the first-tier front bulkheads are to be connected to the underdeck framing members by brackets. The lower ends of other stiffeners are to be welded to the decks. The upper ends of stiffeners are to be connected to the deck beams by means of brackets.

3.8.2.7 The stay of the bulwark welded to the sheerstrake are to be so constructed as to prevent damage of deck plating is case of bumping.

3.8.2.8 Extra strengthening of a flat portion of the bottom in way of the stern may be required to take up loads induced by slamming.

3.8.3 Design loads.

Design loads on hull structures of supply ves-sels are to be taken in compliance with Sections 1 and 2.

3.8.4 Scantlings of structural members.

3.8.4.1 The thickness of the side shell plating is to be 1 mm greater than required by 2.2.4. In no case is the thickness of the side shell plating to be taken less than 9,0 mm.

3.8.4.2 The thickness of deck plating is to be determined from 2.6.4, but it is not to be less than 8,0 mm.

3.8.4.3 The scantlings of deck framing members are to be obtained as required by 2.6.4 with a design load corresponding to the specified value but not less than 35 MPa.

3.8.4.4 The scantlings of girders and pillars supporting these girders are to be suitable for the weight of the deck cargo, as well as for loads induced by towing winches, supports of separate cargo platforms and other concentrated loads. Account is to be also taken of a vertical and a horizontal components of inertia forces due to the vessel's motions. As the first approximation, accelerations determined according to 1.3.3 may be used.

3.8.4.5 The section modulus of hold, 'tween deck and forecastle frames is not to be less than determined according to 3.7.4.4.4 with p to be determined by the Formula (3.7.3.3-1), α_1=1,16, α_2=1,0.

3.8.4.6 The section modulus of stiffeners of the fronts, sides and after ends of the deckhouses situated on the forecastle deck is to be not less than that required by 2.12.4.5.2. The assumed head p, in kPa, is not to be taken less than given in Table 3.8.4.6.

3.8.4.7 The plate thickness of the fronts, sides and after ends is to be taken not less than 6,5 mm for the first-tier front bulkhead and 6,0 mm for other bulkheads. These values are applicable in case of stiffener spacing

Table 3.8.4.6

Deckhouse tier	p, in kPa		
	Front bulkhead	Side bulkhead	After bulkhead
First	90	60	25
Second and above	75	50	25

0,6 m. For stiffener spacings exceeding 0,6 m the thickness is to be increased in proportion to the increased spacings.

3.8.4.8 The plate thickness of the bulwark is to be at least 7 mm, and the width of the stiffener lower end measured along the weld is to be not less than 360 mm. The distance between stays is not to exceed two spacings or 1,3 m, whichever is the lesser.

3.8.5 Special requirements.

3.8.5.1 In vessels having a double skin construction, structures and scantlings of the inner skin framing are to comply with 2.5. Where the forces acting on the frames may be directly transmitted to the inner skin framing, the scantlings of these members are to be specially considered by the Register.

3.8.5.2 Scallops and one-sided welds are not to be used in framing-to-side-shell-plating connections.

3.9 TUGS

3.9.1 General and symbols.

3.9.1.1 The requirements of this Chapter apply to all tugs irrespective of purpose or service area.

3.9.1.2 Structural items not covered by this Chapter are to comply with the requirements of Sections 1 and 2.

3.9.1.3 Symbols:

b_s = width of stem cross section, in mm;

l_s = length of stem cross section, in mm.

3.9.2 Construction.

3.9.2.1 Plate floors are to be fitted at each frame.

Where the double bottom is omitted, the floors are to have a symmetrical face plate.

3.9.2.2 Where a main frame span exceeds 3,0 m, load distributing side stringers are to be fitted along the length of the ship except for the engine room.

3.9.2.3 In the engine room, web frames are to be fitted between the inner bottom (floor face plates) and the upper deck at a distance not exceeding four spacings. Web frames should be fitted at main engine ends.

3.9.2.4 A fender is to be fitted at upper deck and long forecastle deck level.

3.9.2.5 Areas to which concentrated loads are applied (e.g. due to towing winches) shall be additionally strengthened.

3.9.2.6 The stems of harbour tugs shall have rounded shape above the summer load waterline.

3.9.3 Design loads.

Design loads on hull structures of tugs shall be assumed in compliance with the requirements of Sections 1 and 2.

3.9.4 Scantlings of structural members.

3.9.4.1 The minimum plating thickness of shell and upper deck as well as of watertight bulkheads is not to be less than 5 mm.

3.9.4.2 The thickness of shell plating adjacent to the stem is not to be less than stipulated under 2.2.4.6.

The shell plating thickness in way of the engine room, when located aft, is not to be less than required for the midship region.

3.9.4.3 When determining the section modulus of the web frames in accordance with 2.5.4.5, the distance measured from the inner bottom plating (floor upper edge) and the upper deck at side is to be taken as the design span.

3.9.4.4 The scantlings of load distributing side stringers shall be determined in accordance with 2.8.2.7.

3.9.4.5 Within the region from the keel to the summer load waterline, the cross-section of a rectangular solid bar stem is not to be less than:

$$l_s = 1{,}6L + 100; \qquad (3.9.4.5\text{-}1)$$

$$b_s = 0{,}5L + 25. \qquad (3.9.4.5\text{-}2)$$

The scantlings and location of brackets for strengthening the stem shall be determined proceeding from 2.10.4.1.3.

The stem is to be extended abaft the fore peak bulkhead for not less than three spacings.

Ship-handling tugs are not permitted to have reduced cross-section and scantlings of the stem (if constructed of steel plates) above the summer load waterline.

The steel plates of the stem are to be strengthened over their length with horizontal brackets spaced not more than 0,6 m apart, the plate thickness of the stem determined in accordance with 2.10.4.1.2 being not reduced.

3.9.4.6 Rectangular solid propeller posts are to have scantlings from the keel to the counter not less than:

$$l_s = 1{,}5L + 100; \qquad (3.9.4.6\text{-}1)$$

$$b_s = 1{,}8L + 25. \qquad (3.9.4.6\text{-}2)$$

The sternframe is to be attached according to 2.10.2.2.4 to two floors, whatever the length of the tug may be.

3.9.4.7 The thickness of the bulwark plating is to be taken according to 2.14.4.1, but not less than 4 mm.

The section modulus of bulwark stays shall be determined in accordance with 2.14.4.2 where $m = 1{,}5$. Bulwark stays shall be fitted not farther than at alternate frames. Bulwark stays welded to the sheerstrake plate may have a flexible element in their structure.

The bulwark is to be inclined to the centre line of the vessel at not less than 7°.

3.9.5 Special requirements.

For unrestricted service tugs above 40 m in length, the number of watertight bulkheads is to be not less than four.

3.10 STRENGTHENING OF ICE SHIPS AND ICEBREAKERS

3.10.1 General provisions and requirements.

3.10.1.1 Application.

3.10.1.1.1 The requirements of this Chapter apply to self-propelled ice ships and icebreakers, as well as to ships which may be given the same status proceeding from the conditions of their ice navigation.

3.10.1.1.2 Self-propelled ice-strengthened ships which comply with the requirements of this Chapter are assigned an ice category mark in their class notation in accordance with 2.2.3, Part I "Classification".

3.10.1.1.3 Requirements of this Chapter are supplementary with regard to those of other chapters of the Rules which apply to a particular ship, and they establish the minimum strength level necessary to withstand ice loads, as well as hull structure, proceeding from the ice mark in the class notation.

3.10.1.1.4 The calculated dependences of this Chapter are directly applicable to those ice ships and icebreakers only which have a standard hull form and which comply with the requirements of 3.10.1.2. The possibility of departing from the requirements of 3.10.1.2, as well as of using bow lines (spoon-like, multi-plane) other than standard ones, is subject to special consideration by the Register.

3.10.1.1.5 In the Rules, an assumption is made that during service the owner will be guided by the requirements contained in the ice certificate of the ship which is to be drawn up by a competent body and is to include a precise outline of conditions under which safe navigation in ice can be ensured proceeding from the ice category mark, ice situation and icebreaker support.

3.10.1.2 Requirements for hull configuration.

3.10.1.2.1 The hull configuration parameters α, α_0, β, φ, in deg., are to be measured in conformity with Figs 3.10.1.2-1 to 3.10.1.2-4.

3.10.1.2.2 The hull configuration parameters of ice class ships are to be within the limits stated in Table 3.10.1.2.2.

In the forward and intermediate region of ice strengthening of **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships and icebreakers, there are to be no areas of shell plating within which the configuration parameters α and β would simultaneously take the values $\beta = 0$ and $\alpha > 0$.

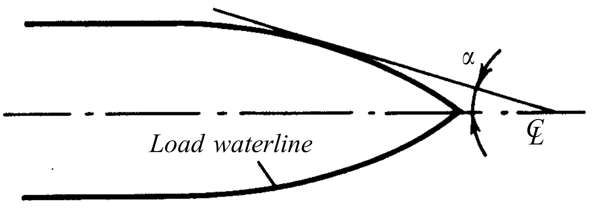


Fig. 3.10.1.2-1:
α — slope of summer load waterline at the section considered, in deg.

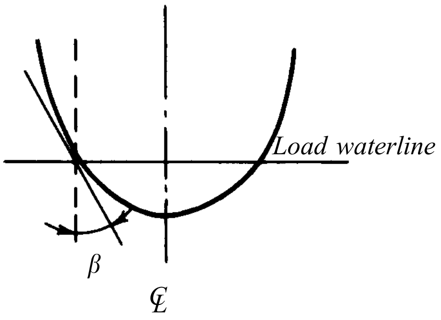


Fig. 3.10.1.2-2:
β — slope of frame on the level of summer load waterline at the section considered, in deg.

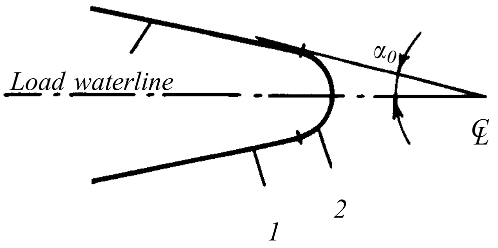


Fig. 3.10.1.2-3:
α_0 — slope of summer load waterline at the forward perpendicular, in deg;
1 — shell plating; *2* — stem

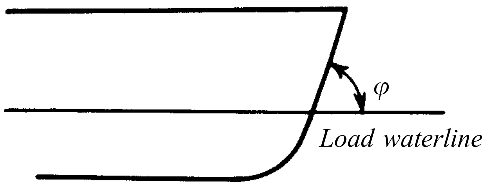


Fig. 3.10.1.2-4:
φ — slope of stem on the level of summer load waterline, in deg.

3.10.1.2.3 The values of hull configuration parameters in icebreakers are to comply with the following requirements.

At 0 — 0,25L from forward perpendicular at service draughts, straight and convex waterlines are to be used. The entrance angle for above waterlines is to be 22° to 30°.

Table 3.10.1.2.2

Hull configuration parameter	Category of ice strengthening				
	ЛУ8, ЛУ9	ЛУ7, ЛУ6	ЛУ5	ЛУ4	ЛУ1, ЛУ2 ,ЛУ3
φ not greater than	25°	30°	45°	60°	—
α_0 not greater than	30°	30°	40°	40°	50°
β within 0,05L from forward perpendicular, min	45°	40°	25°	20°	—
at main frame, min	15°	—	—	—	—

At service draughts, the angle shall not exceed:

30° for **ЛЛ6**, **ЛЛ7** category icebreakers;

25° for **ЛЛ8**, **ЛЛ9** category icebreakers.

The cross section of stem shall be executed in the form of a trapezoid with a bulging forward face.

For icebreakers with standard bow lines, slope angles of frames shall be adopted from Table 3.10.1.2.3-1. In case of departure from the requirements of Table 3.10.1.2.3-1, the ice load values will be specially considered by the Register.

Table 3.10.1.2.3-1

Distance from section to forward perpendicular	0,1L	0,2 — 0,25L	0,4 — 0,6L	0,8 — 1,0L
Permissible range of the angle variation β, in deg.	40° — 55°	23° — 32°	15° — 20°	Approximately coinciding with the angles β of within 0 — 0,2L

In way of construction water line, frames shall have a straight-lined or moderately convex shape.

The construction water line projection upon a horizontal plane shall cover the blade tips of side propellers.

The tip clearance is not to be less than stated in Table 3.10.1.2.3-2.

Table 3.10.1.2.3-2

Clearance, in mm	Category of icebreaker			
	ЛЛ9	**ЛЛ8**	**ЛЛ7**	**ЛЛ6**
δ	1500	1250	750	500

3.10.1.2.4 In the afterbody of icebreakers and **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, provision shall be made for an appendage (ice knife) aft of the rudder to protect the latter on the sternway.

3.10.1.2.5 No transom stern (with the transom coming in the region of ice strengthening) is permitted for icebreakers and **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships. For **ЛУ4** and **ЛУ5** category ships having a transom stern, the value of ice loads upon the transom is subject to the special consideration of the Register.

3.10.1.2.6 For icebreakers and **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, provision shall be made for a step in the lower part of the stem. The height of the step is to be 0,1d at least. The transition from the step to the lower part of the stem shall be smooth.

3.10.1.2.7 In ships of categories **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9**, bulbous bow is not permitted. In ships of category **ЛУ4**, this kind of bow is subject to special consideration by the Register.

3.10.1.3 Region of ice strengthening.

3.10.1.3.1 The hull length is to be subdivided into regions of ice strengthening as follows:

forward region — A;

intermediate region — A_1;

midship region — B;

aft region — C.

The hull depth and bottom are subdivided into regions of ice strengthening as follows:

region of alternating draughts and similar regions — I;

region from the lower edge of region I to the upper edge of bilge strake — II;

bilge strake — III;

region from the lower edge of bilge strake to the centre line — IV.

3.10.1.3.2 The length of regions of ice strengthening in ice class ships is to be determined on the basis of Fig. 3.10.1.3.2 and Table 3.10.1.3.2.

Table 3.10.1.3.2

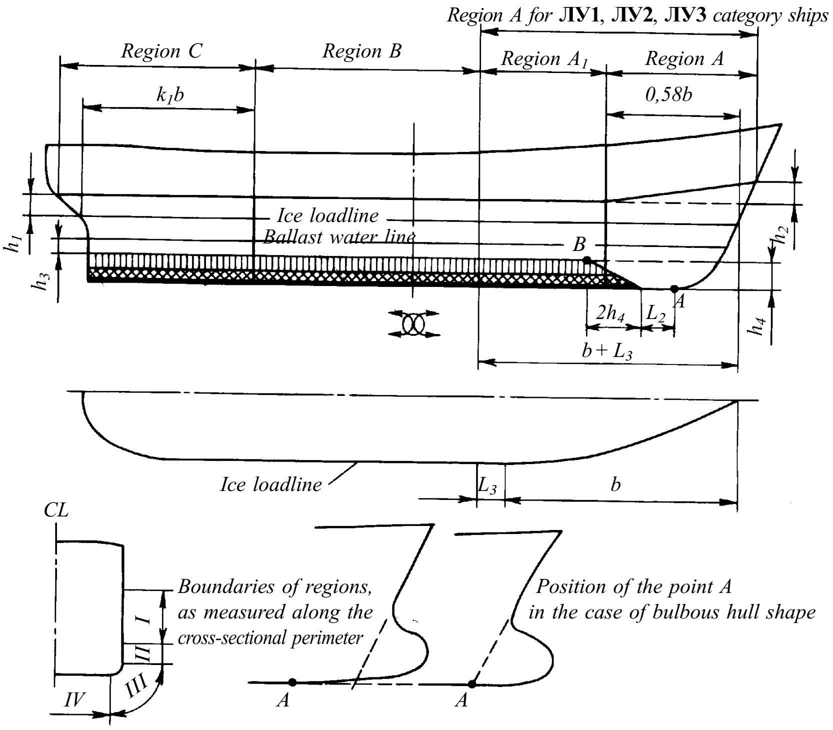
Parameter		Ice category					
		ЛУ7, ЛУ8, ЛУ9	ЛУ5, ЛУ6	**ЛУ4**	**ЛУ3**	**ЛУ2**	**ЛУ1**
h_1, in m	where $B\leqslant 20$ m	0,75		0,60	0,50		
	where $B>20$ m	$\frac{0{,}5B+8}{24}$		$\frac{0{,}5B+8}{30}$	$\frac{0{,}5B+8}{36}$		0,50
h_2, in m		1,4	0,8	0,6	0,2		
h_3, in m		1,6h_1	1,35h_1	1,20h_1	1,10h_1	h_1	
L_2, in m		0,15L	0,1L	0,05L	0,02L		—
L_3, in m		0,06L	0,05L	0,045L	0,04L	0,02L	
k_1		0,84	0,69	0,55	0,53	0,50	—

An ice loadline is to be determined as a loadline enveloping all the ship loadlines (heel disregarded) possible during ice navigation.

For **ЛУ1**, **ЛУ2**, **ЛУ3** category ships no intermediate region of ice strengthening will be established. In this case, it shall be considered that the aft boundary of the forward region of ice strengthening coincides with the forward boundary of the midship region of ice strengthening.

3.10.1.3.3 The length of regions of ice strengthening in icebreakers is to be determined on the basis of Fig. 3.10.1.3.3 and Table 3.10.1.3.3.

3.10.1.3.4 Proceeding from the ice category, the requirements of the Chapter apply to the regions of ice



□ I — ice strake in the region of alternating draughts
▥ II — from the lower boundary of region I to the upper boundary of Region III
▩ III — bilge strake
■ IV — flat bottom

b — distance from the point of the ice loadline and stem intersection to the section where the ice loadline is the widest, but not greater than 0,4*L*.

Notes **1.** For **ЛУ1** category ships, the lower boundary of the region A is by h_3 distant from the ballast waterline. 2.

2. Point B is not to be further than the aft boundary of the region A_1.

Fig. 3.10.1.3.2
Regions of ice strengthening of ice class ships

Table 3.10.1.3.3

Parameter		Category of icebreaker			
		ЛЛ9	**ЛЛ8**	**ЛЛ7**	**ЛЛ6**
h_1, in m	where $B \leqslant 20$ m	1,00	0,80	0,75	
	where $B > 20$ m	$\frac{0,5B+12}{22}$	$\frac{0,5B+7,6}{22}$	$\frac{0,5B+8}{24}$	
h_2, in m		2	1,7	1,4	1,1
h_3, in m		$1,9+1,6h_1 \geqslant 3,5$	$1,72+1,6h_1 \geqslant 3,0$	$1,6+1,6h_1 \geqslant 2,8$	$0,4+1,6h_1 \geqslant 1,6$

strengthening marked with "+" in Table 3.10.1.3.4. For the purpose of Table 3.10.1.3.4, the absence of this mark means that the particular region of ice strengthening is not covered by the requirements of the Chapter.

3.10.2 Structure.

3.10.2.1 Side grillage structure where transverse framing is used.

3.10.2.1.1 A grillage may include vertical girders of main framing which are denoted as conventional frames, vertical web members which are denoted as deep frames, and longitudinals which are denoted as stringers.

Conventional frames are subdivided into:

main frames lying on the same plane as floors or bilge brackets;

intermediate frames not lying on the same plane as floors or bilge brackets.

The presence of intermediate frames within a grillage is not mandatory.

Not more than one intermediate frame may be fitted between every two adjacent main frames.

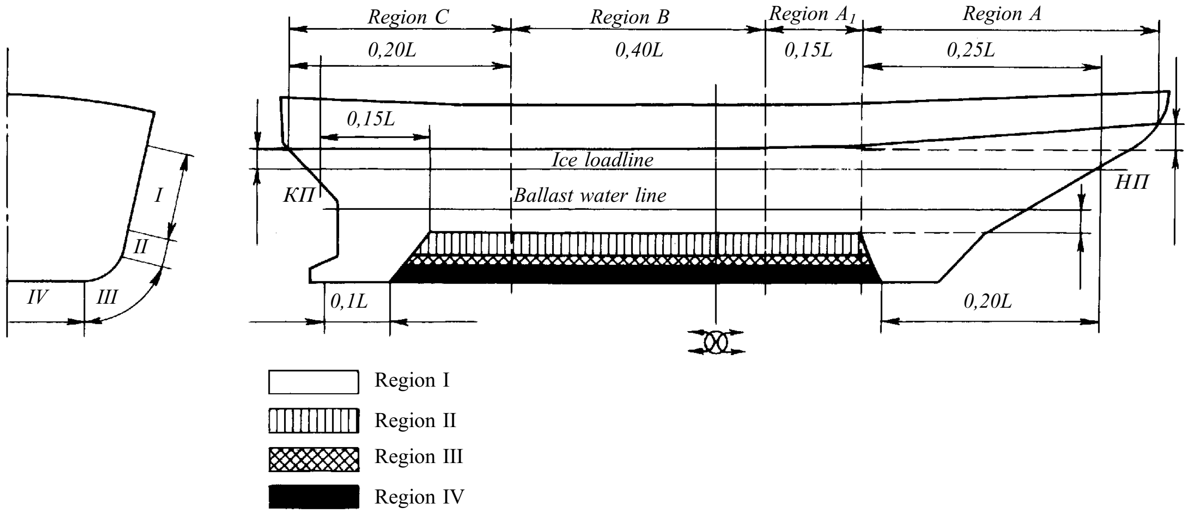


Fig. 3.10.1.3.3
Regions of ice strengthening of icebreakers

Table 3.10.1.3.4

Ice category	Vertical regioning															
	I				II				III				IV			
	Horizontal regioning															
	A	A_1	B	C	A	A_1	B	C	A	A_1	B	C	A	A_1	B	C
ЛЛ9, **ЛЛ8**, **ЛЛ7**, **ЛУ9**, **ЛУ8**	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
ЛУ7	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
ЛЛ6, **ЛУ6**	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
ЛУ5	+	+	+	+	+	+	+	+	+	+	+		+	+		
ЛУ4	+	+	+	+	+	+	+		+	+			+	+		
ЛУ3	+		+	+	+											
ЛУ2	+		+	+												
ЛУ1	+															

Stringers are subdivided into:

intercostal stringers by which joint taking-up of local ice loads by the frames is ensured. It is recommended that the stringers shall be inter-costal;

side stringers by which a transition of forces is ensured from conventional frames which directly take up the ice load to deep frames or to transverse bulkheads.

Side grillage structures are permitted as follows:

grillage with transverse main frames which is formed by conventional frames of the same section and by intercostal stringers;

grillage with transverse web frames which is formed by conventional frames, side stringers and deep frames. Intercostal stringers may be fitted together with side stringers.

With a double-bottom structure available, the functions of deep frames are taken over by vertical diaphragms, and those of the side stringers, by horizontal diaphragms.

3.10.2.1.2 In icebreakers and **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, frames are to be attached to decks and platforms with brackets; if a frame is intercostal in way of deck, platform or side stringer, brackets are to be fitted on both sides of it.

3.10.2.1.3 The end attachments of main frames are to comply with the requirements of 2.5.5. In icebreakers solid floors are to be fitted on each main frame. In **ЛУ8**, **ЛУ9** category ships, solid floors shall be fitted on every other main frame.

The end attachments of intermediate frames are to comply with the following requirements.

In **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships and icebreakers, the bottom ends of intermediate frames are to be secured at margin plate stiffened with a lightened margin bracket (or a system of stiffeners) reaching up to longitudinal stiffeners or intercostal members and welded thereto (Fig. 3.10.2.1.3-1).

Where there is no double bottom, the intermediate frames are to extend as far as longitudinal stiffeners or intercostal structure and welded thereto. The particular longitudinal stiffener or intercostal structure is to be fitted not higher than the floor face-plate level.

In **ЛУ1**, **ЛУ2**, **ЛУ3** category ships having transverse main framing, the bottom ends of intermediate frames may be secured at intercostal longitudinal fitted 1000 mm beneath the lower boundary of region I.

In **ЛУ1**, **ЛУ2**, **ЛУ3** category ships with deep framing, it is permitted to secure the bottom ends of intermediate frames, except for the region A of category **ЛУ3**, at a longitudinal (which may be intercostal) fitted 1000 mm below the side stringer lying beneath the lower

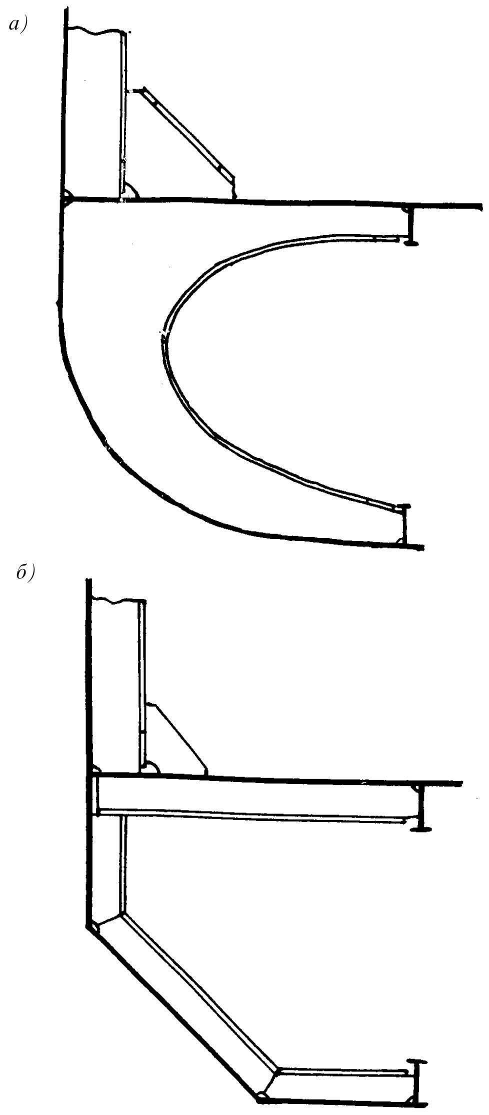


Fig. 3.10.2.1.3-1:
a — lightened margin bracket;
b — system of stiffeners.

boundary of region I (Fig. 3.10.2.1.3-2). In this case, the web area and plastic modulus of the above side stringer are not to be less than required for a stringer fitted in region I.

In icebreakers and **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, the upper ends of intermediate frames are to be secured on a deck or platform lying above the upper boundary of region I. In **ЛУ1**, **ЛУ2**, **ЛУ3** category ships having transverse main framing, the upper ends of intermediate frames may be secured in way of an intercostal longitudinal fitted 500 mm above the upper boundary of region I.

In **ЛУ1**, **ЛУ2**, **ЛУ3** category ships with deep framing, the upper ends of intermediate frames may be secured in way of a longitudinal (which may be intercostal) fitted 500 mm higher than the side stringer lying above the upper boundary of region I (see Fig. 3.10.2.1.3-2). In this case, the web area (and the ultimate section modulus of the above side stringer are not to be less than required for a stringer fitted in region I.

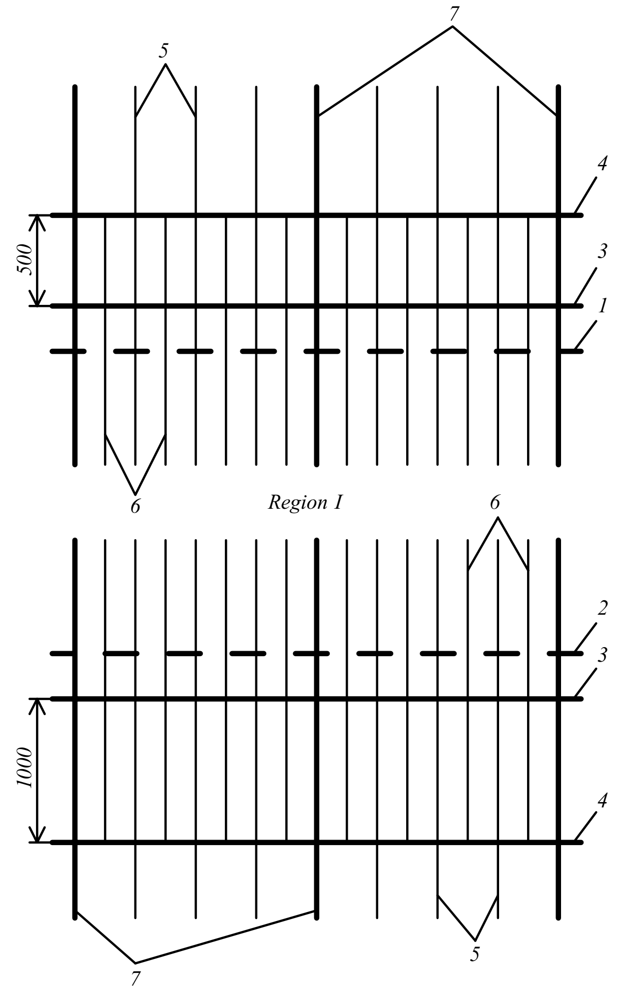


Fig. 3.10.2.1.3-2
Permissible method for securing the ends of intermediate frames in **ЛУ1**, **ЛУ2**, **ЛУ3** category ships with deep framing:
1 — upper boundary of region I; *2* — lower boundary of region I;
3 — side stringer; *4* — intercostal longitudinal;
5 — main frames; *6* — intermediate frames;
7 — deep frames

3.10.2.1.4 In regions I and II of icebreakers and **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, intercostal and/or side stringers shall be fitted the distance between which or the stringer-to-deck or platform distance is not to exceed 2 m, as measured on a chord at side.

For region I of **ЛУ1**, **ЛУ2**, **ЛУ3** category ships, this distance is not to exceed 3 m.

Side stringers are to be fitted in the loadline and ballast water line regions. If there is a deck or platform lying on the same level, the side stringer may be omitted. Stringers are to be attached to bulkheads by means of brackets.

3.10.2.2 Determining the supporting sections of frames in grillages with transverse framing.

3.10.2.2.1 The supporting sections of conventional and deep frames are to be found in supporting structures only.

For frames, horizontal grillages (decks, platforms, bottom) are considered to be supporting structures. A supporting structure consists of plating (decks, platforms, double bottom) and framing connected thereto (beams, half-beams, floors, tank-side brackets). Where there is no double bottom, the formulae to be found below shall be used on the assumption that the plating lies level with floor face plates.

3.10.2.2.2 The supporting section of a conventional frame is considered to be fixed, if one of the following conditions is met at least:

the frame is connected to the framing of a supporting structure;

the frame crosses the plating of a supporting structure.

A supporting section is considered to be freely supported, if a conventional frame is not connected to supporting structure framing and is terminated on the structure plating.

Where a conventional frame terminates on an intercostal longitudinal (intercostal stringer), its end is considered to be free, i.e. no supporting section is available.

3.10.2.2.3 The position of a supporting section of a frame (conventional or deep frame) is determined in the following way.

Where the frame is connected to the supporting structure plating only, the supporting section coincides with the plating surface.

Where the frame is connected to the supporting structure framing, the supporting section:

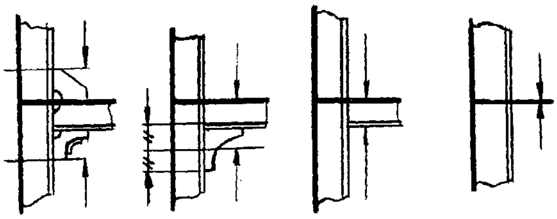
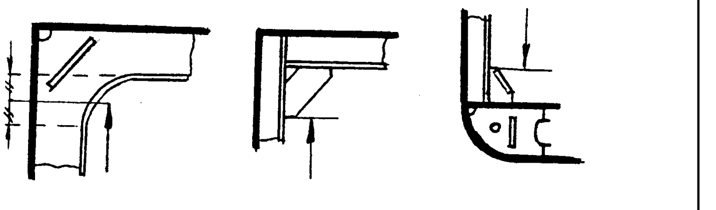
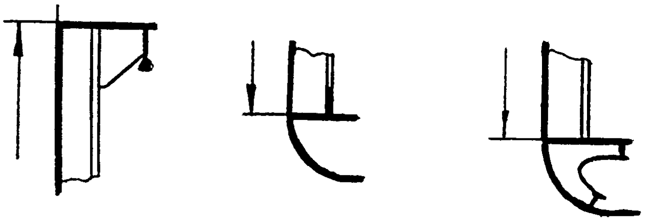
coincides with the face plate surface of the supporting structure frame in case of bracketless joint;

lies at bracket end where brackets with a straight or rounded and stiffened edge are concerned;

lies in the middle of the bracket side where brackets with a rounded free edge are concerned.

3.10.2.2.4 When determining the conditions of fixation and the position of supporting sections in typical structures, one is to be guided by Table 3.10.2.2 (the

Table 3.10.2.2

Type of joint in way of the supporting section of the frame	Type of supporting section	Sketch showing structure and the position of supporting section therein
Intersection of supporting structure	Fixed	
Securing on supporting structure with connection to its framing	Fixed	
Securing on supporting structure without connection to its framing	Freely supported	
Securing on intercostal longitudinal	Free end	 No supporting section

position of a supporting section is indicated with an arrow in the sketches of the Table), as well as by the requirements of 3.10.2.2.2 and 3.10.2.2.3.

3.10.2.3 Side grillage structure where longitudinal framing is used.

3.10.2.3.1 A longitudinally framed side grillage structure is permitted which consists of longitudinals and web frames. Intercostal additional frames may be fitted between deep frames (see 3.10.2.3.3).

In a double-side structure, the functions of deep frames are taken over by vertical diaphragms. Where a double-side structure includes horizontal diaphragms, they are considered to be platforms, and the requirements of 3.10.2.4 and 3.10.4.9 for platforms apply to them. Longitudinal framing system is not recommended for ice and **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships.

3.10.2.3.2 Longitudinals which are intercostal in way of plate structures (see 3.10.2.4) shall be secured with brackets on both sides of the plate structure, and the webs of the longitudinals shall be welded to the plate structure.

3.10.2.3.3 In icebreakers and **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships where the spacing of frames is greater than 2 m, additional frames shall be fitted.

The end fixation method is to be the same as in the case of intermediate frames of **ЛУ1**, **ЛУ2**, **ЛУ3** category ships with transverse main framing in accordance with 3.10.2.1.3, irrespective of the ice category.

3.10.2.4 Plate structures.

3.10.2.4.1 By plate structures, the sections of deck, platform and double bottom plating, of transverse bulkhead plating, deep frame plates, stringers of side and bottom, centre-plane girder, solid and lightened plate floors and bilge brackets which adjoin the shell plating are meant.

3.10.2.4.2 For hull members mentioned under 3.10.2.4.1, the areas to be covered by the requirements for plate structures will be established as follows:

fore peak and after peak bulkheads of icebreakers and **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships throughout their breadth; for ships of other categories, on a breadth of 1,2 m from the shell plating;

other bulkheads in regions I and II of ice-breakers and **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, decks and platforms of icebreakers and **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, on a breadth of 1,2 m from the shell plating;

other hull members — on a breadth of 0,6 m from the shell plating.

3.10.2.4.3 In the areas of plate structures mentioned under 3.10.2.4.2, corrugated structures with corrugations arranged along the shell plating (i.e. vertical corrugations on transverse bulkheads and longitudinal corrugations on decks or platforms) are not permitted.

3.10.2.4.4 The plate structures of icebreakers, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships and region I of **ЛУ4** category ships are to be provided with stiffeners fitted at right angles approximately to the shell plating. The stiffeners must be spaced not farther apart than stipulated in Table 3.10.2.4.4.

Table 3.10.2.4.4

Orientation of main framing fitted at shell plating	Maximum spacing of stiffeners	
	Icebreakers, **ЛУ5** (region I), **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9**	**ЛУ5** (except region I), **ЛУ4** (region I)
Main framing lies across a plate structure	*a*, but not greater than 0,5 m	2*a*, but not greater than 1,0 m
Main framing lies parallel to a plate structure	0,6 m	0,8 m

Note. *a* is the spacing of main framing girder, as measured on the shell plating.

The plate structures of **ЛУ1**, **ЛУ2**, **ЛУ3**, **ЛУ4** (except region I) category ships may be provided with stiffeners fitted in parallel approximately to the shell plating.

3.10.2.4.5 The intersections of plate structures with main framing shall be executed in accordance with Table 3.10.2.4.5. The stiffeners by which the plate structure is strengthened and which lie on the same plane as the main framing girders are to be secured to the above girders. Other methods of attaching the webs of main framing girders to the plate structure may be applied, if found equivalent by the Register.

3.10.2.4.6 Where main framing girders are intercostal in way of the plate structure, brackets are to be fitted on both sides of the structure on the same plane as each of the girders, and the girder webs are to be welded to the plate structure.

3.10.2.4.7 The following requirements are put forward additionally for the intersections (connections) of the plate structures of decks and platforms with main framing.

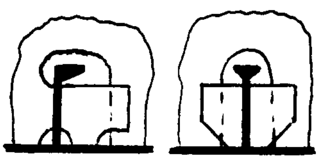
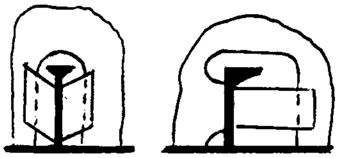
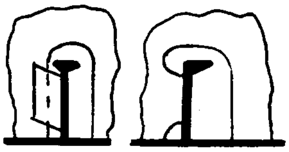
Where transverse framing is used for sides, the frames shall be attached to the beams with brackets. In **ЛУ5** (region I only), **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, the girders are to be fitted on the same plane as each of the frames (see also Table 3.10.2.4.4).

In **ЛУ5** (except region I) and **ЛУ4** (region I) category ships, the frame on whose plane no girder is fitted shall be secured to the plate structure with brackets which are to terminate on the intercostal stiffener.

Where longitudinal framing is used for sides, the girders shall be attached to the shell plating with brackets reaching as far as the nearest longitudinal.

3.10.2.4.8 The distance from the edge of opening or manhole to the shell plating is not to be less than 0,5 m in a plate structure. The distance from the edge of opening or manhole in a plate structure to the edge of opening for the passage of a girder through the plate structure is not to be less than the height of that girder.

Table 3.10.2.4.5

Ice category	Sketch of structure		
			
ЛЛ9, **ЛЛ8**	Fore peak, after peak, region I, region II with longitudinal framing	Regions II, AIII, A_1III, CIII, AIV, A_1IV	Other regions as per Table 3.10.1.3.4
ЛЛ7, **ЛЛ6**	Fore peak, after peak, regions I, II with longitudinal framing	Regions I and II (except fore peak and after peak), AIII, A_1III, CIII	Ditto
ЛУ9, **ЛУ8**, **ЛУ7**	Fore peak, region I with longitudinal framing	Regions I and II (except fore peak), AIII, AIV, A_1IV, A_1III	Ditto
ЛУ6, **ЛУ5**	Fore peak, region AI, A_1I, BI with longitudinal framing	Regions I (except fore peak), II, AIII, A_1III	Ditto
ЛУ4	—	Regions I, AII, A_1II, AIII, A_1III	Ditto
ЛУ3, **ЛУ2**, **ЛУ1**	—	—	All regions
Note. Stiffeners of plate structure and brackets stipulated in 3.10.2.4 are not shown schematically in the sketches.			

3.10.2.5 Fore peak and after peak structure.

3.10.2.5.1 A longitudinal bulkhead welded to the stem or sternframe is to be fitted on the centre line of the ship in the fore peak and after peak of icebreakers and **ЛУ8**, **ЛУ9** category ships, and the lower ends of all frames are to be connected to floors or brackets.

3.10.2.5.2 In the fore peak of icebreakers and **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, platforms with lightening holes should be fitted instead of stringers and panting beams (see 2.8.2.3), the distance between platforms measured along a chord at side, is not to exceed 2,0 m. This structure is recommended for **ЛУ4** category ships as well.

3.10.2.5.3 In the after peak of icebreakers and **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships (see 2.8.2.10), side stringers and panting beams are to be fitted so that the distance between the stringers as measured along a chord at side, would not be greater than 2,0 m. The dimensions of stringer webs are not to be less than determined by the formulas:

height $h = 5L + 400$ mm;

thickness $s = 0{,}05L + 7$ mm.

Platforms with lightening holes are recommended instead of panting beams and stringers.

3.10.2.5.4 In icebreakers and **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, the side stringers in the fore peak and after peak are generally to be a continuation of those fitted in the regions A and C (see 3.10.2.1.4).

3.10.2.5.5 In the case of **ЛУ4** category ships, the area and inertia moment of panting beams are to be increased by 25 per cent as compared to those required by 2.9.4. The dimensions of stringer webs shall not be less than given by the formulae:

height $h = 3L + 400$ mm;

thickness $s = 0{,}04L + 6{,}5$ mm.

3.10.2.5.6 In the fore peak and after peak, the free edges of side stringers are to be stiffened with face plates having a thickness not less than the web thickness and a width not less than ten thicknesses. The interconnections of frames with side stringers are to be in accordance with Table 3.10.2.4.5, and brackets shall be carried to the face plates of the stringers.

3.10.2.6 Stem and sternframe construction.

3.10.2.6.1 **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships are to have a solid section stem made of steel (cast steel is recommended). The stems and sternframes of icebreakers, as well as the sternframes of **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, are to be made of forged or cast steel. Stems and sternframes welded of cast or forged parts are admissible.

3.10.2.6.2 In **ЛУ1**, **ЛУ2**, **ЛУ3**, **ЛУ4**, **ЛУ5** category ships, a stem of combined structure (a bar with thickened plates welded thereto) or plate structure may be used, and where the ship length is under 150 m with a sharp-lined bow, the stem design shown in Fig. 3.10.2.6 may be used (the value of s is to be as determined by the Formula (3.10.4.10.1-3).

In **ЛУ1**, **ЛУ2**, **ЛУ3**, **ЛУ4** category ships, sternframes of combined structure may be used.

3.10.2.6.3 In **ЛУ1**, **ЛУ2**, **ЛУ3**, **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7** category ships, the stem is, where practicable, to be strengthened by a centre line web having its section

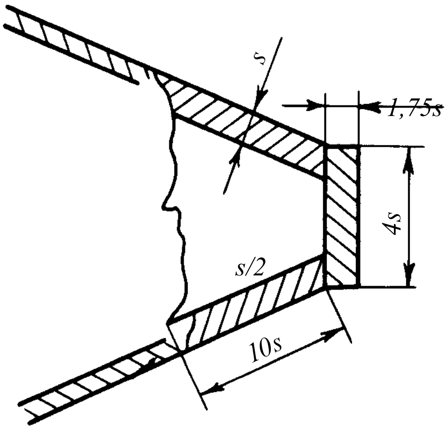


Fig. 3.10.2.6

depth equal to h_v at least (see Table 3.10.4.10.1) with a face plate along its free edge or a longitudinal bulkhead fitted on the ship centre line, on the entire stem length from the keel plate to the nearest deck or platform situated above the level H_1 referred to in 3.10.4.10 and in Table 3.10.4.10.1. The thickness of this plate shall not be less than that of the brackets with which the stem is strengthened (see 3.10.2.6.4). In icebreakers and **Л8**, **Л9** category ships, a longitudinal bulkhead may be substituted for the centre line web.

3.10.2.6.4 Within the vertical extent defined in 3.10.2.6.3, the stem is to be strengthened by horizontal webs at least 0,6 m in depth and spaced not more than 0,6 m apart. The webs are to be carried to the nearest frames and connected thereto. Where in line with side stringers, the webs are to be attached to them. In stems of combined or plate type, the webs are to be extended beyond the welded butts of the stem and shell plating. Above the deck or platform located, by the value of H_1 at least, higher than the upper boundary of region I, the spacing of horizontal webs may gradually increase to 1,2 m in icebreakers and **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, and to 1,5 m in ships of other categories.

The web thickness shall be adopted not less than half the stem plate thickness. In icebreakers and **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, the free edges of webs are to be strengthened with face plates welded to the frames at their ends. The side stringers of the fore peak are to be connected to the webs fitted in line with them.

In case of a full bow, vertical stiffeners may be required additionally to be fitted to the stem plates.

3.10.2.6.5 Where the stern frame has an appendage (ice knife), the clearance between the latter and the rudder plate is not to exceed 100 mm. The appendage shall be reliably connected to the stern frame. Securing the appendage to plate structures is not permitted.

3.10.2.6.6 In icebreakers, the lower edge of solepiece is to be constructed with a slope of 1:8 beginning from the propeller post.

3.10.2.7 Bottom structure.

3.10.2.7.1 In icebreakers and **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, double bottom shall be provided between the fore peak bulkhead and the after peak bulkhead.

3.10.2.7.2 In icebreakers, provision shall be made for solid floors at each main frame, and in **ЛУ8**, **ЛУ9** category ships, at each but one main frame.

3.10.2.7.3 In regions of ice strengthening in way of bottom, as established in accordance with Table 3.10.1.3.4, bracket floors are not permitted.

3.10.2.7.4 In icebreakers and **ЛУ8**, **ЛУ9** category ships the centre-plane girder height is not to be less than given by the formula

$$h = \varphi(9L + 800) \qquad (3.10.2.7.4)$$

where $\varphi = 0,8$ for **ЛУ8** category ships;
$\varphi = 0,9$ for **ЛУ9** category ships;
$\varphi = 1$ for icebreakers.

3.10.2.7.5 In icebreakers and **ЛУ8**, **ЛУ9** category ships, the spacing of bottom stringers is not to exceed 3,0 m.

3.10.2.8 Special requirements.

3.10.2.8.1 In icebreakers, double side structure is generally to be provided between the fore peak bulkhead and the after peak bulkhead.

3.10.2.8.2 In **ЛУ7**, **ЛУ8**, **ЛУ9** category ships double side structure is necessary for machinery room, and for the region mentioned in 3.10.2.8.1 it is recommended.

3.10.2.8.3 Where the web plate of a girder or a plate structure is considerably inclined to the shell plating (the angle between them being less than 50°), the framing normal to the shell plating or an inclined plate structure is recommended (Fig. 3.10.2.8.3). Otherwise, special measures must be taken to prevent the collapsing of the girder or the bulging of the plate structure.

3.10.3 Ice load.

3.10.3.1 Ice load is the approximate design load upon the hull due to ice forces, by which the level of requirements for scantlings is determined proceeding from the ice category mark, hull shape and ship displacement.

The ice load depends on three parameters:

p — ice pressure being a characteristic of the maximum pressure in the area of dynamic contact between the hull and ice, in kPa;

b — vertical distribution of ice pressure characterizing the maximum transverse dimension of the dynamic contact area between the hull and ice, in m;

p — horizontal distribution of ice pressure characterizing the maximum longitudinal dimension of the dynamic contact area between the hull and ice, in m.

The ice load is solely intended to determine the scantlings of structural components of ice strengthening on the basis of the formulae included in this Chapter.

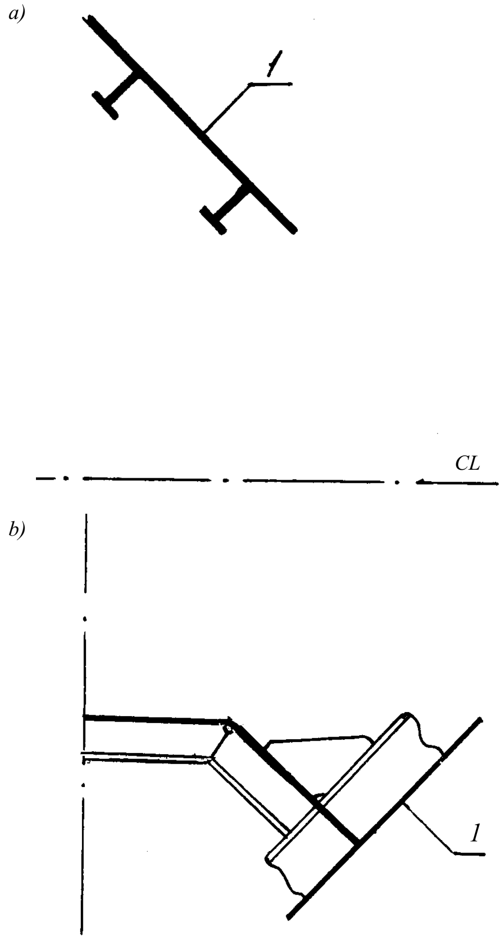


Fig. 3.10.2.8.3:
a — framing normal to shell plating; *b* — inclined plate structure;
1 — shell plating

Using the ice load parameters for strength estimation on the basis of other procedures and programs is not permitted without prior consent of the Register.

The ice-load parameters to be determined according to 3.10.3.2 to 3.10.3.7 apply only to ice ships and icebreakers with hull shape complying with the requirements of 3.10.1.2.2 and 3.10.1.2.3. The ice load for ice ships and icebreakers of other hull shapes is subject to special consideration by the Register.

3.10.3.2 For ice class ships, the ice pressure, in kPa, is to be determined from the following formulae:

.1 in region AI

$$p_{\mathrm{AI}} = 2500 a_1 v_m \sqrt[6]{\frac{\Delta}{1000}} \qquad (3.10.3.2.1)$$

where a_1 = factor to be adopted from Table 3.10.3.2.1 proceeding from the ice category;

Δ = displacement to summer loadline, in t;

v_m = value of the shape factor v, which is the maximum one for the region, as determined at sections within $x = 0$; $0{,}05L$; $0{,}1L$, etc. from the forward perpendicular on the ice loadline level (as far as **ЛУ1**, **ЛУ2**, **ЛУ3** category ships are concerned, design sections where $x \leqslant 0{,}58b$ shall only be considered; for b, see Fig. 3.10.1.3.2). The value shall be determined by the formulae:

$$v = \left(0{,}278 + \frac{0{,}18x}{L}\right)\sqrt[4]{\frac{\alpha^2}{\beta}} \text{ PRI } \frac{x}{L} \leqslant 0{,}25;$$

$$v = \left(0{,}343 - \frac{0{,}08x}{L}\right)\sqrt[4]{\frac{\alpha^2}{\beta}} \text{ PRI } \frac{x}{L} > 0{,}25;$$

x = the distance between the considered section and the forward perpendicular, in m;

α = angles of summer loadline inclination which are to be measured in accordance with Figs 3.10.1.2-1 and 3.10.1.2-3 (where $x = 0$), in deg.;

β = angles of frame inclination on summer loadline level which are to be measured in accordance with Fig. 3.10.1.2-2, in deg.; where the frame is concave in the design section, a minimal angle should be chosen for in the case of **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships which is measured on the level of contingent service waterlines.

Table 3.10.3.2.1

Factor	Ice category								
	ЛУ1	**ЛУ2**	**ЛУ3**	**ЛУ4**	**ЛУ5**	**ЛУ6**	**ЛУ7**	**ЛУ8**	**ЛУ9**
a_1	0,36	0,49	0,61	0,79	1,15	1,89	2,95	5,3	7,9
a_2	—	—	—	0,80	1,17	1,92	3,06	5,75	8,95
a_3	—	0,22	0,33	0,50	0,78	1,2	1,84	3,7	5,6
a_4	—	0,5	0,63	0,75	0,87	1	—	—	—

If $\alpha > 0$ and $\beta = 0$ in the design section of **ЛУ1**, **ЛУ2**, **ЛУ3** category ships, it shall be considered that $v = 0{,}72$ in this section.

If the angle of α is less than 3° in the design section of **ЛУ1**, **ЛУ2**, **ЛУ3**, **ЛУ4**, **ЛУ5** category ships, such a section may be omitted when calculating v_m;

.2 in region $\mathrm{A_1I}$

$$p_{A_1\mathrm{I}} = 2500 a_2 v_m \sqrt[6]{\frac{\Delta}{1000}} \qquad (3.10.3.2.2)$$

where a_2 = factor to be adopted from Table 3.10.3.2.1 proceeding from the ice category;

v_m is to be determined by the method described in 3.10.3.2.1;

for Δ, see 3.10.3.2.1;

.3 in region BI

$$p_{\mathrm{BI}} = 1500 a_3 \sqrt[6]{\frac{\Delta}{1000}}$$

см.Б1 (3.10.3.2.3)

where a_3 = factor to be adopted from Table 3.10.3.2.1 proceeding from the ice category;

for Δ, see 3.10.3.2.1;

.4 in region CI of **ЛУ2**, **ЛУ3**, **ЛУ4**, **ЛУ5**, **ЛУ6** category ships,

$$p_{\mathrm{CI}} = a_4 p_{\mathrm{BI}} \qquad (3.10.3.2.4\text{-}1)$$

where a_4 = factor to be adopted from Table 3.10.3.2.1 proceeding from the ice category;

for $\mathrm{P_{BI}}$, see 3.10.3.2.3.

For **ЛУ7**, **ЛУ8**, **ЛУ9** category ships, the ice pressure in region CI is determined by the formula

$$p_{\mathrm{CI}} = 0{,}75 p_{\mathrm{AI}} \qquad (3.10.3.2.4\text{-}2)$$

where for p_{AI}, see 3.10.3.2.1;

.5 in regions II, III and IV, the ice pressure is determined as a part of the ice pressure in region I at the appropriate section of the ship length

$$p_{kl} = a_{kl} / p_{k\mathrm{I}} \qquad (3.10.3.2.5)$$

where k = A, $\mathrm{A_1}$, B, C;
l = II, III, IV;
a_{kl} = factor to be adopted from Table 3.10.3.2.5.

Table 3.10.3.2.5

Ice category	Region vertically								
	forward and intermediate regions (A and AI)			midship region (B)			aft region (C)		
	Region lengthwise								
	II	III	IV	II	III	IV	II	III	IV
ЛУ3	0,4	—	—	—	—	—	—	—	—
ЛУ4	0,5	0,4	0,35	0,4	—	—	—	—	—
ЛУ5	0,65	0,65	0,45	0,5	0,4	—	0,5	—	—
ЛУ6	0,65	0,65	0,5	0,5	0,45	—	0,5	0,35	0,15
ЛУ7	0,65	0,65	0,5	0,5	0,45	—	0,5	0,4	0,2
ЛУ8	0,7	0,65	0,5	0,55	0,45	0,25	0,55	0,4	0,3
ЛУ9	0,7	0,65	0,5	0,55	0,45	0,3	0,55	0,4	0,35

3.10.3.3 The vertical distribution of ice pressure, in m, shall be as given by the following formulae:

.1 in regions AI, AII, AIII, AIV

$$b_{\mathrm{A}} = C_1 k_{\Delta} u_m \qquad (3.10.3.3.1)$$

where C_1 — factor to be adopted from Table 3.10.3.3.1 proceeding from the ice category;

$k_{\Delta} = \sqrt[3]{\dfrac{\Delta}{1000}}$, but not greater than 3,5;

for Δ, see 3.10.3.2.1;

u_m = maximum value of the shape factor u for the region, to be determined in sections within $x = 0$; $0{,}05L$; $0{,}1L$, etc. from forward perpendicular at the ice loadline level (as far as **ЛУ1**, **ЛУ2**, **ЛУ3** category ships are concerned, design sections where $x \leqslant 0{,}58b$ shall only be considered; for b, see Fig. 3.10.1.3.2). The value shall be determined by the formulae:

$$u = k_{\mathrm{B}}\left(0{,}635 + \frac{0{,}61x}{L}\right)\sqrt{\frac{\alpha}{\beta}} \text{ where } \frac{x}{L} \leqslant 0{,}25;$$

$$u = k_{\mathrm{B}}\left(0{,}862 - \frac{0{,}30x}{L}\right)\sqrt{\frac{\alpha}{\beta}} \text{ where } \frac{x}{L} > 0{,}25;$$

$$k_{\mathrm{B}} = \begin{cases} 1 \text{ where } \beta \geqslant 7^{\circ} \\ 1{,}15 - 0{,}15\dfrac{\beta}{7} \text{ where } \beta < 7^{\circ} \end{cases}$$

for x, α, β, see 3.10.3.2.1.

Table 3.10.3.3.1

Factor	Ice category						
	ЛУ1	**ЛУ2**	**ЛУ3**	**ЛУ4**	**ЛУ5**	**ЛУ6**	**ЛУ7, ЛУ8, ЛУ9**
C_1	0,38	0,42	0,44	0,49	0,6	0,62	0,64
C_2	—	—	—	0,55	0,7	0,73	0,75
C_3	—	0,27	0,30	0,34	0,40	0,47	0,50

If $\alpha > 0$ and $\beta = 0$ in the design section of **ЛУ1**, **ЛУ2**, **ЛУ3** category ships, it shall be considered that $u = 0{,}92$ for this section.

If the angle of is less than 3° in the design section of **ЛУ1**, **ЛУ2**, **ЛУ3**, **ЛУ4**, **ЛУ5** category ships, such a section may be omitted when calculating u_m;

.2 in regions $\mathrm{A_1I}$, $\mathrm{A_1II}$, $\mathrm{A_1III}$, $\mathrm{A_1IV}$

$$b_{\mathrm{A_1}} = C_2 k_{\Delta} u_m, \text{ but not greater than } 1{,}25 b_{\mathrm{A}} p_{\mathrm{AI}} / p_{\mathrm{A_1I}} \qquad (3.10.3.3.2\text{-}1)$$

where C_2 = factor to be adopted from Table 3.10.3.3.1 proceeding from the ice category;
for k_{Δ}, see 3.10.3.3.1;
u_m is to be determined by the procedure described in 3.10.3.3.1;
for b_{A}, see 3.10.3.3.1;
for p_{AI}, see 3.10.3.2.1;
for $p_{\mathrm{A_1I}}$, see 3.10.3.2.2.

In any case, the vertical distribution b_{A_1} is to be not less than

$$b_{\mathrm{A_1}} = \rho B_i b / \rho_{A_1 I} \qquad (\ 3.10.3.3.2\text{-}2\ )$$

where for $\rho_{A_1 I}$, see 3.10.2.2;
for ρ_{B_1}, see 3.10.3.2.3;
for b_B, see 3.10.3.3.3;

.3 in regions BI, BII, BIII, BIV

$$b_B = C_3 C_4 k_{\Delta} \qquad (3.10.3.3.3)$$

where C_3 = factor to be adopted from Table 3.10.3.3.1 proceeding from the ice category;
C_4 = factor to be adopted from Table 3.10.3.3.3 proceeding from the minimal side inclination angle with regard to normal in the midship region of ice strengthening on summer loadline level;
for k_{Δ}, see 3.10.3.3.1;

Table 3.10.3.3.3

Factor	Angle of side slope amidships, in deg.						
	⩽6	8	10	12	14	16	18
C_4	1,00	0,81	0,68	0,54	0,52	0,47	0,44

.4 in regions CI, CII, CIII, CIV

$$b_{\mathrm{C}} = 0{,}8 b_{\mathrm{B}} \text{ — for categories } \textbf{ЛУ2, ЛУ3, ЛУ4, ЛУ5, ЛУ6};$$

$$b_{\mathrm{C}} = b_{\mathrm{A}} \text{ — for categories } \textbf{ЛУ7, ЛУ8, ЛУ9} \qquad (3.10.3.3.4)$$

where for b_{A}, see 3.10.3.3.1;
for b_{B}, see 3.10.3.3.3.

3.10.3.4 Horizontal distribution of ice pressure, in m, shall be determined by the following formulae:

.1 in regions AI, AII, AIII, AIV

$$l^p_{\mathrm{A}} = 11{,}3\sqrt{b_{\mathrm{A}} \sin \beta^{\mathrm{A}}_m}\text{ , but not less than } 3{,}5\sqrt{k_\Delta} \quad (3.10.3.4.1)$$

where for b_{a}, k_Δ, see 3.10.3.3.1;

β^{A}_m = angle β in the design section of region A for which the value of the u parameter is maximum (see 3.10.3.3.1);

.2 in regions $\mathrm{A_1I}$, $\mathrm{A_1II}$, $\mathrm{A_1III}$, $\mathrm{A_1IV}$

$$l^p_{\mathrm{A_1}} = 11{,}3\sqrt{b_{\mathrm{A_1}} \sin \beta^{\mathrm{A_1}}_m}\text{ , but not less than } 3\sqrt{k_\Delta} \quad (3.10.3.4.2)$$

where for $b_{\mathrm{A_1}}$, see 3.10.3.3.2;

$\beta^{\mathrm{A_1}}_m$ = angle β in the design section of region $\mathrm{A_1}$ for which the value of the u parameter is maximum (see 3.10.3.3.1);

for k_Δ, see 3.10.3.3.1;

.3 in regions BI, BII, BIII, BIV

$$l^p_{\mathrm{w}} = 6b_{\mathrm{w}}\text{, but not less than } 3\sqrt{k_\Delta} \quad (3.10.3.4.3)$$

where for b_{w}, see 3.10.3.3.3;

for $k\Delta$, see 3.10.3.3.1;

.4 in regions CI, CII, CIII, CIV

$$l^p_{\mathrm{s}} = 6b_{\mathrm{s}}\text{, but not less than } 3\sqrt{k_\Delta} \quad (3.10.3.4.4)$$

where for b_{C}, see 3.10.3.3.4;

for k_Δ, see 3.10.3.3.1.

3.10.3.5 For icebreakers, the ice pressure is to be determined by the following formulae:

.1 in region AI

$$p_{\mathrm{AI}} = k_p p^{\mathrm{c}}_{\mathrm{AI}} \quad (3.10.3.5.1)$$

where $p^{\mathrm{c}}_{\mathrm{AI}}$ = ice pressure in region AI, to be determined in accordance with 3.10.3.2.1 as in the case of a ship whose ice category number coincides with the category number of the icebreaker;

$$k_p = \begin{cases} 1 \text{ where } N_\Sigma \leqslant N_0; \\ (N_\Sigma/N_0)^{0,4} \text{ where } N_\Sigma > N_0; \end{cases}$$

N_Σ = propeller shaft output, in MW;

N_0 is to be adopted from Table 3.10.3.5.1;

Table 3.10.3.5.1

Category of icebreaker	N_0, in MW
ЛЛ6	10
ЛЛ7	20
ЛЛ8	40
ЛЛ9	60

.2 in regions $\mathrm{A_1I}$, BI and CI

$$p_{k\mathrm{I}} = a_k p_{\mathrm{AI}} \quad (3.10.3.5.2)$$

where for p_{AI}, see 3.10.3.5.1;

a_k = factor to be adopted from Table 3.10.3.5.2 proceeding from the region of the ship length and the category of icebreaker;

k = $\mathrm{A_1}$, B, C;

Table 3.10.3.5.2

Region	Category of icebreaker			
	ЛЛ6	**ЛЛ7**	**ЛЛ8**	**ЛЛ9**
$\mathrm{A_1I}$	0,65	0,75	0,85	0,85
BI	0,6	0,65	0,7	0,75
CI	0,75	0,75	0,75	0,75

.3 in regions II, III and IV, the ice pressure shall be determined as a part of the ice pressure in region I for the appropriate region of ship length.

$$p_{mn} = a_{mn} p_{m\mathrm{I}} \quad (3.10.3.5.3)$$

where $m = \mathrm{A}, \mathrm{A_1}, \mathrm{B}, \mathrm{C}$;

n = II, III, IV;

a_{mn} = factor to be adopted from Table 3.10.3.5.3.

Table 3.10.3.5.3

Factor	Region vertically and region lengthwise											
	AII	AIII	AIV	$\mathrm{A_1II}$	$\mathrm{A_1III}$	$\mathrm{A_1IV}$	BII	BIII	BIV	CII	CIII	CIV
a_{mn}	0,7	0,65	0,5	0,6	0,55	0,45	0,55	0,45	0,35	0,55	0,40	0,30

3.10.3.6 As far as icebreakers are concerned, the vertical distribution of ice pressure is to be adopted equal for all regions and shall be determined in accordance with 3.10.3.3.1, i.e. as for the forward region of the ship whose ice category number coincides with the category number of the icebreaker. When determining u_m, the values of u shall be calculated for those sections only which are included in the forward region of ice strengthening of the icebreaker.

3.10.3.7 As far as icebreakers are concerned, the horizontal distribution of ice pressure is to be adopted equal for all regions and shall be determined in accordance with 3.10.3.4.1, i.e. as for the forward region of the ship whose ice category number coincides with the category number of the icebreaker. When determining β^a_m, only those sections shall be considered which are included in the forward region of ice strengthening of the icebreaker.

3.10.4 Scantlings of ice-strengthening structures.

3.10.4.1 Shell plating.

In regions of ice strengthening, the shell plating thickness s_{sp}, in mm, shall not be less than given by the formula

$$s_{sp} = s_{sp0} + \Delta s_{sp0} \quad (3.10.4.1)$$

where

$$s_{sp0} = 15{,}8 a_0 \sqrt{\frac{p}{R_{eH}}}\ ;$$

$$\Delta s_{sp0} = 0{,}75\,Tu\ ;$$

$$a_0 = \frac{a}{1 + 0{,}5\frac{a}{c}}\ ;$$

p = ice pressure in the region under consideration according to 3.10.3.2 or 3.10.3.5, in kPa;

$c = b$ where the grillage is transversely framed in the region under consideration. In this case, c is not to be greater than the spacing of intercostal stringers or the distance between plate structures;

$c = l$ where the grillage is longitudinally framed in the region under consideration;

b = vertical distribution of ice pressure in the region under consideration according to 3.10.3.3 or 3.10.3.6, in m;
l = distance between adjacent transverse members, in m;
a = spacing of main direction girders, in m;
T = planned ship life, in years;
u = annual reduction of shell plating thickness as a result of corrosion wear and abrasion, in mm per year, to be adopted from Table 3.10.4.1. When taking measures to protect the shell plating from corrosion wear and abrasion (by applying special coats, clad steels, etc.), the magnitude of the value u is subject to the special consideration by the Register.

Table 3.10.4.1

Ice category	u, in mm per year	
	Region lengthwise	
	forward and intermediate (A and A_1)	midship and after (B and C)
ЛУ1	0,2	In accordance with 1.1.5.2
ЛУ2	0,25	
ЛУ3	0,3	
ЛУ4	0,36	0,26
ЛУ5	0,38	0,28
ЛУ6, ЛУ7, ЛУ8, ЛУ9	0,4	0,3
ЛЛ6	0,4	0,3
ЛЛ7	0,5	0,35
ЛЛ8	0,6	0,4
ЛЛ9	0,7	0,4

3.10.4.2 Procedure for determining the required and actual geometrical characteristics of girder structures.

3.10.4.2.1 The dependences, as given in 3.10.4.3 to 3.10.4.8, for determining the required geometrical characteristics of girder structure cross sections, such as the ultimate section modulus W and the web area A, are based on the ultimate strength criterion. The following recommendations shall preferably be considered when determining the values of W and A.

3.10.4.2.2 The required value of the ultimate section modulus W is proportionate to the factor k which varies on the basis of the dependence between the required web area A and the actual web area A (adopted when choosing the section)

$$W = W_0 k;\ k = k(\gamma);\ \gamma = A/A_a \qquad (3.10.4.2.2\text{-}1)$$

where W_0 = required value of W, web area margin disregarded, to be determined in accordance with 3.10.4.3.1, 3.10.4.4.1, 3.10.4.5.1, 3.10.4.6.1, 3.10.4.7.1.

In the absence of a web area margin ($A = A_a$, $\gamma = 1$), the value of W is maximum ($k = 1$). The increase of the actual web area as compared with the required one ($\gamma < 1$) makes it possible to reduce the value of W (asseming $\gamma = 0{,}9$ — 0,8; $k = 0{,}7$ — 0,63). Thus, the application of a flexible procedure for choosing the section is ensured which makes it possible to do without redundant margins of material, but provides for several approximations during the calculation. By way of the first approximation, the following assumptions shall be made in the Formulae (3.10.4.3-1), (3.10.4.4-1), (3.10.4.5-1), (3.10.4.6-1), (3.10.4.7-1):

$$\begin{cases} \gamma_i = 0{,}9, \text{ i.e. the actual girder web area shall be at least by 10 per cent greater than the required one;} \\ k_f = \dfrac{1}{F + 0{,}11j} \text{ — for conventional frames;} \\ k_i = 0{,}7 \text{ — for other girder types} \end{cases} \qquad (3.10.4.2.2\text{-}2)$$

см.Б1

where i = girder type index (f for frame, s for stringer, wf for web frame, l for longitudinal);
for F, j, see 3.10.4.3-1.

3.10.4.2.3 For grillages comprising deep frames, provision is made for a procedure to take account of the redundant margins of material which emerge when choosing girder sections as a result of the actual section modulus W_a and the actual web area A_a exceeding the required values of W and A. Redundant margins are accounted for by applying the factors

$$\gamma_i \leqslant 1;\ \psi_i = \frac{W_{ai}}{W_{0i}} \leqslant k_i \qquad (3.10.4.2.3)$$

where for k_i, γ_i, W_{0i}, see 3.10.4.2.2-1;
for i, see 3.10.4.2.2-2.

If the actual geometrical characteristics of a conventional frame exceed the required ones ($\gamma_f < 1$, $\psi_f > k_f$) in a transversely framed grillage, the required geometrical characteristics of the bearing stringer and deep frame (in the case of the latter, redundant margins, if any, of the bearing stringer ($\gamma_s < 1$, $\psi_s > k_s$) are also considered) are lowered due to this. In a similar way, provision is made in the case of a longitudinally framed grillage for lowering the requirements for the deep frame where longitudinals have redundant margins ($\gamma_l < 1$, $\psi_l > k_l$).

3.10.4.2.4 Where the section choosing procedures in accordance with 3.10.4.2.2 and the procedures for considering the redundant margins of materials in accordance with 3.10.4.2.3 appear too complicated, a simplified calculation can be carried out, assuming

$$\gamma_i = 0{,}9;$$

$$k_f = \frac{1}{F + 0{,}11j} \text{ — for conventional frames;} \qquad (3.10.4.2.4)$$

см.Б1

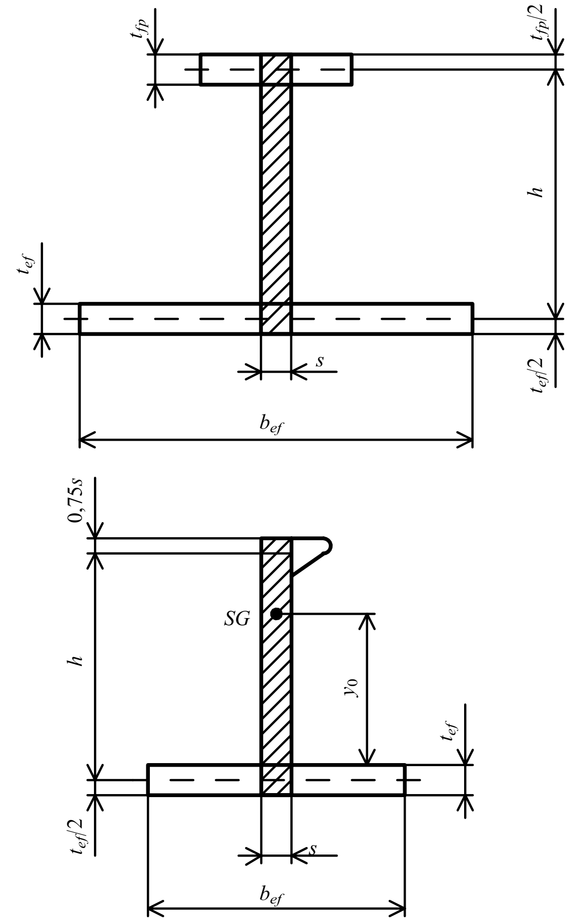
$$k_i = 0{,}7 \text{ — for other types of girders;}$$

$$\psi_i = k_i.$$

Precise instructions concerning the simplified calculation procedure are to be found directly in 3.10.4.3 to 3.10.4.7. см.Б1-добавлено

It shall be borne in mind that the simplified calculation would bring about an increase of girder structural dimensions. Therefore, the simplified calculation is not recommended for icebreakers and **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8**, **ЛУ9** category ships.

3.10.4.2.5 When choosing girder sections, the face plate and effective flange sections whose breadth is equal to the web thickness (Fig. 3.10.4.2.5) are to be included in the actual web area A_a, in cm^2.



▨ — sections included in the actual web area A_a.

Fig. 3.10.4.2.5

If there are openings in girder webs, they may be ignored in the case of side stringers only provided the openings are not made in the vicinity of supporting sections. The requirements for the area of frame webs (both conventional and deep frames) are to be verified on the basis of net sections.

3.10.4.2.6 To determine the actual value of the ultimate section modulus of the girders of ice strengthening structures it is recommended to use the formula

$$W_a = h(f_{sec} - 0{,}5f_w - C)\text{ , in cm}^3 \qquad (3.10.4.2.6\text{-}1)$$

where $C = 0$ with $f_{ef} \geqslant f_{sec}$;

$C = \dfrac{(f_{sec} - f_{ef})^2}{4f_w}$ with $f_{ef} < f_{sec}$;

f_{sec} = girder sectional area minus effective flange of shell plating, in cm^2;

$f_w = 0{,}1[h - 0{,}05(t_{fp} + t_{ef})]s$, cm^2;

h = section height measured from the mid-thickness of effective flange to the mid-thickness of face plate (Fig. 3.10.4.2.5) , in cm;

s = section web thickness, in mm;

$f_{ef} = 0{,}1b_{ef}t_{ef}$ — effective flange area of shell plating, in cm^2;

t_{ef} = effective flange thickness, in mm, of shell plating, to be adopted equal to the average shell plating thickness in way of effective flange breadth;

t_{fp} = face plate thickness, in mm $t_{fp} = 1{,}5s$ to be adopted for bulb steel sections);

b_{ef} = effective flange breadth, in cm, to be adopted equal to:
conventional frame spacing, for conventional and deep frames where transverse framing is used;
longitudinals spacing, for longitudinals where longitudinal framing is used;
1/6 of deep frame span between decks or platforms, or of frame spacing, whichever is less, for deep frames where longitudinal framing is used;
1/6 of frame spacing, for stringers where web framing is used;
half the sum of spacings of two adjacent girders of the same direction or 1/6 of girder span, whichever is less, in all other cases.

For rolled sections where $f_{ef} \geqslant f_{sec}$, it may be assumed that

$$W_a = f_{sec}(y_0 + 0{,}05t_{ef})\text{ , in cm}^3 \qquad (3.10.4.2.6\text{-}2)$$

where y_0 = distance between the gravity centre of the profile cross section, minus effective flange, and the shell plating, in cm (Fig. 3.10.4.2.5).

3.10.4.3 Conventional frames where transverse framing is used.

The requirements of this paragraph apply to conventional frames in grillages with transverse main framing and in grillages with deep frames where transverse framing is used.

In the case of grillages with transverse main framing, the requirements are to be applied to a single span of a conventional frame which lies between the supporting sections of the frame on the upper and lower supporting structures.

In the case of grillages with deep frames, the requirements are to be applied to all the spans of a conventional frame, i.e. between the supporting sections of the upper supporting structure and the upper side stringer, between side stringers (m — 1 section where m is the number of side stringers), between the lower side stringer and the supporting section of the lower supporting structure.

3.10.4.3.1 The ultimate section modulus W_f, in cm^3, of a conventional frame is not to be less than given by the formula

$$W_f = k_f W_{f0} \qquad \text{см.Б1 } (3.10.4.3.1)$$

where $k_f = \dfrac{1}{F + 0{,}25j\sqrt{1 - k_s\gamma_f^2}}$, $k_f = \dfrac{1}{F + 0{,}15j}$ — for the case of the simplified calculation in accordance with 3.10.4.2.4;

$k_s = \begin{cases} 1 \text{ — for plate sections;} \\ 0{,}8 \text{ — in other cases;} \end{cases}$

$F =$ 1 with k=4;

$F =$ 0,5 with k<4;

k = factor equal to:
as far as grillages with transverse main framing are concerned, see Table 3.10.4.3.1-1;

Table 3.10.4.3.1-1

Parameter	Type of intermediate frame end fixation		
	both ends have supporting sections	one end has a supporting section, the other is free (attached to an intercostal member)	both ends are free (attached to an intercostal member)
k	4	3	2
l	Half the sum of distances between the supporting sections of two adjacent frames	Distance between the supporting sections of main frame	

k = 4 for grillages with deep frames;

j = factor equal to:
the number of fixed supporting sections of two adjacent frames j$\leqslant$4 as far as grillages with transverse main framing are concerned,
in the case of grillages with web framing, see Table 3.10.4.3.1-2;

$\gamma_f = \dfrac{A_f}{A_a}$;

for A_f, see 3.10.4.3.2;

for A_a, see 3.10.4.3.3;

$W_{f0} = \dfrac{250}{R_{eH}} pbalYE\omega_f$;

p = ice pressure in the region under consideration in accordance with 3.10.3.2 or 3.10.3.5, in kPa; where the lower boundary of region I is included in the grillage and the requirements of the Chapter cover region of ice strengthening I and II (see 3.10.1.3.4), the following values of p shall be adopted:

$p = p_{kI}$, if the distance from the plating of the upper supporting structure of the grillage to the lower boundary of region I is greater than 1,2b, otherwise $p = p_{kII}$;

p_{kI}, p_{kII} = ice pressure in regions I and II (see 3.10.3.2);

b = vertical distribution of ice pressure, in m, in the region under consideration in accordance with 3.10.3.3 or 3.10.3.6; if $b > l$, $b = l$ is to be adopted for the purpose of determining W_{f0} and A_f;

a = conventional frame spacing, in m, as measured at side;

l = design frame span, in m, to be determined in accordance with Table 3.10.4.3.1-1 in the case of transverse main framing and with Table 3.10.4.3.1-2 in the case of web framing;

$Y = 1 - 0{,}5\beta$;

$\beta = \dfrac{b}{l}$, but not greater than $\beta = 1$;

Table 3.10.4.3.1-2

Position of conventional frame section under consideration	l	j
Between side stringers	Distance between side stringers	4
Between upper (lower) supporting structure and the nearest side stringer	Half the sum of distances between supporting sections on supporting structure and the nearest side stringer for two adjacent frames	$j_0 + 2$ where $j_0 \leqslant 2$ is the number of fixed supporting sections on the supporting structure for two adjacent frames

E = factor equal to:

$E = 4l_i\dfrac{l - l_l}{l^2}$ with $l_i < 0{,}5l$,

$E = 1$ with $l_i \geqslant 0{,}5l$

where l_i = section of the span length l, in m, overlapped by the region of ice strengthening;

$\omega_f = 1 + k_c\dfrac{\Delta s}{s_{af}}$, for the purpose of simplified calculation in accordance with 3.10.4.2.4. $\omega_f = 1{,}15$ may be adopted;

s_{af} = actual frame web thickness, in mm;

for Δs, see 1.1.5.1;

k_c = 0,9 for rolled profile;

k_c = 0,85 for welded profile.

3.10.4.3.2 The web area A_f, in cm^2, of a conventional frame is not to be less than given by the formula

$$A_f = \frac{8{,}7pab}{R_{eH}} k_2k_3k_4 + 0{,}1h_f\Delta s \qquad (3.10.4.3.2)$$

where $k_2 = \dfrac{4}{k}$;

$k_3 = \dfrac{1}{1 + z + \sqrt{2z}\ \beta^{2,5}}$ or

k_3 = 0,7, whichever is greater;

$z = \dfrac{1}{2\beta}(a/l)^2$;

for p, a, b, l, k, β, see 3.10.4.3.1; см.Б1

$k_4 = \begin{cases} 1 \text{ — where no side stringer is provided;} \\ 0{,}9 \text{ — where there is a side stringer in the span;} \\ 0{,}8 \text{ — where there is a side stringer in the frame span for which effective flange continuity is ensured;} \end{cases}$

h_f = frame web height, in cm; hf = 0,89h for symmetric bulb steel and h_f = 0,84h for asymmetric bulb steel;

h_s = rolled section height, in cm;

for Δs, see 1.1.5.1.

3.10.4.3.3 The actual web area A_a, in cm^2, is to be determined in accordance with 3.10.4.2.5. When a simplified calculation is made in accordance with 3.10.4.2.4, the value of A_a shall be at least by 10 per cent greater than the required web area.

3.10.4.3.4 The web thickness s_f, in mm, of a conventional frame shall be adopted not less than the greater of the following values:

$$s_f = \frac{k_s}{R_{eH}} pa + \Delta s\ ; \qquad (3.10.4.3.4\text{-}1)$$

$$s_f = 0{,}0114h_f\sqrt{R_{eH}} + \Delta s \qquad (3.10.4.3.4\text{-}2)$$

where $k_s = 1{,}4\dfrac{W_f}{W_{af}}$, but not less than $k_s = 1{,}0$;

for W_f, see 3.10.4.3.1;

W_{af} = actual ultimate section modulus, in cm^3, of a conventional frame, to be determined in accordance with 3.10.4.2.6 (as a first approximation or for the purpose of the simplified calculation in accordance with 3.10.4.2.4, $W_{af} = W_f$ is to be adopted);

for p, a, see 3.10.4.3.1;

for h_f, see 3.10.4.3.2;

for Δs, see 1.1.5.1.

3.10.4.3.5 The face plate breadth c_f, in mm, of a conventional frame made of bulb or T sections is not to be less than the greater one of the following values:

$$c_f = 0{,}0145R_{eH}\frac{W_f}{W_{af}}\sqrt{t_f s_{af}}\left(\frac{h_f}{s_{af}} - 0{,}98\right); \qquad (3.10.4.3.5\text{-}1)$$

$$c_f = 2{,}5t_f\,; \tag{3.10.4.3.5-2}$$

$$c_f = 69{,}6s_{af}\sqrt{\frac{h_f}{t_f}(\beta^2 - 0{,}0029)} \tag{3.10.4.3.5-3}$$

where $\beta = \frac{(2-\alpha)l_S}{\alpha h_f}$, but not less than $\beta = 0{,}055$;

$\alpha = \left(\frac{s_{af}}{s_{as}}\right)^2 + 0{,}01\,\frac{h_f s_{as}}{a s_{af}}$, but not less tha $\alpha = 1$;

for W_f, see 3.10.4.3.1;
for W_{af}, see 3.10.4.3.4;
s_{af} = actual web thickness of a conventional frame, in mm;
t_f = face plate breadth of a conventional frame, in mm (for beams made of bulbs, $t = 1{,}5s_{af}$ shall be adopted);
for h_f, see 3.10.4.3.2;
s_{as} = actual shell plating thickness, in mm;
for a, see 3.10.4.3.1;
l_s = the greatest spacing, in m, of adjacent stringers crossing the frame span or the greatest distance, in m, between the stringer and the supporting section.

In the case of frames made of standard sections, compliance with the requirements for the face plate breadth may not be verified where a simplified calculation in accordance with 3.10.4.2.4 is carried out.

3.10.4.3.6 If a conventional frame is made of plate sections, the plate height h_f, in cm, and the spacing or distance l_s, in m, are not to be greater than given by the formulae:

$$h_f = \frac{8{,}98s_{af}}{\left(\left(R_{eH}\frac{W_f}{W_{af}}\right)^2\left(1+75a\frac{s_{af}^2}{s_{as}^3}\right)\right)^{0{,}2}}; \tag{3.10.4.3.6-1}$$

$$l_s = 0{,}0541\frac{\alpha_n h_f}{2-\alpha_n} \tag{3.10.4.3.6-2}$$

where $\alpha_n = \left(\frac{s_{af}}{s_{as}}\right)^2 + 0{,}02\,\frac{h_f s_{as}}{a s_{af}}$, but $1 \leqslant \alpha_n \leqslant 1{,}9$;

for l_s, s_{af}, s_{as}, W_f, W_{af}, a, see 3.10.4.3.5.

3.10.4.4 Side and intercostal stringers as part of transverse framing with deep frames.

3.10.4.4.1 The ultimate section modulus W_s, in cm^3, of a bearing side stringer is not to be less than given by the formula

$$W_s = W_{s0}k_s \tag{3.10.4.4.1}$$

where $W_{s0} = \frac{125}{R_{eH}}k_s^p p a_1^2 b Q \omega_s$;

$$\left\{\begin{array}{l} k_s = \dfrac{1}{1+\sqrt{1-0{,}8\gamma_s^2}} \\ \\ \omega_s = 1+0{,}95\dfrac{\Delta s}{s_{as}}; \end{array}\right.$$

for the purpose of simplified calculation in accordance with 3.10.4.2.4 $k_s = 0{,}63$, shall be adopted; $\omega_s = 1{,}15$;

$k_s^p = 0{,}82 - 0{,}55a_1/1^p \geqslant 0{,}6$ with $l^p \geqslant a_1$
$k_s^p = 0{,}82l^p/a_1 - 0{,}55 \geqslant 0{,}6l^p/a_1$ with $l^p < a_1$.
for l^p, see 3.10.3.4;
for p, b, see 3.10.4.3.1;
a_1 = deep frame spacing, in m, as measured along the side;
$Q = C_{1i} + C_{2i}\frac{b}{l} + C_{3i}\psi_f + \frac{C_{4i}}{\gamma_f} + C_{5i}\frac{\psi_f}{\gamma_f}$;

for the purpose of simplified calculation in accordance with 3.10.4.2.4,

$Q = C_{6i} + C_{2i}\frac{b}{l}$;

i = factor taking up the following values:
$i = 1$ with $m = 1$;
$i = 2$ with $m \geqslant 2$;
m = number of side stringers in a grllage;
for C_{1i}, C_{2i}, ..., C_{6i} , see Table 3.10.4.4;
for l, γ_f, see 3.10.4.3.1;
ψ_f = factor to be adopted equal to the lesser of the following:

$\psi_f = \frac{W_{af}}{W_{f0}}$,

$\psi_f = 1{,}4k_f$;

for W_{f0}, k_f, see 3.10.4.3.1;
for W_{af}, see 3.10.4.3.4;

$\gamma_s = \frac{A_s}{A_a}$;

for A_s, see 3.10.4.4.2;
for A_a, see 3.10.4.4.3;
s_{as} = actual web thickness of a side stringer, in mm;
for Δs, see 1.1.5.1.

Table 3.10.4.4

i	C_{1i}	C_{2i}	C_{3i}	C_{4i}	C_{5i}	C_{6i}
1	0,003	0,132	0,398	0,584	−0,785	0,320
2	0,363	0,11	−0,078	0,186	−0,202	0,358

3.10.4.4.2 The web area A_s, in cm^2, of a side stringer is not to be less than given by the formula

$$A_s = \frac{8{,}7k_s^p pab}{R_{eH}}Qn + 0{,}1h_s\Delta s \tag{3.10.4.4.2}$$

where for p, a, b, see 3.10.4.3.1;
n = number of frames fitted between two adjacent deep frames;
for k_s^p, Q, see 3.10.4.4.1;
h_s = web height of a bearing side stringer, in cm;
for Δs, see 1.1.5.1.

3.10.4.4.3 The actual web area A_a, in cm^2, of a side stringer is to be determined in accordance with 3.10.4.3.3.

3.10.4.4.4 The web thickness s_s, in mm, of a side stringer is not to be less than given by the formula

$$s_s = 2{,}63c_1\sqrt{\frac{R_{eH}}{5{,}34+4\left(\frac{c_1}{c_2}\right)^2}} + \Delta s \qquad \text{см.Б1}(3.10.4.4.4)$$

where c_1, c_2 = the shorter and longer side, in m, of the panels into which the stringer web is divided by its stiffeners;
for an unstiffened web, $c_1 = 0{,}01(h_s - 0{,}8h_f)$, $c_2 = a_1$;
for h_s, see 3.10.4.4.2;
for h_f, see 3.10.4.3.2;
for a_1, see 3.10.4.4.1
for Δs, see 1.1.5.1.

3.10.4.4.5 The web height h_s, in cm, of a side stringer is not to be less than given by the formula

$$h_s = 2h_f, \tag{3.10.4.4.5}$$

where for h_f, see 3.10.4.3.2.

3.10.4.4.6 The face plate thickness of a side stringer is not to be less than its actual web thickness.

3.10.4.4.7 The face plate breadth c_s, in mm, of a side stringer is not to be less than the greater of the following

$$c_s = 0{,}0165 R_{eH} \frac{W_s}{W_{as}} \sqrt{t_s s_{as}} \left(\frac{h_s}{s_{as}} - 2{,}6\right); \qquad (3.10.4.4.7\text{-}1)$$

$$c_s = 7{,}5 t_s \qquad (3.10.4.4.7\text{-}2)$$

where for W_s, see 3.10.4.4.1;
W_f = actual ultimate section modulus, in cm^3, of a side stringer, to be determined in accordance with 3.10.4.2.6 (in first approximation or for the purpose of simplified calculation in accordance with 3.10.4.2.4, $W_{as} = W_s$ shall be adopted);
t_s = face plate thickness, in mm, of a bearing stringer;
for s_{as}, see 3.10.4.4.1;
for h_s, see 3.10.4.4.2.

Bearing stringer design providing for no face plate (plate section) is not permitted.

3.10.4.4.8 The web height h_{is}, in cm, of an intercostal stringer at a section in way of a conventional frame is not to be less than given by the formula

$$h_{is} = 0{,}8 h_f \qquad (3.10.4.4.8)$$

where for h_f, see 3.10.4.3.2.

3.10.4.4.9 The web thickness of an intercostal stringer is not to be less than that of a conventional frame, as required in accordance with 3.10.4.3.4.

3.10.4.5 Deep frames as part of transverse framing.

3.10.4.5.1 The ultimate section modulus W_{wf}, in cm^3, of a deep frame is not to be less than given by the formula

$$W_{wf} = W_{wf0} k_{wf}, \qquad (3.10.4.5.1)$$

where $W_{wf0} = \frac{250}{R_{eH}} k^p_{wf}\ pabl_{wf}(1 - \frac{0{,}5b}{l_{wf}}\ + k_m G)\omega_{wf}$;

$k_{wf} = \frac{1}{1 + \sqrt{1 - 0{,}8\gamma^2}}$; $G = 2nQ_m(1 - R)$, for the purpose of a simplified calculation in accordance with 3.10.4.2.4; $k_{wf} = 0{,}63$ is to be adopted; $G = nQ_m$;
for n, see 3.10.4.4.2;
for k_m, see Table 3.10.4.5.1-1;

Table 3.10.4.5.1-1

m	1	2	3	4	5	6
k_m	1,0	1,33	2,0	2,4	3,0	3,43

$R = 0{,}5\sqrt{2\psi_s - (\psi_s\gamma_{s1})^2}$ with $\psi_s < \frac{1}{\gamma^2_{s1}}$;
$R = 0{,}5/\gamma_{s1}$ with $\psi_c \geqslant \frac{1}{\gamma^2_{s1}}$;
$\gamma_{wf} = \frac{A_{wf}}{A_f}$,
$\psi_s = \frac{W_{sf}}{W_{s0}} k_d$;
γ_{s1} = factor to be adopted as the greater of the following:
$\gamma_{s1} = \frac{\gamma_s}{k_d}$
γ_{s1} = 0,7;
k_d = 1 with $m \leqslant 2$,
$k_d = \frac{Q}{Q_m}$ with $m > 2$, for the purpose of a simplified calculation in accordance with 3.10.4.2.4, $k_d = 1{,}2$ shall be adopted, with $m > 2$;
Q_m = Q with $m = 1$; 2;
$Q_m = C_{m1} + C_{m2}(0{,}5\frac{b}{l}(\psi_{[} - 0{,}5) - \psi_{[})$ with $m = 3$; 4; 5; 6;
C_{m1}, C_{m2} = factors to be determined from Table 3.10.5.1-2;

Table 3.10.4.5.1-2

m	3	4	5	6
C_{m1}	0,5	0,417	0,333	0,292
C_{m2}	0,25	0,167	0,111	0,083

$\omega_{wf} = 1 + 0{,}95\frac{\Delta s}{s_{awf}}$, for the purpose of a simplified calculation in accordance with 3.10.4.2.4, $\omega_{wf} = 1{,}15$ may be adopted;
for p, a, b, see 3.10.4.3.1;
for m, l, Q, ψ_f, W_{s0}, γ_s, see 3.10.4.4.1;
l_{wf} = span length, in m, of a deep frame, equal to the distance between supporting sections;
for W_{as}, see 3.10.4.4.7;

$k^p_{wf} = 0{,}82(1 - a_1/l^p) \geqslant 0{,}6$ with $l^p \geqslant 2a_1$;
$k^p_{wf} = 0{,}41(l^p/a_1 - 1) \geqslant 0{,}3l^p/a_1$ with $l^p < 2a_1$;

for l^p, see 3.10.3.4;
for a_1, see 3.10.4.4.1;
for A_{wf}, see 3.10.4.5.2;
for A_f, see 3.10.4.5.3;
s_{awf} = actual thickness, in mm, of a deep frame web;
for Δs, see 1.1.5.1.

3.10.4.5.2 The web area A_{wf}, in cm^2, of a deep frame is not to be less than given by the formula

$$A_{wf} = \frac{8{,}7pabk^p_{wf}}{R_{eH}}\ (1 + m/G) + 0{,}1h_{wf}\Delta s \qquad (3.10.4.5.2)$$

where for p, a, b, see 3.10.4.3.1;
for m, see 3.10.4.4.1;
for k^p_{wf}, G, see 3.10.4.5.1;
h_{wf} = deep frame web depth, in cm;
for Δs, see 1.1.5.1.

3.10.4.5.3 The actual web area A_a, in cm^2, of a deep frame is to be determined in accordance with 3.10.4.3.3.

3.10.4.5.4 The web thickness s_{wf}, in mm, is to be adopted not less than the greater one of the following values:

$$s_{wf} = \frac{k_s}{R_{eH}} pa + \Delta s\ ; \qquad (3.10.4.5.4\text{-}1)$$

$$s_{wf} = 2{,}63c_1\sqrt{\frac{R_{eH}}{5{,}34 + 4(\frac{c_1}{c_2})^2}} + \Delta s \qquad \text{см.Б1}\ (3.10.4.5.4\text{-}2)$$

where $k_s = \frac{1}{1{,}25\frac{W_{awf}}{W_{wf}} - 0{,}75}$, but not less than $k_s = 1{,}0$;
for W_{wf}, see 3.10.4.5.1;
W_{awf} = actual ultimate section modulus, in cm^3, of a deep frame, to be determined in accordance with 3.10.4.2.6 (in the first approximation or for the purpose of the simplified calculation in accordance with 3.10.4.2.4, $W_{awf} = W_{wf}$ is to be adopted);
for p, a, see 3.10.4.3.1;
c_1, c_2 = the shorter and the longer side, in m, of panels into which the web of a deep frame is divided by its stiffeners;
for Δs, see 1.1.5.1.

3.10.4.5.5 The face plate thickness of a deep frame is not to be less than the actual thickness of its web.

3.10.4.5.6 The face plate breadth c_{wf}, in mm, of a deep frame is not to be less than the greater one of the following values:

$$c_{wf} = A_1 R_{eH} \frac{W_{wf}}{W_{awf}} \sqrt{t_{wf} s_{awf}} \left(\frac{h_{wf}}{s_{awf}} - A_2\right); \qquad (3.10.4.5.6\text{-}1)$$

$$c_s = A_3 t_{wf} \qquad (3.10.4.5.6\text{-}2)$$

where for W_{wf}, see 3.10.4.5.1;
for W_{awf}, see 3.10.4.5.4;
t_{wf} = face plate thickness, in mm, of a deep frame;
for s_{awf}, see 3.10.4.5.1;
for h_{wf}, see 3.10.4.5.2;
A_1 = 0,0039; $A_2 = 1,4$; $A_3 = 5$, if the deep frame web is provided with stiffeners fitted approximately normal to the shell plating;
A_1 = 0,0182; $A_2 = 2,6$; $A_3 = 10$, if the deep frame web is provided with stiffeners fitted approximately normal to the shell plating or if it is unstiffened.

Deep frame design providing for no face plate (plate section) is not permitted.

3.10.4.6 Side and bottom longitudinals as part of longitudinal framing.

3.10.4.6.1 The ultimate section modulus W_l, in cm^3, of a longitudinal is not to be less than given by the formula

$$W_l = W_{l0} k_l \qquad \text{см.Б1 } (3.10.4.6.1)$$

where $W_{l0} = \frac{125}{R_{eH}} p b_1 l^2 c^2 \omega_l$;

$k_l = \frac{1}{1 + \sqrt{1 - k_s \gamma_l^2}}$, $k_l = 0,63$; for the purpose of simplified calculation in accordance with 3.10.4.2.4, for k_s, see 3.10.4.3.1;
c = 1 — for bottom longitudinals and for side longitudinals where no panting frames are fitted;
$c = \frac{1}{1 + \frac{0,25}{e}}$ — for side longitudinals where panting frames are fitted;
$b_1 = k_0 b_2$;
$b_2 = b(1 - 0,25\bar{b})$ with $\bar{b} < 2$;
$b_2 = a$ with $\bar{b} \geqslant 2$;
$e = \bar{b} + 1$;
$\bar{b} = \frac{b}{a}$;
$k_0 = 1 - \frac{0,3}{\bar{b}}$;
$\omega_l = 1 + k_c \frac{\Delta s}{s_{al}}$, $\omega_l = 1,15$; may be adopted for the purpose of the simplified calculation in accordance with 3.10.4.2.4;
for p, b, see 3.10.4.3.1;
a = spacing, in m, of longitudinals;
l = spacing, in m, of deep frames or floors;
$\gamma_l = \frac{A_l}{A_a}$;
for A_l, see 3.10.4.6.2;
for A_a, see 3.10.4.6.3;
s_{al} = actual web thickness, in mm, of a longitudinal;
for Δs, see 1.1.5.1;
for k_c, see 3.10.4.3.1.

3.10.4.6.2 The web area A_l, in cm^2, of a longitudinal is not to be less than given by the formula

$$A_l = \frac{8,7}{R_{eH}} p b_1 l c k_1 + 0,1 h_l \Delta s \qquad (3.10.4.6.2)$$

where for p, see 3.10.4.3.1;
for b_1, l, c, see 3.10.4.6.1;
k_1 = factor to be adopted as the greater of the following:

$k_1 = \frac{1}{1 + 0,76\frac{a_0}{l}}$,

$k_1 = 0,8$;
for a_0, see 3.10.4.1;
h_l = web height, in cm, of a longitudinal;
for Δs, see 1.1.5.1.

3.10.4.6.3 The actual web area A_a, in cm^2, of a longitudinal is to be determined in accordance with 3.10.4.3.3.

3.10.4.6.4 The web area s_l, in mm, of a longitudinal shall be adopted not less than the greater one of the following values:

$$s_l = \frac{k_s}{R_{eH}} p b_1 + \Delta s \qquad (3.10.4.6.4\text{-}1)$$

$$s_l = 0,013 h_l \sqrt{R_{eH}} + \Delta s \qquad (3.10.4.6.4\text{-}2)$$

where $k_s = 1,4\frac{W_l}{W_{al}}$, but not less than $k_s = 1,0$;
for W_l, see 3.10.4.6.1;
W_{al} = actual ultimate section modulus, in cm^3, of a longitudinal, to be determined in accordance with 3.10.4.2.6 (in the first approximation or for the purpose of the simplified calculation in accordance with 3.10.4.2.4, $W_{al} = W_l$ shall be adopted);
for p, see 3.10.4.3.1;
for b_1, see 3.10.4.6.1;
for h_l, see 3.10.4.6.2;
for Δs, see 1.1.5.1.

3.10.4.6.5 The face plate thickness c_l, in mm, of a longitudinal having a bulb-plate or T section is not to be less than the greater one of the following values:

$$c_l = 0,0145 R_{eH} \frac{W_l}{W_{al}} \sqrt{t_l s_{al}} \left(\frac{h_l}{s_{al}} - 0,98\right); \qquad (3.10.4.6.5\text{-}1)$$

$$c_l = 2,5 t_l\,; \qquad (3.10.4.6.5\text{-}2)$$

$$c_l = 69,6 s_{al} \sqrt{\frac{h_l}{t_l} (\beta^2 - 0,0029)} \qquad (3.10.4.6.5\text{-}3)$$

where $\beta = \frac{(2 - \alpha) l_s}{\alpha h_l}$, but not less than $\beta = 0,055$;
$\alpha = \left(\frac{s_{al}}{s_{as}}\right)^2 + \frac{0,01 h_l s_{as}}{a s_{al}}$, but not less than $\alpha = 1$;
for W_l, see 3.10.4.6.1;
for W_{al}, see 3.10.4.6.4;
s_{al} = actual web thickness, in mm, of a longitudinal;
t_l = face plate thickness, in mm, of a longitudinal (for longitudinals having a bulk-plate section, $t_l = 1,5 s_{al}$ shall be adopted);
for h_l, see 3.10.4.6.2;
s_{as} = actual shell plating thickness, in mm;
for a, see 3.10.4.6.1;
l_s = maximum spacing, in m, of adjacent transverse members crossing the span of a longitudinal.

As far as longitudinals made of standard sections are concerned, conformance with the requirements for the face plate breadth may not be verified in case of carrying out a simplified calculation in accordance with 3.10.4.2.4.

3.10.4.6.6 Where a longitudinal is made of plate sections, the plate height h_l, in cm, and the spacing l_s, in m, are not to be greater than given by the formulae:

$$h_l = \frac{8{,}98 s_{al}}{[(R_{eH} W_l / W_{al})^2 (1 + 75 a s_{\mathrm{al}}^2 / s_{al}^3)]^{0{,}2}}; \qquad (3.10.4.6.6\text{-}1)$$

$$l_s = \frac{0{,}0541 \alpha_n h_l}{2 - \alpha_n} \qquad (3.10.4.6.6\text{-}2)$$

where $\alpha_n = \left(\frac{s_{al}}{s_{as}}\right)^2 + \frac{0{,}02 h_l s_{as}}{a s_{al}}$, with $1 \leqslant \alpha_n \leqslant 1{,}9$;

for l_s, s_{al}, s_{as}, W_l, W_{al}, a, see 3.10.4.6.5.

3.10.4.7 Deep frames as part of longitudinal framing.

3.10.4.7.1 The ultimate section modulus W_w, in cm^3, of a deep frame is not to be less than given by the formula

$$W_w = W_{w0} k_w \qquad (3.10.4.7.1)$$

where $W_{w0} = \frac{500}{R_{eH}} pabk_w^p\, l(1 + k_g)(Q - \frac{k_g R}{e})\omega_w$;

$k_w = \frac{1}{1 + \sqrt{1 - 0{,}8\gamma_w^2}}$;

$Q = 2 - N$;

$N = \sqrt{2\psi_l \beta - (\psi_l \gamma_l)^2}$ with $\psi_l < \frac{\beta}{\gamma_l^2}$;

$N = \frac{\beta}{\gamma_l}$ with $\psi_l \geqslant \frac{\beta}{\gamma_l^2}$;

$R = \frac{\beta \psi_l}{\sqrt{(\psi_l \gamma_l)^2 + 4}}$.

For the purpose of a simplified calculation in accordance with 3.10.4.2.4, $k_w = 0{,}63$, $N = 1{,}1\beta$, $R = 0{,}33\beta$ shall be adopted;

$\beta = \frac{b_1 e}{b}$;

for p, b, see 3.10.4.3.1;
for a, l, b_1, e, γ_l, see 3.10.4.6.1;
for k_w^p, ω_w, see 3.10.4.5.1;
k_g = factor to be adopted as the lesser of the following:

$k_g = 0{,}5\left(\frac{eQ}{R} - 1\right)$;

$k_g = 0{,}5(k - 0{,}25(e + 1))$;

k = number of longitudinals in a deep frame span;

$\psi_l = \frac{W_{al}}{W_{l0}}$;

for W_{al}, see 3.10.4.6.4;
for W_{l0}, see 3.10.4.6.1;

$\gamma_p = \frac{A_{wf}}{A_a}$;

for A_{wf}, see 3.10.4.7.2;
for A_a, see 3.10.4.7.3.

3.10.4.7.2 The web area A_{wf}, in cm^2, of a deep frame is not to be less than given by the formula

$$A_{wf} = \frac{8{,}7}{R_{eH}} pbk_w^p\, lQ + 0{,}1 h_{wf} \Delta s \qquad (3.10.4.7.2)$$

where for p, b, see 3.10.4.3.1;
for l, see 3.10.4.6.1;
for Q, see 3.10.4.7.1;
h_{wf} = deep frame web height, in cm;
for Δs, see 1.1.5.1.

3.10.4.7.3 The actual web area A_a, in cm^2, of a deep frame is to be determined in accordance with 3.10.4.3.3.

3.10.4.7.4 The web thickness of a deep frame is not to be less than the greater one of the values given by the Formulae (3.10.4.5.4-1), (3.10.4.5.4-2) while W_{wf} shall be in accordance with 3.10.4.7.1 and a shall be in accordance with 3.10.4.6.1.

The requirements of this paragraph apply to the vertical diaphragms of the double side as well.

3.10.4.7.5 The web height of a deep frame is not to be less than given by the formula

$$h_{wf} = 2h_l \qquad (3.10.4.7.5)$$

where for h_l, see 3.10.4.6.2.

3.10.4.7.6 The face plate thickness of a deep frame is not to be less than its actual web thickness.

3.10.4.7.7 The face plate breadth of a deep frame is to be determined in accordance with 3.10.4.5.6 while W_{wf} shall be in accordance with 3.10.4.7.1. The deep frame design providing for no face plate (plate section) is not permitted.

3.10.4.8 Additional frames and horizontal diaphragms as part of longitudinal framing.

3.10.4.8.1 The web height of an additional frame $h_{ad.f}$, in cm, (see 3.10.2.3) at a section in way of a longitudinal is not to be less than given by the formula

$$h_{ad.f} = 0{,}8 h_l \qquad (3.10.4.8.1)$$

where h_l = web height, in cm, of a longitudinal.

3.10.4.8.2 The web thickness of an additional frame is not to be less than that of a longitudinal, as required in accordance with 3.10.4.6.4.

3.10.4.8.3 The cross-sectional area of a horizontal diaphragm forming part of double-side structure where the outboard side is longitudinally framed is not to be less than the web area of a deep frame (vertical diaphragm) in accordance with 3.10.4.7.2.

3.10.4.9 Plate structures.

3.10.4.9.1 The thickness of plate structures forming part of web framing of side grillages (deep frames, side stringers) is to be determined in accordance with 3.10.4.4.4, 3.10.4.5.4, 4.10.4.7.4.

3.10.4.9.2 The plate structure thickness of decks and platforms, as well as of double bottom, bottom stringers and centre girder is not to be less than s_{ps1}, in mm, to be determined from the formula

$$s_{ps1} = s_{ps0} + \Delta s \qquad \text{см.Б1}\ (3.10.4.9.2)$$

where $s_{ps0} = s_{ps01}$, if the plate structure is provided with stiffeners fitted approximately normal to the shell plating;
$s_{ps0} = s_{ps02}$, if the plate structure is not provided with stiffeners fitted approximately normal to the shell plating (permitted for **ЛУ1**, **ЛУ2**, **ЛУ3** category ships);

$s_{ps01} = b\left\{0{,}8\frac{p_1}{R_{eH}} - 0{,}0045 k_2 \left[1 + 4\left(\frac{c_\mathrm{p}}{k_2 b}\right)^2\right]\left(\frac{s_{p0}}{10 c_{sp}}\right)^{3{,}5}\right\}$;

$s_{ps02} = \frac{0{,}95 p_1 b}{R_{eH}}$;

for k_1, see Table 3.10.4.9.2;

$k_2 = k_T \sqrt{k_{wf}}$;

k_T = $0{,}17\Delta^{1/6}$, but not less than 1,0;
k_p = shall be in accordance with 3.10.3.5.1 as far as icebreakers are concerned;
k_p = 1 for ice ships;
for Δ, see 3.10.3.2.1;
for p, b, see 3.10.4.3.1;
c_{sp} = spacing, in m, of stiffeners in a plate structure or distance, in m, between other framing members fitted approximately normal to the shell plating;
for s_{p0}, see 3.10.4.1;
for Δs, see 1.1.5.1.

Table 3.10.4.9.2

Ice category	k_1
ЛУ1, ЛУ2, ЛУ3, ЛУ4, ЛУ5	1,3
ЛУ6, ЛЛ6	1,2
ЛУ7, ЛЛ7	1,1
ЛУ8, ЛЛ8, ЛУ9, ЛЛ9	1,0

3.10.4.9.3 In addition to the requirements of 3.10.4.9.2, the thickness of plate structures in decks and platforms, where the side is transversely framed, shall not be less than s_{ps2}, in mm, to be determined from the formula

$$s_{ps2} = s_{ps0} + \Delta s \qquad (3.10.4.9.3)$$

where $s_{ps0} = \frac{0{,}866}{\alpha}\left[1{,}1\frac{p_1}{R_{eH}}lb\left(1 - \frac{b}{4l}\right) - 0{,}5\frac{W_{af}l\cdot 10^{-3}}{\omega_f a l_1 l_2}\left(\frac{h_f}{10l}\right)^{1{,}5} - \frac{0{,}1f_{st}}{a_1}\right]$;

for p_1, see 3.10.4.9.2;

$l = \frac{1}{2}(l_1 + l_2)$;

$\alpha = 1 - \frac{a_2}{a}$;

l_1, l_2 = distance, in m, from the plate structure under consideration to the nearest plate structures (decks, platforms, side stringers, inner bottom plating) on both sides;
a_1 = spacing, in m, of plate structure stiffeners fitted approximately normal to shell plating and welded thereto;
f_{st} = cross-sectional area of stiffener, in cm^2, without effective flange; where stiffeners are fitted parallel to the shell plating or snipped, $f_{st} = 0$ shall be adopted;
for b, a, ω_f, see 3.10.4.3.1;
for W_{af}, see 3.10.4.3.4;
for h_f, see 3.10.4.3.2;
a_2 = length, in m, of unstiffened section of opening in plate structure for the passage of a conventional frame, as measured on the shell plating;
for Δs, see 1.1.5.1.

3.10.4.9.4 The plate structure thickness in transverse bulkheads where the side is transversely framed and the floor and bilge bracket thickness where the bottom is longitudinally framed are not to be less than s_{ps3}, in mm, to be determined from the formula

$$s_{ps3} = s_{ps0} + \Delta s \qquad (3.10.4.9.4)$$

where $s_{ps0} = a\left\{1{,}8\frac{p_2}{R_{eH}} - 0{,}009\left[1 + \left(\frac{a}{k_g}\right)^2\right]\left(\frac{s_{sp0}}{10a}\right)^{3{,}5}\right\}$;

$p_2 = \frac{p_1}{k_2}$;

for p_1, k_2, see 3.10.4.9.2;
k_g = $0{,}4k_2b$, but not greater than $k_g = a$;
a = spacing, in m, of side (bottom) longitudinals;
for b, see 3.10.4.3.1;
for s_{sp0}, see 3.10.4.1;
for Δs, see 1.1.5.1.

3.10.4.9.5 The plate structure thickness of transverse bulkheads in a transversely framed side, and of floors in a transversely framed bottom is not to be less than s_{ps4}, in mm, to be determined from the formula

$$s_{ps4} = s_{ps0} + \Delta s \qquad (3.10.4.9.5)$$

where $s_{ps0} = a\left\{1{,}8\frac{p_2}{R_{eH}} - 0{,}009\left[1 + \left(\frac{a}{k_g}\right)^2\right]\left(\frac{s_{sp0}}{10a}\right)^{3{,}5}\right\}$;

k_g = $0{,}4k_2b$, but not greater than $k_g = c_{sp}$;
for b, see 3.10.4.3.1;
for k_2, c_{sp}, see 3.10.4.9.2;
for p_2, see 3.10.4.9.4;
a = spacing, in m, of conventional frames (for plate structures of bulkheads) or floors (for plate structures of floors);
for s_{sp0}, see 3.10.4.1;
for Δs, see 1.1.5.1.

3.10.4.9.6 In any case, the plate structure thickness of decks and platforms, transverse bulkheads, inner bottom, floors and bilge brackets, bottom stringers and centre girder is not to be less than s_{ps}, in mm, to be determined from the formula

$$s_{ps} = s_{ps0} + \Delta s, \qquad (3.10.4.9.6)$$

where $s_{ps0} = \sqrt[3]{\frac{q}{n}}$ with $q \leqslant q_1$;

$s_{ps0} = 0{,}455\cdot\left[\frac{q}{R_{eH}} + \sqrt{\left(\frac{q}{R_{eH}}\right)^2 + \frac{1{,}32R_{eH}}{n}}\right]$ with $q_1 < q < q_2$,

$s_{ps0} = 1{,}73\sqrt{\frac{R_{eH}}{n}}$ with $q \geqslant q_2$;

q = $0{,}6p_1b(1 - \frac{0{,}1bk_2}{a})$ — for plate structures of decks and platforms, inner bottom, bottom stringers and centre girder in a longitudinally framed side or bottom;
q = $0{,}89p_2a$ for other types of plate structures mentioned in 3.10.4.9.2 to 3.10.4.9.5;
for p_1, k_2, see 3.10.4.9.2;
for p_2, see 3.10.4.9.4;

$q_1 = 0{,}353\sqrt{\frac{R^3_{eH}}{n}}$;

$q_2 = 4{,}9q_1$;

$n = \frac{0{,}294n_1}{c_1^2}$;

n_1 = $\left[1 + \left(\frac{c_1}{c_2}\right)^2\right]^2$ — where the longer side of plate structure panel adjoins the shell plating,
n_1 = 4 where the shorter side of plate structure panel adjoins the shell plating;
c_1, c_2 = the shorter and longer sides, in m, of panels into which a plate structure is divided by its stiffeners;
for b, see 3.10.4.3.1;
a = spacing, in m, of main framing girders of shell plating;
for Δs, see 1.1.5.1.

3.10.4.9.7 The intertia moment i, in cm^4, of stiffeners by which the plate structures are strengthened and which are fitted approximately normal to the shell plating is not to be less than determined from the formula

$$i = 0{,}01R_{eH}l^2(10s_{ps}a + f_p) \qquad (3.10.4.9.7)$$

where l = span length, in m, of stiffener, not greater than $l = 6a$;
s_{ps} = thickness, in mm, of plate structure being strengthened;
a = spacing, in m, of stiffeners;
f_p = sectional area of stiffener, in cm^2, without effective flange.

3.10.4.9.8 A horizontal grillage adjoining the shell plating in an region of ice strengthening, but not reaching from side to side (deck or platform in way of large openings, horizontal diaphragm of double side, etc.) may be considered a platform if the sectional area of its plating (on one side) is not less than F, in cm^2, to be determined from the formula

$$F = \frac{6pbl^*}{R_{eH}}(1 - \frac{b}{4l}) \qquad (3.10.4.9.8)$$

where for p, see 3.10.3.2;
for b, see 3.10.3.3;
l^* = design distribution length, in m, for the load taken up by the transverse main framing of side, to be adopted equal to l^p, or to l^p or $2a_1$, whichever is less, in the case of framing (transverse or longitudinal) including deep frames;
for l^p, see 3.10.3.4;
for a_1, see 3.10.4.4.1;
for l, see 3.10.4.9.3.

Otherwise, such a structure shall be considered a bearing side stringer.

A structure considered to be a platform is to comply with the requirements of 3.10.4.9 for the plate structures of platforms, and one considered to be a stringer, with the requirements of 3.10.4.4.

3.10.4.10 Stems and sternframes.

3.10.4.10.1 The requirements of this paragraph for the area, section modulus and plate thickness of stem are to be complied with on the stem section from the keel to a level extending above the upper boundary of the ice strake by a value of H_1 (see Table 3.10.4.10.1). In the case of icebreakers, this stem section is to extend as far as the nearest deck or platform lying higher than this level. Outside the borders of the area considered, the stem scantlings may gradually reduce and the cross-sectional area of the bar is not to be less than required in 2.10.4 while the plate thickness of a combined or plate stem is not to be less than k_s (where s is the shell plating thickness in way of ice strake in region AI, for k, see Table 3.10.4.10.1).

The cross-sectional area S, in cm^2, of stem irrespective of design is not to be less than determined from the formula

$$S = k_k f(\Delta) \qquad (3.10.4.10.1\text{-}1)$$

where k_k = factor whose values are to be found in Table 3.10.4.10.1;

$$f(\Delta) = \begin{cases} 0{,}031\Delta + 137 \text{ with } \Delta < 5000\ t; \\ \Delta^{2/3} \text{ with } \Delta \geqslant 5000\ t; \end{cases}$$

Δ ∔ displacement, in t.

The section modulus W, in cm^3, of the stem cross-sectional area with regard to an axis perpendicular to the centreline is not to be less than given by the formula

$$W = 1{,}16pb \qquad (3.10.4.10.1\text{-}2)$$

where for p, b, see 3.10.4.3.1 as far as region of ice strengthening AI is concerned.

To be included in the design cross-sectional area of a combined or plate stem are areas of shell plates and centreline girder or of longitudinal bulkhead on the centre plane on a breadth not exceeding ten times the thickness of relevant plates.

The plate thickness s, in mm, of combined and plate stems, as well as of the structure shown in Fig. 3.10.2.6, is not to be less than determined from the formula

$$s = 1{,}2\left(s_{sp_0}\frac{a_b}{a_{sp}}\sqrt{\frac{R_{eH}^{sp}}{R_{eH}}} + \Delta s_{sp_0}\right) \qquad (3.10.4.10.1\text{-}3)$$

where for s_{sp}, Δs_{sp_0} see 3.10.4.1 as far as the region of ice strengthening AI is concerned;
a_b = spacing, in m, of transverse brackets of stem;
a_{af} = main framing spacing, in m, in way of shell plating in the region of ice strengthening AI, which was adopted when determining s_{sp};
R_{eH}^{sp} = tensile strength, in MPa, of shell plating material, which was adopted when determining s_{sp}.
R_{eH} = tensile strength, in MPa, of stem plate material.

3.10.4.10.2 Sternframe. The sectional area S, in cm^2, of propeller post and rudder post shall be as given by the formula

$$S = kS_0 \qquad (3.10.4.10.2)$$

where k = factor to be adopted from Table 3.10.4.10.2;
s_0 = sectional area of propeller post or rudder post, in cm^2, as required for a ship without an ice category in accordance with 2.10.4.

Table 3.10.4.10.2

Strengthening factor k	Ice category								
	ЛУ1	ЛУ2	ЛУ3	ЛУ4	ЛУ5	ЛУ6, ЛЛ6	ЛУ7, ЛЛ7	ЛУ8, ЛЛ8	ЛУ9, ЛЛ9
Propeller post	1,1	1,1	1,15	1,25	1,5	1,75	2	2,5	3
Rudder post and sole-piece	1,15	1,15	1,25	1,5	1,8	2	2,5	3,5	4

For the sternframes of single-screw ships of categories **ЛУ1**, **ЛУ2**, **ЛУ3** having no rudder post or fitted

Table 3.10.4.10.1

Parameter	Ice ships									Icebreakers			
	ЛУ1	**ЛУ2**	**ЛУ3**	**ЛУ4**	**ЛУ5**	**ЛУ6**	**ЛУ7**	**ЛУ8**	**ЛУ9**	**ЛЛ6**	**ЛЛ7**	**ЛЛ8**	**ЛЛ9**
Section H_1, in m, from top of ice belt to upper boundary of ice strengthening of the stem	0,5	0,5	0,6	0,7	0,8	0,9	1,0	1,1	1,2	1,0	1,5	1,75	2,0
Factor k of stem plate thickening above the upper boundary of strengthening	1,25	1,2	1,15	1,1	1,1	1,05	1	1	1	1	1	1	1
Factor k_k from the Formula (3.10.4.10.1)	0,30	0,34	0,4	0,54	0,66	1,02	1,25	1,4	1,55	1,43	1,75	1,96	2,17
Depth of centreline vertical web h_v, in m, by which the stem is strengthened	0,5	0,5	0,5	0,6	1,0	1,3	1,5	Longitudinal bulkhead in fore peak centreline					

up with a rudder axle for Simplex rudders, the greatest value out of those stipulated by 2.10.4.2.5 (account being taken of 2.2.2.2, Part III "Equipment, Arrangements and Outfit") shall be adopted for the scantlings of the sole-piece cross section, or they shall be determined from the Formula (3.10.4.10.2), whichever is greater.

Where the sternframe has a horn for a semi-spade rudder, the scantlings of the rudder horn are to be determined according to 2.10.4.4 with due regard for the requirements of 2.2.2.2, Part III "Equipment, Arrangements and Outfit".

The sternframe sectional area of twin-screw ice ships or icebreakers is not to be less than the rudder post area stipulated in 3.10.4.10.2.

3.11 ICE STRENGTHENING OF TUGS

3.11.1 General provisions and requirements.

3.11.1.1 Tugs provided with ice strengthening in compliance with the requirements stated below are provided with one of the following ice-category marks in their class notation: **ЛУ2**, **ЛУ3**, **ЛУ4**, **ЛУ5**.

The ultimate and permissible thickness of ice in which ice-strengthened tugs may operate is to be determined on the basis of 2.2.3.4 and 2.2.3.5, Part I "Classification" as in the case of ice transport ships of categories **ЛУ2**, **ЛУ3**, **ЛУ4**, **ЛУ5**.

3.11.1.2 The hull form of ice-strengthened tugs is to be in accordance with the requirements of 3.10.1.2 for the hull form of ice ships of the respective category.

3.11.1.3 Regions of ice strengthening.

3.11.1.3.1 For tugs, the boundaries of regions of ice strengthening are to be established in accordance with 3.10.1.3 as in the case of ice ships, unless specifically provided otherwise below.

3.11.1.3.2 In tugs with a small length of loadline fore run ($b+L_3<0{,}35L$, see 3.10.1.3), the intermediate region of ice strengthening (or the forward region where no intermediate region is established) is to be extended aft so that the forward boundary of the midship region would be at least 0,35L away from the forward perpendicular.

3.11.1.3.3 The parameters h_1; h_3; L_2 (see Fig. 3.10.1.3.2) are to be adopted from Table 3.11.1.3.3.

Table 3.11.1.3.3

Parameter, in m	Ice category	
	ЛУ2, ЛУ3	**ЛУ4, ЛУ5**
h_1	0,3	0,5
h_3	0,6	0,8
L_2	0,10L	0,15L

3.11.1.3.4 In tugs of **ЛУ2** and **ЛУ3** categories, an intermediate region of ice strengthening may also be established, and its boundaries are to be determined on the basis of the same regulations as for tugs of higher categories.

3.11.1.3.5 The regions of ice strengthening of tugs to which the requirements of this Chapter apply are to be determined proceeding from Table 3.10.1.3.4 as in the case of a transport ship of the respective ice category, with due regard for 3.11.1.3.4.

3.11.2 Construction.

3.11.2.1 The ice-strengthening construction of tugs is to comply with the requirements of 3.10.2 for the construction of ice ships of respective categories.

3.11.2.2 The hull attachments of ice-protection components of the screw-rudder system are to ensure their reliable connection to main and web framing and, as far as practicable, to the sternframe and to longitudinal and transverse bulkheads so as to rule out the possibility of crack formation as a result of ice impacts on the stern.

3.11.3 Ice load.

3.11.3.1 The ice pressure is to be as given by the following formulae:

.1 in region **AI**

$$p_{\mathrm{AI}} = k_p p^{\mathrm{c}}_{\mathrm{AI}} \qquad (3.11.3.1.1)$$

where $p^{\mathrm{c}}_{\mathrm{AI}}$ = ice pressure in region AI, as determined in accordance with 3.10.3.2.1 as in the case of a transport ship whose ice category number coincides with the ice category number of the tug;

$k_p = \begin{cases} 1 & \text{with } N_\Sigma \leqslant N_0; \\ (N_\Sigma/N_0)^{0,4} & \text{with } N_\Sigma > N_0; \end{cases}$

N_Σ = total shaft power of tug, in kW;

$N_0 = C_N \Delta^{2/3}$;

C_N = factor to be adopted from Table 3.11.3.1.1;

Δ = displacement to summer loadline, in t;

Table 3.11.3.1.1

Factor	Ice category of tug			
	ЛУ2	**ЛУ3**	**ЛУ4**	**ЛУ5**
C_N	14	16	18	20

.2 in regions **A1I**, **BI** and **CI**

$$p_{k\mathrm{I}} = a_k p_{\mathrm{AI}} \qquad (3.11.3.1.2)$$

where for pAI, see 3.11.3.1.1;

a_k = factor to be adopted from Table 3.11.3.1.2 proceeding from the region of ice strengthening and the ice category of tug;

k = A_1, B, C;

Table 3.11.3.1.2

Values of factor a_k

Region	Ice category of tug			
	ЛУ2	**ЛУ3**	**ЛУ4**	**ЛУ5**
A_1I	0,55	0,6	0,65	0,65
BI	0,4	0,5	0,55	0,6
CI	0,65	0,7	0,75	0,75

.3 in regions **II**, **III** and **IV**, an ice pressure is to be taken as required by 3.10.3.2.5 as in the case of transport ships with respective ice categories.

3.11.3.2 For tugs the vertical extension of ice load is to be adopted equal in all regions and shall be determined in accordance with 3.10.3.3.1 as in the case of the forward region of a transport ship whose ice category number coincides with that of the tug. When determining u_m, the values of u shall be found for those sections only which are included in the forward region of ice strengthening of the tug.

3.11.3.3 For tugs the horizontal extension of ice load is to be adopted equal in all regions and shall be determined in accordance with 3.10.3.4.1 as in the case of the forward region of a transport ship whose ice category number coincides with that of the tug. When determining β_m, only those sections shall be considered which are included in the forward region of ice strengthening of the tug.

3.11.4 Scantlings of ice-strengthening structures.

3.11.4.1 The scantlings of ice-strengthening structures in tugs shall be determined in accordance with 3.10.4 as in the case of transport ships of the corresponding category, unless expressly provided otherwise below.

3.11.4.2 When establishing the shell plating thickness in regions of ice strengthening in accordance with 3.10.4.1, the wear allowance ΔS_{sp0} may be reduced on agreement with the Register, if special measures are taken to protect the shell plating from corrosion wear and abrasion, but in any case, ΔS_{sp0} shall be adopted not less than 2 mm.

3.11.4.3 In addition to the requirements of 3.10.4.10, the stem and sternframe are to have a sectional area not less than given by the formula

$$S = kS_0 \qquad (3.11.4.3)$$

where k = factor whose values are to be found in Table 3.11.4.3;
S_0 = area of the tug stem or sternframe without ice strengthening, to be determined in accordance with 3.9.4.5 or 3.9.4.6.

Table 3.11.4.3

Structural item	k			
	ЛУ2	ЛУ3	ЛУ4	ЛУ5
Stem	1,2	1,3	1,4	1,5
Sternframe	1,1	1,2	1,3	1,4

3.12 FLOATING DOCKS

3.12.1 General.

3.12.1.1 Application.

The requirements of this Chapter apply to hull structures of wing-walled (caisson, pontoon, sectional) docks.

Caisson dock is a structure fitted with a solid pontoon and two wings continuous along the entire length and structurally inseparable (including caisson docks with end pontoons for docking a centre pontoon).

Pontoon dock is a structure fitted with two wings continuous along the entire length and several pontoons connected to the wings by bolts, rivets, welding.

Sectional dock is a structure consisting of several sections, each section being a caisson or a pontoon dock, connected by bolts, welded plates, hinges.

The requirements apply to the docks having a ratio of the length over the pontoon deck to the breadth more than 3,5.

Other structural configurations of docks and their proportions require individual consideration.

3.12.1.2 Definitions.

Length of dock at the pontoon deck $L_{p.d}$ is the distance measured along the pontoon deck parallel to the base line between moulded surfaces of the pontoon end bulkheads.

Breadth of the dock B is the distance measured normal to the centre line between the moulded surfaces of the outer wall sides.

Depth of the dock D is the vertical distance measured at the midship section from the base line to the moulded surface of the top deck at the outer wall side.

Design waterline is a waterline of a floating dock corresponding to its draught with full stores, a ship of a design weight and a required quantity of ballast.

Design draught d is a vertical distance measured from the base line to the design waterline.

Light draught d_l is a vertical distance measured at the midship section from the base line to the waterline corresponding to the dock displacement with no stores, docked ship and ballast.

Maximum submersion depth $d_{m.s}$ is a vertical distance measured at the midship section from the base line to the waterline to which the dock may theoretically be lowered.

Lifting capacity of the dock Δ, in tons, is mass of the heaviest ship or ships that the dock shall lift in normal service.

Ship weight for docking Δ_s, in tons, is weight of the light ship to be docked with necessary stores and ballast to provide the ship's draught and trim as required for docking.

Ballast water is sea water pumped into ballast compartments in order to change dock's draught and trim.

Rest water ballast is ballast water which pumps cannot discharge.

Compensating ballast water is ballast water pumped into ballast tanks in order to reduce transverse and/or longitudinal bending moments and deflections of pontoon and/or wing wall structures.

Dock wing wall is a part of floating dock hull structurally connected to a pontoon or pontoons and intended to provide stability when the dock is lowered and lifted; a wing wall is divided by decks, platforms, bulkheads into spaces and compartments for arranging dock equipment and ballast.

Wall breadth at top deck $b_{t.d}$ is a distance measured normal to the centre line between the moulded surfaces of the inner and outer wall sides at the level of the moulded surface of the top deck.

Wall breadth at pontoon deck $b_{p.d}$ is the distance measured normal to the centre line between the moulded surfaces of the inner and outer wall sides at the level of the moulded surface of the pontoon deck.

Pontoon deck is the deck on which keel blocks or bilge blocks are fitted.

Pontoon deck breadth $B_{p.d}$ is the distance measured normal to the centre line between the lines of intersection of moulded surfaces of the inner wall sides and the pontoon deck.

Safety deck is the watertight deck in wing walls of the dock, forming a boundary of the ballast compartments from above.

Top deck is the uppermost deck of dock wing walls.

Pontoon is a part of the dock hull intended to maintain buoyancy of the dock which is defined by volumes of its compartments.

Pontoon depth D_p is the distance measured at the centre line from the base line to the moulded surface of the pontoon deck.

Ballast compartment is a compartment in a pontoon or wing wall of the dock, bounded by watertight structures and intended for pumping ballast water.

Dry compartment is a compartment below the safety deck (or below the margin line where safety deck is omitted) not intended for pumping ballast water.

Air cushion is an area of a higher air pressure between the top of compartment and a level of ballast water therein.

Crinolines are cantilever structures of the dock, fitted at the end bulkheads of the dock pontoon at the pontoon deck level, aiming to increase an area available for docking operations at the ship's ends projecting beyond the pontoon deck.

Length of keel blocks track L_k is the distance measured at the centre line parallel to the base line between outer ends of keel blocks.

3.12.1.3 Materials:

3.12.1.3.1 When selecting steel for hull structures of floating docks, provisions of 1.2 are to be applied, having regard to subdivision of structural members into groups according to Table 3.12.1.3.1.

3.12.1.3.2 Plate and beam items of crinolines, walkways and other secondary structures of a floating dock may be fabricated from steel having lower strength characteristics than specified in 1.2.2.1, provided their welding is guaranteed at the shipyard.

3.12.1.4 Estimation of wear. Minimum thicknesses.

3.12.1.4.1 The effect of wear on the scantlings of structures is estimated on the basis of specification of strength to the end of the dock service life. Corrosion allowances are to permit operation of the dock during the full specified service life with average corrosion rates of structural items.

3.12.1.4.2 Scantlings and strength characteristics of structures with due regard for wear and corrosion are to be determined in compliance with 1.1.5, with a corrosion allowance Δs, in mm, being obtained from the formula

$$\Delta s = kuT \qquad (3.12.1.4.2)$$

where k = factor taking into account zone conditions of floating dock service and equal to: 1,0 for Baltic basin; 1,1 for Northern, Black-and-Azov and Caspian-and-Volga basins; 1,2 for Pacific basin;

u = average annual reduction in thickness of structural members according to Table 3.12.1.4.2, in mm/year;

T = design service life of dock; where service life is not specified, it is to be taken as T = 50 years.

3.12.1.4.3 Average annual thickness reduction of dock structures plates and beams, given in Table 3.12.1.4.2, is to be used when dock structures have appropriate protective paint coatings.

Table 3.12.1.3.1

Dock members	Group of members	
	within midship region	outside midship region (see 1.1.3)
Thickened top deck plates in way of openings; bottom plating of pontoon deck wing walls and plate strengthenings of pontoon structures in pontoon docks at sections between pontoons and in adjacent regions, plate members of sectional dock structures in way of dock section connections	III	II
Pontoon deck plating and bottom plating of pontoon (pontoons); transverse and longitudinal framing members of pontoon deck and bottom; plate structures of primary transverse members (non-tight and tight bulkheads) of pontoon (pontoons); bottom strakes of wing walls and adjacent strakes of shell plating, longitudinal bulkhead plating of pontoon docks	II	II
Plating strakes, framing members of top deck, safety deck, wing walls and pontoon shell plating; plates and framing members of wing wall interior structures (other than dock structural members referred to in 1 and 2)	II	I

Table 3.12.1.4.2

Nos	Structure	u
1	Top deck plating and wing wall plating above margin line	0,04
2	Safety deck plating	$0{,}08^1$
3	Wing wall bottom of pontoon docks	0,08
4	Inner and outer wing wall plating from pontoon deck to the margin line	$0{,}08^1$
5	Pontoon deck plating:	
5.1	in the middle portion	0,10
5.2	at ends over a length $0{,}1L_{p.d}$	0,12
6	Side plating and outer transverse wall plating of pontoon (pontoons):	
6.1	top ($\leqslant$1,0 m) and bottom ($\leqslant$0,5 m) strakes	$0{,}09^1$
6.2	other strakes	$0{,}08^1$
7	Bottom plating of pontoon (pontoons)	$0{,}08^{1,2}$
8	Interior bulkheads of ballast compartments:	
8.1	bottom strake ($\leqslant$0,5 m)	0,09
8.2	other strakes	$0{,}08^1$
9	Framing members, dock truss items in ballast compartments	$0{,}10^1$
10	Plates and framing members of internal wing structures above safety deck, top deck and wing wall framing	0,04

[1] In way of compartments heated in winter by live steam, u is to be increased by 10 per cent.
[2] For bottom plating in way of ballast system suctions and discharges u is to be increased by 15 per cent.

Specified corrosion rates may be reduced if special protective arrangements are made on agreement with the Register.

3.12.1.4.4 Thickness of primary members (including corrosion allowance) are not to be less than given in Table 3.12.1.4.4 and determined depending on the assumed spacing a.

3.12.1.5 Guidelines on design of floating dock structures.

When designing floating dock structures, the following sequence is recommended:

.1 execution of structural layout of pontoon (pontoons) and wing walls (see 3.12.2);

.2 determination of design loads resulting in local and longitudinal deflection of dock hull structures (see 3.12.3);

.3 design of plate items and framing members of dock structures on the basis of local strength and buckling, having regard to minimum thickness restrictions;

.4 design of structures which provide both transverse and longitudinal strength of dock pontoon. Values of structural parameters obtained in implementation of 3.12.1.5.3 are used here as initial data;

.5 design of dock hull structures which provide dock longitudinal strength under design operating conditions (docking operations). Values of structural parameters

Table 3.12.1.4.4

Structure	s_{min}, in mm	Note
Plating of outer structures other than pontoon deck; structural items in ballast compartments and tanks, including framing members	7,5 $7{,}5+10(a-0{,}6)$ $8{,}0+6{,}5(a-0{,}6)$	$a<0{,}6$ m $a\leqslant0{,}75$ m $a>0{,}75$ m
Pontoon deck plating	9,0 $9{,}0+13(a-0{,}6)$ $10{,}0+6(a-0{,}6)$	$a<0{,}6$ m $a\leqslant0{,}75$ m $a>0{,}75$ m
Top deck plating; plates and beams of structures above safety deck	$6{,}5+8(a-0{,}6)$ 6,5	$a\geqslant0{,}6$ m $a<0{,}6$ m

obtained in implementation of 3.12.1.5.3 and 3.12.1.5.4 are used here as initial data;

.6 design of structures, having regard to the requirements for strengthening (e.g. wing wall decks and sides in way of openings, engine room, etc.);

.7 check calculations of both longitudinal and transverse, as well as local strength of hull structures under conditions of real ship docking;

.8 check calculations of both longitudinal and transverse, as well as local strength of dock structures during passage from a place of build to a place of operation. Development of recommendations on dock structure strengthening.

3.12.2 Construction.

3.12.2.1 Framing systems of pontoon (pontoons) and wing walls.

For pontoon (pontoons) of caisson, pontoon and sectional docks transverse framing is preferable.

Wing wall sides and decks of pontoon docks with lifting capacities of 10 000 t and above are to be longitudinally framed; docks having lifting capacities below 10 000 t may be framed transversely.

Wing wall sides and decks of caisson docks above the safety deck are to be longitudinally framed, wing wall sides below the safety deck may be transversely framed.

For pontoon bottom plating portions of caisson docks in way of wing walls a longitudinal framing may be adopted.

For transverse and longitudinal bulkheads of the pontoon and wing walls structures with horizontal and vertical stiffeners are permitted.

Truss arrangements may be used in the pontoon (pontoons) and wing walls.

3.12.2.2 Structural layout of pontoons.

Plate and beam structures of the pontoon are to maintain local strength of the appropriate pontoon strucures (pontoon deck, bottom, longitudinal and transverse bulkheads, etc.), as well as transverse strength of the pontoon.

Spacing of primary longitudinal and transverse framing members of the pontoon is to be determined according to 1.1.3 with $L = L_{p.d}$.

Primary transverse structures of the pontoon (pontoons), i.e. non-tight bulkheads, are to be fitted in 3 to 7 spacings, but they are not to be spaced more than $(B - b_{p.d})/6$ apart.

A centre line bulkhead is to be fitted under the keel blocks. A box structure formed by two longitudinal bulkheads arranged symmetrically on each side of the centre line may be used in lieu of the centre line bulkhead.

Bulkheads or girders are to be aligned with inner wall sides.

Where transverse framing is adopted for a pontoon (pontoons), additional primary longitudinal supporting members may be fitted to limit a span of transverse members of the bottom and pontoon deck. They are to be spaced not more than 3 to 5 spacings apart.

3.12.2.3 Structural layout of wing walls.

Spacing of primary longitudinal and transverse framing members of wing walls is to be determined as required by 1.1.3.

Where wall sides and decks are longitudinally framed, deck transverses and web frames are to be aligned with primary transverse structures of the pontoon (pontoons) (see 3.12.2.2).

Where wall sides are transversely framed, side stringers are to be fitted. Spacing of stringers and distance between stringers and deck are, in general, not to exceed 3,5 m.

Where transverse framing is adopted for wing walls below the safety deck it is advisable to provide web frames on wall sides in line with primary transverse structures of the pontoon, and deck transverses on the safety deck plating.

Primary supporting members of outer and inner wall sides below the safety deck (web frames with longitudinal framing and side stringers with transverse framing) are to be connected by cross ties which are to be fitted in line with each primary transverse of the pontoon (see 3.12.2.2).

3.12.2.4 Additional provisions.

Use of butt-lap connections for girders and transverses of pontoon (pontoons) and wing walls is permitted.

Where proper quality control of welding joints is provided, assembling joints aligned on plate structures and framing members are permitted.

Hollow square and tubular cross ties and struts are not to be used in ballast compartments and other tanks.

3.12.3 Design loads.

3.12.3.1 Loads for structure design based on local strength.

3.12.3.1.1 Design pressure p, in kPa, for plate and beam bottom structures is to be determined by the formulae:

in way of dry compartments

$$p = 10d_{m.s}; \qquad (3.12.3.1.1\text{-}1)$$

in way of ballast compartments not communicated with wing walls

$$p = 10(d_{m.s} - D_p), \qquad (3.12.3.1.1\text{-}2)$$

and communicated with wing walls

$$p = 10(d_{m.s} - z_{s.d} + \Delta z) \qquad (3.12.3.1.1\text{-}3)$$

where $z_{s.d}$ = distance of the safety deck from the base line, in m;
Δz = thickness of air cushion, in m.

3.12.3.1.2 Design pressure p, in kPa, for plate and beam structures of the pontoon deck in way of dry and ballast compartments is to be determined by the Formula (3.12.3.1.1-2).

3.12.3.1.3 Design pressure p, in kPa, for plate and beam structures of pontoon sides and end bulkheads is to be obtained using the following formulae:

$$p = 10(d_{m.s} - z_i) \qquad (3.12.3.1.3\text{-}1)$$

where z_i = distance of the lower edge of the plate or mid-span of the framing member from the base line, in m;

in way of ballast compartments

$$p = 10(d_0 - D_p) \qquad (3.12.3.1.3\text{-}2)$$

where d_0 = depth of the dock corresponding to filling of a side ballast compartment up to the safety deck, in m.
d_0 is not to be taken more than $d_{m.s}$.
As the first approximation, where no special information is available, it may be assumed that
$d_0 = D_p + G/2L_{p.d}\, b_{p.d}\, \rho$;
G = mass of dock without rest water and compensating ballast;
ρ = sea water density (see 1.1.3).

3.12.3.1.4 Design pressure p, in kPa, for plate and beam structures of wall sides and end bulkheads are to be determined from the following formulae:

in way of dry compartments, using the Formula (3.12.3.1.3-1);

in way of ballast compartments

$$p = 10(d_0 - z_i) \qquad (3.12.3.1.4)$$

where z_i, d_0 = as defined above.

3.12.3.1.5 Design pressure p, in kPa, for plate and beam structures of the safety deck in way of dry compartments is to be taken equal to 5 kPa; in way of ballast compartments p is to be determined by the formula

$$p = 10(d_{m.s} - z_{s.d} + \Delta z) \qquad (3.12.3.1.5)$$

where $z_{s.d}$, Δz = as defined in 3.13.3.1.1.

3.12.3.1.6 Design pressure p, in kPa, for plate and beam structures of inner watertight bulkheads of ballast compartments is to be determined by the formula

$$p = 10(d_{m.s} - z_t + \Delta z) \qquad (3.12.3.1.6)$$

where z_t = distance of ballast compartment top from the base line, in m;
Δz = as defined in 3.13.3.1.1.

3.12.3.1.7 Design pressure p, in kPa, for plate and beam structures of main watertight bulkheads is to be obtained from the Formula (3.12.3.1.3-1).

3.12.3.1.8 Design pressure for plate and beam structures of the top deck is to be equal to 5 kPa.

3.12.3.1.9 Design pressure p, in kPa, for plate and beam structures of oil fuel, lubricating oil, water and other tanks is derived from the following formulae:

when internal pressure is calculated

$$p = 10\rho_1(z_{a.p} - z_i) \qquad (3.12.3.1.9)$$

where ρ_1 = density of liquid contained in the tank, in t/m^3;
$z_{a.p}$ = distance of the upper edge of the air pipe from the base line, in m;

when external pressure is calculated, the Formula (3.12.3.1.3-1) is to be used.

For plate structures arranged parallel to the base line, z_i is the distance of the plate structure from the base line.

3.12.3.1.10 Design pressure on crinoline structures is assumed to be equal to 5 kPa.

3.12.3.1.11 Design pressure on walkway structures is assumed to be equal to 3,5 kPa.

3.12.3.1.12 Design pressure on structures of safety deck, intermediate deck and platforms where equipment of the electric generating plant is arranged are assumed equal to 18 kPa; in way of accommodation and service spaces, 5 kPa.

3.12.3.2 Loads for structure design based on both transverse and longitudinal strength of pontoon (pontoons).

3.12.3.2.1 Design loads to be used in design of pontoon structures of caisson, pontoon and sectional docks are to be calculated for the condition when the ship of length L_S and weight equal to the maximum lifting capacity of the dock is supported on the keel blocks symmetrically about the midship section of the dock. The draught of the dock is to correspond to the design one (see 3.12.1.2); ballast water is considered evenly distributed over the length and breadth of the dock.

3.12.3.2.2 For pontoon and sectional docks an additional condition is to be considered for pontoons loaded by buoyancy forces the value of which corresponds to the condition specified in 3.13.3.2.1 corrected for rest-water counterpressure and gravitational forces of light-dock weight components, opposite in direction.

Where no initial data are available, buoyancy force p, in kPa, may be obtained from the formula

$$p = g\Delta/[BL_{p.d} - (n-1)Ba_0] \qquad (3.12.3.2.2)$$

where n = number of pontoons of pontoon docks or sections of sectional docks;
a_0 = distance between pontoons or sections, in m.

3.12.3.2.3 Design length of the ship L_c is to be assumed equal to the length of the shortest ship whose docking weight is equal to the maximum lifting capacity of the dock, but not more than $0{,}9L_{p.d}$. For docks having lifting capacity more than 40 000 t, the design length of the ship is not to be taken less than $0{,}9L_{p.d}$.

3.12.3.2.4 The weight curve of the ship is to be taken as a rectangle with a superimposed parabola of half the area of the rectangle. Linear docking load q_x, in kN/m, at the section distant at x forward and aft from the midship section is to be determined by the formula

$$q_x = \frac{g\Delta}{L_s\varphi}[1-3(1-\varphi)(2x/L_s)^2] \qquad (3.12.3.2.4)$$

where φ = block coefficient of ship weight curve.

For docks of 40 000 t lifting capacity and less block coefficient of the ship weight curve is to be assumed depending on a design ship type according to Table 3.12.3.2.4.

Table 3.12.3.2.4

Type of ship	φ
Icebreakers	0,67
Ships with machinery space amidships	0,75 — 0,8
Ships with machinery space aft or semi-aft	1,0

For docks above 40 000 t lifting capacity, $\varphi = 0,8$ is to be assumed.

3.12.3.2.5 Where it is intended to lift ships simultaneously on keel and side blocks, as well as where different cases of simultaneous docking of several ships are expected, they are to be taken into account in design of structures which provide both longitudinal and transverse strength of the pontoon. Design loads are to be determined using the procedures approved by the Register.

3.12.3.2.6 Design loads on end pontoons of pontoon and sectional docks or on the end portions of caisson docks and when ships with overhung ends are docked are to be specially considered by the Register.

3.12.3.3 Loads for design of structures based on longitudinal strength.

3.12.3.3.1 Design loads are to be determined for the following conditions:

dock's sagging when a ship having the shortest length L_s expected and a weight equal to the maximum lifting capacity of the dock Δ is lifted;

dock's hogging when a ship having the largest length L_s expected and a weight equal to the maximum lifting capacity of the dock Δ is lifted, or two or more ships installed in line and having a total weight equal to Δ are docked.

Ballast water is considered to be evenly distributed over the entire length of the dock.

3.12.3.3.2 The form of ship weight curve is determined by the Formula (3.12.3.2.4).

3.12.3.3.3 The design length of the shortest ship is to be as required by 3.12.3.2.3.

The design length of the largest ship or a total length of several ships installed in line over the length of the dock is not to be less than $1,3L_{p.d}$.

3.12.3.3.4 The design block coefficient of the ship weight curve is to be assigned according to 3.12.3.2.4; for hogging, $\varphi = 1,0$ is to be taken, unless expressly provided otherwise.

3.12.4 Scantlings of structural members.

3.12.4.1 The thickness requirements for plate structures based on local strength.

The plating thicknesses of pontoon (pontoons), wall sides, interior and outer watertight bulkheads, decks and platforms are to be determined using the Formula (1.6.4.4) with $m = 22,4$ and $k_\sigma = 1,8$. A corrosion allowance is to be obtained according to the recommendations given in 3.12.1.4. The design transverse pressure p is specified in 3.12.3.1.

3.12.4.2 Scantling requirements for framing members based on local strength:

3.12.4.2.1 The section modulus of primary members is to be determined as required by 1.6.4.1.

3.12.4.2.2 The net sectional area of girders and transverses, as well as sectional area of beams and longitudinals having a relationship $l/h \leqslant 10$ (where l = design span, in m; h = web depth of a beam or longitudinal, in cm) are to be obtained from 1.6.4.3.

3.12.4.2.3 The design pressure p is to be determined at a mid-span of framing members as required by 3.13.3.1.

3.12.4.2.4 The design span l of framing members is to be selected in accordance with 1.6.3.1.

3.12.4.2.5 Coefficients of permissible normal and shear stresses specified in 1.6.4.1 and 1.6.4.3 are to be assumed equal to $k_\sigma = 0,8$ and $k_\tau = 0,8$.

3.12.4.2.6 The factor ω_c which takes account of framing member wear as given in 1.1.5.3 is to be taken with Δ_s according to 3.12.1.4.

3.12.4.2.7 Factors of design bending moments m and shear forces n are to be assumed as follows:

$m = 12$ and $n = 0,5$ for bottom transverse and longitudinal members, beams and longitudinals of the pontoon deck; for stiffeners of watertight transverse bulkheads with longitudinally framed bottom and pontoon deck; for stiffeners of interior watertight longitudinal bulkheads with transversely framed bottom and pontoon deck; for longitudinal framing members of wall sides and decks; for safety deck beams with transversely framed wall sides below the safety deck; for girders and transverses of bottom and pontoon deck and side stringers of outer and inner wall sides;

$m = 8$ and $n = 0,5$ for stiffeners of watertight transverse bulkheads with transversely framed bottom and pontoon deck; for stiffeners of interior longitudinal bulkheads with longitudinally framed bottom and pontoon deck; for horizontal stiffeners of watertight transverse bulkheads of wing walls with transversely framed wall sides; for safety deck beams with longitudinally framed wall sides;

$m = 13$ and $n = 0,5$ for wall deck and platform beams with transversely framed wall sides below the considered deck or platform; top deck or safety deck transverses;

$m = 11$ and $n = 0{,}6$ for frames and web frames of the pontoon (pontoons), outer and inner wall sides.

3.12.4.2.8 The scantlings and structures of girders and transverses of the pontoon and wing walls are to satisfy the requirements of 1.7.3.3. For girders and transverses of the wing walls above the safety deck the requirements for similar structures of dry cargo ships may be applied.

3.12.4.3 Requirements for cross ties, struts and braces.

3.12.4.3.1 The sectional area of cross ties and struts S, in cm^2, is not to be less than determined by a successive approximation method using the Formula (2.9.4.1) with a design load $P = 0{,}5(P_1 + P_2)$, in kN, and factor $k = 1{,}15$ (where $P_1 = p_1ac$, $P_2 = p_2ac$ are maximum compressive forces acting at the ends of struts and cross ties; p_1 and p_2 are design pressures (see 3.12.3.1), in kPa; a = distance between members supported by struts or cross ties, in m; c is half-sum of span lengths on each side of the strut or cross tie under consideration, in m).

As a first approximation, S may be taken as:

$$S = 0{,}11P$$

and the radius of gyration $i = \sqrt{I/S}$, in cm, may be estimated for a suitable section having this area (where I = minimum central moment of inertia, cm^4). If the area determined from the Formula (2.9.4.1-1) using this radius of gyration differs by more than 10 per cent from the first approximation, a second approximation calculation is to be made. The radius of gyration is to correspond to the mean area of the first and second approximation.

3.12.4.3.2 The web plates of cross ties and struts of channel or I sections are to be so selected that the ratio of the breadth to the thickness is not to exceed $42l/i$ or 40, whichever is the greater (where l is length of a cross tie or strut, in m).

For ordinary angle or channel sections, the ratio of the breadth to the thickness of the flanges is not to exceed $14l/i$ or 13, whichever is the greater.

For cross ties of fabricated sections or I sections cross ties, the ratio of the breadth to the thickness of face plates is not to exceed $28l/i$ or 25, whichever is the greater.

The thickness of cross tie or stay items is not to be less than 7,5 mm.

3.12.4.3.3 The scantlings of trusses are to be determined according to a procedure approved by the Register.

3.12.4.4 Additional local strength requirements for plates and beams.

If hull structures of the dock are subjected to the loads not covered by 3.12.3.1, the scantlings of plates and beams are to be determined using the procedures approved by the Register.

3.12.4.5 Scantling requirements for primary transverse and longitudinal members of pontoon (pontoons).

3.12.4.5.1 The section modulus W, in cm^3, of the primary transverse and longitudinal members of the pontoon (pontoons) is to be determined by the formula

$$W = W' + \Delta W \tag{3.12.4.5.1-1}$$

where W' = specified section modulus of the end of the dock service life to be determined from the formula

$$W' = M10^3/k_\sigma\sigma_n\ , \qquad \text{см.Б1} \tag{3.12.4.5.1-2}$$

M = design bending moment, in kN·m (see also 3.12.4.5.6);
ΔW = corrosion allowance to the section modulus to be determined by the formula

$$\Delta W = 100h[\Delta f_d + \frac{\Delta f_w}{6}(2 - \beta)], \tag{3.12.4.5.1-3}$$

h = web depth of members of the section under consideration, in m;
Δf_d, Δf_w = additions to the upper flange and web area of members, respectively, including corrosion allowances as based on the entire service life of the dock, in cm^2, derived from the formulae:

$\Delta f_d = 10\Delta s_d b_{e.f} + \Delta f_{fr}$;
$\Delta f_w = 10\Delta s_w h$,
$\Delta s_{d(w)} = u_{d(w)}T$ — reduction, in mm, of the plating thickness of the pontoon deck (member web) due to wear during service life of the dock T (years) with corrosion rate $u_{d(w)}$, in mm/year, according to Table 3.12.1.4.2;
$b_{e.f}$ = width of the effective flange (see 3.12.4.5.5), in m;
Δf_{fr} = addition to the flange area of the member allowing for corrosion wear of framing members, to be taken as:

for framing members of tee sections or flat

$$\Delta f_{fr} = 0{,}1n(b_0 + h_0)u_{fr}T; \tag{3.12.4.5.1-4}$$

for framing members of bulb flat

$$\Delta f_{fr} = 0{,}86nf_0u_{fr}T/s_0\ ; \tag{3.12.4.5.1-5}$$

When addition Δf_{fr} is determined, results obtained in design of framing members based on local strength (see 3.12.4.2) are used. Where the sectional area of members does not include primary members, $\Delta f_{fr} = 0$;

n = number of primary members over the breadth $b_{e.f}$;
b_0 and h_0 = face plate width and web depth of T-beam, respectively (for members of flat, $b_0 = 0$), in cm;
f_0 = area of isolated section;
s_0 = web thickness of bulb flat;
u_{fr} = specified corrosion rate for framing members of ballast compartments (see Table 3.12.1.4.2), in mm/year;
β = factor dependent on web areas f'_w of the upper f'_d and lower f'_b face plates, having regard to wear to the end of the service life, to be determined by the formula

$$\beta = (2f'_d + f'_w)/(2f'_d + f'_w); \tag{3.12.4.5.1-6}$$

as a first approximation, it may be assumed that $\beta = 1{,}0$.

3.12.4.5.2 The sectional area of the web f_w, in cm^2, of primary transverse members of the pontoon (pontoons) is to be obtained from the formula

$$f_w = f'_w + \Delta f_w \tag{3.12.4.5.2-1}$$

where f'_w = specified sectional area, in cm^2, of the web to the end of the service life of the dock, to be derived from the formula

$$f'_w = 10N_x/k_\tau\tau_n\ ; \tag{3.12.4.5.2-2}$$

N_x = designed shear force (see 3.12.4.5.7), in kN;
for Δf_w, see 3.12.4.5.1.

3.12.4.5.3 The scantlings of the truss (struts and braces) of the pontoon (pontoons) are to be adequate to take shear forces arising in longitudinal bending of the pontoon.

3.12.4.5.4 To be included in the design section of primary transverse members of the pontoon (pontoons) are all structural items which are continuous between the pontoon sides; design section of primary longitudinal members is to include all structural items which are continuous between the end bulkheads of the pontoon.

3.12.4.5.5 The width of the effective flanges of the primary transverse members $b_{e.f}$, in m, of the bottom and pontoon deck plating is to be taken as:

$$b_{e.f} = \min\{(B — b_{e.f})/6;\ c\} \qquad (3.12.4.5.5)$$

where c = average distance between the member under consideration and members on the right and on the left thereof, in m.

3.12.4.5.6 The design bending moments M_x and M_y, in kN·m, acting in transverse and longitudinal members at the middle of a continuous pontoon of a caisson dock (Fig. 3.12.4.5.6-1) for the cases referred to in 3.12.3.2, are to be determined by the formulae:

$$M_x = q(B - b_{p.d})c_x\delta_1; \qquad (3.12.4.5.6\text{-}1)$$

$$M_y = q(B - b_{p.d})c_y\delta_2 \qquad (3.12.4.5.6\text{-}2)$$

where $q = q\Delta/L_s$ = average value of the linear load of the dock, in kN/m (L_s, Δ as defined in 3.12.3.2);

B, $b_{p.d}$ = breadth of the dock and wing wall at the pontoon deck level;

c_x, c_y = distance between primary transverse and longitudinal members of the pontoon, respectively, as shown in Fig. 3.12.4.5.6-1, in m;

δ_1, δ_2 = factors to be obtained from the diagrams given in Fig. 3.12.4.5.6-2 and 3.12.4.5.6-3 as dependent on parameters $L_s/L_{p.d}$, $n = L_{p.d}/(B - b_{p.d})$ and φ.

For pontoon and sectional docks, the design bending moment in design of primary transverse members M_x, in kN·m, is to be equal to the greater of the two values:

$$M_x = 0{,}25q\,\frac{c_x}{\varphi}\,(B - b_{p.d})(1 - 0{,}5\varphi\,\frac{L_s}{L_{p.d}}\,\frac{B - b_{p.d}}{B})\ ; \qquad (3.12.4.5.6\text{-}3)$$

or

$$M_x = 0{,}125pc_x(B - b_{p.d})^2 \qquad (3.12.4.5.6\text{-}4)$$

where p = as defined in 3.12.3.2.2,

whichever is the greater.

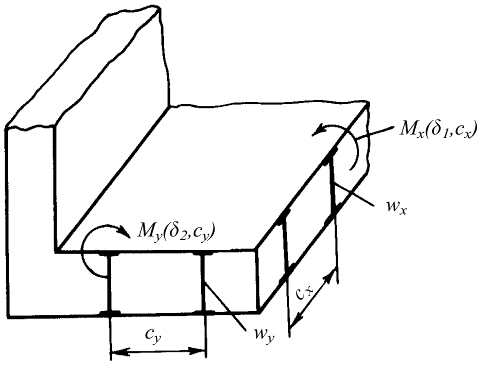


Fig. 3.12.4.5.6-1

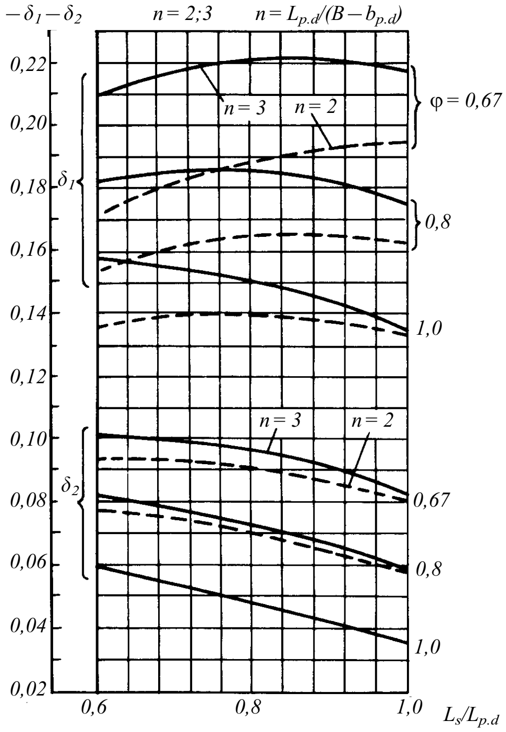


Fig. 3.12.4.5.6-2

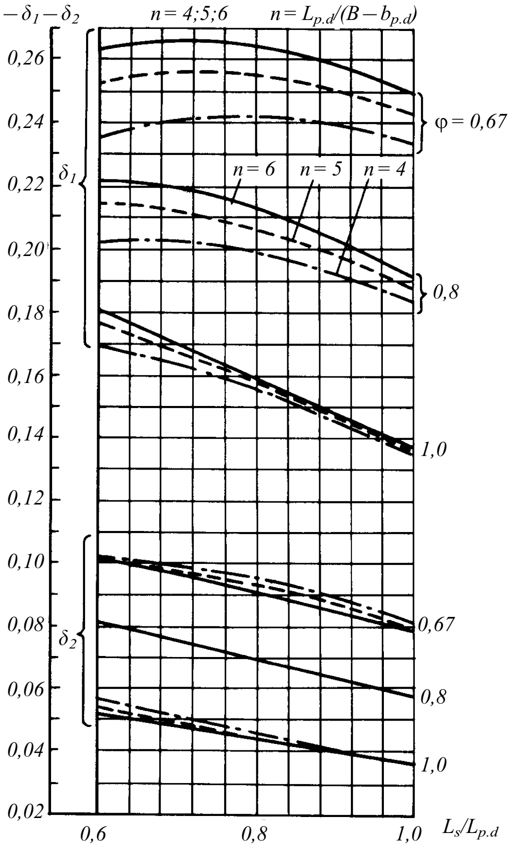


Fig. 3.12.4.5.6-3

3.12.4.5.7 The design shear force N_x, in kN, taken by a transverse member of the dock (primary transverse member, or struts and braces of the pontoon truss) is to be determined by the formula

$$N_x = 0{,}75\frac{g\Delta}{L_s}(1-1{,}33\frac{L_s}{L_{p.d}}\frac{y}{B})c \qquad (3.12.4.5.7\text{-}1)$$

where y = distance of the section under consideration from the centre line of the dock, in m;

c = distance between the members under consideration, in m.

In design of the primary transverse members or struts and braces of the pontoon trusses of pontoon and sectional docks, the design shear force N_x, in kN, is not to be taken less than:

$$N_x = pcy \qquad (3.12.4.5.7\text{-}2)$$

where p = as defined in 3.12.3.2.2.

3.12.4.5.8 The coefficients of permissible stresses in the Formulae (3.12.4.5.1-2) and (3.12.4.5.2-2) in design of primary transverse members of the pontoon (pontoons) are to be taken as follows: $k_\sigma = 0{,}85$, $k_\tau = 0{,}8$.

Guidelines on the selection of permissible normal stresses in primary longitudinal members of the pontoon of caisson-type docks are given in 3.12.4.6.5.

3.12.4.5.9 The web thickness of primary transverse members are to meet the buckling strength requirements under the action of shear and normal stresses arising in transverse bending of the pontoon (pontoons).

The plating thickness of the pontoon deck and bottom is to meet the requirements for buckling strength under the action of compressive stresses arising in transverse bending of the pontoon (pontoons).

3.12.4.5.10 Buckling strength conditions are to comply with 1.6.5.2 and 1.6.5.3. Factor k in the Formula (1.6.5.2) is taken equal to 0,75.

When Euler's stresses are determined according to the formulae given in 1.6.5.5 it is to be taken that $s' = s - \Delta s$, where Δs is obtained in compliance with 3.12.1.4.

3.12.4.6 The scantling requirements for structures based on strength and buckling conditions in longitudinal bending.

3.12.4.6.1 The assumed scantlings of dock longitudinal structures (with regard to the provisions of 3.12.4.6.2) are to provide the required hull section modulus of the floating dock.

The hull section modulus W, in cm^3, of a floating dock is not to be less than:

$$W = W'\omega_c \qquad (3.12.4.6.1\text{-}1)$$

where W' = specified section modulus to the end of the service life of the dock, in cm^3, determined by the formula

$$W' = M \cdot 10^3/k_\sigma\sigma_n\,; \qquad (3.12.4.6.1\text{-}2)$$

M = maximum bending moment determined by the Formula (3.12.4.6.3), in kN·m;

ω_c = factor which takes account of corrosion allowance to the section modulus for wear determined by the formula

$$\omega_c = (1 - F^{-1}\Sigma\Delta f_i\varphi_i)^{-1}\,; \qquad (3.12.4.6.1\text{-}3)$$

F = sectional area of the floating dock hull, in cm^2, corresponding to the Rule section modulus W;

Δf_i = addition to the sectional area of the i-th plate strake, which takes account of corrosion allowance to be determined by the formula

$$\Delta f_i = 10\Delta s_i b_i\,; \qquad (3.12.4.6.1\text{-}4)$$

$\Delta s_i = u_i T$ — thickness reduction of the i-th plate member due to wear during service life T (years), with a corrosion rate u_i, in mm/year, taken according to Table 3.12.1.4.2, in mm;

b_i = width of the i-th member, in m.

Additions to the sectional area of the floating dock hull which take account of corrosive wear of framing members are to be not less than those obtained from the following formulae:

for framing members of tee sections or flat

$$\Delta f_i = 0{,}1 n_i (b_{0i} + h_{0i}) u_{fr_i} T \qquad (3.12.4.6.1\text{-}5)$$

where n_i = number of framing members of the i-th group;

b_{0i}, h_{0i} = face plate width and web depth of T-beam, respectively, in cm (for members of flat, $b_{0i} = 0$);

for framing members of bulb flat

$$\Delta f_i = 0{,}86 n_i f_{0i} u_{fr_i} T/s_{0i} \qquad (3.12.4.6.1\text{-}6)$$

where f_{0i} = sectional area of bulb flat section proper, in cm^2;

u_{fr_i} = corrosion rate of framing members of the i-th group, in mm/year;

s_{0i} = web thickness of bulb flat;

φ_i = multiplier taking account of the effect of changing sectional area of the i-th member on the section modulus W, to be obtained from the formula

$$\varphi_i = c_i^2(F/I) + c_i/z_0 \qquad (3.12.4.6.1\text{-}7)$$

where I = hull inertia moment, in $\text{cm}^2.\text{m}^2$, of the dock, corresponding to the specified section modulus W;

z_0, c_i = distance of the point at the level of which section modulus is determined and centre of gravity of sectional area of the i-th member (i-th group of longitudinal members) from the neutral axis, the position of which corresponds to W and I; in determination of z_0 and c_i their sign is to be taken into account: positive downwards and negative upwards from the neutral axis.

3.12.4.6.2 Wing wall and pontoon longitudinals continuous in the middle region of the dock are to be included in the design cross-section of a caisson-type floating dock.

To be included in the design section of a pontoon dock are wing wall longitudinals continuous in the middle region of the dock.

3.12.4.6.3 The design bending moment M, in kN·m, is to be determined for the cases referred to in 3.12.3.3, using the formula

$$M = -0{,}125 g \Delta L_{p.d}\left(1 - \frac{3\varphi - 1}{2\varphi}\,\frac{L_s}{L_{p.d}}\right). \qquad (3.12.4.6.3)$$

Recommendations on the choice of design values of φ and L_s are given in 3.12.3.3.2.

3.12.4.6.4 The coefficient of permissible stresses due to longitudinal bending referred to in the Formula (3.12.4.6.1-2) is to be taken as $k_\sigma = 1{,}0$.

3.12.4.6.5 For caisson-type docks the following condition is to be fulfilled:

$$\sigma_1 + \sigma_2 \leqslant k_\sigma \sigma_n \qquad (3.12.4.6.5\text{-}1)$$

where σ_1 = stresses in primary longitudinal members of the pontoon due to longitudinal bending of the dock;
σ_2 = stresses in primary longitudinal members of the pontoon due to longitudinal bending of the pontoon.

Stresses σ_1, in MPa, are to be determined by the formula

$$\sigma_1 = 10^5 Mz/I' \qquad (3.12.4.6.5\text{-}2)$$

where M = as defined in 3.12.4.6.3;
z = distance of the point under consideration from the neutral axis of the dock, in m;
I' = inertia moment of the dock to the end of the service life, in cm^4.

Stresses σ_2, in MPa, are to be derived from the formula

$$\sigma_2 = 10^5 M_y z'/I'_y \qquad (3.12.4.6.5\text{-}3)$$

where M_y = as defined in 3.12.4.5.6;
z' = distance of the point under consideration from the neutral axis of the section of the primary longitudinal, in m;
I'_y = inertia moment of primary longitudinal, determined with regard to the wear of the members to the end of the service life of the dock and provisions of 3.13.4.5.4, in cm^4.

3.12.4.6.6 In design of the dock hull, the requirements for buckling strength under the action of longitudinal bending of plate structures, girders and longitudinals, such as wall sides and deck plating, shell plating, longitudinal bulkhead plating of the pontoon and pontoon deck plating of caisson-type docks, bottom shell of pontoon dock wings are to be met in the middle region within $0{,}4L_{p.d}$.

The scantlings of top deck beams where transverse framing is adopted, top deck transverses in case of longitudinal framing are to be adequate to provide buckling strength of deck structure portions between deck girders, deck girders and wall sides or between wall sides where deck girders are omitted.

3.12.4.6.7 The design compressive stresses σ_c, in MPa, obtained in estimation of the buckling strength are to be not less than:

$$\sigma_{ci} = \frac{M}{I'} z_i \cdot 10^5 \qquad (3.12.4.6.7\text{-}1)$$

where M = design bending moment causing the compression of the i-th member under consideration (see 3.12.4.6.3), in kN·m;
I' = actual central inertia moment of the hull girder with regard to wear to the end of the service life, in cm^4;
As a first approximation, I' value, in cm^4, may be determined by the formula

$$I' = W'_d(D_0 - e) \cdot 10^2 \qquad (3.12.4.6.7\text{-}2)$$

where W'_d = required section modulus of the hull girder at a level of the lower edge of the top deck plating determined according to the requirements of 3.12.4.6.1, in cm^3;
D_0 = depth of wing walls (for pontoon docks), in m;
D_0 = D for caisson-type docks;
e = distance of the neutral axis from the base line for caisson-type docks; distance of the neutral axis from the abutment line of the pontoon deck to the inner wall sides for pontoon docks, in m. As a first approximation, it may be assumed that $e = 0{,}32D$ for caisson-type docks; $e = 0{,}5D_0$ for pontoon docks.
z_i = distance of the member under consideration from the neutral axis, in m (z_i is measured from the edge most distant from the neutral axis for a plate structure; from the middle of the thickness of the effective flange for a beam member of the deck and bottom; from the middle of the thickness of the beam web for a beam of the wall side, side plating and longitudinal bulkhead of the pontoon).

3.12.4.6.8 The buckling strength conditions are to comply with 1.6.5.2 and 1.6.5.3. Factor k in Formulae of 1.6.5.2 is to be taken equal to 0,8 for the top deck plating and wall sides; for the bottom and side plating of the pontoon and pontoon deck plating of caisson-type docks, girders and longitudinals.

3.12.4.6.9 Euler stresses for plate structures are to be determined according to 1.6.5.5, and for girders and longitudinals as required by 1.6.5.4 taking $s' = s - \Delta s$ where Δs is obtained as given in 3.12.1.4.

3.12.4.6.10 The inertia moment of beams of the transversely framed top deck is to meet the requirements of 2.6.4.3.

The inertia moment of top deck transverses is to be as required by 2.6.4.9.

3.12.4.6.11 The assumed scantlings of wing wall structures are to provide buckling strength in simple bending of the wing wall in design cases of dock sagging. The procedure of supporting buckling strength in simple bending is to be agreed with the Register.

3.12.4.7 Deflection control system.

Deflection of the dock hull is to be controlled according to the procedure approved by the Register.

In docks over 80 m in length at least two meters of different types to monitor the deflection of the dock are to be provided.

The maximum deflection stated in the Working Instructions supplied to the Dockmaster is to be agreed with the Register. The deflections are not to exceed the values obtained from the formula

$$\sigma(T) = (0{,}6 + 0{,}003T)\sigma_n \qquad (3.12.4.7)$$

where T = service life of the dock to the date of monitoring, years;
σ_n = as defined in 1.1.4.3.

3.12.4.8 Requirements for dock towing.

3.12.4.8.1 The minimum section modulus $W_{\min}$, in cm^3, required to ensure the strength of the dock during towing is to be determined by the formula

$$W_{\min} = \frac{M}{\sigma_{perm}} \cdot 10^3 \qquad (3.12.4.8.1\text{-}1)$$

where M = design bending moment, in kN.m, obtained from the formula

$$M = 5{,}03 k_w h_p B L^2_{p.d} \ ; \qquad (3.12.4.8.1\text{-}2)$$

k_w = factor of wave bending moment determined by the formula

$$k_w = 7{,}93 \cdot 10^{-3} + 4{,}13 \cdot 10^{-3}(L_{p.d}/B) - 0{,}125(d_{tow}/L_{p.d}); \qquad (3.12.4.8.1\text{-}3)$$

d_{tow} = dock draught amidships during voyage in tow, in m;

h_d = design wave height, in m, determined depending on the length of the dock:

$$h_d = 10{,}9 - \left(\frac{300 - L_{p.d}}{100}\right)^2 \text{ for } L_{p.d} < 300 \text{ m},$$

$$h_d = 10{,}9 \text{ for } L_{p.d} \geqslant 300 \text{ m}; \qquad (3.12.4.8.1\text{-}4)$$

σ_{perm} = permissible normal stresses in longitudinal bending of the dock, in MPa, taken equal to:

150 for docks under 100 m in length;

$150 + 0{,}75(L_{p.d} - 100)$ for docks between 100 and 200 m in length;

225 for docks over 200 m in length.

3.12.4.8.2 The still water bending moment M, in kN. m, in the midship section of the dock during the voyage in tow is to be reduced to the minimum possible level by suitable ballasting.

3.12.4.8.3 Sea state considered permissible for voyage in tow is that corresponding to the height of wave of 3 per cent probability of exceeding level, in m, determined by the formula

$$h_{3\%} = h^0_{3\%} + m(\lambda_1^2/\lambda_2^2 - 1) \qquad (3.12.4.8.3\text{-}1)$$

where $h^0_{3\%}$ = rated wave height, in m, permissible for voyage of a floating dock, with a relationship $L_{p.d}/B = 4{,}25$, obtained from the formulae:

$$h^0_{3\%} = 0{,}313 + 0{,}0438 L_{p.d} \text{ for } L_{p.d} < 130 \text{ m};$$
$$h^0_{3\%} = 3{,}10 + 0{,}0223 L_{p.d} \text{ for } 130 \leqslant L_{p.d} \leqslant 260 \text{ m}; \qquad (3.12.4.8.3\text{-}2)$$
$$h^0_{3\%} = 0{,}422 + 0{,}0326\, L_{p.d} \text{ for } L_{p.d} > 260 \text{ m}.$$

m = factor determined from the formulae:

$$m = 0{,}483 + 0{,}0218 L_{p.d} \text{ for } L_{p.d} < 130 \text{ m};$$
$$m = 2{,}42 + 0{,}00685 L_{p.d} \text{ for } 130 \leqslant L_{p.d} \leqslant 260 \text{ m}; \qquad (3.12.4.8.3\text{-}3)$$
$$m = 0{,}356 + 0{,}0148\, L_{p.d} \text{ for } L_{p.d} > 260 \text{ m}.$$

Factors λ_1 and λ_2 are derived from the formulae:

$$\lambda_1 = M/M^0;$$
$$\lambda_2 = 1{,}276 - 0{,}065(L_{p.d}/B); \qquad (3.12.4.8.3\text{-}4)$$

M^0 = basic bending moment, in kN·m, determined by the formula

$$M^0 = 0{,}77 \cdot 10^{-2} L^{3{,}65}_{p.d} \ /\eta \ ; \qquad (3.12.4.8.3\text{-}5)$$

for η, see 1.1.4.3;

M = bending moment, in kN·m, corresponding to the actual section modulus of the floating dock hull, obtained from the formula

$$M = k_\sigma \sigma_n W \cdot 10^{-3} \qquad (3.12.4.8.3\text{-}6)$$

where W = actual minimum section modulus of the dock hull to the moment of voyage;

k_σ = 0,8 = factor of permissible normal stresses;

σ_n = as defined in 1.1.4.3.

3.12.4.8.4 Correspondence between permissible sea state during voyage and heights of waves of 3 per cent probability of exceeding level is to be determined according to Table 3.12.4.8.4.

Table 3.12.4.8.4

Permissible sea state	$h_{3\%}$, in m
5	2,0 – 3,5
6	3,5 – 6,0
7	6,0 – 8,5
8	8,5 – 11,0
9	11,0

3.12.4.8.5 A possibility of voyage of a dock in tow whose architecture and relationships of the dimensions differ from those referred to in 3.12.1.1 is to be supported using the procedure approved by the Register.

3.12.4.8.6 Voyage of a dock in tow within the limits of one and the same sea is permitted when the environmental conditions (sea state) corresponding to the requirements of 3.12.4.8.3 to 3.12.4.8.5 are expected.

APPENDIX 1

TIGHTNESS TEST OF SHIP'S HULL

1 GENERAL

1.1 Definitions.

Shop primer is a thin coating applied after surface preparation and prior to fabrication as a protection against corrosion during fabrication.

Protective coating is a final coating protecting the structure from corrosion.

Structural testing is a hydrostatic test carried out to demonstrate the tightness, as well as the structural adequacy of the design. Where practical limitations prevail and hydrostatic testing is not feasible (for example when it is difficult, in practice, to apply the required head at the top of the tank), hydropneumatic testing may be carried out instead. When hydropneumatic testing is performed, its conditions should simulate, as far as practicable, the actual loading of the tank.

Hydropneumatic testing is a combination of hydrostatic and air testing, consisting in filling the tank with water up to its top and applying an additional air pressure. The value of the additional air pressure is at the discretion of the Register, but is to be at least as defined in 2.2.

Leak testing is an air or other medium test carried out to demonstrate the tightness of the structure.

Hose testing is carried out to demonstrate the tightness of structural items not subjected to hydrostatic or leak testing and of other components which contribute to the watertight and weathertight integrity of the hull.

1.2 Application.

The following requirements determine the testing conditions for:

gravity tanks (including independent tanks) of 5 m^3 and more in capacity;

watertight or weathertight structures.

The purpose of these tests is to check the tightness and/or strength of structural elements at the time of the ship construction and on the occasion of major repairs.

The tests are to be carried out in the presence of the Surveyor at a stage sufficiently close to completion so that any subsequent work could not impair the strength and tightness of the structure.

For general testing requirements, see Section 3.

2 TESTING METHODS

2.1 Structural testing.

Structural testing may be carried out after the application of shop primer.

Structural testing may be carried out after the protective coating has been applied, provided that one of the two following conditions is satisfied:

all the welds are completed and carefully inspected visually to the satisfaction of the Surveyor prior to the application of the protective coating;

leak testing is carried out prior to the application of the protective coating.

In the absence of leak testing, protective coating shall be applied after the structural testing of:

all erection welds, both manual and automatic;

all manual fillet weld connections on tank boundaries and manual penetration welds.

2.2 Leak testing.

Where leak testing is carried out, in accordance with the table, air pressure of 15 kPa is to be applied during the test.

Prior to inspection, it is recommended that the air pressure in the tank is raised to 20 kPa and kept at this level for about 1 hour to reach a stabilized state, with a minimum number of personnel in the vicinity of the tank, and then lowered to the test pressure.

After the pressure has reached a stabilized state at 20 kPa, the test may be conducted without lowering the pressure, provided the safety of the personnel involved in the test is guaranteed.

Welds are to be coated with an efficient indicating liquid.

A U-tube filled with water up to a height corresponding to the test pressure is to be fitted to avoid overpressure in the compartment tested and verify the test pressure. The U-tube shall have a cross-section larger than that of the pipe supplying air. In addition, the test pressure is also to be verified by means of one master pressure gauge.

Alternative means may be accepted which are considered to be equally reliable. Thus, two pressure gauges and a safety valve may be fitted in the compartment being tested. The connections for the pressure gauges and the safety valve shall be positioned on manhole covers, blank flanges and at other locations convenient for maintenance. The pressure gauges are to have an accuracy rating of 1,5 to 2,5 and a range by one third greater than the test pressure. The scale factor of the pressure gauges shall not exceed 2 kPa.

Leak testing is to be carried out, prior to the application of a protective coating, on all fillet weld connections on tank boundaries, penetrations and erection welds on tank boundaries excepting welds made by automatic processes. Selected locations of automatic erection welds and pre-erection manual or automatic welds may be required to be similarly tested at the discretion of the Surveyor taking account of the quality control procedures operating in the shipyard. For other welds, leak testing may be carried out, after the protective coating has been applied, provided that these welds were carefully inspected visually.

Any other recognized method may be accepted on agreement with the Register.

2.3 Hose testing.

When hose testing is required to verify the tightness of the structures, as defined in the table, the minimum pressure in the hose, at least equal to 200 kPa, is to be applied at a maximum distance of 1,5 m. The nozzle diameter is not to be less than 12 mm.

2.4 Hydropneumatic testing.

When hydropneumatic testing is performed, the same safety precautions as for leak testing are to be adopted.

2.5 Other testing methods.

Other testing methods may be accepted, at the discretion of the Register, based upon equivalency considerations.

Table

3 GENERAL TESTING REQUIREMENTS

Item number	Structure to be tested	Type of testing	Test pressure	Remarks
1	Double bottom tanks	Structural testing[1]	The greater of the following: head of water up to the top of overflow head of water up to the margin line	Compartment boundaries tested from at least one side
2	Double side tanks	Structural testing[1]	The greater of the following: head of water up to the top of overflow 2,4 m head of water above highest point of tank	Compartment boundaries tested from at least one side
3	Tank bulkheads, deep tanks Fuel oil bunkers	Structural testing[1] Structural testing	The greater of the following: head of water up to the top of overflow 2,4 m head of water above highest point of tank setting pressure of the safety relief valves, where relevant[2]	Compartment boundaries tested from at least one side
4	Ballast holds in bulk carriers	Structural testing[1]	The greater of the following: head of water up to the top of overflow 0,9 m head of water above top of hatch	
5	Fore peak and after peak used as tank	Structural testing	The greater of the following: head of water up to the top of overflow 2,4 m head of water above highest point of tank	Test of the after peak carried out after the sterntube and rudder tube have been fitted
	Fore peak not used as tank After peak not used as tank	See Note 1 Leak testing		
6	Cofferdams	Structural testing[3]	The greater of the following: head of water up to the top of overflow 2,4 m head of water above highest point of tank	
7	Watertight bulkheads	See Note 1[4]		
8	Watertight doors below freeboard or bulkhead deck	See Note 2		
9	Double plate rudders, spaces between outer and inner plating of fixed and steering nozzles, hollow elements of foil structure	Leak testing		
10	Shaft tunnel clear of deep tanks	Hose testing		
11	Shell doors	Hose testing		
12	Watertight hatch covers in bulk carriers	Hose testing		
	Watertight hatch covers in combination carriers	Structural testing[1]	The greater of the following: 2,4 m head of water above the top of hatch cover setting pressure of the safety relief valves, where relevant	At least every 2nd hatch cover to be tested

Table — continued

Item number	Structure to be tested	Type of testing	Test pressure	Remarks
13	Weathertight hatch covers and closing appliances	Hose testing		
14	Chain locker (if aft of collision bulkhead)	Structural testing	Head of water up to the top	
15	Independent tanks	Structural testing	Head of water up to the top of overflow, but not less than 0,9 m	
16	Ballast ducts	Structural testing	Ballast pump maximum pressure	
17	Independent tanks in edible liquid carriers	Structural testing	Head of water up to the top of overflow, without being less than 0,9 m	Cargo space boundaries tested from at least one side
18	Integral or independent tanks in chemical carriers	Structural testing	The greater of the following: 2,4 m head of water above highest point of tank setting pressure of the safety relief valves, where relevant	

[1] Leak or hydropneumatic testing may be accepted under the conditions specified in 2.2, provided that at least one compartment or tank of each type is structurally tested, to be selected in connection with the design approval. Structural testing of compartments or tanks need not be repeated for subsequent vessels of a series of identical newbuildings. This relaxation does not apply to cargo space boundaries in tankers and combination carriers and tanks for segregated cargoes or pollutants. If structural test reveals weakness or severe faults not detected by the leak test, all compartments or tanks are to be structurally tested.

[2] Where applicable, the highest point of the tank is to be measured to the deck and excluding hatches. In holds for liquid cargo or ballast with large hatch covers, the highest point of the tank is to be taken at the top of the hatch.

[3] Leak or hydropneumatic testing may be accepted under the conditions specified in 2.2 at the discretion of the Register.

[4] Where hose test cannot be performed without damaging the equipment (machinery, cables, switchboards, insulation, etc.) already installed, it may be replaced, at the Register discretion, by a thorough visual inspection of all the crossings and welded joints; where necessary, dye penetrant test or ultrasonic leak test may be required.

Note 1

Regulation 14, Chapter II-1 of SOLAS 74 Convention

Construction and initial testing of watertight bulkheads, etc. in passenger ships and cargo ships

1 Each watertight subdivision bulkhead, whether transverse or longitudinal, shall be constructed in such a manner that it shall be capable of supporting, with a proper margin of resistance, the pressure due to the maximum head of water which it might have to sustain in the event of damage to the ship but at least the pressure due to a head of water up to the margin line. The construction of these bulkheads shall be to the satisfaction of the Administration.

2.1 Steps and recesses in bulkheads shall be watertight and as strong as the bulkhead at the place where each occurs.

2.2 Where frames or beams pass through a watertight deck or bulkhead, such deck or bulkhead shall be made structurally watertight without the use of wood or cement.

3 Testing main compartments by filling them with water is not compulsory. When testing by filling with water is not carried out, a hose test shall be carried out, where practicable. This test shall be carried out in the most advanced stage of the fitting out of the ship. Where hose test is not practicable because of possible damage to machinery, electrical equipment insulation or outfitting items, it may be replaced by a thorough visual inspection of welded connections, supported where deemed necessary by such means as a dye penetrant test or an ultrasonic leak test or an equivalent test. In any case, a thorough inspection of the watertight bulkheads shall be carried out.

4 The forepeak, double bottoms (including duct keels) and inner skins shall be tested with water to a head corresponding to the requirements of paragraph 1.

5 Tanks which are intended to hold liquids, and which form part of the subdivision of the ship, shall be tested for tightness with water to a head up to the deepest subdivision load line or to a head corresponding to two-thirds of the depth from the top of keel to the margin line in way of the tanks, whichever is the greater; provided that in no case shall the test head be less than 0.9 m above the top of the tank.

6 The tests referred to in paragraphs 4 and 5 are for the purpose of ensuring that the subdivision structural arrangements are watertight and are not to be regarded as a test of the fitness of any compartment for the storage of oil fuel or for other special purposes for which a test of a superior character may be required depending on the height to which the liquid has access in the tank or its connections.

Note 2

Regulation 18, Chapter II-1 of SOLAS 74 Convention

Construction and initial tests of watertight doors, sidescuttles, etc. in passenger ships and cargo ships

1 In passenger ships:

.1 the design, materials and construction of all watertight doors, sidescuttles, gangway, cargo and coaling ports, valves, pipes, ash-shoots and rubbish-shoots referred to in these regulations shall be to the satisfaction of the Administration;

.2 the frames of vertical watertight doors shall have no groove at the bottom in which dirt might lodge and prevent the door closing properly.

2 In passenger ships and cargo ships each watertight door shall be tested by water pressure to a head up to the bulkhead deck or freeboard deck respectively. The test shall be made before the ship is put into service, either before or after the door is fitted.

APPENDIX 2

MEMBER SCANTLING ASSESSMENT OF TRANSVERSE WATERTIGHT CORRUGATED BULKHEAD IN BULK CARRIERS WITH CARGO HOLD FLOODED

1 APPLICATION AND DEFINITIONS

Scantlings of transverse watertight vertically corrugated bulkheads in each cargo hold flooded are to be evaluated for all ships[1] having a length of 150 m and more, intended for the carriage of bulk cargoes with density of 1,0 t/m^3 and more, which are contracted for construction on or after 1 July 1998, excluding those for which the inspection required by 3.3.5.2, Part II "Hull" may be omitted.

Net thickness (t_{net}) is the thickness obtained as a result of applying the strength criteria given in Section 4 of this Appendix.

Required thickness is the sum of net thickness (t_{net}) and the corrosion allowance (t_s) given in Section 6 of this Appendix.

Uniform loading is the loading for which the maximum-to-minimum filling ratio for each cargo hold does not exceed 1,20 with regard for a correction depending on cargo density.

2 LOADING MODEL

2.1 General provisions.

Loads considered to act upon the bulkhead are loads due to a combination of cargo loads and those resulting from flooding a hold adjacent to the bulkhead in question. In any case, the pressure of water flooding a hold without cargo is to be considered.

To assess the member scantlings of each bulkhead, the most unfavourable combinations of loading and hold flooding are to be used proceeding from the following loading conditions described in the loading manual:

uniform loading;

non-uniform loading;

loading with regard for individual loaded or empty holds being flooded.

The limits set for design loads in cargo holds are to be taken into consideration by the designer when determining typical loading conditions to be included in the Loading Manual.

Partially non-uniform loading which may occur during cargo-handling operations in port may not be considered where the final typical loading of the ship is uniform.

Holds in which pallet cargo is loaded are to be considered empty.

Except where the ship being non-uniformly loaded is intended only for the carriage of iron ore or a cargo with a density of 1,78 t/m^3 or above, it is to be considered that the maximum cargo mass which may be present in a hold will fill it to the upper deck level on the centreline plane.

2.2 Water head applied to a corrugated bulkhead as a result of hold flooding.

Water head, h_f (see Fig. 2.2 of this Appendix) is the distance, in m, measured vertically, with the ship in the upright position, from a reference point to a level removed to the distance d_f, in m, from the base line and equal to:

.1 in general case:

D for the forward transverse corrugated bulkhead;

0,9D for other bulkheads.

If a ship is non-uniformly loaded with a bulk cargo with the density below 1,78 t/m^3 , the following values may be adopted for the calculation:

0,95D for the forward transverse corrugated bulkhead;

0,85D for other bulkheads;

.2 for ships with a freeboard of B type and a deadweight below 50000 t:

0,95D for the forward transverse corrugated bulkhead;

0,85D for other bulkheads.

If a ship is non-uniformly loaded with a bulk cargo with the density below 1,78 t/m^3 , the following values may be adopted for the calculation:

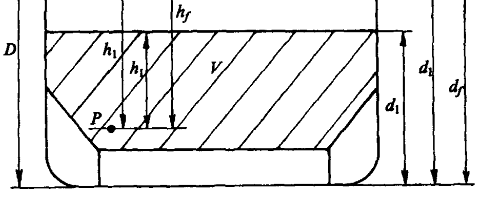


Fig. 2.2:
V = volume of cargo; P = reference point;
D = distance, in m, from the base line to the freeboard deck measured along the side

0,9D for the forward transverse corrugated bulkhead;

0,8D for other bulkheads.

---

[1] The main structural type of bulk carrier is defined in 3.3.1.4, Part II "Hull".

2.3 Pressure in unflooded holds filled with bulk cargo.

For any point on the bulkhead, the pressure p_c, in kN/m^2 , is to be determined by the formula

$$p_c = \rho_c g h_1 \tan^2\gamma$$

where ρ_c = bulk cargo density, in t/m^3;
g = gravity acceleration equal to 9,81 m/s^2;
h_1= vertical distance, in m, from a reference point to a horizontal plane corresponding to the cargo surface level (see Fig. 2.2 of this Appendix) and distanced by d_1, in m, from the base line;
$\gamma = 45° - (\varphi/2)$;
φ = repose angle generally adopted equal to 35° for iron ore and to 25° for cement.

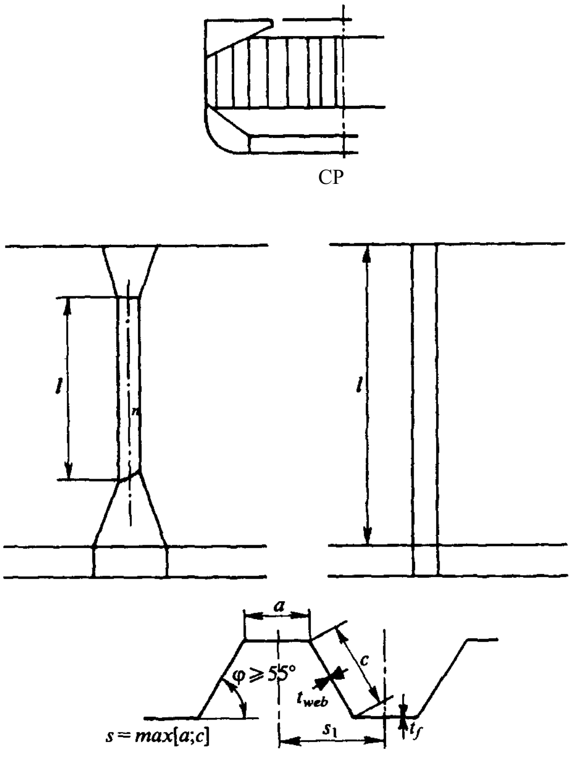


Fig. 2.3:
n=neutral axis of corrugation;
t_f=corrugation face plate thickness;
t_{web}=corrugation web thickness

The force F_c, in kN, acting upon a corrugation is to be determined by the formula

$$F_c = \rho_c g s_1 \frac{(d_1 - h_{DB} - h_{LS})^2}{2} \tan^2\gamma$$

where s_1 = corrugation spacing, in m, (see Fig. 2.3 of this Appendix);
h_{LS} = average height, in m, of the lower bulkhead support above the inner bottom;
h_{DB} = double bottom height, in m.

2.4 Pressure in flooded holds.

2.4.1 Bulk cargo holds.

Two cases of hold loading are to be considered proceeding from the values of d_1 and d_f:

.1 $d_f \geqslant d_1$.

For any point on the bulkhead lying between d_1 and d_f above the base line, the pressure $p_{c,f}$, in kN/m^2, is to be determined by the formula

$$p_{c,f} = \rho g h_f$$

where ρ = seawater density, in t/m^3;
g = gravity acceleration (see 2.3 of this Appendix);
h_f = water head (see 2.2 of this Appendix).

For any point on the bulkhead lying lower than d_1 above the base line, the pressure $p_{c,f}$, in kN/m^2 , is to be determined by the formula

$$p_{c,f} = \rho g h_f + [\rho_c - \rho(1 - perm)] g h_1 \tan^2\gamma$$

where for ρ_c, g, h_1, γ see 2.3 of this Appendix;
$perm$ = cargo permeability (see 3.3.5.2, Part II "Hull").

The force $F_{c,f}$, in kN, applied to a corrugation is to be detemined by the formula

$$F_{c,f} = s_1[\rho g \frac{(d_f - d_1)^2}{2} + \frac{\rho g(d_f - d_1) + (p_{c,f})_{le}}{2} \times (d_1 - h_{DB} - h_{LS})]$$

where for s_1, g, d_1, h_{DB}, h_{LS}, see 2.3 of this Appendix;
for d_f, see 2.2 of this Appendix;
$(p_{c,f})_{le}$= pressure on the level of the lower support section of the bulkhead , in kN/m^2;

.2 $d_f < d_1$.

For any point on the bulkhead lying between d_1 and d_f above the base line, the pressure $p_{c,f}$, in kN/m^2 , is to be determined by the formula

$$p_{c,f} = \rho_c g h_1 \tan^2\gamma$$

where for ρ_c, g, h_1, γ, see 2.3 of this Appendix.

For any point on the bulkhead lying below d_f above the base line, the pressure $p_{c,f}$, in kN/m^2 , is to be determined by the formula

$$p_{c,f} = \rho g h_f + [\rho_c h_1 - \rho(1 - perm) h_f] g \tan^2\gamma$$

where for ρ, h_f, $perm$, see 2.4.1.1 of this Appendix;
for ρ_c, g, h_1, γ, see 2.3 of this Appendix.

The force $F_{c,f}$, in kN, applied to a corrugation is to be determined by the formula

$$F_{c,f} = s_1[\rho g \frac{(d_1 - d_f)^2}{2} \tan^2\gamma + \frac{\rho_c g(d_1 - d_f)\tan^2\gamma + (p_{c,f})_{le}}{2} \times (d_f - h_{DB} - h_{LS})]$$

where for s_1, ρ_c, g, d_1, γ, h_{DB}, h_{LS}, see 2.3 of this Appendix;
for d_f, see 2.2 of this Appendix;
$(p_{c,f})_{le}$ = pressure on the level of the lower support section of the bulkhead, in kN/m^2.

2.4.2 Water pressure when a hold containing no cargo is flooded.

For any point on the bulkhead, the hydrostatic pressure p_f due to the water head h_f is to be considered which results from hold flooding.

The force F, in kN, applied to a corrugation is to be determined by the formula

$$F_f = \rho g s_1 \frac{(d_f - h_{DB} - h_{LS})^2}{2}$$

where for s_1, g, d_1, h_{DB}, h_{LS}, see 2.3 of this Appendix;
for ρ, see 2.4.1.1 of this Appendix;
for d_f, see 2.2 of this Appendix.

2.5 Resultant pressure and resultant force.

2.5.1 Uniform ship loading.

For calculating member scantlings at any point on the bulkhead, the resultant pressure p, in kN/m^2 , is to be determined by the formula

$$p = p_{c,\,f} - 0{,}8 p_c.$$

The resultant force F, in kN, applied to a corrugation is to be determined by the formula

$$F = F_{c,\,f} - 0{,}8 F_c.$$

2.5.2 Non-uniform ship loading.

For calculating member scantlings at any point on the bulkhead, the resultant pressure p, in kN/m^2, is to be determined by the formula

$$p = p_{c,\,f}.$$

The resultant force F, in kN, applied to a corrugation is to be determined by the formula

$$F = F_{c,\,f}.$$

3 BENDING MOMENT AND SHEARING FORCE IN BULKHEAD CORRUGATIONS

In bulkhead corrugations the bending moment M and the shearing force Q are to be determined by the formulae given in 3.1 and 3.2 of this Appendix. The values of M an Q are to be used for checks to be undertaken in accordance with 4.5 of this Appendix.

3.1 Bending moment.

For bulkhead corrugations, the design bending moment M, in kN·m, is to be determined by the formula

$$M = Fl/8$$

where F = resultant force, in kN (see 2.5 of this Appendix);
l = corrugation span, in m (see Fig. 2.3 and 3.1 of this Appendix).

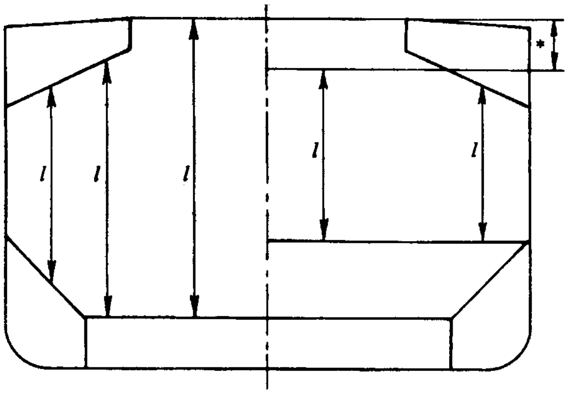


Fig. 3.1:
l = corrugation span;
* = distance, in the centreline plane, between the lowest point of the upper support for the bulkhead and the deck, which, when l is determined, is to be adopted not greater than:
three times the height of corrugation section in the general case;
two times the height of corrugation section where the upper support of the bulkhead has a rectangular cross section

3.2 Shearing force.

In the lower supporting sections of bulkhead corrugations, the shearing force Q, in kN, is to be determined by the formula

$$Q = 0{,}8F$$

where for F, see 2.5 of this Appendix.

4 STRENGTH CRITERIA

4.1 General.

4.1.1 The strength criteria given below apply to vertically corrugated transverse bulkheads (see Fig. 2.3 of this Appendix).

In ships 190 m or above in length, the bulkheads in question are to be attached to the lower support (transverse girder) and, as a rule, to the upper support (transverse girder) below the deck.

In ships less long, the corrugations may be attached to the inner bottom and deck.

The corrugation angle shown in Fig. 2.3 of this Appendix is not to be less than 55°.

The requirements for the local net thickness of plates are given in 4.7 of this Appendix. Besides, the requirements given in 4.2 and 4.5 of this Appendix are to be complied with.

The thickness of the lower part of corrugations determined in accordance with 4.2 and 4.3 of this Appendix, is to remain without variation within 0,15l of the inner bottom at least, if a lower support is not fitted for the bulkhead, or from the upper point of the lower support.

The thickness of the middle part of corrugations determined in accordance with 4.2 and 4.4 of this Appendix, is to remain without variation within not more than 0,3l of the deck, if an upper support (transverse girder) is not fitted for the bulkhead, or from the lower point of the upper support (transverse girder) for the bulkhead.

The section modulus of corrugations in the remaining upper part of the bulkhead is not to be less than 75% of the value required for the middle part of the bulkhead and is to be corrected proceeding from the tensile strength of the material.

4.1.2 Lower support of bulkhead.

The height of the support is generally to be at least equal to three times the height of the corrugation section. The thickness and material of the upper horizontal/inclined supporting plate (flange plate) are not to be lower than those stipulated under 4.1.1 for the bulkhead plating. In the upper part of vertical or inclined supporting wall, on the height equal to the breadth of corrugation face plate (corrugation face parallel to the bulkhead plane) from the upper supporting plate, the plate thickness and material are not to be lower than required for the face plate in the lower cross section of corrugation to ensure compliance with the requirement for the bulkhead strength. The plate thickness of the supporting wall and the section modulus of stiffeners adjacent to the wall are not to be less than required in 3.3, Part II "Hull" with due regard for the loading model to be determined on the basis of Section 2 of this Appendix. The ends of vertical stiffeners adjacent to the supporting wall are to be connected to brackets at the upper and lower section of the support.

The distance between the edge of the upper horizontal/inclined supporting plate (flange plate) and the surface of corrugation face plate shall be in accordance with Fig. 4.1. The lower sections of supporting walls are to be fitted on the plane of double bottom floors and spaced at least 2,5 times the average height of corrugation section. The diaphragms of the support are to be fitted on the plane of longitudinal web girders of double bottom to ensure and efficient attachment of the corrugated bulkhead. No openings are permitted in brackets and diaphragms in way of attachment to the horizontal supporting plate.

If corrugations terminate in way of the support, the former and the supporting walls are generally to be attached to the upper horizontal/inclined supporting plate (flange plate) with a complete penetration weld. The supporting wells and floors are generally to be connected to the inner bottom plating with a complete penetration weld.

4.1.3 Upper support of bulkhead.

The upper support, if fitted, is to have a height generally equal to two or three times the height of corrugation section. Support with a rectangular cross section are to have a height equal to two times the height of corrugation section, as measured on deck level and at cargo hatch carling. The support is to be structurally fixed between hatch-end beams by means of carlings or reinforced brackets.

The breadth of the lower horizontal supporting plate (flange plate) is generally to be equal to that of the upper horizontal plate of the lower support (flange). The upper supporting section of a non-rectangular shape is to have a breadth of at least two times the height of corrugation section. The thickness and material of the lower horizontal supporting plate (flange plate) are to be the same as those of the adjacent bulkhead plating. If the same material is used for the wall and bulkhead, the thickness of the lower part of the support wall should be at least 80% of that required for the upper part of bulkhead plating. The supporting wall thickness and the section modulus of stiffeners adjacent to the supporting wall should not be less than required by the Register, with due regard for the loading model mentioned in Section 2 of

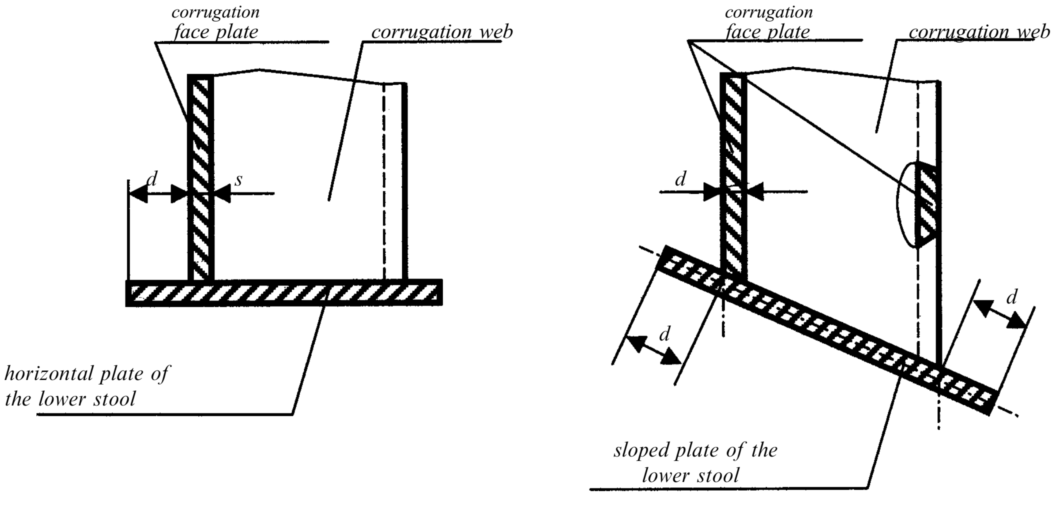


Fig. 4.1: s = as-built flange thickness; $d \geqslant s$

this Appendix. The stiffener ends adjacent to the supporting wall are to be connected to brackets in way of the upper and lower section of the support. To support effectively the corrugated bulkhead, the diaphragms are to be fitted inside the support on the plane of underdeck web longitudinals reaching up to the hatch-end beams. No openings are permitted in brackets and diaphragms in way of attachments to the lower horizontal supporting plate (flange plate).

4.1.4 Alignment.

On deck where no support is fitted, two transverse reinforced beams are to be fitted on the plane of the corrugation face plates of the bulkhead.

On the double bottom where no support is fitted, the face plates of corrugations are to be fitted on the plane of floors.

Corrugations and floors are generally to be attached to the inner bottom plating with a complete penetration weld. The thickness and properties of the floor material under the corrugations are not to be lower than those of the material used for corrugation face plates.

Besides, the openings for the passage of main framing girders of inner bottom through floors under the corrugations are to be sealed. Under the corrugations the floors are to be interconnected with special brackets complying with the requirements of 3.3, Part II "Hull". To ensure an adequate load distribution between stiffeners, the lower supporting wall is to be flattened in alignment with the corrugation face plate and vertical stiffeners adjacent to the supporting wall, and their stiffening brackets in the lower support are to be fitted on the plane of main framing girders of inner bottom. The supporting wall is not to have a bend between the inner bottom plating and the upper supporting plate.

4.2 Bearing capacity of bulkhead in bending and the tangential stresses τ.

The bearing capacity of a bulkhead in bending is to be in accordance with the following relationship

$$\frac{M \cdot 10^3}{0{,}5Z_{le}\sigma_{a,le} + Z_m\sigma_{a,m}} \leqslant 0{,}95$$

where M = bending moment, in kN·m (see 3.1 of this Appendix);

Z_{le} = section modulus, in cm^3, of a corrugation half-breadth in the lower supporting section of corrugations determined in accordance with 4.3 of this Appendix;

Z_m = section modulus, in cm^3, of the cross-sectional area of a corrugation mid-span, to be determined in accordance with 4.4 of this Appendix;

$\sigma_{a,le}$ = permissible stresses, in N/mm^2, for the lower supporting sections of corrugations in accordance with 4.5 of this Appendix;

$\sigma_{a,m}$ = permissible stresses, in N/mm^2, for the cross-sectional area of a corrugation mid-span in accordance with 4.5 of this Appendix.

Always when the bearing capacity of a bulkhead in bending is determined, the value of Z_m is not to be adopted greater than $1{,}15Z_{le}$ or $1{,}15Z'_{le}$, whichever is the less (Z'_{le} is defined below).

Where shedder plates are fitted in such a way that:

.1 they have no bend;

.2 they are attached to corrugations and to the upper horizontal/inclined plate (flange) of the lower support with a full penetration weld made on one side or by another similar procedure;

.3 they have a minimal inclination of 45° and their lower end is a continuation of the lower supporting wall for the bulkhead;

.4 they have a thickness not less than 75 per cent of the corrugation face plate thickness;

.5 the properties of their material correspond at least to those of the material used for corrugation face plates;

or where gasset plates are fitted in such a way that:

.1 if combined with shedder plates, their thickness, properties of their material and their welds are in compliance with the above requirements;

.2 their height is equal to half the breadth of a corrugation face plate at least;

.3 they are fitted on the plane of the supporting wall for the bulkhead;

.4 they are generally attached to the upper horizontal/inclined plate (flange) of the lower support for the bulkhead with a complete penetration weld, and with an incomplete penetration weld on one side or similar weld to corrugations and shedder plates;

.5 thicknesses and properties of their material are at least similar to those of the corrugation face plate material,

the section modulus Z_{le}, in cm^3, is not to be less than Z'_{le}, in cm^3, to be determined by the formula

$$Z'_{le} = Z_g + 10^3\,\frac{Qh_g - 0{,}5h_g^2 s_1 p}{\sigma_a}$$

where Z_g = section modulus, in cm^3, of a corrugation half-breadth in accordance with 4.4 of this Appendix, on the level of the upper ends of shedder or gasset plates, if fitted;

Q = shearing force, in kN (see 3.2 of this Appendix);

h_g = height, in m, of shedder or gasset plates (see Figs 4.2-1, 4.2-2, 4.2-3 and 4.2-4 of this Appendix);

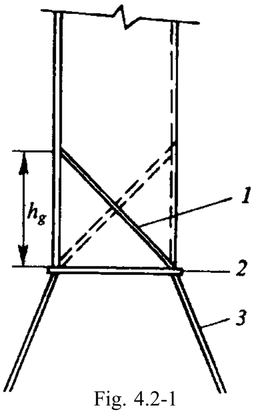


Fig. 4.2-1

Symmetrical shedder plates:

1 — shedder plate;

2 — horizontal/inclined supporting plate (flange plate) of the lower support for the bulkhead;

3 — vertical/inclined supporting wall of the lower support for the bulkhead

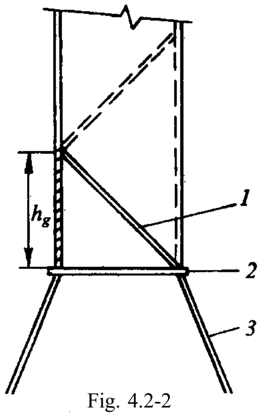


Fig. 4.2-2

Unsymmetrical shedder plates:

1 — shedder plate;

2 — horizontal/inclined supporting plate (flange plate) of the lower support for the bulkhead;

3 — vertical/inclined supporting wall of the lower support for the bulkhead

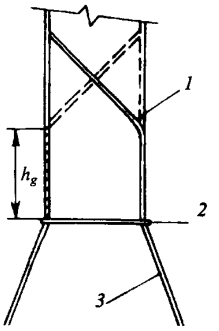


Fig. 4.2.-3
Symmetrial gasset/shedder plates:
1 — gasset/shedder plate;
2 — horizontal/inclined supporting plate (flange plate) of the lower support for the bulkhead;
3 — vertical/inclined wall of the lower support for the bulkhead

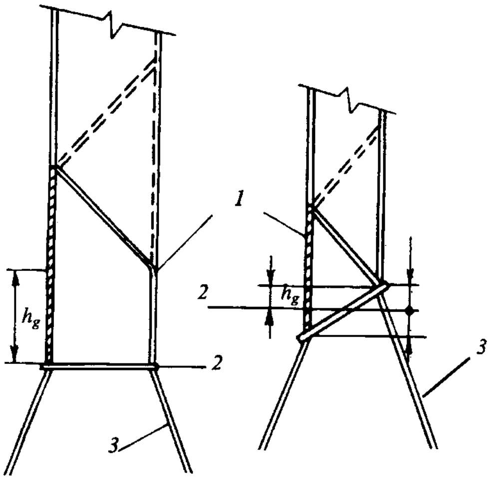


Fig. 4.2-4
Unsymmetrial gasset/shedder plates:
1 — gasset/shedder plate;
2 — horizontal/inclined supporting plate (flange plate) of the lower support for the bulkhead;
3 — vertical/inclined wall of the lower support for the bulkhead

for s_1 see 2.3 of this Appendix;
p = resultant pressure, N·m^2 , in accordance with 2.5 of this Appendix, determined on the level of mid-length of shedder or gasset plates, if fitted;
σ = permissible stresses, in N·mm^2 , in accordance with 4.5 of this Appendix.

Tangential stresses τ are to be determined by dividing the shearing force Q by the shear are. The shear area is to be reduced where the face plate and wall of corrugation (adjacent sides of corrugation) are not perpendicular. A reduced shear area may generally be obtained by multiplying the cross-sectional area of corrugation wall (corrugation side lying at an angle to the bulkhead plane) by sin φ where φ is the angle between the wall and face plate of corrugation. When determining section moduli and shear areas, net plate thicknesses is to be used.

The section moduli of corrugations are to be determined in accordance with 4.3 and 4.4 of this Appendix.

4.3 Section modulus of the cross-sectional area of corrugations in the lower supporting section.

4.3.1 The section modulus is to be calculated for a compressed corrugation face plate having the effective breadth b_{ef} not grater than mentioned in 4.6 of this Appendix. Where a corrugation wall is not stiffened with brackets fitted under the upper horizontal/inclined plate (flange) of the lower support for the bulkhead (or below the inner bottom), the section modulus of the lower part of corrugations is to be determined proceeding from 30% efficiency of corrugation walls.

4.3.2 If efficient shedder plates are fitted in accordance with 4.2 of this Appendix (see Figs 4.2-1 and 4.2-2), the corrugation face plate area, in cm^2, when determining its section modulus in the lower supporting section, may be increased by

$$(2{,}5a\sqrt{t_f t_{sh}}),\ \text{but not more than by}\ 2{,}5at_f$$

where a = corrugation face plate width, in m (see Fig. 2.3 of this Appendix);
t_{sh} = net thickness, in mm, of shedder plate;
t_f = net thickness, in mm, of corrugation face plate.

4.3.3 If efficient gusset plates are fitted in accordance with 4.2 of this Appendix (see Figs 4.2-3 and 4.2-4), the corrugation face plate area, in cm^2, may be increased, when determining its section modulus in the lower supporting section, by multiplying it by

$$(7h_g t_{gu})$$

where h_g= gusset plate height, in m (see Figs 4.2-3 and 4.2-4), with $h_g \leqslant (10/7)s_{gu}$;
s_{gu} = gusset plate breadth, in m;
t_f = net thickness, in mm, of a corrugation face plate, as determined proceeding from the building thickness.

4.3.4 Where corrugation walls are welded to an inclined upper plate (flange) of the lower support for the bulkhead, which lies at an angle of not less than 45° to the horizontal, the section modulus of the corrugation cross section may be determined proceeding from full efficiency of corrugation walls. If efficient gusset plates are fitted, the corrugation face plate area can be increased in accordance with 4.3.3 when determining the corrugation section modulus. This does not apply to shedder plates.

For angles less than 45°, the efficiency of corrugation walls may be determined by linear interpolation between 30% for the angle of 0° and 100% for the angle of 45°.

4.4 Corrugation section moduli in areas outside the lower supporting section.

The section modulus is to be determined taking into consideration the corrugation walls completely involved in bending and corrugation face plates having the effective breadth b_{ef} not greater than that given in 4.6.1 of this Appendix.

4.5 Verification of permissible stresses.

Normal and tangential stresses σ and τ are not to exceed the permissible values σ_a and τ_a, in N/mm^2, determined by the formulae:

$$\sigma_a = R_{eH};$$
$$\tau_a = 0{,}5R_{eH}$$

where R_{eH} = minimal upper yield stress, in N/mm^2, for the material.

4.6 Effective breadth of compressed corrugation face plate and corrugation testing for shear resistance.

4.6.1 Effective breadth of compressed corrugation face plate.

The effective breadth b_{ef}, in m, of a compressed corrugation face plate is to be determined by the formula:

$$b_{ef} = C_e a$$

where $C_e = 2{,}25/\beta - 1{,}25/\beta^2$ for $\beta > 1{,}25$;
$C_e = 1{,}0$ for $\beta \leqslant 1{,}25$;
$\beta = 10^3 \frac{a}{t_f} \sqrt{R_{eH}/E}$;

t_f = net thickness, in mm, of corrugation face plate;
a = corrugation face plate breadth, in m (see Fig. 2.3 of this Appendix);
for R_{eH}, see 4.5 of this Appendix;
E = elastic modulus of material, equal to $2{,}06 \cdot 10^5$ N/mm^2 for steel.

4.6.2 Shear.

Corrugation resistance is to be tested for walls in way of supporting sections.

Tangential stresses τ are not to exceed critical stresses τ_C, in N/mm^2, to be determined by the formulae:

$$\tau_C = \tau_E \text{ when } \tau_E \leqslant \tau_F/2;$$
$$\tau_C = \tau_F\left(1 - \frac{\tau_F}{4\tau_E}\right) \text{ when } \tau_E > \tau_F/2$$

where $\tau_F = R_{eH}/\sqrt{3}$;
for R_{eH} see 4.5 of this Appendix;
$\tau_E = 0{,}9k_tE\left(\frac{t}{100c}\right)^2$, in N/mm^2;
k_t = 6,34;
E = elastic modulus of material in accordance with 4.6.1 of this Appendix;
t = net thickness of corrugation wall, in mm;
c = corrugation wall breadth, in mm (see Fig. 2.3 of this Appendix).

4.7 Local net thickness of plates.

The local net thickness of bulkhead plates t, in mm, is to be determined by the formula

$$t = 14{,}9s_w\sqrt{1{,}05p/R_{eH}}$$

where s_w = plate breadth, in m, to be adopted equal to the face plate or corrugation wall breadth, whichever is greater (see Fig. 2.3 of this Appendix);
p = resultant pressure, in kN/m^2 , in accordance with 2.5 of this Appendix, in the lower part of each bulkhead plating strake; the net thickness of the lowest strake in any case is to be determined under the resultant pressure at the highest point of the lower support for the bulkhead or in way of inner bottom where the lower support is not fitted, or at the highest point of shedder places where the shedder or the gusset/shedder plates are fitted;
for R_{eH}, see 4.5 of this Appendix.

In composite corrugated bulkheads, where the thickness of face plate and that of corrugation wall are different, the net thickness of the narrower side is not to be less than t_n, in mm, determined by the formula

$$t_n = 14{,}9s_w\sqrt{1{,}05p/R_{eH}}$$

where s_n = breadth of the narrower corrugation side, in m.

The net thicknessof the wider corrugation side , in mm, is not to be less than the greater of the following values:

$$t_w = 14{,}9s_w\sqrt{1{,}05p/R_{eH}}\ ;$$

$$t_w = \sqrt{(440s_w^2 1{,}05p)/R_{eH}} - t_{np}^2$$

where t_{np} is to be adopted not greater than the actual net thickness of the narrower corrugation side or $14{,}9s_w\sqrt{1{,}05p/R_{eH}}$, whichever is the less.

5 LOCAL STRENGTHENING

Local strengthening is to be designed in accordance with the Register requirements, so that forces and moments originating in the bulkheads could be transferred to adjacent structures, among others, to double bottom and crossdeck structures.

In particular, the thickness and the types of shedder and gusset plates, determined according to 4.3 of this Appendix, are to comply with the Register requirements, taking due regard of the loading model described in Section 2 of this Appendix. Unless expressly provided otherwise, the type and dimensions of welds are to be chosen according to 1.7, Part II "Hull".

6 CORROSION ALLOWANCE AND MATERIAL REPLACEMENT

Corrosion allowance t_s is to be equal to 3,5 mm.

If the measured thickness is below t_{net}+0,5 mm, the bulkhead section is to be replaced. Where the measured thickness is between t_{net}+0,5 mm and t_{net}+1 mm, a protective coating may be applied (the coating being applied in conformity with the manufacturer's recommendations), or the residual thicknesses of the bulkhead section may be measured annually as alternative of bulkhead section replacement.

APPENDIX 3

ASSESSMENT OF PERMISSIBLE LOADING OF A CARGO HOLD IN VIEW OF THE POSSIBILITY OF ITS BEING FLOODED IN BULK CARRIERS

1 APPLICATION AND DEFINITIONS

Permissible loading of each cargo hold being flooded is to be evaluated for all ships[1] having a length 150 m and more, designed for the carriage of bulk cargoes having a density 1,0 t/m^3 and more, which are contracted for construction on or after 1 July 1998, excluding those for which the inspection required by 3.3.5.2, Part II "Hull" may be omitted.

The loading of each hold determined in Section 4 of this Appendix is not to exceed the permissible hold loading in flooded condition when loads given in Section 2 and the bearing capacity of double bottom by shear given in Section 3 of this Appendix are used.

In no case the permissible hold loading in flooded condition is to exceed the design loading of an intact hold.

2 LOADING MODEL

2.1 General.

The following loads are considered to be applied to the double bottom: external pressure from the sea side and the combination of loads from cargo and water when the hold in which the double bottom is fitted is flooded.

During calculations the most unfavourable combinations of loading and hold flooding depending on the following loading conditions contained in the Loading Manual are to be used:

uniform loading;

non-uniform loading;

pallet cargo loading (rolled iron, for instance).

The permissible loading for a hold is to be determined for each type of loading condition in case of maximum density of bulk cargo carried.

2.2 Water head acting upon the inner bottom.

Water head h_f (see Fig. 2.2 of this Appendix) is the distance, in m, measured vertically, with the ship in the upright position, from the inner bottom to a level removed to the distance d_f, in m, from the base line and equal to:

.1 in the general case:

D for the first hold;

0,9 D for other holds;

.2 for ships with type B freeboard which deadweight is below 50000 t:

0,95 D for the first hold;

0,85 D for other holds.

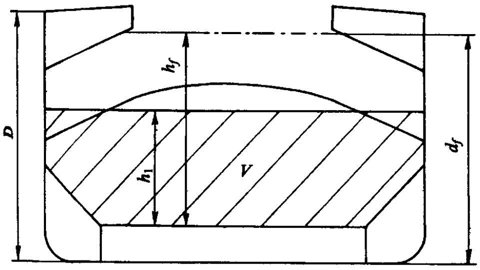


Fig. 2.2:
V = cargo volume;
D = distance, in m, from the base line to the freeboard deck measured along the side

3 BEARING CAPACITY OF DOUBLE BOTTOM BY SHEAR

3.1 The bearing capacity, C, of double bottom by shear is to be determined on its contour as the sum of shearing forces in web girder cross sections:

.1 all floors attached to both bilge tanks;

less than half of the shearing forces in two floors adjacent to each lower support for a transverse bulkhead or to a transverse bulkhead where no support is fitted (see Fig.3.1 of this Appendix);

.2 all double-bottom stringers attached to both lower supports for transverse bulkheads or to transverse bulkheads where no supports are fitted.

If stringers or floors terminate between holds and are not directly attached to the lower support of a transverse bulkhead or a bilge tank wall, the relevant shearing forces are to be assessed for a single cross section only.

The floors and stringers under consideration are those installed within the hold boundaries and formed by bilge tanks and lower supports for transverse bulkheads (or by transverse bulkheads where no supports are fitted). The bilge tank walls and floors fitted directly below the joints of lower supports for transverse bulkheads (or of transverse bulkheads where no supports are fitted) to the inner bottom are not to be considered during calculation.

If the geometry and/or framing system of double bottom is not in compliance with the above provisions, the bearing capacity C of double bottom is to be determined according to the requirements of 3.3, Part II "Hull" or Strength Norms for Sea-Going Ships on a special agreement with the Register.

When determining the carrying capacity by shear, net thicknesses of floors and stringers are to be used. The net thickness tnet, in mm, is to be determined by the formula

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[1] See footnote at p.194.

$$t_{net} = t - 2{,}5$$

where t = thickness of floors and stringers , in mm.

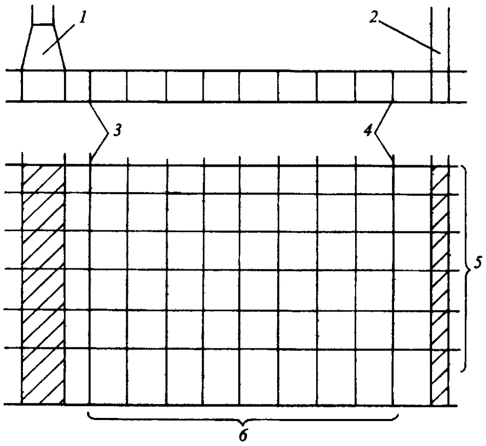


Fig. 3.1:
1 — lower support for transverse bulkhead;
2 — transverse bulkhead;
3 — floor adjacent to lower support for bulkhead;
4 — floor adjacent to transverse bulkhead;
5 — stringers; *6* — floors

3.2 Shearing force in floors.

The shearing force S_{f1}, in kN, in the floor panel cross section adjacent to bilge tanks and the shearing force S_{f2}, in kN, in the cross section of the ultimate panel of a lightened floor (i.e. the lightened panel nearest to the bilge tank) are to be determined by the formulae:

$$S_{f1} = 10^{-3} A_f \tau_a / \eta_1;$$
$$S_{f2} = 10^{-3} A_{f,h} \tau_a / \eta_2$$

where A_f= cross-sectional areaof a floor panel adjacent to bilge tanks , in mm^2;
$A_{f,h}$ = net cross-sectional areaof the ultimate panel of a lightened floor (i.e. the lightened panel adjacent to the bilge tank) , in mm^2;
τ_a = permissible tangential stresses, in N/mm^2, to be adopted equal to:

$$\tau_a = \frac{162 R_{eH}^{0,6}}{(s/t_{net})^{0,8}} \text{ or } R_{eH}/\sqrt{3}, \text{ whichever is the less.}$$

For floors attached to the lower supports for transverse bulkheads or to transverse bulkheads, may be adopted as

$$R_{eH}/\sqrt{3}$$

where R_{eH} = minimal upper yield stress of material, in N/mm^2;
s = spacing of stiffeners on the floor panel in question, in mm;
η_1 =1,10;
η_2 =1,20, whereas may be reduced to 1,10 at the Register discretion, provided the relevant stiffeners comply with the requirements of Instruction on Assessing the Technical Condition, Renovation and Repair of Hulls of Sea-Going Ships (see Annex 2 of Rules for the Classification Surveys of Ships).

3.3 Shearing force in stringer.

The shearing force S_{g1}, in kN, in the cross section of the stringer panel adjacent to the lower supports for transverse bulkheads (or to transverse bulkheads where no supports are fitted) and the shearing force S_{g2}, in kN, in the cross section of the margin panel of the most lightened stringer (i.e. the lightened panel nearest to the lower support for the transverse bulkhead or to the transverse bulkhead where no support is fitted) are to be determined by the formulae:

$$S_{g1} = 10^{-3} A_g \tau_a / \eta_1;$$
$$S_{g2} = 10^{-3} A_{g,h} \tau_a / \eta_2$$

where A_g = cross-sectional areaof stringer panel adjacent to the lower supports for bulkheads (or to transverse bulkheads where no support is fitted), in mm^2;
$A_{g,h}$ = net cross-sectional areaof margin panel of the most lightened stringer (i.e. the lightened panel nearest to the lower support for the transverse bulkhead or to the transverse bulkhead where no support is fitted), in mm^2;
τ_a = permissible tangential stresses, in N/mm^2, as specified in 3.2 of this Appendix;
η_1= 1,10;
η_2= 1,15, whereas may be reduced to 1,10 at the Register discretion, provided the relevant stiffeners are fitted (see 3.2 of this Appendix).

4 PERMISSIBLE LOADING OF HOLD

The permissible loading of hold W, in t, is to be determined by the formula

$$W = \rho_c V \frac{1}{F}$$

where F =1,1 for general loading conditions;
F =1,05 for rolled iron;
ρ_c = bulk cargo density, in t/m^3 (see 2.1 of this Appendix). For steel products ρ_c is to be adopted equal to the steel density;
V = cargo volume, in m^3, corresponding to the hold being filled to the level h_1 by depth;
$h_1 = X/\rho_c g$.

For bulk cargoes X is to be adopted as the lesser value of X_1 or X_2 determined by the formulae:

$$X_1 = \frac{Z + \rho g(E - h_f)}{1 + \rho/\rho_c(perm - 1)};$$

$$X_2 = Z + \rho g(E - h_f\, perm)$$

where $X = X_1$ for steel products with $perm$=0;
ρ = seawater density, in t/m^3;
g = gravity acceleration equal to 9,81 m/s^2;
$E = d_f - 0{,}1D$=ship draught with a hold flooded, in m;
for d_f, D see 2.2 of this Appendix;
h_f= water head during flooding , in m (see 2.2 of this Appendix);
$perm$ = cargo permeability (i.e. the relationship between the interstitial space and cargo volume), whereas $perm$ is not to be adopted greater than 0,3;
Z=Z_1 or Z_2, whichever is the less, whereas:

$$Z_1 = C_h / A_{DB,h};$$
$$Z_2 = C_e / A_{DB,e};$$

C_h = bearing capacity, in kN, of double bottom by shear in accordance with Section 3 of this Appendix, while the shearing force S_{f1} or S_{f2} for each floor, whichever is the less, is to be determined according to 3.2 of this Appendix, and the shearing force S_{g1} or S_{g2} for each stringer, whichever is the less, is to be determined acording to 3.3 of this Appendix;

C_e = bearing capacity, in kN, of double bottom by shear in accordance with Section 3 of this Appendix, while the shearing force S_{f1} for each floor are to be determined according to 3.2 of this Appendix, and the shearing force S_{g1} or S_{g2} for each stringer, whichever is the less, are to be determined according to 3.3 of this Appendix;

$$A_{DB,h} = \sum_{i=1}^{i=n} S_i B_{DB,i} ;$$

$$A_{DB,e} = \sum_{i=1}^{i=n} S_i (B_{DB} - s_1);$$

n = number of floors between lower supports for transverse bulkheads (or between transverse bulkheads where no supports are fitted);

s_i = spacing of i-the floor, in m;

$B_{DB,i} = B_{DB} - s_1$ for floors for which shearing forces are determined by S_{f1} determined according to 3.2 of this Appendix;

$B_{DB,i} = B_{DB,h}$ for floors for which the shearing forces are determined by S_{f2} determined according to 3.2 of this Appendix;

B_{DB} = double bottom breadth between bilge tanks, in m (see Fig. 4 of this Appendix);

$B_{DB,h}$ = distance between two openings under consideration, in m (see Fig.4 of this Appendix);

s_1 = distance between bilge tank wall and the nearest main framing longitudinal of inner bottom, in m.

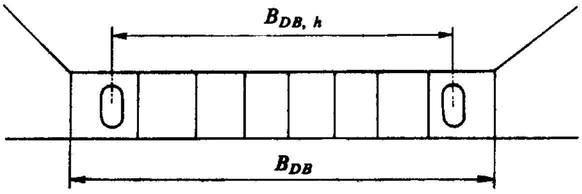


Fig. 4

APPENDIX 4

REQUIREMENTS FOR SHIP LOADING INSTRUMENTS

1 GENERAL

1.1 The present Requirements are to be applied together with those of Part II, "Hull" of the Rules and of Guidelines on Technical Supervision during Construction of Ships and Manufacture of Materials and Equipment when approving the loading instruments of ships whose instruments are not yet approved.

1.2 The Requirements apply to loading instruments representing a computer-based system consisting of a program for ship load calculation and of hardware for its realization. Requirements pertinent to the program and its functional capabilities are to be found in 3.1 and Section 4 of this Appendix respectively. Requirements pertinent to type approval for hardware are to be found in 1.8 and 3.2 of this Appendix.

1.3 A loading instrument is not to substitute for an approved Loading Manual.

1.4 The loading instrument belongs to special equipment carried onboard, and the calculation results obtained by using it apply only to the ship for which it was approved.

1.5 Ships undergoing major modifications or modernization, such as elongation or deck removal affecting the longitudinal strength of hull, are to be considered new ships for the purpose of the Requirements.

1.6 For each ship, the loading instrument approval procedure will include the following:

basic data verification and loading conditions approval with issuing of a Report (Form 6.3.29) for subsequent testing of the program;

hardware approval with issuing of a Certificate (Form 6.5.30) where necessary;

handover tests with a subsequent issuing of a Report (Form 6.3.10).

1.7 The program for the loading instrument is to be type-approved by the Register which is to be confirmed by issuing a Type Approval Certificate for the computer program (Form 6.8.5). In such cases, certain stages may be omitted in the basic data verification procedure for a particular ship (see 2.1.7).

1.8 Hardware is to be approved, if there is a single computer for which a Type Approval Certificate (Form 6.3.8) was issued in accordance with the requirements of 3.2 of this Appendix, or there are two computers specially installed for the case one of them fails. If there are two computers, no type approval is necessary for them but in this case, each computer is to pass handover tests. Besides, computers being a part of the shipboard net are to be approved by the Register which is to be confirmed by issuing a Certificate (Form 6.5.30) in accordance with the relevant requirements of the Rules and Guidelines on Technical Supervision during Construction of Ships and Manufacture of Materials and Equipment.

1.9 A Report (Form 6.3.10) is to be issued for the program on the basis of the satisfactory results of handover tests of the loading instrument carried out onboard the ship in accordance with the requirements of 2.3 of this Appendix.

2 APPROVAL PROCEDURE

2.1 Basic data verification and approval. Loading conditions approval for program testing.

2.1.1 Calculation results and the actual ship data used for the program are to be verified onboard the ship for which the program is intended.

2.1.2 On receipt of an application for data verification, the Register is to offer to the applicant four loading conditions as a minimum, borrowed from an approved Ship Loading Manual and to be used for program testing. These loading conditions are to ensure the loading of each ship compartment for one time at least. These loading conditions are generally to cover the whole range of possible ship draughts from the greatest one in the loaded condition to the smallest one in the ballasted condition.

2.1.3 Control points are generally to be positioned on transverse bulkheads or other obvious compartment boundaries. Additional control points may be necessary between the bulkheads of long holds or tanks, or between container stacks.

2.1.4 If the torque on calm water is to be determined, the program is to provide for this to be demonstrated on a single test loading condition of the ship.

2.1.5 It is important that the basic data included in the program are in agreement with those contained in the approved Loading Manual. Special attention is to be paid to the final mass value of the ship in the light condition and the position of its gravity centre adopted on the basis of inclining test or proceeding from the results of the light ship condition verification.

2.1.6 The following basic data are to be submitted to the Register by the applicant in order to verify whether they are in agreement with the ship constructed:

principal dimensions, coefficients of fineness of the lines and, where necessary, the lateral projection of the ship;

position of forward and aft perpendiculars and, where necessary, the procedure for determining the forward and stern draughts at actual draught mark locations;

light ship displacement and its distribution through the ship length;

lines drawing and/or tables of offsets, or Bonjean scales including 21st section on the length between perpendiculars;

compartments description including spacing, volume centres and volume tables (tank capacity tables/tables showing the mass of liquid in a tank filled to different levels) where necessary;

deadweight composition for each loading condition.

Identification details of the program including the version number are to be verified also.

2.1.7 The basic data verification procedure may be considered to be completed, if:

the requirements of 3.1 of this Appendix are fulfilled in respect of the program;

the purpose of the program is clearly formulated and the calculation methods with the algorithm are in accordance with the requirements of the Rules and Guidelines on Technical Supervision during Construction of Ships and Manufacture of Materials and Equipment;

the requirements of Section 4 of this Appendix are fulfilled with regard to the functional capabilities of the program;

the precision of calculations made on the basis of the program is within the tolerances stipulated by 2.5 of this Appendix;

ship particulars are in accordance with the requirements of 2.1.5 of this Appendix;

the program user's manual is clear and brief and complies with the requirements of 2.4 of this Appendix and is checked and duly noted by the Register;

data are given concerning the minimal requirements for hardware;

ship loading conditions intended for the program testing are approved which is confirmed by Report (Form 6.3.29).

2.1.8 Computer Program Type Approval Certificate (Form 6.8.5) will be issued on the basis of the requirements of 2.2 of this Appendix. Where the program is type approved, the basic data verification procedure may be considered to be completed, if:

it is found that the type-approved program is applicable to the ship in question;

information contained in valid Certificate (Form 6.8.5) is in compliance with the program being identified and its version number;

the precision of calculations made on the basis of the program is within the tolerances stipulated in 2.5 of this Appendix;

ship particulars are in accordance with the requirements of 2.1.5 of this Appendix;

the program user's manual is clear and brief and complies with the requirements of 2.4 of this Appendix and is checked and duly noted by the Register;

data are given concerning the minimal requirements for hardware;

ship loading conditions intended for the program testing are approved and there is a Report (Form 6.3.29) on the program operation testing.

2.1.9 Approved loading conditions given in Ship Loading Manual and the Report (Form 6.3.29) are sent to the Inspectorate by the RS Head Office noting the necessity of handover tests to be held. Where the ship is in service, the approved loading conditions and the Report (Form 6.3.29) are sent to the shipowner who is to ensure that they are delivered onboard and that handover tests are held with the Register surveyor participating.

2.2 Type approval.

2.2.1 A program for the loading instrument may be type approved according to the requirements of this Chapter. If the tests are completed satisfactorily, Computer Program Type Approval Certificate (Form 6.8.5) is to be issued for the program.

2.2.2 The Certificate (Form 6.8.5) is to be valid for an identified version of the program only.

2.2.3 After the application for the type approval of a program has been submitted, the Register will provide the applicant with data for its testing for two ship types at least. Where programs using basic data on hull shape are concerned, the program test data will be provided for three ship types. These data are to be used by the applicant for running the program in respect of the tested ships. The results (including the data-of-the-lines-plan curve and the interpolation curve output, if applicable) obtained by using the program are to be submitted to the Register in order the precision of calculations might be assessed. The Register is to make parallel calculations using the same basic data and compare their results with those obtained by means of the program submitted.

2.2.4 The Certificate (Form 6.8.5) may be issued if:

the requirements of 3.1 of this Appendix are fulfilled in respect of the program;

the purpose of the program is clearly formulated and the calculation methods with the algorithm are in accordance with the requirements of the Rules and Guidelines on Technical Supervision during Construction of Ships and Manufacture of Materials and Equipment;

the requirements of Section 4 of this Appendix are fulfilled with regard to the functional capabilities of the program;

the precision of calculations made on the basis of the program is within the tolerances stipulated in 2.5 of this Appendix;

the program user's manual is clear and brief, and is submitted to the Register for consideration;

data are given concerning the minimal requirements for hardware.

2.2.5 The Certificate (Form 6.8.5) is to include a detailed description of calculations for which the program is approved and of limitations imposed upon the program.

2.2.6 The Certificate (Form 6.8.5) is to be issued for a maximum period of 5 years. The Certificate may be extended after the developer has confirmed that the algorithm is unchanged in the program.

2.2.7 A valid Certificate (Form 6.8.5) will be invalidated, if the algorithm is changed in the program by the developer without prior agreement with the Register. In such a case, the revised program is to be considered a new one.

2.3 Handover tests.

2.3.1 Handover tests are to be held soon after the loading instrument installation aboard the ship.

2.3.2 During handover tests, the user, one of the senior officers is to use the instrument for calculating a test loading condition of the ship. The operation is to be confirmed by a surveyor to the Register. Data obtained by means of the instrument are to agree with those stated for the approved test loading conditions. Where the numerical output data given by the instrument do not agree with those stated in the approved test loading conditions, the Report (Form 6.3.10) is not to be issued.

2.3.3 Handover tests are also to be carried out in respect of the second computer specially installed to be used if the first one fails. Data obtained by means of the loading instrument are to agree with those stated for the approved tests loading conditions. Where the output numerical data of the loading instrument do not agree with those stipulated for the approved tests loading conditions, no Report (Form 6.3.10) is to be issued. If handover tests are effected using a computer for which a Type Approval Certificate (Form 6.8.3) was issued, the second specially installed computer need not be tested.

2.3.4 Where hardware is not approved, it is to be demonstrated that handover tests results for the program are satisfactory for both the first and the second specially installed computer, subsequent to which a Report (Form 6.3.10) on the program handover tests may be issued.

2.3.5 After satisfactory completion of handover tests, the Register surveyor is to attach the approved test loading conditions for the ship, as well as the Program Test Report (Form 6.3.29), to the Program User's Manual formerly duly noted by the Register. Then, the Report (Form 6.3.10) on handover tests of the program will be issued by the Register.

2.4 Program User's Manual.

2.4.1 The Manual is to be submitted for consideration by the Register. In case of satisfactory results of the consideration, the Manual will be duly noted by the Register.

2.4.2 The Manual is to be drawn up in a brief and clear way and is to be provided preferably with drawings and block diagrams.

2.4.3 The Manual is to include the following information:

general description of the program with indication of its version identification number;

a copy of Computer Program Type Approval Certificate (Form 6.8.5);

data on minimal required hardware properties necessary for program operation;

description of error messages and warning reports that can be issued by computer and clear instructions concerning the user's subsequent steps in this case;

light ship displacement and gravity centre of the ship coordinates;

full deadweight composition for each test loading condition of the ship;

values of permissible shearing forces and bending moments in calm water given or taken into consideration by the Register, as well as of permissible cargo torque, where applicable;

correction factors for shearing forces, where applicable;

local permissible limitations on the loading of particular holds and two adjacent holds proceeding from the maximum cargo mass for each hold in relation to the relevant ship draught, where applicable;

example of ship loading conditions determination with illustrations and computer data out;

example of each display screen data out with explanations.

2.5 Allowance for calculation accuracy.

The accuracy of calculations made using the program is to be within the range of acceptable allowances given in Table 2.5. The accuracy of calculations can be determined by comparing, at each control point, the results of calculations made using the program to those obtained by using an independent program of the Register or an approved loading manual containing the similar basic data.

Table 2.5

Range of allowances for calculation accuracy

Design value	Allowance (percentage of permissible value)
Shearing force on still water N_{sw}	±5
Bending moment on still water M_{sw}	±5
Torque on still water M_{tsw}	±5

2.6 Hardware approval.

The hardware of a loading instrument is to be in accordance with the requirements of 1.8 and 3.2 of this Appendix if it is type-approved by the Register.

3 REQUIREMENTS TO THE SYSTEM

3.1 Program.

3.1.1 It is recommended that the development and release of the program be carried out in accordance with the relevant international quality standards (for instance, ISO 9000-3 or equivalent).

3.1.2 Software is to be developed so as to render it impossible for the user to modify data files of the ship containing the following information:

lightweight displacement of the ship, lightweight ship mass distribution and the relevant gravity centres;

structural restrictions imposed by the Register;

data essential for hull geometry;

hydrostatic data;

description of compartments including spacing, volume centres and volume tables (tank capacity tables/tables showing the volume of liquid in a tank when filled to different levels) where necessary.

3.1.3 Any changes to software that can influence longitudinal strength are to be introduced by the developer or his appointed representative, and the Register is to be immediately notified accordingly. The absence of a notification of any changes to the program may render the Certificate (Form 6.8.5) issued by the Register invalid. When the Certificate (Form 6.8.5) is found to be invalid by the Register, the modified program will be considered anew in accordance with the requirements of this Appendix.

3.2 Hardware of an independent computer.

3.2.1 Type Approval Certificate (Form 6.8.3) and Hardware Approval Certificate (Form 6.5.30) are to be issued by the Register on condition the hardware is in accordance with the requirements contained in 3.2.2 of this Appendix, as well as with the requirements of the Rules and Guidelines on Technical Supervision during Construction of Ships and Manufacture of Materials and Equipment.

3.2.2 The developer is to submit the detailed information on the hardware to be installed on board. The following information is to be submitted to the Register for consideration:

hardware specification;

the relevant design drawings with indicated materials, catalogues, data sheets, calculations and functional descriptions;

test program suggested for demonstration, confirming that the operational requirements of the above standards can be fulfilled;

certificates and the relevant test reports obtained for the product earlier.

3.2.3 When considering the documentation mentioned in 3.2.2, the Register may recognize the validity of certificates and reports issued by another certification body or accredited laboratory.

3.2.4 The operational and climatic tests are to be held in the presence of the Register representative under the standard test conditions so that a type approval could be issued in accordance with Part XV "Automation" of the Rules and Part 3 "Manufacture Supervision of Ship Equipment" of Guidelines on Technical Supervision during Construction of Ships and Manufacture of Materials and Equipment. The following inspections and tests are to be completed satisfactorily:

external examination;

functional tests;

disturbance in electric power supply;

thermal resistance testing;

moisture resistance testing;

vibration tests;

testing by oscillating and prolonged tilting motion conditions;

testing of insulation electric strength, insulation resistance measurement;

cold resistance tests;

electromagnetic compatibility tests.

3.2.5 The Register is to be notified of any modifications to hardware specification.

4 REQUIREMENTS CONCERNING FUNCTIONAL CAPABILITIES

4.1 General.

4.1.1 The computational functions inherent in the program will depend on the requirements contained in the Rules and in Guidelines on Technical Supervision during Construction of Ships and Manufacture of Materials and Equipment.

4.1.2 The program is to be convenient for the user and to be developed so as to minimize the possibility of incorrect initial data input by the user.

4.1.3 Calculations of the fore, midlength and after draughts at relevant perpendiculars are to be submitted in a form easily understandable for the user both in files and as hard copies.

4.1.4 For the case of the actual ship loadline positions of the, the fore, midlength and after draughts are to be determined and submitted in a form easily understandable for the user both in files and as hard copies. Provision is to be made for submitting the sagging/hogging data for the hull.

4.1.5 Displacement is to be determined for the particular loading condition of the ship and the corresponding value of the draught, and is to be submitted to the user both in file and as a hard copy.

4.1.6 The loading instrument is to issue printouts containing output data both in digital and graphic form. The output data in digital form are to be represented both in the absolute values and as percentage of permissible values. Printouts are to contain description of the relevant loading condition of the ship.

4.1.7 All the electronic and hard copy data are to be represented in a form easily understandable for the user with indication of the identification number of the program version.

4.2 Forces and moments originating in the hull.

4.2.1 The program is to ensure an analysis of the following forces and moments in the ship hull in accordance with the requirements of Part II "Hull":

shearing force N_{sw} in still water, with a correction where applicable;

bending moment M_{sw} in still water, with a correction where applicable;

torque M_{tsw} in still water, where applicable.

In case of open ships, particular attention is to be paid to loads under which hull twisting occurs.

4.2.2 Data to be submitted to or duly noted by the Register are included in Table 4.2.2.

4.2.3 Forces and moments are to be determined in absolute values and as percentage of permissible values, and are to be submitted both in graphical and tabulated form. The forces and moments determined, as well as their permissible values for each of the control points indicated, are to be submitted both in files and as hard copies. Any limitations concerning hull bending in the vertical direction in still water or hull twisting, for instance, may be considered on the basis of the requirements of the Rules.

4.3 Permissible loads, loading and capacity.

4.3.1 The program user is to be timely, clearly and unambiguously informed about the following restrictions imposed by the Register, concerning:

all permissible shearing forces and bending moments in still water;

permissible torques in still water, where applicable; all local loading restrictions pertinent to both the loading of a particular hold and of the one adjacent thereto, where applicable;

mass of cargo contained in the hold;

ballast tanks and holds capacity;

restrictions on filling.

4.3.2 Violation of any of the restrictions imposed must be easily detectable by the program user.

Table 4.2.2

Design value	Data to be submitted to or duly noted by the Register
Shearing force N_{sw} on still water	**1.** Control points (frame numbers) for N_{sw} determination. Such points are generally to be chosen on transverse bulkheads or other obvious boundaries of compartments. Additional control points may be indicated between the bulkheads of long holds or tanks, as well as between container stacks. **2.** Correction factors for shearing forces and their application procedure. **3.** Permissible values [of N_{sw}], at sea and in port, for control points mentioned in item 1. Where necessary, an additional range of permissible values [of N_{sw}] can be specified.
Bending moment M_{sw} on still water	**1.** Control points (frame numbers) for M_{sw} determination. Such points are generally to be chosen on transverse bulkheads, at hold centres or other obvious boundaries of compartments. **2.** Permissible values [of M_{sw}], at sea and in port, for control points mentioned in item 1. Where necessary, an additional range of permissible values [of M_{sw}] can be specified.
Torque M_{tsw} on still water (where applicable)	**1.** Control points (frame numbers) for M_{tsw} determination. **2.** Permissible values [of M_{tsw}] for control points mentioned in item 1.

5 PERFORMANCE TEST

5.1 General.

When a loading instrument is to be installed on board and Report on Survey of the Ship (Form 6.3.10) or a report on its previous testing by the Register is not available, the Register surveyor is to notify the Register Head Office accordingly.

5.2 Extent of survey.

When a loading instrument is tested, the results obtained on the basis of the program must be identical to those given in the approved test loading conditions of the ship. If the numerical output data obtained using the loading instrument do not agree with those to be found in the approved test loading conditions, the class assignment requirements are to be applied to the ship and the owner is to be notified accordingly. The program is to be tested on all the computers intended for it (those which are type approved or specially designed for the program).

PART III. EQUIPMENT, ARRANGEMENTS AND OUTFIT

1 GENERAL

1.1 APPLICATION

1.1.1 The present Part of the Rules applies to equipment, arrangements and outfit of sea-going ships navigating in a displacement condition. To hydrofoil boats, air cushion vehicles, hydrogliders and other similar ships, unless expressly provided otherwise below, the requirements of this Part are applicable to the extent that is practicable and reasonable, and the equipment, arrangements and outfit of these ships are subject to special consideration by the Register in each case.

см.Б1 **1.1.2** Ship's equipment, arrangements and outfit designed for special purposes (such as special anchor arrangements of dredgers, a deep-sea anchor arrangement for special purpose ships and similar arrangements) are not subject to the Register survey.

1.1.3 The present Part of the Rules applies, as far as practicable and reasonable, to floating metallic wing-walled docks, unless expressly provided otherwise. The Rules do not specify conditions for mooring of floating docks in a particular place of operation and selection of types and characteristics of the equipment, arrangements and outfit (anchor, mooring, etc.) used for this purpose.

1.2 DEFINITIONS AND EXPLANATIONS

The definitions and explanations relating to the general terminology of the Rules are given in Part I "Classification".

For the purpose of the present Part of the Rules the following definitions have been adopted:

1.2.1 Waterlines.

Damage waterlines are the waterlines of a damaged ship after flooding of corresponding separate compartments or their combinations as provided in Part V "Subdivision".

Summer load waterline is the waterline indicated by the upper edge of the line which passes through the centre of the ring of the load line mark for a ship in upright position.

Summer timber load waterline is the waterline indicated by the upper edge of the assigned summer timber load line.

Deepest load waterline is the waterline indicated by the upper edge of the assigned uppermost regional or seasonal load line, including fresh water load lines.

Deepest subdivision load waterline is the uppermost waterline at which the requirements of Part V "Subdivision" are still fulfilled.

Margin line at docking is the envelope of the waterlines corresponding to the maximum permitted trims of the floating docks and docklift ships when carrying out the docking operations.

1.2.2 Dimensions and draught of the ship.

Length of ship L is taken as 96 per cent of the total length on a waterline at 85 per cent of the least moulded depth or as the length from the fore side of the stem to the axis of the rudder stock on that waterline, if that be greater.

Where the stem contour is concave above that waterline, the length of the ship shall be measured from the vertical projection to that waterline of the aftermost point of the stem contour (above that waterline).

In ships designed with a rake of keel the waterline on which this length is measured shall be parallel to the design waterline.

Length of floating dock L is the distance measured along the pontoon deck and parallel to the base line, between the inner sides of the pontoon end bulkheads.

Moulded draught d is the vertical distance measured amidships from the top of the plate keel or from the point where the inner surface of the shell (outer surface in a ship with a non-metal shell) abuts upon the bar keel, to the summer load waterline.

Moulded depth D is the vertical distance measured amidships from the top of the plate keel, or from the point where the inner surface of the shell abuts upon the bar keel, to the top of the freeboard deck beam at side.

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

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

Moulded breadth B is the maximum breadth measured amidships from outside of frame to outside of frame in a ship with a metal shell and to the outer surface of the hull in a ship with a shell of any other material.

1.2.3 Superstructures, deckhouses.

Superstructure is a decked structure on the freeboard deck, extending from side to side of the ship or with the side plating not being inboard of the shell plating more than 4 per cent of the breadth B.

The superstructure may be either complete, i.e. extending over the entire ship's length L, or detached, i.e.

extending only over a definite part of this length. Both complete and detached superstructures may be arranged either in a single or several tiers.

Deckhouse is a decked structure on the freeboard or superstructure deck which is set in from the sides of the ship for more than 4 per cent of the breadth *B* and has doors, windows or other similar openings in the outer bulkheads. The deckhouses may be arranged in a single or several tiers.

Trunk is a decked structure on the freeboard deck which is set in from the sides of the ship for more than 4 per cent of the breadth *B* and has no doors, windows or other similar openings in the outer bulkheads.

1.2.4 Tightness.

Tight under pressure head up to... is the term pertaining to closing appliances of openings, which means that under specified pressure the liquid will not penetrate through the openings inside the ship.

Weathertight is the term pertaining to closing appliances of openings in the above-water hull, which means that in any sea conditions water will not penetrate through the openings inside the ship. The above closing appliances shall undergo tests according to the requirements of 2.3, Appendix 1 to Part II «Hull». It is allowed that the specialized organizations recognized by the Register carry out tests by means of the ultrasonic equipment as well as other test methods approved by the Register.

1.2.5 Decks.

Upper deck is the uppermost continuous deck extending for the full length of the ship.

The upper deck may be stepped.

Raised quarter deck is the after upper part of a stepped deck, the forward lower part of which is taken as a portion of the freeboard deck.

Freeboard deck is the deck from which the freeboard is measured.

In a ship having a discontinuous deck the lowest line of this deck and the continuation of that line parallel to upper part of the deck is taken as a freeboard deck.

Superstructure deck, deckhouse top or trunk deck is the deck forming the top of a superstructure, deckhouse or trunk, respectively.

Superstructure deck or deckhouse top of the first, second, etc. tiers is the deck forming the top of the superstructure or deckhouse of the first, second, etc. tiers, counting from the freeboard deck.

Bulkhead deck is the deck up to which the main transverse watertight subdivision bulkheads are carried.

The bulkhead deck may be discontinuous, i.e. with a step or steps formed both by main transverse watertight bulkheads reaching the keel and transverse watertight bulkheads not reaching the keel.

Lower decks are the decks below the upper deck.

Weather deck is the deck which is completely exposed to the weather from above and from at least two sides.

Pontoon deck of the dock is the deck on which the ship to be docked is fitted.

Top deck of the dock is the uppermost deck of the dock (the uppermost deck of the wing walls).

1.2.6 Perpendiculars and amidships.

Amidships is at the middle of the ship's length *L*.

Forward and after perpendiculars are the vertical lines passing in the centre line at the fore and after ends of the ship's length *L*, respectively.

1.2.7 Ships.

Type "A" ship is a ship designed to carry only liquid cargoes in bulk, and in which cargo tanks have only small access openings closed by gasketed covers tight under an appropriate inner pressure of liquid which is carried in the tanks. Furthermore, a type "A" ship is to have some other features, as defined in the Load Line Rules for Sea-Going Ships which permit this ship to be assigned a freeboard based on Tables 4.1.2.3, 6.4.2.2 or 6.4.3.2 of the above Rules.

Type "B" ship is a ship which does not comply with the requirements regarding type "A" ships and which is assigned a freeboard based on Table 4.1.3.2, 6.4.2.3 or 6.4.3.3 of the Load Line Rules for Sea-Going Ships.

A type "B" ship may not be classified as a type "A" ship even though, as a result of her features detailed in the Load Line Rules, a reduction in tabular freeboard is permitted up to the total difference between the values given in Tables 4.1.2.3, 6.4.2.2, 6.4.3.2 and those in Tables 4.1.3.2, 6.4.2.3, 6.4.3.3, respectively, of the above Rules.

Docklift ship is a dry cargo ship adapted to carry out cargo handling operations using the docking principle in ports and protected water areas.

1.2.8 Active means of the ship's steering (AMSS) are special propulsion and steering units and any combination of them or with the main propulsion devices, capable of producing thrust or traction force both at a fixed angle to the centre line plane of the ship and at a variable angle, either under all running conditions or part thereof including small and zero speed.

The active means of the ship's steering comprise steerable propellers including retractable units of all types, active rudders, vertical-axis propellers, waterjets, propellers in transverse tunnel (athwartship thrusters), separate nozzle rudders and other devices of similar purpose.

Requirements for AMSS construction and design, exclusive of the separate nozzle rudders and rudder section of the active rudders are outlined in Part VII "Machinery Installations". Requirements for AMSS used in the dynamic positioning systems of mobil offshore drilling units shall be fulfilled with consideration for Rules for the Classification and Construction of Mobil Offshore Drilling Units.

1.2.9 Steering gear.

Main steering gear is the machinery, rudder actuators, steering gear power units, if any, ancillary equipment and the means of applying torque to the rudder stock (e.g. tiller or quadrant) necessary for effecting movement of the rudder for the purpose of steering the ship under normal service conditions.

Auxiliary steering gear is the equipment other than any 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 is:

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

in the case of electrohydraulic steering gear an electric motor and its associated equipment and connected pump;

in the case of other hydraulic steering gear a driving engine and connected pump.

Power actuating system is the hydraulic equipment provided for supplying power to turn the rudder stock, 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 is the equipment by which orders are transmitted from the navigating 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.

1.3 SCOPE OF SURVEY

1.3.1 General provisions on survey of ship's equipment, arrangements and outfit are given in General Regulations for the Classification and Other Activity and in Part I "Classification".

1.3.2 The following items included into ship's equipment, arrangements and outfit are subject to the survey by the Register during their manufacture.

1.3.2.1 Rudder and steering gear:

.1 rudder stocks;

.2 rudders;

.3 nozzle rudders;

.4 rudder axles;

.5 pintles of rudders and nozzle rudders;

.6 bushes of pintles;

.7 fastenings of rudder stocks, rudder stock with rudder or nozzle rudder, and also of rudder axle with sternframe (muff couplings, keys, bolts, nuts, etc.);

.8 parts of the system of rudder stops;

.9 active means of the ship's steering (only in the case specified in 2.1.3.2).

1.3.2.2 Anchor arrangement:

.1 anchors;

.2 chain cables or ropes;

.3 anchor stoppers;

.4 devices for securing and releasing the inboard end of chain cable or rope;

.5 anchor hawse pipes.

1.3.2.3 Mooring arrangement:

.1 mooring ropes;

.2 mooring bollards, belaying cleats, fairleaders, chocks, rollers and stoppers.

1.3.2.4 Towing arrangement:

.1 tow lines;

.2 towing bollards, bitts, fairleaders, chocks and stoppers;

.3 tow hooks and towing rails with fastenings for their securing to ship's hull;

.4 towing snatch-blocks.

1.3.2.5 Masts and rigging:

.1 metal, wooden and glass-reinforced plastic spars;

.2 standing ropes;

.3 permanent attachments to masts and decks (eyeplates, hoops, etc.);

.4 loose gear of masts and rigging (shackles, turnbuckles, etc.).

1.3.2.6 Closing appliances of openings in hull, superstructures and deckhouses:

.1 side and deck scuttles;

.2 doors of bow, side and stern openings in the shell plating;

.3 doors in superstructures and deckhouses;

.4 companion hatches, skylights and ventilating trunks;

.5 ventilators;

.6 manholes to deep and other tanks;

.7 hatchway covers in dry cargo ships and tankers;

.8 cargo tank hatchway covers in tankers;

.9 doors in subdivision bulkheads.

1.3.2.7 Equipment of ship's spaces:

.1 ceiling and battens in cargo holds;

.2 exit doors from ship's spaces in escape routes;

.3 stairways and vertical ladders;

.4 guard rails, bulwark and gangways;

.5 cellular guide members in the holds of container ships.

1.3.2.8 Emergency outfit:

.1 collision mats;

.2 tools;

.3 materials.

1.3.3 The Register survey of the manufacture of items specified in 1.3.2.1.7, 1.3.2.1.8, 1.3.2.5, 1.3.2.7.1, 1.3.2.7.5, 1.3.2.8.2 and 1.3.2.8.3 is confined to consideration of the relevant technical documentation.

1.3.4 For items specified in 1.3.2 the following documents shall be submitted to the Register:

.1 assembly drawing;

.2 calculations (no approval stamps are needed);

.3 detail drawings if parts or assemblies are not manufactured in accordance with standards and specifications approved by the Register.

1.3.5 Materials used for items specified in 1.3.2.1.1 to 1.3.2.1.5, 1.3.2.2.1, 1.3.2.2.2, 1.3.2.4.3, 1.3.2.6.2 and 1.3.2.6.7 to 1.3.2.6.9 are subject to the Register survey during manufacture.

1.3.6 The following equipment, arrangements and outfit are subject to the Register survey when the ship is under construction:

.1 rudder and steering gear;

.2 anchor arrangement;

.3 mooring arrangement;

.4 towing arrangement;

.5 masts and rigging;

.6 openings in hull, superstructures and deckhouses and their closing appliances;

.7 arrangement and equipment of ship's spaces;

.8 emergency outfit;

.9 cellular guide members in the holds of container ships;

.10 active means of the ship's steering (see 2.1.3).

1.4 GENERAL PROVISIONS

1.4.1 In ships intended to carry in bulk flammable liquids with the flash point 60 °C and below no deck machinery is to be fitted directly on the decks being the top of cargo and fuel tanks. In this case, the deck machinery is to be fitted on special foundations, the construction of which provides for free circulation of air underneath the machinery.

1.5 WORKING AND ALLOWABLE STRESSES

1.5.1 Wherever the working stresses are mentioned in the text of the present Part of the Rules, they mean combined stresses σ_{com}, in MPa, calculated from the formula

$$\sigma_{com} = \sqrt{\sigma^2 + 3\tau^2} \qquad (1.5.1)$$

where σ = normal stresses in the section under consideration, in MPa;

τ = shear stresses in the section under consideration, in MPa.

The strength conditions shall be checked against these stresses.

1.5.2 Allowable stresses with which the combined stresses are to be compared when verifying the strength conditions are specified in the present Part in fractions of the upper yield stress of the material used; the upper yield stress shall not be taken as more than 0,7 times the tensile strength of this material, unless expressly provided otherwise.

1.6 MATERIALS AND WELDING

1.6.1 Steel forgings and castings, steel plates, sections and bars and also chain steel used for items specified in 1.3.2.1.1 to 1.3.2.1.5, 1.3.2.1.7, 1.3.2.2.1, 1.3.2.2.2, 1.3.2.4.3, 1.3.2.6.2, 1.3.2.6.7 and 1.3.2.6.9 shall meet the relevant requirements of Part XIII "Materials". Materials for other items of equipment, arrangements and outfit shall meet the requirements specified in the design documentation approved by the Register, unless expressly provided otherwise in the Rules.

1.6.2 The grades of steel plates and sections (see Tables 3.2.2-1 and 3.2.2-2, Part XIII "Materials") for items specified in 1.3.2.1.2 and 1.3.2.1.3 shall be selected according to 1.2.3.1, Part II "Hull" in the same manner as for hull structural members of category II; in this case, for ships of ice categories **Л4** and higher and for icebreakers steel not lower than Grade B shall be adopted, and for rudder blades of icebreakers, not lower than Grade D. For items specified in 1.3.2.6.2 the grades of steel plates and sections of the main carrying framing members and plating of cover structures ensuring fixing of items when stowed for sea, as well as essential parts of drivers intended for opening at sea shall be selected according to 1.2.3.1, Part II "Hull" as for hull structural members of category II.

1.6.3 Welding of structural elements of ship's equipment, arrangements and outfit shall be performed in accordance with the requirements of Part XIV "Welding"; besides, welded structures and joints of items specified in 1.3.2.6.2, 1.3.2.6.7 and 1.3.2.6.9 shall comply with the applicable requirements of 1.7, Part II "Hull".

1.7 DESIGN ACCELERATIONS DUE TO HEAVE OF THE SEA

1.7.1 The dimensionless, gravity related, design accelerations due to heave of the sea as described in this Chapter are to be applied when determining the loads upon equipment, arrangements and batches of cargo items carried by ships of unrestricted service and those of restricted area of navigation **I**.

With regard to ships of other areas of navigation, accelerations may be applied different from those required herein which are to be substantiated by calculations approved by the Register.

1.7.2 The dimensionless acceleration a_z due to heave, pitch and roll normal to the water planes of the ship is to be determined from the formula

$$a_z = \pm a_0 \sqrt{1 + \left(5{,}3 - \frac{45}{L}\right)^2 \left(\frac{x}{L} - 0{,}45\right)^2 \left(\frac{0{,}6}{C_B}\right)^{3/2}} \tag{1.7.2-1}$$

where $a_0 = 0{,}2\frac{V}{\sqrt{L}} + \frac{34 - 600/L}{L}$; (1.7.2-2)

V = maximum ahead speed, in knots, with the ship on summer load waterline on still water;

L = ship's length, in m;

x = longitudinal distance from the centre of gravity of equipment, arrangement or batch of cargo items in question to the aft perpendicular;

C_B = block coefficient.

a_z does not include the component of the static weight.

1.7.3 The dimensionless acceleration a_y due to transverse displacement, yaw and roll normal to the centre line of the ship is to be determined from the formula

$$a_y = \pm a_0 \sqrt{0{,}6 + 2{,}5\left(\frac{x}{L} - 0{,}45\right)^2 + k_1\left(1 + 0{,}6 k_1 \frac{z}{B}\right)^2} \tag{1.7.3-1}$$

where k_1 = coefficient of stability to be determined from the formula

$$k_1 = \frac{13\overline{GM}}{B}\,. \tag{1.7.3-2}$$

If k_1 as determined from the Formula (1.7.3-2), is below 1,0, k_1 = 1,0 shall be assumed for calculating a_y;

$\overline{GM}$ = transverse metacentric height of loaded ship when the volume and distribution of stores are such as to yield maximum $\overline{GM}$, in m;

B = ship's breadth, in m;

z = vertical distance, in m, from the summer load waterline to the centre of gravity of equipment, arrangement or batch of cargo items in question; z is positive above and negative below the summer load waterline.

a_y includes the component of the static weight in the transverse direction due to rolling.

1.7.4 The dimensionless acceleration a_x due to longitudinal displacement and pitch normal to the midship section plane is to be determined from the formula

$$a_x = \pm a_0 \sqrt{0{,}06 + k_2^2 - 0{,}25 k_2} \tag{1.7.4-1}$$

where k_2 = factor determined from the formula

$$k_2 = \left(0{,}7 - \frac{L}{1200} + 5\frac{z}{L}\right)\frac{0{,}6}{C_B}\,. \tag{1.7.4-2}$$

a_x includes the component of the static weight in the longitudinal direction due to pitching.

1.7.5 When determining loads it shall be considered that the accelerations calculated using a_x, a_y and a_z act independently of each other.

2 RUDDER AND STEERING GEAR

2.1 GENERAL PROVISIONS

2.1.1 Every ship, except for shipborne barges, is to be provided with a reliable device ensuring her steering and course-keeping facilities (see 2.10). Such devices may be rudder, nozzle rudder, etc., approved by the Register.

In the case of non-propelled vessels of the dredging fleet with regard to the area of navigation and service conditions the Register may allow to omit such device or provide only stabilizers. The area of navigation and service conditions taken into account when it is allowed to omit such device or to provide only stabilizers are subject to special consideration by the Register in each case.

2.1.2 The present Section applies only to ordinary streamlined rudders or nozzle rudders with streamlined profiles and rigidly fixed stabilizers.

Unordinary rudders, nozzle rudders with steerable stabilizers, Voith-Schneider propellers, etc. are subject to special consideration by the Register in each case.

2.1.3 Active means of the ship's steering.

2.1.3.1 The active means of the ship's steering may be both the means supplementary to the regulated minimum (see 2.1.1) and the main means of the ship's steering.

2.1.3.2 Taking into account the ship's purpose, design features and intended service conditions it may be permitted, on agreement with the Register, that the regulated steerability of the ship shall be provided at the low speed by simultaneous operation of the devices specified in 2.1.1 and the active means of the ship's steering.

In case where the AMSS are the main means of the ship's steering the regulated steerability shall be ensured under those running conditions of the ship for which the means are intended.

In any case, it shall be demonstrated by the method recognized by the Register that the steerability will not then be at least worse than that ensured in case of fulfilment of the requirements of 2.10.

2.1.4 The number of rudder pintles supporting the rudder is not regulated by the Register, except for icebreakers and ships of ice categories **ЛУ4** and higher for which this number is to be not less than that given in Table 2.1.4.

Table 2.1.4

Categories of icebreakers and ice strengthening in ships	Number of rudder pintles
ЛЛ9, ЛЛ8	4
ЛЛ7, ЛЛ6, ЛУ7, ЛУ8, ЛУ9	3
ЛУ6, ЛУ5	2
ЛУ4	1

In exceptional cases, in icebreakers and ships of ice category **ЛУ7, ЛУ8, ЛУ9** the number of rudder pintles indicated in Table 2.1.4, may be reduced to two on agreement with the Register; the conditions under which this reduction may be permitted are subject to special consideration by the Register.

In icebreakers and ships of ice category **ЛУ7, ЛУ8, ЛУ9** the nozzle rudders are not to be fitted.

In ships of ice categories **ЛУ4, ЛУ5, ЛУ6** the arrangement of the nozzle rudder without the lower pintle in the solepiece is not permitted.

2.1.5 Wherever the upper yield stress R_{eH} of the material used enters into the formulae of this Section, the provisions of 1.5.2 shall be taken into account, but in all cases the upper yield stress R_{eH} of the material is not to be taken more than 390 MPa.

2.1.6 When checking the rudder pintles and rudder stock bearings for surface pressure, the latter is not to exceed the values indicated in Table 2.1.6.

Table 2.1.6

Materials	Surface pressure p, MPa	
	Water lubrication	Oil lubrication
Stainless steel or bronze against lignum vitae	2,4	—
Stainless steel or bronze against textolite or synthetic materials	On special agreement with the Register	—
Stainless steel against bronze or vice versa	6,9	—
Steel against white metal	—	4,4

2.1.7 In ships of ice category **ЛУ5, ЛУ6** the arrangement of two nozzle rudders (in case of twin-screw ships) is subject to special consideration by the Register in each case.

2.1.8 In ships of ice categories **ЛУ4** and higher the structural measures for ice protection of nozzle rudders are subject to special consideration by the Register in each case.

2.2 INITIAL DESIGN DATA

2.2.1 The initial design data specified in this Chapter are valid only for the choice of scantlings of ordinary rudders and nozzle rudders with rigidly fixed stabilizers and cannot be used for determination of steering gear output characteristics. Methods of determination of these characteristics are not regulated by the Register, and the relevant calculations are not subject to approval by the Register. The steering gear is checked by the Register during sea trials of the ship to make sure that the steering gear output characteristics comply with the requirements of 2.9.2, 2.9.3 and 2.9.8.

2.2.2 Rudder force and rudder torque.

2.2.2.1 The rudder force F, in kN, for the ahead condition is to be determined from the formula

$$F = F_1 + F_2 \qquad (2.2.2.1\text{-}1)$$

where

$$F_1 = 5{,}59 \cdot 10^{-3} k_1 k_2 (6{,}5 + \lambda)(b_1 — C_B)^2 A V^2; \qquad (2.2.2.1\text{-}2)$$

$$F_2 = 0{,}177 k_1 (6{,}5 + \lambda) \frac{T}{D_p^2} A_p \qquad (2.2.2.1\text{-}3)$$

where k_1 = factor equal to:
1,0 for rectangular and trapezoidal rudders, except for rudders behind the rudder post;
0,95 for semispade rudders (rudders of types I, II, VII and VIII in Fig. 2.2.4.1);
0,89 for rudders behind the rudder post (rudders of types IV, X and XIII in Fig. 2.2.4.1);
k_2 = factor equal to:
1,0 for rudders operating directly behind the propeller;
1,25 for rudders not operating directly behind the propeller;
λ = value determined from the formula

$$\lambda = h_r^2 / A_t \qquad (2.2.2.1\text{-}4)$$

where h_r = mean height of the rudder part abaft the centre line of the rudder stock, in m;
A_t = sum of the rudder area and lateral area of the rudder horn or rudder post, if any, within the height h_r , in m^2. In case of no rudder horn or rudder post, the value of A_t is taken as A in the calculations;
A = rudder area, in m^2;
A_p = portion of the rudder area in the wake of the propeller when the rudder is in the non-reversed position, in m^2;
b_1 = value equal to:
2,2 for rudders situated at the centre plane of the ship;
2,32 for side rudders;
C_B = block coefficient with the ship on the summer load waterline;
V = maximum ahead speed with the ship on the summer load waterline, in knots;
T = propeller thrust at the speed V, in kN, (see 2.2.6);
D_p = propeller diameter, in m.

2.2.2.2 The value of the force F specified in 2.2.2.1 is not to be taken less than F_3 , in kN, determined from the formula

$$F_3 = k_3 A \qquad (2.2.2.2)$$

where k_3 = factor equal to:
171 — for icebreakers of category **ЛЛ9**;
150 — for icebreakers of category **ЛЛ8**;
130 — for icebreakers of category **ЛЛ7**;
110 — for icebreakers of category **ЛЛ6** and for ships of ice category **ЛУ9**;

95 — for ships of ice category **ЛУ8**;
81 — for ships of ice category **ЛУ7**;
75 — for ships of ice category **ЛУ6**;
66 — for ships of ice category **ЛУ5**;
53 — for ships of ice category **ЛУ4**;
18 — for other ships.

When the value of the force F_3 is greater than that of the force F specified in 2.2.2.1, in subsequent calculations the value of F_3 is taken instead of F, and the value F_2 is taken equal to zero.

2.2.2.3 For the ahead condition the rudder torque M_t, in kN·m, is not to be taken less than determined from the formula

$$M_t = F\frac{A}{h_r}\left(0{,}35 - \frac{A_1}{A}\right) \qquad (2.2.2.3\text{-}1)$$

where A_1 = portion of the rudder area forward of the centre line of the rudder stock, in m^2.

For single-plate solid-cast rudders with the leading edge aft of the rudder stock centre line A_1 is taken as the negative value of the area formed by the leading edge of the rudder and the rudder stock centre line.

For icebreakers and ships of ice categories **ЛУ4, ЛУ5, ЛУ6, ЛУ7, ЛУ8** and **ЛУ9** the rudder torque M_t, in kN·m, due to the force F_3 specified in 2.2.2.2, is not to be taken less than determined from the formula

$$M_t = 0{,}35F_3b_r \qquad (2.2.2.3\text{-}2)$$

where b_r = distance from the centre line to the rear edge of the rudder at the level of the midheight of the rudder, in m.

2.2.2.4 For the astern condition the rudder torque M_{as} , in kN·m, is not to be taken less than determined from the formula

$$M_{as} = k_4\frac{A^2}{h_r}\left(0{,}7 - \frac{A_1}{A}\right)v_{as}^2 \qquad (2.2.2.4)$$

where k_4 = factor equal to:
0,185 — for rudders operating directly behind the propeller;
0,139 — for rudders not operating directly behind the propeller;
v_{as} = maximum specification speed of the ship for the astern condition, but not less than 0,5v, in knots.

2.2.2.5 For the astern condition the rudder force F_{as} , in kN, is to be determined from the formula

$$F_{as} = M_{as}\frac{h_r}{A\left(0{,}7 - \frac{A_1}{A}\right)}. \qquad (2.2.2.5)$$

When determining the bending moments and reactions of the supports according to the provisions of 2.2.4 to 2.2.7 for the astern condition, the force F_{as} shall be considered as the force F_1 , and the value of F_2 is then taken equal to zero.

2.2.2.6 In case reliable data are not available on the value of the propeller thrust mentioned in 2.2.2.1, the value of T, in kN, may be determined from the formulae:

for fixed-pitch propellers

$$T = 0{,}0441\left(\frac{30{,}6N_e}{nH_1\sqrt[3]{z\theta}} - n^2D_p^4\right); \qquad (2.2.2.6\text{-}1)$$

for controllable-pitch propellers

$$T = 0{,}0441\left(\frac{110N_e}{v(b_1 - C_B)\sqrt[3]{z}} - n^2D_p^4\right) \qquad (2.2.2.6\text{-}2)$$

where N_e = nominal total output of the propulsion plant of the ship divided by the number of the propellers, in kW;
n = number of propeller revolutions per second, in s^{-1};
H_1 = propeller pitch at the zero thrust, in m, determined from the formula

$$H_1 = H + \frac{0{,}055D_p}{\theta + 0{,}3}; \qquad (2.2.2.6\text{-}3)$$

H = design propeller pitch, in m;
θ = blade area ratio;
z = number of propeller blades.

2.2.3 Nozzle rudder force and torque.

2.2.3.1 The total force F, in kN, acting on the nozzle rudder and stabilizer is not to be taken less than determined from the formula

$$F = F_n + F_{st} \qquad (2.2.3.1\text{-}1)$$

where F_n = force acting on the nozzle, in kN;
F_{st} = force acting on the stabilizer, in kN.

F_n and F_{st} are determined from the formulae:

$$F_n = 9{,}81\cdot10^{-3}pD_nl_nv_1^2; \qquad (2.2.3.1\text{-}2)$$
$$F_{st} = 9{,}81\cdot10^{-3}qmA_{st}v_1^2 \qquad (2.2.3.1\text{-}3)$$

where D_n = inner minimum nozzle rudder bore, in m;
l_n = nozzle rudder length, in m;
A_{st} = area of nozzle rudder stabilizer, in m^2;
v_1 = speed, in knots, determined from the formula

$$v_1 = v(1 - W) \qquad (2.2.3.1\text{-}4)$$

where W = average wake factor. In case reliable experimental data are not available, the wake factor may be determined from the formula

$$W = 0{,}165C_B^n\sqrt{\sqrt[3]{\Delta}/D_p} \qquad (2.2.3.1\text{-}5)$$

where C_B = block coefficient of the ship;
Δ = volume displacement, in m^3, with the ship on summer load waterline;
n = number of propellers;
D_p = propeller diameter, in m;
v = maximum ahead speed, in knots, with the ship on summer load waterline; this speed is not to be taken less than:
17 knots for ships of ice category **ЛУ5** and **ЛУ6**;
14 knots for ships of ice category **ЛУ4**;
11 knots for other ships;
p, q = coefficients determined from the formulae:

$$p = 78{,}4 - 55{,}6\sqrt{\lambda_n} + (44{,}0 - 33{,}4\sqrt{\lambda_n})C_{HB} \qquad (2.2.3.1\text{-}6)$$

$$q = 7{,}43 - 5{,}72\lambda_n + (2{,}82 - 2{,}2\lambda_n)C_{HB}. \qquad (2.2.3.1\text{-}7)$$

C_{HB} being determined from the formula

$$C_{HB} = 9{,}38T/(D_p^2 v_1^2) \qquad (2.2.3.1\text{-}8)$$

where T = propeller thrust at speed v, in kN;
D_p = propeller diameter, in m;
λ_n is determined from the formula

$$\lambda_n = l_n/D_n; \qquad (2.2.3.1\text{-}9)$$

m = coefficient determined from the formula

$$m = 4{,}5 - 0{,}12(\lambda_{st} - 5{,}43)^2; \qquad (2.2.3.1\text{-}10)$$

λ_{st} is determined from the formula

$$\lambda_{st} = h_{st}/l_{st} \qquad (2.2.3.1\text{-}11)$$

h_{st} = height of nozzle rudder stabilizer, in m;
l_{st} = length of nozzle rudder stabilizer, in m.

2.2.3.2 A point situated at the level of the longitudinal axis of the nozzle rudder at the distance r_n from the nozzle rudder leading edge should be considered as a point of application of force F_n. The distance r_n , in m, is not to be less than determined from the formula

$$r_n = l_n(bk + c) \qquad (2.2.3.2\text{-}1)$$

where k = coefficient determined from the formula

$$k = l_{r.s}/l_n \qquad (2.2.3.2\text{-}2)$$

$l_{r.s}$ = distance between the centre line of the rudder stock and the leading edge of the nozzle rudder, in m;
b, c = coefficients determined from the formulae:

$$b = 0{,}796 - 0{,}011(C_{HB} - 7{,}18)^2; \qquad (2.2.3.2\text{-}3)$$

$$c = 0{,}1585 - 0{,}0916\sqrt{C_{HB}}\,. \qquad (2.2.3.2\text{-}4)$$

A point situated at the level of the nozzle rudder longitudinal axis at the distance r_{st} from the stabilizer leading edge shall be considered as a point of application of force F_{st}. The distance r_{st} , in m, is not to be less than determined from the formula

$$r_{st} = 0{,}25l_{st}. \qquad (2.2.3.2\text{-}5)$$

2.2.3.3 The total torque M_t, in kN·m, for the nozzle rudder is to be determined from the formula

$$M_t = M_n - M_{st} \qquad (2.2.3.3\text{-}1)$$

where M_n = torque of force F_n, in kN·m;
M_{st} = torque of force F_{st}, in kN·m;
M_n and M_{st} are determined from the formulae:

$$M_n = F_n(l_{r.s} - r_n), \qquad (2.2.3.3\text{-}2)$$
$$M_{st} = F_{st}(a + r_{st}) \qquad (2.2.3.3\text{-}3)$$

where a = distance between the centre line of the rudder stock and the leading edge of the stabilizer, in m.

In any case, the total torque M_t for the nozzle rudder is not to be taken less than the minimum value of torque $M_{\min}$, in kN·m, determined from the formula

$$M_{\min} = \frac{28{,}1F_n}{p}(0{,}72l_n - l_{r.s}) + \frac{7{,}8F_{st}}{qm}(l_n - l_{r.s} + 0{,}5l_{st}). \qquad (2.2.3.3\text{-}4)$$

2.2.4 Bending moments and reactions of supports for rudders of types I — IV, VI — XII and nozzle rudders of type V (Fig. 2.2.4.1).

2.2.4.1 The design values of the bending moments and reactions of supports are to be determined from the formulae of this Chapter depending on the types of the rudders shown in Fig. 2.2.4.1 having regard to the provisions of Table 2.2.4.1 as well as the type and location of the steering gear as specified in 2.2.4.2.

Table 2.2.4.1

Type of rudder (see Fig. 2.2.4.1)	Design value of load Q_2	Design value of load Q_1
I, II, VII, VIII	$Q_2 = \left(\frac{F_1}{A} + \frac{F_2}{A_p}\right)A_1$	$Q_1 = F - Q_2$
III — VI and IX — XII	$Q_2 = 0$	

Notes: 1. The value of A_1 is the portion the semispade rudder area below the lower pintle (below section *4* in Fig. 2.2.4.1), in m^2.
2. For nozzle rudders of type V the design value of the ratio $l_{r.s}/l_r$ is taken equal to zero.
3. The force F is taken in accordance with the provisions of 2.2.2 for rudders and of 2.2.3 for nozzle rudders.

2.2.4.2 The transverse force P, in kN, created on the rudder stock by steering gear (quadrant steering gears, steering gears with single-arm tillers and similar steering gears) is determined from the formula

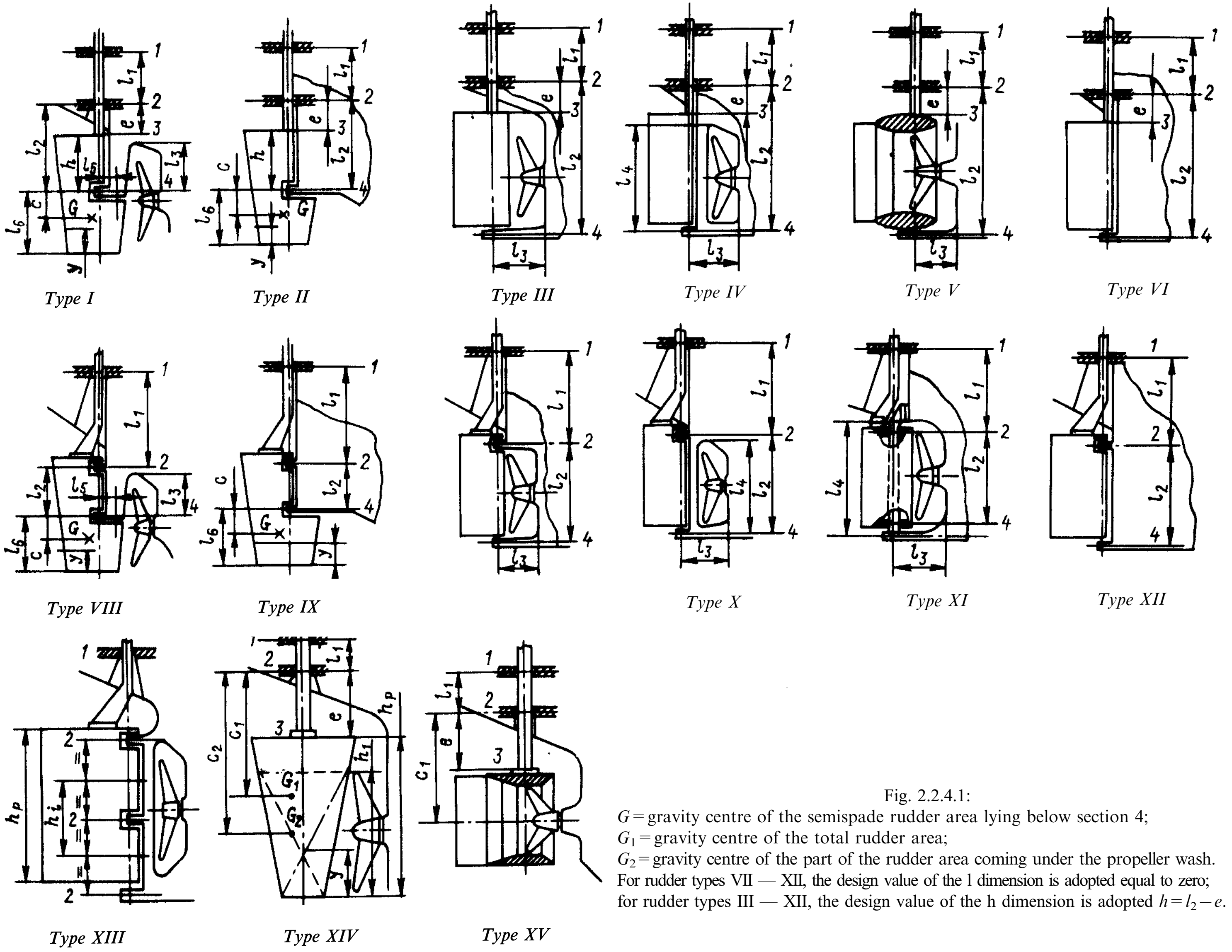
$$P = M_t/r_1 \qquad (2.2.4.2)$$

where M_t = rudder torque, in kN·m, specified in 2.2.2.3 and 2.2.3.3. When considering the astern running of the ship, the rudder torque M_t is taken as the value M_{as} specified in 2.2.2.4;
r_1 = radius of the steering gear quadrant or tiller resultant force arm measured from the centre line of the rudder stock, in m.

Depending on the location of the steering gear quadrant or tiller indicated in Fig. 2.2.4.2 the value P for Case I is taken as P_{I} and the value P_{II} is taken equal to zero. For Case II the value of P is taken as P_{II} and the value of P_{I} is taken equal to zero. The values of P_{I} or P_{II} are assumed to be positive when the quadrant or tiller are located forward of the rudder stock centre line and they are assumed to be negative when the quadrant or tiller are located aft of the rudder stock centre line.

For steering gears the rudder torque of which is transmitted to the rudder stock by a pair (or pairs) of forces (four-piston, rotary vane steering gears or similar) the values of P_{I} and P_{II} are taken equal to zero.

2.2.4.3 In the formulae of the present Chapter the numerical indices of symbols of the bending moments



Type I

Type II

Type III

Type IV

Type V

Type VI

Type VIII

Type IX

Type X

Type XI

Type XII

Type XIII

Type XIV

Type XV

Fig. 2.2.4.1:

G = gravity centre of the semispade rudder area lying below section 4;

G_1 = gravity centre of the total rudder area;

G_2 = gravity centre of the part of the rudder area coming under the propeller wash.

For rudder types VII — XII, the design value of the l dimension is adopted equal to zero;

for rudder types III — XII, the design value of the h dimension is adopted $h = l_2 - e$.

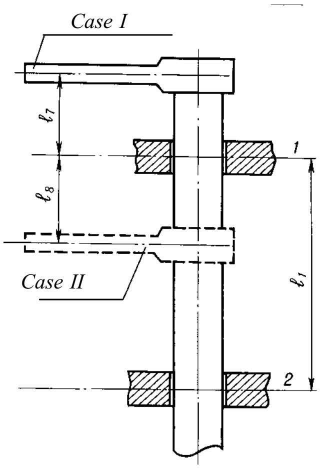


Fig. 2.2.4.2

(M_1, M_2, M_3, M_4) and reactions of supports (R_1, R_2, R_4) correspond to the number of the support or section given in Figs 2.2.4.1 and 2.2.4.2 for the relevant type of the rudder.

2.2.4.4 Unless expressly provided otherwise, in the formulae of the present Chapter the linear dimensions shown in Figs 2.2.4.1 and 2.2.4.2 are to be taken in metres, and the forces, in kN.

2.2.4.5 The design values of the bending moments and reactions of supports may be taken less than those specified in 2.2.4.1 on condition that the detailed calculation is submitted where due consideration is given to the flexibility of the rudder supports and to the non-uniformity of the force distribution over the rudder area.

2.2.4.6 For Case I of the quadrant steering gear or tiller location (see Fig. 2.2.4.2) the design value of bending moment M_1 , in kN·m, in section *1* of the rudder stock (at the upper bearing) is to be determined from the formula

$$M_1 = P_{\mathrm{I}} l_7 \tag{2.2.4.6}$$

where for P_{I} and l_7, see 2.2.4.2 and 2.2.4.4.

For Case II of the steering gear quadrant or tiller location M_1 is taken equal to zero.

2.2.4.7 The design value of the bending moment M_2, in kN·m, acting in section *2* of the rudder stock (at the lower bearing for rudders of types I-VI; in the rudder stock and rudder body coupling for rudders of types VII-XII) is to be determined from the formula

$$M_2 = \frac{1}{8} Q_1 h \frac{k_5}{k_7} - \frac{1}{2} Q_2 c \frac{k_6}{k_7} - \frac{1}{2} P_{\mathrm{I}} l_7 \frac{k_8}{k_7} + \frac{1}{2} P_{\mathrm{II}} l_8 \frac{k_9}{k_7} \tag{2.2.4.7-1}$$

where Q_1, Q_2 = loads determined in accordance with Table 2.2.4.1;
P_{I} , P_{II} = forces determined in accordance with 2.2.4.2;
h, c, l_7 , l_8 = linear dimensions (see 2.2.4.4);
k_5 , k_6 , k_7 , k_8 , k_9 = factors determined from the formulae:

$$k_5 = 2\left(\frac{e}{h}\right)^2\left(3 + \frac{e}{h}\right) + \left(1 + 5\frac{e}{h}\right)\frac{I_{r.s}}{I_r} + 12\left(1 + 2\frac{e}{h}\right)\frac{I_{r.s}\alpha_4}{h^3}; \tag{2.2.4.7-2}$$

$$k_6 = \left(\frac{e}{h}\right)^2\left(3 + \frac{e}{h}\right) + \left(1 + 3\frac{e}{h}\right)\frac{I_{r.s}}{I_r} - 6\left(1 + \frac{l_2}{c}\right)\frac{I_{r.s}\alpha_4}{h^3}; \tag{2.2.4.7-3}$$

$$k_7 = \left(1 + \frac{e}{h}\right)^2\left(1 + \frac{e}{h} + \frac{l_1}{h}\right) - 1 + \frac{I_{r.s}}{I_r} + 3\frac{I_{r.s}\alpha_4}{h^3}; \tag{2.2.4.7-4}$$

$$k_8 = l_1 l_2^2/h^3; \tag{2.2.4.7-5}$$

$$k_9 = \frac{l_1 l_2^2}{h^3}\left(1 - \frac{l_8^2}{l_1^2}\right) \tag{2.2.4.7-6}$$

where e, l_1 and l_2 = linear dimensions (see 2.2.4.4);
$I_{r.s}$ = mean moment of inertia of the rudder stock cross-section, in cm^4;
Ir = mean moment of inertia of the rudder cross-section at the portion between sections *3* — *4* (rudder types I — VI) or between sections *2* — *4* (rudder types VII — XII), in cm^4;
α_4 = coefficient determined in accordance with the provisions of 2.2.4.17 to 2.2.4.21 depending on the type of the rudder, in m^3/cm^4.

2.2.4.8 The design value of the bending moment M_3, in kN·m, acting in section *3* of the rudder stock (in the rudder stock and rudder body coupling for rudders of types I — VI) is to be determined from the formula

$$M_3 = M_2 \frac{h}{l_2} + Q_2 c \frac{e}{l_2} - \frac{1}{2} Q_1 h \frac{e}{l_2}. \tag{2.2.4.8}$$

2.2.4.9 The design value of the bending moment M_4, in kN·m, acting in section *4* of the rudders of types I, II, VII and VIII is to be determined from the formula

$$M_4 = Q_2 c. \tag{2.2.4.9}$$

For rudders of these types the value of M_4 is taken as the bending moment acting in any rudder cross-section above support *4* of the rudder.

For other rudders the value of the bending moment M_4 is taken equal to zero.

2.2.4.10 The design value of the reaction R_1 , in kN, of support *1* of the rudder (of the upper bearing) is to be determined from the formula

$$R_1 = \frac{M_2}{l_1} - P_{\mathrm{I}}\left(1 + \frac{l_7}{l_1}\right) - P_{\mathrm{II}}\left(1 - \frac{l_8}{l_1}\right). \tag{2.2.4.10}$$

2.2.4.11 The design value of the reaction R_2 , in kN, of support *2* of the rudder (of the lower bearing for rudder types I — VI, of the upper bearing of the rudder axle for rudder type XI, of the upper pintle of rudders for types VII — X and XII) is to be determined from the formula

$$R_2 = -M_2\left(\frac{1}{l_1} + \frac{1}{l_2}\right) + Q_2\frac{c}{l_2} - \frac{1}{2} Q_1 \frac{h}{l_2} + P_{\mathrm{I}}\frac{l_7}{l_1} - P_{\mathrm{II}}\frac{l_8}{l_1}. \tag{2.2.4.11}$$

2.2.4.12 The design value of the reaction R_4 , in kN, of support *4* of the rudder (of the lower pintle) is to be determined from the formula

$$R_4 = \frac{M_2}{l_2} - \frac{1}{2}Q_1\Big(1 + \frac{e}{l_2}\Big) - Q_2\Big(1 + \frac{c}{l_2}\Big). \qquad (2.2.4.12)$$

2.2.4.13 The design value of the bending moment M_r, in kN·m, acting in the considered section of the lower part of the semispade rudder body (below section *4* shown in Fig. 2.2.4.1 for rudder types I, II, VII and VIII) is to be determined from the formula

$$M_r = \frac{1}{2} Q_2 \frac{y^2}{l_6} \qquad (2.2.4.13)$$

where y, l_6 = linear dimensions (see 2.2.4.4).

2.2.4.14 The design value of the bending moment M_r, in kN·m, acting in any cross-section of the rudders of types III, IV, VI and IX — XII is to be determined from the formula

$$M_r = \frac{1}{2}M_2\frac{h}{l_2}\Big(2 - \frac{h}{l_2} - \frac{M_2}{Q_1 l_2}\Big) - \frac{1}{8}\,Q_1 h\Big(2 - \frac{h}{l_2}\Big)^2. \qquad (2.2.4.14)$$

2.2.4.15 The design value of the bending moment $M_{r·a}$, in kN·m, acting in the section of the rudder axle near its flange is to be determined from the formula

$$M_{r·a} = R_4 l_4\Big[0{,}42\frac{(l_4 - l_2)}{l_4} + 0{,}24\,\frac{l_3}{l_4}\,\frac{I_{r·p}}{I_s} + 0{,}15\Big(\frac{l_3}{l_4}\Big)^2\Big] \qquad (2.2.4.15)$$

where l_3, l_4 = linear dimensions (see 2.2.4.4);
$I_{r·p}$ = mean moment of inertia of the rudder axle or rudder post cross-section, in cm^4;
I_s = mean moment of inertia of the solepiece cross-section, in cm^4.

2.2.4.16 For Case II of the steering gear quadrant or tiller location (see Fig. 2.2.4.2) the design value of the bending moment M_s, in kN·m, acting in the section of the rudder stock in way of the quadrant or tiller location is to be determined from the formula

$$M_s = R_1 l_8. \qquad (2.2.4.16)$$

For Case I of the steering gear quadrant or tiller location M_s is taken equal to zero.

2.2.4.17 The coefficient α_4 , in m^3/cm^4, for rudders of types I and VII (for the horn of the semispade rudder) is to be determined from the formula

$$\alpha_4 = \frac{1{,}07 l_3^3}{3I_1}\Big(4 - 3\,\frac{b_{h0}}{b_{h1}}\Big) + \frac{1{,}3 l_5^2 l_3}{I_2}\Big(1 + \frac{b_{h1}}{b_{h0}}\Big)\frac{b_{h1}}{b_{h0}} \qquad (2.2.4.17\text{-}1)$$

where l_5 = linear dimension (see 2.2.4.4);
I_1 = moment of inertia of the rudder horn cross-section at its root about the axis parallel to the centre plane of the ship, in cm^4;
b_{h0} = maximum width of the horizontal section of the rudder horn at the lower pintle (section *4* in Fig. 2.2.4.1), in m;
b_{h1} = maximum width of the horizontal section of the rudder horn at its root, in m;
I_2 = polar moment of inertia of the rudder horn cross-section at its root, in cm^4, determined from the formula

$$I_2 = \frac{4A_{r·h}^2}{\sum\limits_{i=1}^{n} l_{0i}/s_{0i}} \qquad (2.2.4.17\text{-}2)$$

where $A_{r.h}$ = area enclosed by the centre line of the rudder horn plating (with the cross-section at the horn root), in cm^2;
l_{0i} = length of the centre line of the rudder horn plating (in the cross-section at the horn root) of the given thickness, in cm;
s_{0i} = thickness of the considered portion of the rudder horn plating with the length l_{0i} , in cm;
n = number of portions of the rudder horn plating with the length l_{0i} and thickness s_{0i} .

2.2.4.18 The coefficient α_4, in m^3/cm^4, for rudders of types III, V and IX (for the solepiece) is to be determined from the formula

$$\alpha_4 = \frac{l_3^3}{3I_{s1}}\Big(4 - 3\,\frac{b_{s0}}{b_{s1}}\Big) \qquad (2.2.4.18)$$

where I_{s1} = moment of inertia of the solepiece cross-section at its root about the vertical axis, in cm^4;
b_{s0} = width of the solepiece cross-section at the rudder or nozzle rudder pintle, in cm;
b_{s1} = width of the solepiece cross-section at its root, in cm.

2.2.4.19 The coefficient α_4, in m^3/cm^4, for rudders of types IV and X (for the rudder post with the solepiece) is to be determined from the formula

$$\alpha_4 = \frac{l_3^3}{3I_s}\Big(0{,}075\frac{I_s}{I_{r·p}} + 0{,}334\frac{l_4}{l_3}\Big). \qquad (2.2.4.19)$$

2.2.4.20 The coefficient α_4 , in m^3/cm^4, for rudders of type XI (for rudder axle with the solepiece) is to be determined from the formula

$$\alpha_4 = \frac{l_3^3}{3I_s}\Big\{\Big(0{,}075\,\frac{I_s}{I_{r·p}} + 0{,}334\,\frac{l_4}{l_3}\Big) - 0{,}282\,\frac{(l_4 - l_2)}{l_4}\times$$

$$\times\Big[1{,}55\frac{l_4}{l_3} + 0{,}053\Big(\frac{l_4}{l_3}\Big)^2 + \frac{(l_4 - l_2)}{l_4}\frac{I_s}{I_{r·p}}\Big]\Big\}. \qquad (2.2.4.20)$$

2.2.4.21 The coefficient a_4 for rudders of types II, VI, VIII and XII is to be taken equal to zero.

2.2.5 Bending moments and reactions of supports for rudder type XIII (Fig. 2.2.4.1).

2.2.5.1 The requirements of 2.2.4.2 to 2.2.4.6 and 2.2.4.16 are also applicable to the rudders of type XIII.

2.2.5.2 The design value of the bending moment acting in way of the rudder stock and rudder body coupling is to be taken equal to zero.

2.2.5.3 The design value of the bending moment M_r, in kN·m, acting in any cross-section of the rudder is to be taken from the formula

$$M_r = 0{,}1Fh_i^2/h_r \qquad (2.2.5.3)$$

where F = force determined according to the provisions of 2.2.2.1, 2.2.2.2 and 2.2.2.5, in kN;

h_i, h_r = linear dimensions (see 2.2.4.4); in this case, the greater of the value h_i is to be taken as the design value.

2.2.5.4 The design value of the reaction R_1 of support *1* of the rudder (of the upper bearing) is to be taken equal to zero.

2.2.5.5 The design value of the reaction R_2 , in kN, of support *2* of the rudder (of any pintle) is to be determined from the formula

$$R_2 = Fh_i/h_r. \qquad (2.2.5.5)$$

2.2.6 Bending moments and reactions of supports for rudder type XIV (Fig. 2.2.4.1).

2.2.6.1 The requirements of 2.2.4.2 to 2.2.4.6 and 2.2.4.16 are also applicable to the rudders of type XIV.

2.2.6.2 The design value of the bending moment M_2, in kN·m, acting in section *2* of the rudder stock (at the lower bearing) is to be determined from the formula

$$M_2 = F_1c_1 + F_2c_2 \qquad (2.2.6.2)$$

where F_1, F_2 = forces determined according to the provisions of 2.2.2.1, 2.2.2.2 and 2.2.2.5, in kN;

c_1, c_2 = linear dimensions (see 2.2.4.4), in m.

2.2.6.3 The design value of the bending moment M_3, in kN·m, acting in section *3* of the rudder stock (in the rudder stock and rudder body coupling) is to be determined from the formula

$$M_3 = F_1(c_1 - e) + F_2(c_2 - e) \qquad (2.2.6.3)$$

where e = linear dimension (see 2.2.4.4), in m.

2.2.6.4 The design value of the bending moment M_r, in kN·m, acting in the considered section of the rudder body is to be determined from the formulae:

for sections with $y < h_1$

$$M_r = \frac{1}{2}\left(\frac{F_1}{h_r} + \frac{F_2}{h_1}\right)y^2 \qquad (2.2.6.4\text{-}1)$$

for sections with $y \geqslant h_1$

$$M_r = \frac{1}{2}\frac{F_1}{h_r}y^2 + F_2\left(y - \frac{1}{2}h_1\right) \qquad (2.2.6.4\text{-}2)$$

where h_r, h_1 and y = linear dimensions (see 2.2.4.4), in m.

2.2.6.5 The design value of the reaction R_1, in kN, of support *1* of the rudder (of the upper bearing) is to be determined from the formula

$$R_1 = F_1\frac{c_1}{l_1} + F_2\frac{c_2}{l_1} - P_{\text{I}}\left(1 + \frac{l_7}{l_1}\right) - P_{\text{II}}\left(1 - \frac{l_8}{l_1}\right) \qquad (2.2.6.5)$$

where l_1 = linear dimension (see 2.2.4.4), in m.

2.2.6.6 The design value of the reaction R_2 , in kN, of support *2* of the rudder (of the lower bearing) is to be determined from the formula

$$R_2 = F_1\left(1 + \frac{c_1}{l_1}\right) + F_2\left(1 + \frac{c_2}{l_1}\right) - P_{\text{I}}\frac{l_7}{l_1} + P_{\text{II}}\frac{l_8}{l_1}. \qquad (2.2.6.6)$$

2.2.7 Bending moments and reactions of supports for nozzle rudders of type XV (Fig. 2.2.4.1).

2.2.7.1 The requirements of 2.2.4.2 to 2.2.4.4, 2.2.4.6 and 2.2.4.16 are also applicable to the nozzle rudder of type XV.

2.2.7.2 The design value of the bending moment M_2, in kN·m, acting in section *2* of the rudder stock (at the lower bearing) is to be determined from the formula

$$M_2 = Fc_1 \qquad (2.2.7.2)$$

where F = force determined according to the provisions of 2.2.3.1, in kN;

c_1 = linear dimension (see 2.2.4.4), in m.

2.2.7.3 The design value of the bending moment M_3, in kN·m, acting in section *3* of the rudder stock (at the rudder stock and nozzle rudder coupling) is to be determined from the formula

$$M_3 = F(c_1 - e) \qquad (2.2.7.3)$$

where e = linear dimension (see 2.2.4.4), in m.

2.2.7.4 The design value of the reaction R_1, in kN, of support *1* (of the upper bearing) is to be determined from the formula

$$R_1 = F\frac{c_1}{l_1} - P_{\text{I}}\left(1 + \frac{l_7}{l_1}\right) - P_{\text{II}}\left(1 - \frac{l_8}{l_1}\right) \qquad (2.2.7.4)$$

where l_1 = linear dimension (see 2.2.4.4), in m.

2.2.7.5 The design value of the reaction R_2 , in kN, of support *2* (of the lower bearing) is to be determined from the formula

$$R_2 = F\left(1 + \frac{c_1}{l_1}\right) - P_{\text{I}}\frac{l_7}{l_1} + P_{\text{II}}\frac{l_8}{l_1}. \qquad (2.2.7.5)$$

2.2.8 The design values of bending moments and reactions of supports for the steering gears which differ from those indicated in Fig. 2.2.4.1 are subject to special consideration by the Register.

2.3 RUDDER STOCK

2.3.1 The diameter of the rudder head d_0 , in cm, is to be not less than the greater value determined from the formula

$$d_0 = k_{10}\sqrt[3]{M_t/R_{eH}} \qquad (2.3.1)$$

where k_{10} = factor equal to:
26,1 for the ahead condition;
23,3 for the astern condition;
M_t = torque according to 2.2.2.3, 2.2.2.4 or 2.2.3.3, in kN·m;
R_{eH} = upper yield stress of the rudder stock material, in MPa.

2.3.2 Under combined action of the torque and bending moment the working stresses (see 1.5.1) acting in rudder stock sections *1, 2* or *3* shown in Fig. 2.2.4.1 for the appropriate type of the rudder are not to exceed 0,5 times the upper yield stress for the ahead condition and 0,7 times the upper yield stress of the material for the astern condition (see 1.5.2 and 2.1.5). In this case, the normal stress σ and the shear stress τ, in MPa, are to be determined from the formulae:

$$\sigma = 10{,}2 \cdot 10^3 M_b \cdot d_i^3; \qquad (2.3.2\text{-}1)$$

$$\tau = 5{,}1 \cdot 10^3 M_t \cdot d_i^3 \qquad (2.3.2\text{-}2)$$

where M_b = bending moment acting in the considered section of the rudder stock (M_1, M_2 or M_3) determined according to the provisions of 2.2.4 to 2.2.7 for the appropriate type of the rudder, in kN·m;
d_1 = diameter of the rudder stock in the considered section, in cm.

2.3.3 The change in the rudder stock diameter between the adjacent sections specified in 2.3.1 and 2.3.2 is not to be more sudden than that permitted by the linear law.

Where the change of the rudder stock diameter is stepped, the steps are to be provided with fillets having as large radius as practicable. The transition of the rudder stock into the flange is to be carried out with a radius of fillet of not less than 0,12 times the diameter of the rudder stock in way of the flange.

2.4 RUDDER

2.4.1 Ordinary rudders.

2.4.1.1 The thickness of the streamlined rudder side plating *s*, in mm, is to be not less than determined from the formula

$$s = ak_{11}\sqrt{\frac{98d + k_{12}\left(\frac{F_1}{A} + k_{13}\frac{F_2}{A_p}\right)}{R_{eH}}} + 1{,}5 \qquad (2.4.1.1\text{-}1)$$

where d = draught of the ship, in m;
F_1, F_2 = forces according to 2.2.2.1 and 2.2.2.2, kN;
for A and A_p, see 2.2.2.1;
a = distance between horizontal or vertical web plates, whichever is the less, in m;
k_{11} = factor determined from the formula

$$k_{11} = 10{,}85 — 2{,}516\left(\frac{a}{b}\right)^2; \qquad (2.4.1.1\text{-}2)$$

R_{eH} = upper yield stress of the rudder plating material, in MPa;
b = distance between horizontal or vertical web plates whichever is the greater, in m;
k_{12} = factor equal to:
18,6 for the rudder plating within 0,35 of the rudder length from its leading edge;
8,0 for the rudder plating within 0,65 of the rudder length from its rear edge;
k_{13} = factor equal to:
1 for the rudder plating in the wake of the propeller (when rudder is in the non-reversed position);
0 for the rudder plating beyond the wake of the propeller (when rudder is in the non-reversed position).

2.4.1.2 In any case, the thickness of the streamlined rudder side plating $s_{\min}$, in mm, is to be not less than determined from the formulae:

for ships of less than 80 m in length

$$s_{\min} = 21{,}5\frac{L + 51}{L + 240}; \qquad (2.4.1.2\text{-}1)$$

for ships of 80 m in length and over

$$s_{\min} = 24\frac{L + 37}{L + 240} \qquad (2.4.1.2\text{-}2)$$

where L = length of the ship, in m.

2.4.1.3 For the ship assigned an ice category the thickness of the rudder side plating in way of the ice belt is to be not less than that of the ice belt of the shell plating in the after part of the ship, specified in 3.10.4.1, Part II "Hull", with the frame spacing being equal to the distance between the vertical web plates of the rudder.

The thickness *s*, in mm, of the rudder side plating for the icebreakers is to be not less than determined from the formula

$$s = 9{,}2k_{16}a\sqrt{\frac{p_a}{R_{eH}}} + 6 \qquad (2.4.1.3\text{-}1)$$

where a = distance between horizontal or vertical web plates, whichever is the less, for streamlined welded rudders; distance between rudder arms for single-plate steel solid-cast rudders, m. In any case, in the calculations the value a is not to be taken less than 0,6 m;
p_a = intensity of ice pressure in the CI region determined according to 3.10.3.5.2, Part II "Hull", in kPa;
R_{eH} = upper yield stress of the material of the rudder plating, in MPa;
k_{16} = factor determined for streamlined welded rudders from the formula

$$k_{16} = 1 — 0{,}38(a/b)^2 \qquad (2.4.1.3\text{-}2)$$

where b = distance between horizontal or vertical web plates, whichever is the greater, in m.

For single-plate steel solid-cast rudders the value of k_{16} shall be taken in the calculations equal to 1.

2.4.1.4 The streamlined rudder side plating is to be stiffened from the inside by horizontal and vertical web plates. The thickness of the web plates is to be not less than that of the rudder side plating.

The side plating and web plates are to be welded together by fillet or plug welds with slots of linear form. Dimensions of elements of plug welds are selected according to 1.7.5.13, Part II "Hull". The thickness of the steel flats is to be not less than that of the rudder side plating.

The horizontal and vertical web plates are to be provided with sufficient number of openings for free drainage of water which may penetrate inside the rudder.

The rear edge of the rudder is to be rigidly fixed in the proper way.

2.4.1.5 The streamlined rudders are to be provided with top and bottom plates, the thickness of which is to be not less than 1,2 times the greater value of the side plating thickness according to 2.4.1.1. The top and bottom plates are to be fitted with drain plugs of corrosion-resistant metal.

2.4.1.6 The corners of the openings (in way of the pintles) in the side plating of the semispade rudder are to be rounded off. The radius of curvature is to be not less than 2 times the side plating thickness in this area, and the free edge of the rudder side plating is to be thoroughly stripped.

2.4.1.7 Near the rotation axis of the streamlined rudder one or several vertical web plates are to be provided ensuring the general strength of the rudder body. The section modulus of these web plates, including the effective flanges, is to be such that the normal stresses in the considered section are not more than 0,5 times the upper yield stress of the material of the rudder side plating (see 1.5.2).

The normal stresses σ, in MPa, are to be calculated from the formula

$$\sigma = 1000M_b/W \qquad (2.4.1.7)$$

where M_b = bending moment in the considered section of the rudder (M_4 or M_r) determined according to the provisions of 2.2.4 to 2.2.6 for the appropriate type of the rudder, in kN·m;
W = section modulus of the considered section of the web plates, including the effective flanges, about the axis of symmetry of the rudder profile, in cm^3.

The dimensions of the effective flanges of the web plates are to be as follows:

the thickness equal to that of the rudder side plating;

the width equal to 1/6 of the rudder height or 1/2 of the distance between the nearest web plates located on both sides of the considered web plate, whichever is the less.

2.4.1.8 Special care is to be given to the reliable securing to the rudder body of the flange for coupling the rudder body and the rudder stock and of the gudgeons for pintles.

2.4.1.9 At the leading edge of the single-plate steel solid-case rudders of the ice-breakers the rudder piece is to be provided over the entire height of the rudder.

The combined stresses σ_{com}, in MPa, developed in any horizontal section of the rudder piece and determined from the formula given below are not to exceed 0,5 times the upper yield stress of the rudder material

$$\sigma_{com} = 1000\sqrt{\left(\frac{M_r}{W}\right)^2 + 3\left(\frac{M_t y}{h_r \rho S}\right)^2} \qquad (2.4.1.9)$$

where M_r = bending moment determined according to the provisions of 2.2.5.3, in kN·m;
M_t = torque according to 2.2.2.3, in kN·m;
h_r = height of the rudder measured on the rudder stock centre line, in m;
y = distance between the considered section and the lower edge of the rudder (Fig. 2.4.1.9), in m;
W = section modulus of the considered cross-section of the rudder piece about the axis O_1 — O_2 , ignoring the rudder plating (the rudder piece section taken into account in the calculation of W is hatched in section I — I of Fig. 2.4.1.9), in cm^3;
S = area of the considered cross-section of the rudder piece (see hatched area in section I — I of Fig. 2.4.1.9), in cm^2;
p = distance between the centroid of the area S and the rudder stock centre line, in cm.

2.4.1.10 The single-plate steel solid-case rudder is to be stiffened by the rudder arms founded on both sides of the rudder at the level of each gudgeon (see Fig. 2.4.1.9).

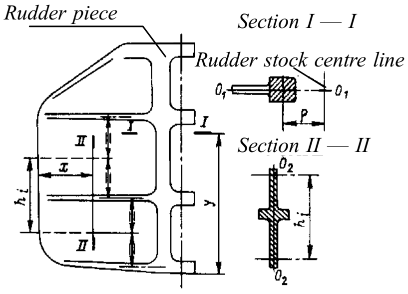


Fig. 2.4.1.9

The section modulus of the considered cross-section of the rudder arms W, in cm^3, (including the body of the rudder within the dimension h_i , see section II — II in Fig. 2.4.1.9) about the axis O_2 — O_2 is to be not less than determined from the formula

$$W = \frac{1000 h_i x^2 F}{A R_{eH}} \qquad (2.4.1.10)$$

where F = force determined according to the provisions of 2.2.2.2, kN;
A = rudder area, in m^2;
h_i = linear dimension, in m (see Fig. 2.4.1.9);
x = distance between the considered section and the rear edge of the rudder, m (see Fig. 2.4.1.9);
R_{eH} = upper yield stress of the rudder material, in MPa.

2.4.2 Nozzle rudders.

2.4.2.1 The thickness s_0, in mm, of the nozzle rudder outside plating is to be not less than determined from the formula*

$$s_0 = k_{14} l_1 \sqrt{\frac{98 D_n l_n d + 20 F_n}{D_n l_n R_{eH}}} + 2 \qquad (2.4.2.1\text{-}1)$$

where D_n = inner minimum nozzle bore, in m;
l_n = length of the nozzle rudder, in m;
d = draught of the ship, in m;
F_n = force acting on the nozzle rudder according to 2.2.3.1, in kN;
R_{eH} = upper yield stress of the material of the nozzle rudder outside plating, in MPa;
k_{14} = factor determined from the formula

$$k_{14} = 7{,}885 — 2{,}221(l_1/u_1)^2; \qquad (2.4.2.1\text{-}2)$$

u_1 = distance between the longitudinal web plates measured along the length of the nozzle rudder outside plating, in m. This distance is not to exceed 1000 mm;
l_1 = distance between transverse web plates or between the transverse web plate and the nearest edge of the nozzle rudder, in m. This distance is not to exceed 600 mm.

2.4.2.2 The thickness s_{in}, in mm, of the nozzle rudder inside plating, except for its middle belt, is to be not less than:

$$s_{in} = 6{,}39 \frac{l_1}{D_n} \sqrt{T} \qquad (2.4.2.2\text{-}1)$$

where T = propeller thrust at speed v, in kN.

The thickness s_m, in mm, of the middle belt of the nozzle rudder inside plating is to be not less than:

$$s_m = 7{,}34 \frac{l_2}{D_n} \sqrt{T} + 0{,}51 \frac{T}{D_n^2} \qquad (2.4.2.2\text{-}2)$$

where l_2 = distance between transverse web plates situated in way of the middle belt of the inside plating, in m.

In case of application of stainless or clad steel the value of s_m may be reduced on agreement with the Register.

2.4.2.3 In any case, the thickness of the outside and inside plating of the nozzle rudder is to be not less than that given in 2.4.1.2.

2.4.2.4 The middle belt of the nozzle rudder inside plating is to extend not less than $0{,}05D_n$ forward and not less than $0{,}1D_n$ aft of the propeller blade tips. Its breadth is to be at least equal to the maximum breadth of the side projection of the propeller blade.

2.4.2.5 The outside and inside plating of the nozzle rudder is to be stiffened from the inside by transverse and longitudinal web plates. The spacing of the web plates is to comply with the requirements of 2.4.2.1. At least four longitudinal web plates are to be provided which are equally spaced around the circumference of the nozzle rudder.

The thickness of web plates, except those situated in way of the middle belt of the nozzle rudder inside plating, is to be not less than the thickness of the outside plating according to 2.4.2.1 and 2.4.2.3.

The transverse and longitudinal web plates are to be welded to the nozzle rudder inside plating by double side continuous welds with full penetration on the inside of the nozzle rudder. When the thickness of the web plates is 10 mm and more, edge preparation is to be carried out.

The outside plating and web plates are to be connected by plug welding with slots of linear form or by backing welding. The dimensions of elements of plug welds with slots of linear form are selected according to 1.7.5.13, Part II "Hull".

The transverse and longitudinal web plates are to be provided with sufficient number of openings for free drainage of water which might penetrate inside the nozzle rudder, and in the lower and upper parts of the outside plating the drain plugs of stainless metal are to be fitted. The distance from the opening edge to the inside and outside plating of the nozzle rudder is to be not less than 0,25 times the web plate height.

It is not allowed to weld on doubling plates to the inside plating of the nozzle rudder.

2.4.2.6 In way of the middle belt of the nozzle rudder inside plating at least two continuous transverse web plates are to be fitted. The thickness of these web plates is to be not less than the thickness of the inside plating off its middle belt as per the Formula (2.4.2.2-1).

2.4.2.7 Special care is to be given to the reliable securing of the nozzle flange, welded-in bush and other nozzle rudder welded-in parts for connecting the nozzle rudder welded-in parts for connecting the nozzle rudder with its stock and pintle.

2.4.2.8 The thickness s_{st} of the stabilizer plating, in mm, is to be not less than determined from the formula

$$s_{st} = k_{14} l_1 \sqrt{\frac{98 A_{st} d + 20 F_{st}}{A_{st} R_{eH}}} + 2 \qquad (2.4.2.8)$$

where A_{st} = area of the nozzle rudder stabilizer, in m^2;
F_{st} = force acting on the stabilizer according to the Formula (2.2.3.1-3), in kN;
k_{14} = factor according to Table 2.4.2.1 when the distance between horizontal web plates equals to u_1, in m;
l_1 = distance between vertical web plates or between the web plate and fore or aft edge of the stabilizer, in m;
R_{eH} = upper yield stress of material of the stabilizer plating, in MPa.

2.4.2.9 The nozzle rudder stabilizer plating is to be stiffened from the inside by horizontal and vertical web plates having the thickness not less than that of the plating in accordance with 2.4.2.8.

The stabilizer body is to terminate in top and bottom plates. The thickness of top and bottom plates is not to be less than 1,5 times the thickness of the plating according to 2.4.2.8. Vertical web plates are to be securely connected to top and bottom plates.

The plating and horizontal and vertical web plates are to be welded together by fillet or plug welds.

The types of plug welds with slots of linear form are selected according to 1.7.5.13, Part II "Hull".

The horizontal and vertical web plates are to be provided with sufficient number of openings, and top and bottom plates are to be fitted with drain plugs of corrosion-resistant material.

2.4.2.10 In way of attachment of the stabilizer to the nozzle rudder one or several vertical web plates are to be provided ensuring general strength of the stabilizer. The section modulus W_{st}, in cm^3, of these web plates, the effective flange included, is to be not less than determined from the formula

$$W_{st} = 1390 F_{st} h_{st} / R_{eH} \qquad (2.4.2.10)$$

where F_{st} = force acting on the stabilizer according to the Formula (2.2.3.1-3), in kN;

h_{st} = stabilizer height, in m;

R_{eH} = upper yield stress of the material used, in MPa.

The effective flange dimensions are to be as follows: thickness equal to the stabilizer plating thickness; width equal to 1/5 of the stabilizer height.

2.4.2.11 The nozzle rudder and stabilizer are to be so connected that rigid fixation of the latter is ensured.

The force F_{st} determined from the Formula (2.2.3.1-3) and uniformly distributed with the height of the stabilizer is to be taken in strength calculations as a force acting on the stabilizer. Depending on the type of connection a torque of force F_{st} acting on this connection is to be considered with regard to the point of application of this force (see the Formula (2.2.3.2-3). In this case, stresses developed in the connection (see 1.5.1) shall not exceed 0,4 times the upper yield stress of the material.

2.5 COUPLINGS

2.5.1 Horizontal flange coupling.

2.5.1.1 The diameter of the coupling bolts d_1 , in cm, is to be not less than:

$$d_1 = 0{,}62\sqrt{\frac{d_2^3 R_{eH_1}}{z_1 r_2 R_{eH_2}}} \qquad (2.5.1.1\text{-}1)$$

where d_2 = diameter of the rudder stock at the coupling flange, in cm;

z_1 = number of coupling bolts;

r_2 = mean distance from the centre of the bolts to the centre of the system of the flange bolt holes, in cm;

R_{eH1} = upper yield stress of the rudder stock material, in MPa;

R_{eH2} = upper yield stress of the bolt material, in MPa.

The coupling bolt diameter at the bottom of threads d_3 , in cm, is to be not less than determined from the formula

$$d_3 = 76{,}84\sqrt{\frac{M_b}{z_1 r_3 R_{eH_2}}} \qquad (2.5.1.1\text{-}2)$$

where M_b = bending moment acting in the rudder stock section at the flange (M_2 or M_3) determined according to the provisions of 2.2.4 to 2.2.7 for the appropriate type of the rudder, in kN·m;

r_3 = mean distance from the centre of the bolts to the longitudinal axis of symmetry of the flange, in cm.

The number of bolts z_1 is to be not less than 6.

The mean distance from the centre of the bolts to the centre of the system of the flange bolt holes is to be not less than 0,9 times the rudder stock diameter according to 2.3.1. When the coupling is under the action of the bending moment, the mean distance from the centre of the bolts to the longitudinal axis of symmetry of the flange is to be not less than 0,6 times the rudder stock diameter at the flange.

2.5.1.2 Only fitted bolts are to be employed, except the cases of a key setting when it is sufficient to have only two fitted bolts. The nuts shall have standard sizes. The bolts and nuts shall be efficiently secured.

2.5.1.3 The thickness of the coupling flanges is not to be less than the diameter of the bolts. The centres of the holes for bolts are to be distant from the outside edges of the flange by not less than 1,15 times the diameter of the bolts.

2.5.1.4 When coupling flanges of nozzle rudders are not built into the nozzle rudder body but connected to it by the structure formed of sheets, the strength of this structure shall be equivalent to that of the rudder stock in accordance with 2.3.2. In this case, the calculated combined stress shall not exceed 0,4 times the upper yield stress of the material used.

2.5.2 Keyed cone coupling.

2.5.2.1 Where the rudder stock has a tapered lower end fitted to the rudder or nozzle rudder and secured by nut and key, the length of the taper is not to be less than 1,5 times the diameter of the rudder stock according to 2.3.2 and the taper is not to be greater than 1:10 on the diameter. The taper is to change into cylindrical portion without any step in the diameter.

2.5.2.2 A key is to be set on the cone generatrix. The ends of the key are to be fairly rounded. The working sectional area of the key A_k (product of the key length by its width), in cm^2, shall be not less than the greater value determined from the formula

$$A_k = \frac{k_{15} M_t}{d_m R_{eH}} \qquad (2.5.2.2)$$

where k_{15} = factor equal to:
6920 for rudders for the ahead condition and for nozzle rudders;
4950 for rudders for the astern condition;

M_t = torque according to 2.2.2.3, 2.2.2.4 or 2.2.3.3, in kN·m;

d_m = diameter of the taper section at the middle of the key length, in cm;

R_{eH} = upper yield stress of the key material, in MPa.

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

The keyway of the rudder stock shall be confined to the tapered coupling.

2.5.2.3 The external diameter of the rudder stock threaded portion is not to be less than 0,9 times the minimum diameter of the taper. The thread is to be fine.

The outer diameter and height of the nut are not to be less than 1,5 and 0,8 times the external diameter of the rudder stock threaded portion, respectively. To prevent self-unscrewing, the nut is to be securely fastened at least by two welded-on strips or one welded-on strip and a split pin.

2.5.3 Keyless cone coupling.

2.5.3.1 The requirements of 2.5.3 are applicable to a keyless fitting of the stock to the rudder or nozzle rudder which is made by oil injection method.

2.5.3.2 The taper length of the stock fitted to the rudder or nozzle rudder is not to be less than 1,5 times the diameter of the stock according to 2.3.2; the taper on the diameter is to be 1:15.

2.5.3.3 The rudder or nozzle rudder is to be a good fit on the rudder stock cone. During the fit up, and before the push-up load is applied, an area of contact of at least 70 per cent of the theoretical area of contact is to be achieved, and this is to be distributed evenly.

The relationship of the rudder or nozzle rudder to stock at which this occurs is to be marked, and push-up length then measured from that point.

In well-founded cases another method of determining the original position of the stock and boss cones relationship can be used on agreement with the Register.

2.5.3.4 To ensure the required interference in the cone coupling the push-up length of the rudder stock (see 2.5.3.3) during its fitting shall be not less than determined from the formula

$$s_1 = \frac{1,1q}{EK}\left[\frac{2d_m}{1 - \left(\frac{d_m}{d_c}\right)^2} + 35,7\right] \qquad (2.5.3.4\text{-}1)$$

where s_1 = push-up length of the rudder stock, in mm;
d_m = mean diameter of the rudder stock taper, in mm;
d_c = outer diameter (or minimum outer dimension) of rudder boss or nozzle rudder (in the mean section), in mm;
E = modulus of elasticity of rudder stock material, in MPa;
K = taper of conical coupling, on the diameter;
q = required contact pressure applied to mating surfaces during the push-up, in MPa, determined from the formula

$$q = \frac{4,25\cdot10^6 nM_t}{d_m^2\, L_a}\sqrt{1 + \left(\frac{5\cdot10^{-6}Qd_m}{M_t}\right)^2} \times \left(1 + 0,257\frac{L_a}{d_m}\frac{M_b}{M_t}\right) \qquad (2.5.3.4\text{-}2)$$

where M_t = maximum value of design torque according to 2.2.2.3, 2.2.2.4 or 2.2.3.3, in kN·m;
M_b = maximum bending moment in way of cone coupling determined according to 2.2.4.8, 2.2.6.3 or 2.2.7.3, in kN·m;
Q = mass of rudder or nozzle rudder, in kg;
L_a = actual length of the contact part of taper, excluding the oil distribution grooves and similar devices, in mm;
n = safety factor against friction slip under the action of rated torque.

The spade rudders and nozzle rudders (types XIV and XV, Fig. 2.2.4.1) the value n is to be taken not less than 2,5; for other types of rudders and nozzle rudders this value shall be not less than 2,0.

If the contact pressure q determined from the Formula (2.5.3.4-2) is less than 40 MPa, then q = 40 MPa is to be taken in the calculations.

2.5.3.5 The strength of the maximum loaded part of the coupling shall be checked: the combined stress on the inside of the rudder boss or nozzle rudder shall not exceed 0,85 of the yield stress of the boss material. The combined stress on the inside of the boss is to be determined from the formula

$$\sigma_1 = \sqrt{0,5(\sigma_1 — \sigma_2)^2 + 0,5(\sigma_2 — \sigma_3)^2 + 0,5(\sigma_3 — \sigma_1)^2} \qquad (2.5.3.5\text{-}1)$$

where σ = combined stress, in MPa;

$$\sigma_1 = q_1\frac{d_c^2 + d_3^2}{d_c^2 — d_3^2}; \qquad (2.5.3.5\text{-}2)$$

$$q_1 = q + 5,73\frac{M_b\cdot10^6}{d_3L_{s.t}^2}; \qquad (2.5.3.5\text{-}3)$$

$$\sigma_2 = — q_1; \qquad (2.5.3.5\text{-}4)$$

$$\sigma_3 = \frac{40Q}{\pi(d_c^2 — d_3^2)} + \frac{M_b\cdot10^7}{d_3^3}; \qquad (2.5.3.5\text{-}5)$$

q_1 = contact pressure between mating tapered surfaces in way of maximum diameter of the stock taper under combined action of torque and bending moments, in MPa;
d_3 = maximum diameter of stock taper, in mm;
$L_{s.t}$ = length of stock taper, in mm.

2.5.3.6 The value of oil pressure applied to the mating tapered surfaces of the stock and boss of the rudder during mounting and dismounting of the coupling shall not exceed $P_{\max}$ determined from the formula:

$$P_{\max} = 0,55R_{eH}\left[1 — \left(\frac{d_m}{d_c}\right)^2\right] \qquad (2.5.3.6)$$

where $P_{\max}$ — in MPa;
R_{eH} — yield stress of material for the rudder or nozzle rudder boss, in MPa.

2.5.3.7 The design and dimensions of the stock tail and the nut, as well as the means for securing the nut shall be a subject of special consideration by the Register.

2.5.4 Where the rudder stock is not made of a solid piece, its parts are to be joined by means of a muff coupling or by other method which will be specially considered by the Register in each case.

2.6 RUDDER PINTLES

2.6.1 The diameter d_4 , in cm, of pintles without liners, as well as of pintles with liners, but before their setting, is to be not less than determined from the formula

$$d_4 = 18\sqrt{R_i/R_{eH}} \qquad (2.6.1)$$

where R_i = design value of the reaction of the considered pintle (R_2 or R_4) determined according to the provisions of 2.2.4 and 2.2.5 for the appropriate type of the rudder, in kN;
R_{eH} = upper yield stress of the pintle material, in MPa.

2.6.2 The length of the taper part of the pintle in rudder gudgeon, in welded-in bush of the nozzle rudder or in the solepiece is not to be less than the diameter of the pintle according to 2.6.1; the taper on the diameter is not to exceed 1:10. The taper is to change into cylindrical portion without any step in the diameter.

The external diameter of the pintle threaded portion is not to be less than 0,8 times the minimum diameter of the taper. The outer diameter and height of the nut are not to be less than 1,5 and 0,6 times the external diameter of the pintle threaded portion, respectively.

2.6.3 The ratio of bearing height to diameter measured outside the pintle liners, where fitted, is not to be less than 1, nor more than 1,3.

2.6.4 The width of material in the rudder gudgeons and welded-in bushes of the nozzle rudder measured outside the hole for the pintle bush is not to be less than 0,5 times the diameter of the pintle without liner.

For rudder pintles of 200 mm and over in diameter it is allowed to reduce the specified width of the gudgeon from 0,5 times the diameter of the gudgeon down to 0,35 times the diameter of the pintle without liner in case the requirements of 2.6.2 and 2.6.3 are met, the following relation is obtained:

$$\frac{l_7}{d_4'} \geqslant \frac{R_{eH(p)}}{R_{eH(g)}} \qquad (2.6.4)$$

where l_7 = height of the pintle bush, in cm;
d_4' = diameter of the pintle, cm, including its liner, where fitted;
$R_{eH(p)}$ = upper yield stress of the pintle material, in MPa;
$R_{eH(g)}$ = upper yield stress of the gudgeon material, in MPa.

2.6.5 To prevent self-unscrewing, the nut is to be securely fastened by means of at least two welded-on strips or one welded-on strip and a split pin, and the pintles are to be securely fastened in gudgeons of the rudder or sternframe.

2.6.6 The chosen dimensions of the pintles are to be checked by the surface loading p, in MPa, this being taken as

$$p = 10R_i/(d_4' \, l_7) \qquad (2.6.6)$$

where for R_i, see 2.6.1;
d_4' = diameter of the pintle, in cm, including its liner, where fitted;
l_7 = height of the pintle bush, in cm.

This surface loading is not to exceed the values specified in Table 2.1.6. Use of the materials different from those specified in this Table for rubbing parts will be specially considered by the Register in each case.

2.7 RUDDER AXLE

2.7.1 The diameter of the rudder axle directly at the flange d_5 is to be such that the normal stresses σ developed in its sections do not exceed 0,5 times the upper yield stress of the rudder axle material. The normal stress σ, in MPa, is to be determined from the formula

$$\sigma = 10^4 M_{r\cdot a}/d_5^3 \qquad (2.7.1)$$

where $M_{r\cdot a}$ = design value of the bending moment determined according to the provisions of 2.2.4.15, in kN·m;
d_5 = diameter of the rudder axle at the flange, in cm.

The diameter of the rudder axle in way of the rudder bearings is to be not less than the diameter d_5. The diameter of the rudder axle between the rudder bearings may be reduced by 10 per cent.

2.7.2 As regards the tapered and threaded portions of the rudder axle and also its nut, the requirements are as stipulated in 2.6.2 for the pintles.

2.7.3 The diameter of bolts of the rudder axle flange coupling d_6 , in cm, is to be not less than determined from the formula

$$d_6 = 6{,}77\sqrt{\frac{R_2 + \frac{M_{\mathrm{r\cdot a}}}{r_4}\sqrt{1 + \left(0{,}17 + 0{,}6\,\frac{R_2 r_5}{M_{\mathrm{r\cdot a}}}\right)^2}}{z_2 R_{eH}}} \qquad (2.7.3)$$

where R_2 = design value of the reaction of the rudder axle upper bearing determined according to 2.2.4.11, in kN;
$\mathrm{M_{r\cdot a}}$ = design value of the bending moment acting in the rudder axle section near its flange determined according to 2.2.4.15, in kN·m;
r_4 = mean distance from the centre of the bolts to the centre of the system of the flange bolt holes, in m;
r_5 = distance from the centre line of the rudder stock to the contact plane of the rudder axle flanges and the sternframe, in m;
z_2 = number of the bolts of the flange coupling;
R_{eH} = upper yield stress of the bolt material, in MPa.

The number of the bolts z_2 is to be not less than 6.

The distance from the centre of any bolt to the centre of the system of the flange bolt holes is to be not less than 0,7, and to the vertical axis of symmetry of the flange plane, not less than 0,6 times the diameter d_5 of the rudder axle given in 2.7.1.

2.7.4 Only fitted bolts are to be employed, except the cases of a key setting when it is sufficient to have only two fitted bolts. The nuts shall have standard sizes, and they shall be securely fastened by split pins or weld-on strips.

2.7.5 The thickness of the coupling flange is not to be less than the diameter of the bolts. The centres of the holes for bolts are to be distant from the outside edges of the flange by not less than 1,15 times the diameter of the bolts.

2.7.6 Where the diameter of the rudder axle changes, sufficient fillets are to be provided. At transition from the rudder axle to the flange a fillet shall be provided with a radius of not less than 0,12 times the rudder axle diameter.

2.7.7 To prevent self-unscrewing, the nut of the rudder axle is to be securely fastened at least by two weld-on strips or one weld-on strip and a split pin.

2.7.8 The requirements of 2.6.6 for pintles are applicable to the rudder bearings on the rudder axle.

2.8 RUDDER STOCK BEARINGS

2.8.1 The requirements of 2.6.6 for pintles are applicable to the rudder stock bearings taking lateral load.

2.8.2 A rudder carrier is to be installed to take the mass of the rudder or nozzle rudder and rudder stock. The deck is to be efficiently strengthened in way of the rudder carrier.

Measures are to be taken against axial displacement of the rudder or nozzle rudder and rudder stock upwards by a value exceeding that permitted by the construction of the steering gear; furthermore, for nozzle rudder measures are to be taken to provide for guaranteed clearance between propeller blades and nozzle under service conditions.

2.8.3 A stuffing box is to be fitted in way of passage of the rudder stock through the top of a rudder trunk which is open to sea to prevent water from entering the ship's space. The stuffing box is to be fitted in a place accessible for inspection and maintenance at all times.

2.9 STEERING GEAR

2.9.1 Ships shall be provided with a main steering gear and an auxiliary steering gear, unless expressly provided otherwise.

2.9.2 The main steering gear shall be capable of putting the rudder or nozzle rudder over from 35° on one side to 35° on the other side, with the ship running ahead at maximum speed corresponding to the draught at which the rudder or nozzle rudder is fully immersed. Under the same conditions the rudder or nozzle rudder shall be capable of being put over from 35° on either side to 30° on the other side in not more than 28 s at the parameters not exceeding the rated values for the gear (see 6.2.1.5, Part IX "Machinery").

2.9.3 The auxiliary steering gear shall be capable of putting the rudder or nozzle rudder over from 15° on one side to 15° on the other side in not more than 60 s, with the ship running ahead at half the maximum speed corresponding to the draught at which the rudder or nozzle rudder is fully immersed or 7 knots, whichever is the greater.

2.9.4 In oil tankers, oil tankers (>60°C), combination carriers, gas carriers and chemical carriers of 10000 tons gross tonnage and upwards, in all nuclear ships and in other ships of 70 000 gross tonnage and upwards the main steering gear shall comprise two or more identical power units satisfying the requirements of 2.9.5 (see also 6.2.1.8 and 6.2.1.9, Part IX "Machinery").

2.9.5 Where the main steering gear comprises two or more power units, an auxiliary steering gear need not be fitted if:

.1 in passenger and nuclear ships as well as in special purpose ships having more than 200 persons of special personnel on board the main steering gear is capable of operating as required in 2.9.2 while any one of the power units is out of operation;

.2 in cargo ships as well as in special purpose ships having 200 or less persons of special personnel on board the main steering gear is capable of operating as required in 2.9.2 while all power units are in operation;

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

2.9.6 Where according to 2.3.1 the diameter of the rudder head is required to be over 230 mm, excluding strengthening for navigation in ice, provision is to be made for an additional source of electrical power as prescribed in 5.5.6, Part XI "Electrical Equipment" sufficient to ensure operation of the steering gear power unit in compliance with the requirements of 2.9.3.

2.9.7 The main steering gear may be hand-operated provided it meets the requirements of 6.2.3.2, Part IX "Machinery" and the rudder stock diameter specified in 2.3.1 does not exceed 120 mm (excluding strengthening for navigation in ice).

In all other cases, the main steering gear shall be operated by power.

2.9.8 The auxiliary steering gear may be hand-operated provided it meets the requirements of 6.2.3.3, Part IX "Machinery" and the rudder stock diameter specified in 2.3.1 does not exceed 230 mm (excluding strengthening for navigation in ice).

In all other cases, the auxiliary steering gear shall be operated by power.

2.9.9 The main and auxiliary steering gears shall act on the rudder stock independently of one another, but it is allowed that the main and auxiliary steering gears have some common parts (such as tiller, quadrant, gear box, cylinder block, etc.) provided the respective scantlings of these parts are increased in accordance with 6.2.8.2, Part IX "Machinery".

2.9.10 The rudder tackle may be considered as an auxiliary steering gear only in the following cases:

.1 in self-propelled ships of less than 500 gross tonnage;

.2 in non-propelled ships.

In other cases, the rudder tackle is not considered as a steering gear and is not necessarily to be fitted in ships.

2.9.11 The rudder arrangement shall be provided with a system of stops permitting to put the rudder or nozzle rudder over either side only to an angle $\beta°$:

$$(\alpha° + 1°) \leqslant \beta° \leqslant (\alpha° + 1{,}5°) \qquad (2.9.11\text{-}1)$$

where $\alpha°$ = maximum hard-over angle to which the steering gear control system is adjusted but not over 35°; the greater hard-over angle is subject to special consideration by the Register in each case.

All the parts of the system of stops, including those which are at the same time the parts of the steering gear, are to be calculated to take forces corresponding to an ultimate reverse torque M_{ult}, in kN·m, from the rudder or nozzle rudder of not less than:

$$M_{ult} = 1{,}135 R_{eH} d_0^3 \cdot 10^{-4} \qquad (2.9.11\text{-}2)$$

where d_0 = actual diameter of the rudder head, in cm;
R_{eH} = upper yield stress of the rudder stock material, in MPa.

The stresses in these parts shall not exceed 0,95 times the upper yield stress of their material. The rudder stops of the system may be fitted on the sternframe, deck platform, bulkhead or other structural members of the ship's hull.

Where the active rudder is provided and there is a need to put the rudder over to an angle exceeding the maximum one, arrangement of stops is to be specially considered by the Register in each case.

2.9.12 Control of the main steering gear shall be provided both on the navigating bridge and in the steering gear compartment.

2.9.13 When the main steering gear is arranged according to 2.9.4 or 2.9.5, two independent steering gear control systems are to be provided, each of which is to be operable separately from the navigating bridge. These systems may have a common steering wheel or level. If the control system comprises a hydraulic telemotor, the Register may waive the requirement for a second independent control system of the steering gear for the ship (with the exception of oil tankers, oil tankers (>60°C), combination carriers, gas carriers and chemical carriers of 10 000 gross tonnage and upwards, of other ships of 70 000 gross tonnage and upwards and of nuclear ships).

2.9.14 The auxiliary steering gear control shall be provided in the steering gear compartment.

For the auxiliary steering gear which is power operated, control shall also be provided from the navigating bridge and shall be independent of the control system for the main steering gear.

2.9.15 A rudder angle indicator shall be fitted near each control station of the main and auxiliary steering gears and in the steering gear compartment. The difference between the indicated and actual positions of the rudder shall be not more than:

1° when the rudder or nozzle rudder is in the centre line or parallel to it;
1,5° for rudder angles from 0° to 5°;
2,5° for rudder angles from 5° to 35°.

The rudder angle indication shall be independent of the steering gear control system.

2.9.16 In all other respects the steering gear shall meet the requirements of Part IX "Machinery" and Part XI "Electrical Equipment".

2.10 EFFICIENCY OF RUDDERS AND NOZZLE RUDDERS

2.10.1 General provisions.

2.10.1.1 The choice of the ship's main characteristics affecting the steerability and the characteristics of the rudder and nozzle rudder is made at the discretion of the designer and shipowner considering the necessity to ensure the proper steerability of the ship according to its purpose and service conditions and to ensure the correspondence between relative areas of rudders and nozzle rudders of the ship under design and the prototype ship provided the total efficiency of the chosen rudders and/or nozzle rudders is not less than that required in the present Chapter.

2.10.1.2 The requirements of the present Chapter apply to stern rudders and nozzle rudders (see 2.1.2) provided according to 2.1.1 in self-propelled ships (other than icebreakers) of 20 m and over in length of unrestricted service and restricted area of navigation **I** sailing in the displacement condition. For ships of restricted areas of navigation **II** and **III** the standards set forth in 2.10.3 are to be considered as recommendations.

For ships of river-sea navigation **IIСП** and **IIIСП** the standards set forth in 2.10.3 are also to be considered as recommendations, and the fulfilment of these standards does not give the grounds for exemption from the fulfilment of the current standards of steerability for ships of inland navigation.

2.10.1.3 The requirements of the present Chapter apply to ships having the geometric characteristics of the hull within the following limits:

L_1/B = 3,2 — 8,0; C_B = 0,45 — 0,85;
L_1/d = 8,3 — 28,6; C_p = 0,55 — 0,85;
B/d = 1,5 — 3,5; σ_a = 0,80 — 0,99

where B = breadth of the ship, in m;
for C_B, d, L_1, C_p and σ_a, see 2.2.2.1, 2.4.1.1 and 2.10.3.3, respectively.

Application of the requirements of the present Chapter to other ships is subject to special agreement with the Register.

2.10.1.4 The requirements of the present Chapter apply to catamarans with two identical hulls (symmetric about the centre plane of the hulls), each having geometric characteristics according to the provisions of

2.10.1.3, and with two identical rudders and/or nozzle rudders arranged in the centre plane of each hull.

2.10.1.5 The active means of the ship's steering which are not the main means of the ship's steering (thrusters, active rudders, etc.) are considered as means supplementing the required minimum and are not taken into account when meeting the requirements of the present Chapter (see also 2.1.3.2).

2.10.2 Estimation of efficiency of rudders and nozzle rudders.

2.10.2.1 The efficiency of the chosen rudder E_r, other than rudders of types IV, X and XIII (see Fig. 2.2.4.1), is to be determined from the formula

$$E_r = \mu_1 \frac{A}{A_2}\Big(1 + C_{\text{HB}}\frac{A_p}{A}\Big)\Big(1 — W\Big)^2 \qquad (2.10.2.1\text{-}1)$$

where

$$\mu_1 = \frac{6,28}{1 + \frac{2A}{h_r^2}}; \qquad (2.10.2.1\text{-}2)$$

W = coefficient:

for rudder arranged in the centre plane behind the propeller

$$W = 0,3C_B; \qquad (2.10.2.1\text{-}3)$$

for rudder arranged in the centre plane with no propeller fitted forward of it

$$W = 0; \qquad (2.10.2.1\text{-}4)$$

for side rudders

$$W = 0,4C_B — 0,13; \qquad (2.10.2.1\text{-}5)$$

A_2 = lateral underwater area at the summer waterline draught, in m^2;
for A, A_p, h_r, C_B, see 2.2.2.1;
C_{HB} = value determined from the Formula (2.2.3.1-8) with regard to the Formula (2.2.3.1-4) at W as specified in the present sub-paragraph with regard to 2.2.2.6; for rudders not operating directly behind the propeller the thrust is taken as $T = 0$.

2.10.2.2 The efficiency of the chosen rudder E_{rr} of types IV, X or XIII (see Fig. 2.2.4.1) is to be determined from the formula

$$E_{rr} = 1,3\mu_2 \frac{A_t}{A_2}(1 — W)^2 \qquad (2.10.2.2\text{-}1)$$

where $$\mu_2 = \frac{6,28\sqrt{b_r/b_t}}{1 + \frac{2b_t^2}{A_t}} + \frac{1,4C_{HB}}{1 + 0,5\Big(\frac{b_t^2}{A_t}\Big)^2} \qquad (2.10.2.2.\text{-}2)$$

where b_r = breadth of the rudder, in m;
b_t = total breadth of the rudder and rudder post, in m;
for A_t, see 2.2.2.1;
for A_2, C_{HB}, W, see 2.10.2.1.

2.10.2.3 The efficiency of the chosen nozzle rudder E_n with or without a stabilizer is to be determined from the formula

$$E_n = 2,86\mu_3\frac{D_o l_n}{A_2}(1 — W)^2 \qquad (2.10.2.3\text{-}1)$$

where

$$\mu_3 = \Big(0,175 + 0,275\frac{D_n}{l_n}\Big)[1 + 0,25(1 + \sqrt{1 + C_{HB}})^2] + 0,25C_{HB}\frac{D_n}{l_n}; \qquad (2.10.2.3\text{-}2)$$

W = coefficient:

for nozzle rudder arranged in the centre plane of the ship

$$W = 0,2C_B; \qquad (2.10.2.3\text{-}3)$$

for side nozzle rudder

$$W = 0,1C_B; \qquad (2.10.2.3\text{-}4)$$

D_o = outside diameter of the nozzle rudder in the plane of the propeller disk, in m;
for C_B, D_n, l_n and A_2, see 2.2.2.1, 2.2.3.1 and 2.10.2.1, respectively;
C_{HB} = value determined from the Formula (2.2.3.1-5) with regard to the Formula (2.2.3.1-4) at W as specified in the present sub-paragraph with regard to 2.2.2.6.

2.10.3 Standards for efficiency of rudders and nozzle rudders.

2.10.3.1 The total efficiency of all rudders and nozzle rudders (see 2.10.2) fitted in the ship (other than catamaran) is not to be less than the greater of the values E, E_1 or E_2 given below.

2.10.3.2 The efficiency of the single rudder or nozzle rudder fitted in the catamaran which is determined according to 2.10.2 is not to be less than the greater of the values E_1, E_2 or E_3 estimated according to the provisions specified below considering each hull of the catamaran as an independent single-screw ship. When determining the lateral windage area, all the above-water structures of the catamaran and the deck cargo (if intended to be carried) are considered as belonging to one hull.

2.10.3.3 For all ships, other than tugs, rescue and fishing vessels, the value of E_1 is determined depending on the values of C_p and σ_a:

for single-screw ships — according to Fig. 2.10.3.3-1;

for twin-screw and triple-screw ships — according to Fig. 2.10.3.3-2.

For intermediate values of C_p the value of E_1 is determined by linear interpolation between the curves for two nearest values of C_p given in Figs 2.10.3.3-1 and 2.10.3.3-2 where C_p is prismatic coefficient of the underwater part of the hull at the summer waterline draught as determined from the formula

$$C_p = C_B/C_m; \qquad (2.10.3.3\text{-}1)$$

C_m = coefficient of fineness of midship section at the summer waterline draught;
σ_a = afterbody lateral area coefficient at the summer waterline draught as determined from the formula

$$\sigma_a = 1 — \frac{2(f — f_0)}{L_1 d}; \qquad (2.10.3.3\text{-}2)$$

L_1 = length of the ship measured on the summer load waterline from the fore side of the stem to the after side of the after end of the ship, in m;
f = area of side projection of the stern counter, in m^2,

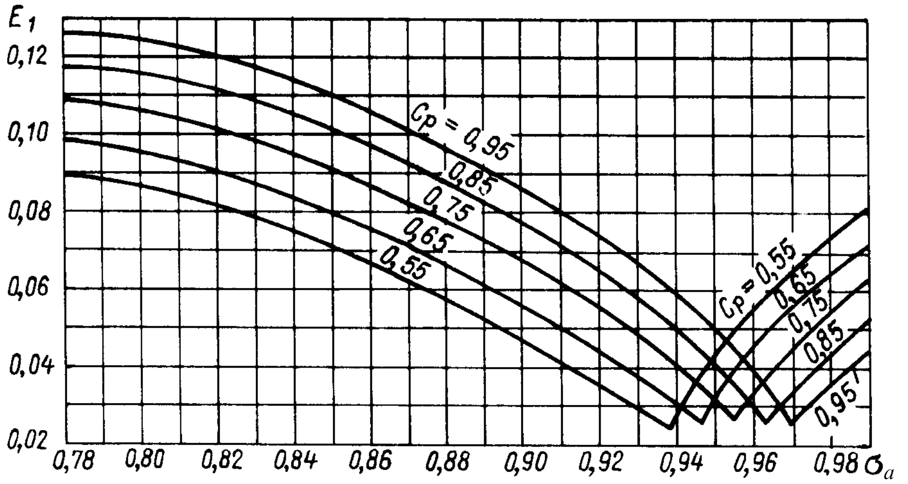


Fig. 2.10.3.3-1

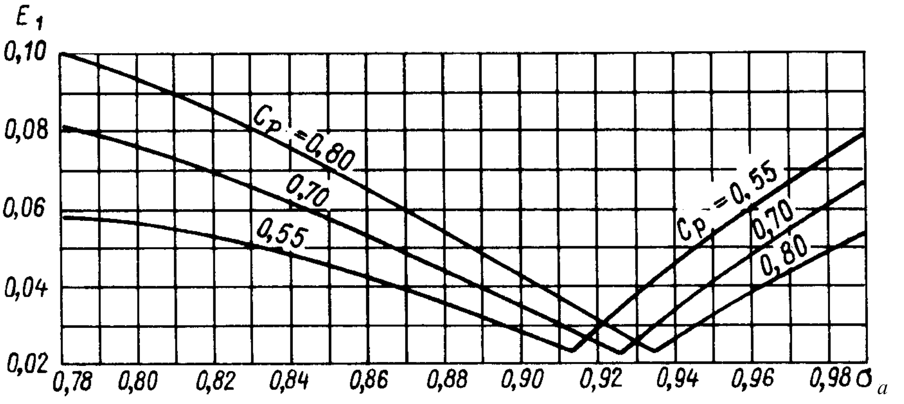


Fig. 2.10.3.3-2

calculated as the area of the figure bounded by the extension line of the keel lower edge, by the perpendicular to this line from the point of intersection of the summer fload waterline and the outline of the centre plane section of the ship's after end and by the sternframe after edge line drawn ignoring the rudder post, solepiece or rudder horn, if any;

f_0 = for twin-screw ships — area of the side projection of the propeller cone (or its part) superimposed on the area of the figure f, in m^2. In all other cases f_0 is to be taken as zero;

for d, see 2.4.1.1.

2.10.3.4 For tugs, rescue ships and fishing vessels the value E_1 is determined according to Fig. 2.10.3.4 depending on the value σ_a.

2.10.3.5 The value E_2 is determined from the formula

$$E_2 = \frac{3,8A_3}{V^2A_4}\left(1 - 0,0667\frac{A_3}{A_4}\right)\left\{1 + (\lambda_r - 1)[0,33+0,015 \times \times (V - 7,5)] - 5\frac{x_0}{L_1}\right\} \quad (2.10.3.5\text{-}1)$$

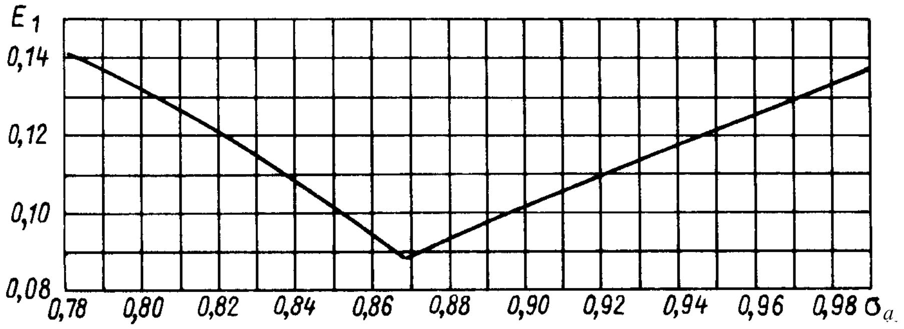


Fig. 2.10.3.4

where A_3 = lateral windage area at such a minimum draught at which the rudder plate or nozzle rudder is fully immersed (at the upright position of the ship), in m^2, to be determined according to 1.4.6, Part IV "Stability";

A_4 = lateral underwater area at such a minimum draught at which the rudder plate or nozzle rudder is fully immersed (at the upright position of the ship), in m^2;

x_0 = horizontal distance from the midship frame (middle of the length L_1) to the centroid of the area A_3, in m. The value of x_0 is taken to be positive in case the centroid is forward of the midship frame, and negative in case of aft position;

λ_r = coefficient determined from the formulae:

for all rudders, other than rudders of types IV, X and XIII (see Fig. 2.2.4.1)

$$\lambda_r = h_r^2/A; \qquad (2.10.3.5\text{-}2)$$

for rudders of types IV, X, XIII (see Fig. 2.2.4.1)

$$\lambda_r = h_r^2/A_t; \qquad (2.10.3.5\text{-}3)$$

for nozzle rudders

$$\lambda_r = D_n/l_n; \qquad (2.10.3.5\text{-}4)$$

for V, h_r, A, A_t, see 2.2.2.1;

for D_n, l_n, see 2.2.3.1.

2.10.3.6 For ships of 70 m in length and more the value E_3 is determined from the formula

$$E_3 = 0{,}03 + 0{,}01(\lambda_r — 1) + 0{,}01\frac{A_5}{A_2}\left(1 — 3\frac{x}{L_1}\right) \qquad (2.10.3.6)$$

where A_5 = lateral windage area of the ship at the summer waterline draught, in m^2, to be determined according to 1.4.6, Part IV "Stability";

x = horizontal distance from the midship frame (middle of the length L_1) to the centroid of the area A_5, in m. The value of x is taken to be positive in case the centroid is forward of the midship frame and negative in case of aft position.

For ships of less than 70 m in length E_3 = 0 is taken in the calculations.

2.10.3.7 For all ships (other than rescue and fishing vessels and tugs, with σ_a>0,865) it is permitted in the calculations to take E_1 as zero (if the value of E_1 is greater than any of the values of E_2 or E_3) provided it is proved by the test of a self-propelled model not less than 2 m in length (at the speed of the model conforming to the ship's speed v, see 2.2.2.1) that:

.1 the steady turning diameter of the ship with the rudder (rudders) or nozzle rudder (rudders) put over to 35° on either side is not less than four lengths of the ship;

.2 the steady spontaneous turning diameter of the ship with non-reversed rudder (rudders) or nozzle rudder (rudders) D_s calculated from the formula

$$D_s = (D_{ss} + D_{sp})/2 \qquad (2.10.3.7)$$

where D_{ts} and D_{tp} = steady turning diameter of the ship with the rudder or nozzle rudder put over to 35° on starboard or port side, respectively;

D_{ss} and D_{sp} = diameter of steady spontaneous turning starboard or port, respectively, with the non-reversed rudder or nozzle rudder,

is not less than 3,35 (D_{ts} + D_{tp}).

If, for technical reasons, the requirement of the present sub-paragraph is not feasible, departure from this requirement is subject to special consideration by the Register.

2.10.3.8 For ships with the displacement exceeding 60000 t and block coefficient exceeding 0,75 at the summer waterline draught, the compliance with the requirements of 2.10.3.7.1 and 2.10.3.7.2 is to be proved by testing a self-propelled model of not less than 2 m in length (at the speed of the model conforming to the ship's speed v, see 2.2.2.1), notwithstanding the fulfilment of the requirements of 2.10.3.1.

3 ANCHOR ARRANGEMENT

3.1 GENERAL PROVISIONS

3.1.1 Each ship is to be provided with anchor equipment and also with chain stoppers for securing the bower anchors in hawse pipes, devices for securing and releasing the inboard ends of the chain cables and machinery for dropping and hoisting the bower anchors as well as for holding the ship at the bower anchors dropped.

Besides, in cases specified in 3.6.1.1 each bower anchor chain cable shall be provided with a stopper for riding the ship at anchor.

3.1.2 If a ship in addition to the anchor arrangement or equipment specified in 3.1.1 is provided with some other anchor arrangement or equipment (for example, special anchors and winches on dredgers, mooring anchors on lightships, etc.), such anchor arrangement or equipment is regarded as special one and is not subject to the Register survey. The use of anchor arrangement specified in 3.1.1 as a working special arrangement for moving the dredgers and also for holding the dredgers in place in the course of dredging carried out by grabs is subject to special consideration by the Register in each case; it is necessary to submit to the Register the required data characterizing the conditions of work of anchor arrangement elements (the value and degree of dynamics of acting forces, the degree of intensity of work and wear rate of the anchor arrangement elements, etc.).

3.1.3 For all ships, except fishing vessels, the anchor equipment shall be selected from Table 3.1.3-1, for fishing vessels — from Table 3.1.3-2 according to

Table 3.1.3-1

Equipment Number N_e		Bower anchors		Mass of stream anchor, in kg	Chain cables for bower anchors				Stream wire or chain		Tow line		Mooring lines		
Exceeding	Not exceeding	Number	Mass of anchor, in kg		Total length of both chain cables, in m	Diameter			Length, in m	Chain cable breaking load or actual breaking strength of wire rope, in kN	Length, in m	Actual breaking strength, in kN	Number	Length of each line, in m	Actual breaking strength, in kN
						Ordinary (grade 1), in mm	Special quality (grade 2), in mm	Extra special quality (grade 3), in mm							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
10	15	2	35	—	110		—	—	—	—	—	—	2	30	29
15	20	2	50	—	137,5	*	—	—	—	—	—	—	2	30	29
20	25	2	65	—	165		—	—	—	—	—	—	2	40	29
25	30	2	80	—	165	11,0	—	—	—	—	—	—	2	50	29
30	40	2	105	35	192,5	11,0	—	—	55	55	120	65	2	50	29
40	50	2	135	45	192,5	12,5	—	—	70	60	150	81	2	60	29
50	70	2	180	60	220	14	12,5	—	80	65	180	98	3	80	34
70	90	2	240	80	220	16	14	—	85	74	180	98	3	100	37
90	110	2	300	100	247,5	17,5	16	—	85	81	180	98	3	110	39
110	130	2	360	120	247,5	19	17,5	—	90	89	180	98	3	110	44
130	150	2	420	140	275	20,5	17,5	—	90	98	180	98	3	120	49
150	175	2	480	165	275	22	19	—	90	108	180	98	3	120	54
175	205	2	570	190	302,5	24	20,5	—	90	118	180	112	3	120	59
205	240	3	660	—	302,5	26	22	20,5	—	—	180	129	4	120	64
240	280	3	780	—	330	28	24	22	—	—	180	150	4	120	69
280	320	3	900	—	357,5	30	26	24	—	—	180	174	4	140	74
320	360	3	1020	—	357,5	32	28	24	—	—	180	207	4	140	78
360	400	3	1140	—	385	34	30	26	—	—	180	224	4	140	88
400	450	3	1290	—	385	36	32	28	—	—	180	250	4	140	98
450	500	3	1440	—	412,5	38	34	30	—	—	180	276	4	140	108
500	550	3	1590	—	412,5	40	34	30	—	—	190	306	4	160	123
550	600	3	1740	—	440	42	36	32	—	—	190	338	4	160	132
600	660	3	1920	—	440	44	38	34	—	—	190	371	4	160	145
660	720	3	2100	—	440	46	40	36	—	—	190	406	4	160	157
720	780	3	2280	—	467,5	48	42	36	—	—	190	441	4	170	172
780	840	3	2460	—	467,5	50	44	38	—	—	190	480	4	170	186
840	910	3	2640	—	467,5	52	46	40	—	—	190	518	4	170	201
910	980	3	2850	—	495	54	48	42	—	—	190	559	4	170	216
980	1060	3	3060	—	495	56	50	44	—	—	200	603	4	180	230
1060	1140	3	3300	—	495	58	50	46	—	—	200	647	4	180	250
1140	1220	3	3540	—	522,5	60	52	46	—	—	200	691	4	180	270
1220	1300	3	3780	—	522,5	62	54	48	—	—	200	738	4	180	284
1300	1390	3	4050	—	522,5	64	56	50	—	—	200	786	4	180	309
1390	1480	3	4230	—	550	66	58	50	—	—	200	836	4	180	324
1480	1570	3	4590	—	550	68	60	52	—	—	220	888	5	190	324
1570	1670	3	4890	—	550	70	62	54	—	—	220	941	5	190	333
1670	1790	3	5250	—	577,5	73	64	56	—	—	220	1024	5	190	353
1790	1930	3	5610	—	577,5	76	66	58	—	—	220	1109	5	190	378
1930	2080	3	6000	—	577,5	78	68	60	—	—	220	1168	5	190	402
2080	2230	3	6450	—	605	81	70	62	—	—	240	1259	5	200	422
2230	2380	3	6900	—	605	84	73	64	—	—	240	1356	5	200	451
2380	2530	3	7350	—	605	87	76	66	—	—	240	1453	5	200	480

Table 3.1.3-1 — continued

Equipment Number N_e		Bower anchors		Mass of stream anchor, in kg	Chain cables for bower anchors				Stream wire or chain		Tow line		Mooring lines		
Exceeding	Not exceeding	Number	Mass of anchor, in kg		Total length of both chain cables, in m	Diameter			Length, in m	Chain cable breaking load or actual breaking strength of wire rope, in kN	Length, in m	Actual breaking strength, in kN	Number	Length of each line, in m	Actual breaking strength, in kN
						Ordinary (grade 1), in mm	Special quality (grade 2), in mm	Extra special quality (grade 3), in mm							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2530	2700	3	7800	—	632,5	90	78	68	—	—	260	1471	6	200	480
2700	2870	3	8300	—	632,5	92	81	70	—	—	260	1471	6	200	490
2870	3040	3	8700	—	632,5	95	84	73	—	—	260	1471	6	200	500
3040	3210	3	9300	—	660	97	84	76	—	—	280	1471	6	200	520
3210	3400	3	9900	—	660	100	87	78	—	—	280	1471	6	200	554
3400	3600	3	10500	—	660	102	90	78	—	—	280	1471	6	200	588
3600	3800	3	11100	—	687,5	105	92	81	—	—	300	1471	6	200	618
3800	4000	3	11700	—	687,5	107	95	84	—	—	300	1471	6	200	647
4000	4200	3	12300	—	687,5	111	97	87	—	—	300	1471	7	200	647
4200	4400	3	12900	—	715	114	100	87	—	—	300	1471	7	200	657
4400	4600	3	13500	—	715	117	102	90	—	—	300	1471	7	200	667
4600	4800	3	14100	—	715	120	105	92	—	—	300	1471	7	200	677
4800	5000	3	14700	—	742,5	122	107	95	—	—	300	1471	7	200	686
5000	5200	3	15400	—	742,5	124	111	97	—	—	300	1471	8	200	686
5200	5500	3	16000	—	742,5	127	111	97	—	—	300	1471	8	200	696
5500	5800	3	16900	—	742,5	130	114	100	—	—	300	1471	8	200	706
5800	6100	3	17800	—	742,5	132	117	102	—	—	300	1471	9	200	706
6100	6500	3	18800	—	742,5	—	120	107	—	—			9	200	716
6500	6900	3	20000	—	770	—	124	111	—	—	Tow lines are not required when ship's length exceeds 180 m		0	200	726
6900	7400	3	21500	—	770	—	127	114	—	—			10	200	726
7400	7900	3	23000	—	770	—	132	117	—	—			11	200	726
7900	8400	3	24500	—	770	—	137	122	—	—			11	200	736
8400	8900	3	26000	—	770	—	142	127	—	—			11	200	736
8900	9400	3	27500	—	770	—	147	132	—	—			13	200	736
9400	10000	3	29000	_	770	_	152	132	_	_			14	200	736
10000	10700	3	31000	_	770	_	_	137	_	_			15	200	736
10700	11500	3	33000	_	770	_	_	142	_	_			16	200	736
11500	12400	3	35500	_	770	_	_	147	_	_			17	200	736
12400	13400	3	38500	—	770	—	—	152	—	—			18	200	736
13400	14600	3	42000	—	770	—	—	157	—	—			19	200	736
14600	16000	3	46000	—	770	—	—	162	—	—			21	200	736

* Chain cables or wire ropes may be used, chain cable breaking load or actual breaking strength of wire rope being not less than 44 kN.

Equipment Number determined in compliance with 3.2 in the case of ships of unrestricted service and of restricted area of navigation I and according to Equipment Number reduced:

by 15 per cent in the case of ships of restricted areas of navigation **II**, **IIСП** and **IIIСП**;

by 25 per cent in the case of ships of restricted area of navigation III, taking account of the provisions specified in 3.1.4, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 3.4.3, 3.4.7 and 3.4.10.

3.1.4 For non-propelled ships the anchor equipment shall be selected according to Equipment Number increased by 25 per cent as against that calculated in compliance with provisions specified in 3.1.3. For self-propelled ships of unrestricted service, restricted areas of navigation **I**, **II**, **IIСП** and **IIIСП** having the maximum ahead speed not more than 6 knots at the draught to the summer load waterline and also for ships of restricted area of navigation **III** having the above speed not more than 5 knots, the anchor equipment shall be selected as in the case of non-propelled ships.

The anchor arrangement of shipborne barges and berth-connected ships shall comply with the require-

Table 3.1.3-2

Equipment Number N_e		Bower anchors		Chain cables for bower anchors			Mooring lines		
					Diameter				
Exceeding	Not exceeding	Number	Mass per. anchor, in kg	Total length, in m	grade 1, in mm	grade 2, in mm	Number	Length of each line, in m	Actual breaking strength, in kN
1	2	3	4	5	6	7	8	9	10
10	15	1	30	55	*	—	2	30	29
15	20	1	40	55		—	2	30	29
20	25	1	50	82,5		—	2	40	29
25	30	1	60	82,5	*	—	2	50	29
30	40	2	80	165	11,0	—	2	50	29
40	50	2	100	192,5	11,0	—	2	60	29
50	60	2	120	192,5	12,5	—	2	60	29
60	70	2	140	192,5	12,5	—	2	80	29
70	80	2	160	220	14	12,5	2	100	34
80	90	2	180	220	14	12,5	2	100	37
90	100	2	210	220	16	14	2	110	37
100	110	2	240	220	16	14	2	110	39
110	120	2	270	247,5	17,5	16	2	110	39
120	130	2	300	247,5	17,5	16	2	110	44
130	140	2	340	275	19	17,5	2	120	44
140	150	2	390	275	19	17,5	2	120	49
150	175	2	480	275	22	19	2	120	54
175	205	2	570	302,5	24	20,5	2	120	59
205	240	2	660	302,5	26	22	2	120	64
240	280	2	780	330	28	24	3	120	71
280	320	2	900	357,5	30	26	3	140	78
320	360	2	1020	357,5	32	28	3	140	86
360	400	2	1140	385	34	30	3	140	93
400	450	2	1290	385	36	32	3	140	100
450	500	2	1440	412,5	38	34	3	140	108
500	550	2	1590	412,5	40	34	4	160	113
550	600	2	1740	440	42	36	4	160	118
600	660	2	1920	440	44	38	4	160	123
660	720	2	2100	440	46	40	4	160	128

* Chain cables or wire ropes may be used, chain cable breaking load or actual breaking strength of wire rope being not less than 44 kN.

ments of Section 3, Part III "Equipment, Arrangements and Outfit" of Rules for the Classification and Construction of Inland Navigation Ships. For the case of sea passage of berth-connected ships having no permanent anchor arrangement, provision shall be made for anchors and anchor chains to be arranged on board.

3.1.5 For remote control systems of the anchor arrangements, if any, the type, extent of automated control and scope of remote control operations are determined by the shipowner.

The additional requirements for the remote-controlled anchor arrangements are given in 3.6.5, the present Part of the Rules, 6.3.6, Part IX "Machinery", and also in 5.1.3, Part XI "Electrical Equipment".

3.2 EQUIPMENT NUMBER

3.2.1 The Equipment Number N_e for all ships, except floating cranes and tugs, is determined from the formula

$$N_e = \Delta^{2/3} + 2Bh + 0,1A \qquad (3.2.1\text{-}1)$$

where Δ = volume displacement, in m^3, to the summer load waterline;
B = breadth of the ship, in m;
h = height, m, from the summer load waterline to the top of the uppermost deckhouse, which is determined by the formula

$$h = a + \Sigma h_i \qquad (3.2.1\text{-}2)$$

where a = distance, m, from the summer load waterline amidships to the top of the upper deck plating at side;

h_i = height, in m, at the centre line of each tier of superstructures or deckhouses having a breadth greater than 0,25B.

In case of ships with two or more superstructures or deckhouses along the length, only one superstructure or deckhouse of the considered tier with the greatest breadth is taken into account.

For the lowest tier h_1 is to be measured at the centre line from the upper deck or, in case of a stepped upper deck, from a notional line which is a continuation of the upper deck.

When calculating h, sheer and trim are to be ignored. See also 3.2.3.

A = area, in m^2, in profile view of the hull, superstructures and deckhouses above the summer load waterline which are within the ship's length L and also have a breadth greater than 0,25B (see also 3.2.2).

3.2.2 The Equipment Number N_e for tugs is determined from the formula

$$N_e = \Delta^{2/3} + 2(Ba + \Sigma h_i b_i) + 0{,}1\ A \qquad (3.2.2)$$

where Δ, B, a, h_i and A are taken according to 3.2.1;

b_i = breadth of the appropriate tier of superstructure or deckhouse, in m. In case of ships with two or more superstructures or deckhouses along the length, the relevant provisions of 3.2.1 must be followed.

3.2.3 Containers or other similar cargoes carried on decks and on hatchway covers, masts, derrick booms, rigging, guard rails and other similar structures may be ignored when determining h and A; bulwarks and hatch coamings less than 1,5 m in height may also be ignored. Screens, bulwarks and hatch coamings more than 1,5 m in height are to be regarded as deckhouses or superstructures.

Main gallows, ladders and pile drivers for lifting the ladders of dredgers may be ignored when determining h; when determining the value A, the area in profile view of these structures shall be calculated as the area limited by the contour of the structure.

3.2.4 The Equipment Number N_e for floating cranes is determined from the formula

$$N_e = 1{,}5\Delta^{2/3} + 2Bh + 2S + 0{,}1A \qquad (3.2.4)$$

where Δ, B, h and A are taken according to 3.2.1; when determining the value of A, account shall be taken of the area in side profile view of the upper structure of floating crane (stowed for sea) which is calculated as the area limited by the outer contour of the structure;

S = projection on the mid-section of the front area, m^2, of the upper structure of the floating crane (stowed for sea) situated above the deck of the uppermost deckhouse taken into account in determination of h, the front area being determined, in this case, as the area limited by the outer contour of the structure.

3.3 BOWER AND STREAM ANCHORS

3.3.1 If the number of bower anchors determined in accordance with provisions of 3.1.3 and 3.1.4 is 3, one of them is supposed to be a spare anchor. On agreement with the Register, the third (spare) anchor may be stored ashore. The third, i.e. the spare anchor, is not required for ships of restricted areas of navigation **I**, **II**, **IIСП**, **IIIСП** and **III**.

Ships with Equipment Number of 205 and less may have the second bower anchor as a spare one on condition that provision is made for its quick getting ready for use.

Ships of restricted area of navigation **III** with Equipment Number of 35 and less, if they are not passenger ships, may have only one bower anchor.

For ships of restricted area of navigation **III** a stream anchor may be omitted.

On ships assigned to restricted navigation areas **IIСП** and **IIIСП** and having Equipment Number in excess of 205 except the values stated in Table 3.1.3-1, provision should be made for a stream anchor with a mass equal to at least 75 per cent.

3.3.2 For admiralty stocked anchors the anchor mass includes the mass of the stock.

The mass of each bower or stream anchor may differ by ±7 per cent from the values determined according to Tables 3.1.3-1 or 3.1.3-2 provided that the total mass of bower anchors is not less than the prescribed total mass thereof.

If high holding power anchors are used, the mass of each anchor may amount to 75 per cent of that determined according to Tables 3.1.3-1 or 3.1.3-2.

Where anchors of super high holding power are used the mass of each anchor is to be not less than 50% of the anchor mass determined according to Tables 3.1.3-1 or 3.1.3-2.

3.3.3 Anchors of the following types are permitted to be used in ships:

.1 Hall's or Gruson's anchor (both are stockless);

.2 admiralty anchor (stocked).

The mass of the head of Hall's or Gruson's anchors including pins and fittings shall be not less than 60 per cent of the total anchor mass.

For admiralty stocked anchors the mass of the stock shall amount to 20 per cent of the total anchor mass including the anchor shackle.

The equipment of ships with anchors of other types is subject to special consideration by the Register in each case.

In order to recognize the anchor as a high holding power anchor, it is necessary to carry out comparative tests of this anchor and Hall's or Gruson's anchor in pair on various types of bottom; in this case, the holding power of the anchor shall be at least twice as much as that of Hall's or Gruson's anchor of the same mass.

To recognize an anchor as a super high holding power anchor comparative tests are to be made of such anchor in pair with a Hall's or Gruson's anchor on different types of bottom to prove that a holding power of the anchor is at least four times that of a Hall's or Gruson's anchor of the same mass. Similar comparative tests with a high holding power anchor may be made, in which case a holding power of the super high holding power anchor is to be at least two times that of the high holding power anchor.

The scope and procedure of such tests are subject to special consideration by the Register in each case.

As to the rest, the anchors shall satisfy the requirements of Section 10.

3.3.4 Super high holding power anchors are suitable for use in ships of restricted areas of navigation **II**, **IIСП**, **III** and **IIIСП**. The super high holding power anchor mass is not generally to exceed 1500 kg.

3.4 CHAIN CABLES AND ROPES FOR BOWER ANCHORS

3.4.1 Ship's with the Equipment Number 205 and less, in which the second bower anchor is permitted to be a spare one, and also ships with the Equipment Number 35 and less and provided according to 3.3.1 with only one bower anchor may be equipped with only one chain cable the length of which is two times less than that required in the relevant Equipment Table for two chain cables. For ships of restricted area of navigation **III** chain cables or wire ropes for a stream anchor may be omitted.

3.4.2 For ships having "supply vessel" notation added to the character of classification the total length of both chain cables for bower anchors shall be taken 165 m greater than the value specified in Table 3.1.3-1, and the diameter of these chain cables shall be taken not less than that given in Table 3.1.3-1 two lines below the Equipment Number for the considered ship (having regard to the provisions of 3.1.3 and 3.1.4).

For supply vessels having the Equipment Number over 720 at the specification depth of the anchorage over 250 m and for those having the Equipment Number 720 and less at the specification depth of the anchorage over 200 m, the length and diameter of chain cables for bower anchors shall be increased taking account of the specification depths and conditions of the anchorage on agreement with the Register.

3.4.3 For hopper barges and dredgers not having hoppers to transport spoil, the diameter of chain cables for bower anchors shall be taken not less than that specified in Table 3.1.3-1 two lines below the Equipment Number of the considered ship, and for dredgers having hoppers to transport spoil, one line below (taking account of the provisions of 3.1.3 and 3.1.4).

3.4.4 Chain cables of bower anchors are to be graded dependent on their strength as specified in 7.1, Part XIII "Materials".

3.4.5 Tables 3.1.3-1 and 3.1.3-2 specify the diameters of chain cables on the assumption that the links of these chain cables are provided with studs, with the exception of the chain cables less than 15 mm in diameter which are assumed to have no studs. The use of short link chain cables of increased diameter instead of stud link chain cables 15 mm in diameter and over will be specially considered by the Register in each case.

3.4.6 The chain cables are to be composed of separate chain lengths, except for the chains less than 15 mm in diameter which need not be divided into chain lengths.

The lengths of chains are to be interconnected with joining links. The use of joining shackles instead of joining links is to be specially considered by the Register in each case.

Depending on their location in the chain cable the lengths are divided into:

anchor length fastened to the anchor;

intermediate lengths;

inboard end chain length secured to the chain cable releasing device.

3.4.7 The anchor length of chain shall consist of a swivel, an end link and a minimum quantity of common and enlarged links required to form an independent length of chains.

The anchor length of chains may consist only of a swivel, an end link and a joining link provided the relation between the dimensions of the chain cable parts allows to form such a length. In chain cables which are not divided into lengths of chains the swivel is to be included into each chain cable as near to the anchor as practicable. In all cases, the pins of swivels shall face the middle of the chain cable.

The anchor length is to be connected with the anchor shackle with the aid of an end shackle the pin of which shall be inserted into the anchor shackle.

3.4.8 The intermediate lengths of chains are to be not less than 25 m and not over 27,5 m, the chains consisting of the odd number of links. The total length of two chain cables given in the Equipment Tables is a sum of intermediate lengths of chains only without the anchor and inboard end lengths of chains.

If the number of intermediate lengths of chains is odd, the starboard chain cable shall have one intermediate length of chains more than the port chain cable.

3.4.9 The inboard end length of chains shall consist of a special link of enlarged size (provided, however, that this link is capable of passing freely through the wildcat of the anchor machinery) being secured to the chain cable releasing device, and of minimum number of common and enlarged links required for forming an independent chain length. The inboard end length of chains may consist of one end link only provided the relation between the dimensions of the chain cable parts and the chain cable releasing device allows to form such a length.

3.4.10 In all other respects, the chain cables for bower anchors are to comply with the requirements of 7.1, Part XIII "Materials".

3.4.11 For fishing vessels under 30 m in length and for other ships having the Equipment Number 205 and less the chain cables may be replaced with wire ropes; for fishing vessels between 30 and 40 m in length one of chain cables may be replaced with a wire rope. The actual breaking strength of such ropes is not to be less than the breaking load of the corresponding chain cables, and the length is to be at least 1,5 times the length of the chain cables.

Wire ropes of trawl winches complying with this requirement may be used as anchor cables.

On agreement with the Register, ships having the equipment number 130 and less may be equipped with synthetic fibre ropes instead of chain cables or wire ropes.

3.4.12 The end of each wire rope is to be spliced into a thimble, clamp or socket and connected to the anchor by means of a chain cable section having a length equal to the distance between the anchor (in stowed for sea position) and the anchor machinery or 12,5 m, whichever is the less; a breaking load of the above chain section is to be not less than the actual breaking strength of the wire rope. The chain cable section is to be securred to the wire rope fitting and the anchor shackle by means of joining shackles being equal to the wire ropes in strength.

The length of the chain cable sections may be included into 1,5 times the length of wire ropes specified in 3.4.11.

3.4.13 The wire ropes for anchors are to have at least 114 wires and one natural fibre core. The wires of the ropes are to have a zinc coating according to recognized standards.

In all other respects, the wire ropes for anchors are to meet the requirements of 3.15, Part XIII "Materials".

3.5 CHAIN CABLE OR WIRE ROPE FOR STREAM ANCHOR

3.5.1 Stream-anchor chain cables shall meet the applicable requirements of 3.4.

Ships assigned to restricted navigation areas **IIСП** and **IIIСП** and having Equipment Number in excess of 205 should be equipped with a stream-anchor chain cable whose length is at least 60% of that required for a bower-anchor chain cable. The chain cable diameter shall be taken not less than that mentioned in Table 3.1.3-1 two lines above the Equipment Number of the ship in question (bearing the provisions of 3.1.3 and 3.1.4 in mind).

Ships having Equipment Number below 205 may be equipped with studless chain cables.

3.5.2 The requirements of 3.4.12 and 3.4.13 are applicable to the wire rope for the stream anchor.

3.6 ANCHOR APPLIANCES

3.6.1 Stoppers.

3.6.1.1 Each bower-anchor chain cable or rope and each stream-anchor chain cable having a mass of 200 kg and above is to be provided with a stopper holding the anchor in the hawse pipe when stowed for sea or, in addition, intended for riding the ship at anchor. In ships having no anchor machinery or having the anchor machinery, which is not in compliance with the requirements of 6.3.2.3.2, Part IX "Machinery" provision of stoppers for riding the ship at anchor is obligatory.

3.6.1.2 Where the stoppers is intended only for securing the anchor in the hawse pipe when stowed for sea, its parts are to be calculated to withstand the chain cable strain equal to twice the weight of the anchor, the stresses in the stopper parts not exceeding 0,4 times the upper yield stress of their material. Where the stopper comprises a chain cable or rope, this shall have safety factor 5 in relation to the breaking load of the chain cable or actual breaking strength of the rope under the action of a force equal to twice the weight of the anchor.

3.6.1.3 Where the stopper is intended for riding the ship at anchor, its parts are to be calculated on assumption that the stopper will be subjected to a force in the chain cable equal to 0,8 times its breaking load. The stresses in the stopper parts shall not exceed 0,95 times the upper yield stress of their material. Where the stopper comprises a chain cable or rope, they shall have strength equal to that of the chain cable for which they are intended.

3.6.1.4 In glass-reinforced plastic ships the stoppers shall be fastened by bolts with the use of steel gaskets or wooden pads on the deck and under deck flooring between the framing. Bolt connections shall comply with the requirements of 1.7.4, Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats".

3.6.2 Device for securing and releasing the inboard end of the chain cable.

3.6.2.1 The parts of the device for securing and releasing the inboard end of the chain cable are to be calculated for strength under the force acting on the device which is equal to 0,6 times the chain breaking load, stresses in these parts not exceeding 0,95 times the upper yield stress of their material.

3.6.2.2 In ships with Equipment Number of more than 205 the device for securing and releasing the inboard end of the chain cable is to be provided with a drive from the deck on which the anchor machinery is fitted or from other deck, in a place which gives quick and ready access at all times. The screw of the drive shall be self-braking.

3.6.2.3 The design of the device for securing and releasing the inboard end of the chain cable shall ensure the efficiency of its operation both under the action of and without the strain of the chain cable referred to in 3.6.2.1.

3.6.2.4 In glass-reinforced plastic ships the device for securing and releasing the inboard end of the chain cable shall be fastened by bolts with the use of steel gaskets on both sides of the bulkhead. Bolt connections shall comply with the requirements of 1.7.4, Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats".

3.6.3 Laying of chain cables.

3.6.3.1 Laying of chain cables shall provide for their free run when dropping or hoisting the anchors.

In ships with a bulbous bow laying of chain cables is to comply with the requirements of 2.8.2.4, Part II "Hull".

3.6.3.2 The anchor shank shall easily enter the hawse pipe under the mere action of the chain cable tension and shall readily take off the hawse pipe when the chain cable is released.

3.6.3.3 The thickness of the hawse pipe is not to be less than 0,4 times the diameter of the chain cable passing through the hawse pipe.

3.6.3.4 In glass-reinforced plastic ships galvanized or stainless steel plates shall be fitted on the outside plating under the hawse pipes; the plates shall be fastened by countersunk bolts.

Bolt connections shall comply with the requirements of 1.7.4, Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats".

3.6.4 Chain lockers.

3.6.4.1 For stowage of each bower anchor chain lockers shall be provided.

When one chain locker is designed for two chains, it shall be provided with an internal division so that separate stowage of each chain is ensured.

3.6.4.2 The chain locker shall be of shape, capacity and depth adequate to provide an easy direct lead of the cables through the chain pipes, an easy self-stowing of the cables and their free veering away when dropping the anchors.

см.Б1 **3.6.4.3** The chain locker design and covers of the access openings shall be watertight as necessary to prevent accidental flooding of the chain locker which could damage essential auxiliaries or equipment (located outside the chain locker) or could affect the proper operation of the ship.

см.Б1 **3.6.4.4** On ships of 24 meters in length and over and more, the construction of chain lockers and chain pipes shall be watertight up to the lower edge of the weather deck. Access openings to chain lockers shall be fitted with strong covers on bolts fitted close one to each other. Upper openings of chain pipes are to be fitted with the permanent buckler plates in order to reduce to a minimum a chance of water penetration into chain lockers.

3.6.4.5 The chain locker design shall meet the requirements of Part II "Hull"; the drainage facilities — with the requirements of 7.12.1, Part VIII "Systems and Piping"; the lighting — with the requirements of 6.7, Part XI "Electrical Equipment".

3.6.5 Additional requirements for remote-controlled anchor appliances.

3.6.5.1 Stoppers and other anchor appliances for which remote control is provided (see 3.1.5) shall also be fitted with means of local manual control.

3.6.5.2 The anchor appliances and the associated means of local manual control shall be so designed that normal operation is ensured in case of failure of separate elements or the whole of the remote control system (see also 5.1.3, Part XI "Electrical Equipment").

3.7 ANCHOR MACHINERY

3.7.1 Anchor machinery shall be fitted on the deck in the fore part of the ship for dropping and hoisting the anchors, as well as for holding the ship with the bower anchors dropped if the mass of the anchor exceeds 35 kg.

Ships of restricted area of navigation **IIСП** and **IIIСП** shall be fitted with the anchor machinery for dropping and hoisting the stream anchor if its mass exceeds 200 kg.

Ships having Equipment Number 205 and less may be fitted with hand-operated anchor machinery and may also use other deck machinery for dropping and hoisting the anchors.

The requirements for the design and power of anchor machinery are given in 6.3, Part IX "Machinery".

In glass-reinforced plastic ships fastening of the anchor machinery shall comply with the requirements of 3.6.1.4.

3.8 SPARE PARTS

3.8.1 Each ship carrying a spare anchor and equipped with a chain cable (cables) for bower anchor (anchors) accordance with the provisions of 3.3.1 and 3.4 shall have: spare anchor length of chain — 1 pc, spare joining link — 2 pcs, spare end shackle — 1 pc.

3.8.2 Each ship equipped with a spare anchor and wire rope (ropes) for bower anchor (anchors) in accordance with the provisions of 3.3.1 and 3.4.11 shall have a spare set of parts for joining the wire rope and anchor shackle.

4 MOORING ARRANGEMENT

4.1 GENERAL PROVISIONS

4.1.1 Each ship is to be supplied with mooring arrangement for warping to coastal or floating berths and for reliable fastening of the ship to them.

For shipborne barges the mooring arrangement is to comply with the requirements of Section 4, Part III "Equipment, Arrangements and Outfit" of the Rules for the Classification and Construction of Ships of Inland Navigation.

4.1.2 For all ships, except fishing vessels, the number, length and actual breaking strength of mooring ropes are to be selected from Table 3.1.3-1, and for fishing vessels — from Table 3.1.3-2 according to Equipment Number determined in compliance with 3.2.

4.1.3 In case the ratio A/N_e for a ship is more than 0,9, the number of mooring ropes shall be increased as against that prescribed in Table 3.1.3-1 by:

1 pc for ships having $0,9<A/N_e\leqslant 1,1$;

2 pcs for ships having $1,1<A/N_e\leqslant 1,2$;

3 pcs for ships having $A/N_e>1,2$

where N_e and A = Equipment Number and area in profile view specified in 3.2, respectively.

4.1.4 For individual mooring ropes with breaking strength above 490 kN according to Table 3.1.3-1 the latter may be reduced with corresponding increase of the number of mooring ropes and vice versa, provided that the total breaking strength of all mooring ropes aboard the ship is not less than the value selected from Table 3.1.3-1 with regard to paragraphs 4.1.3 and 4.1.6. The number of ropes shall be not less than 6 and none of the ropes shall have the breaking strength less than 490 kN.

4.1.5 The length of individual mooring ropes may be reduced by up to 7 per cent as against the prescribed value provided that the total length of all mooring ropes is not less than that specified in Table 3.1.3-1 and paragraph 4.1.3 or Table 3.1.3-2.

4.1.6 In case mooring rope made of synthetic fibre material is used, its actual breaking strength F_s, in kN, shall not be less than determined from the formula

$$F_s = 0{,}0742\delta_m F_t^{8/9} \qquad (4.1.6)$$

where δ_m = mean elongation at breaking of a synthetic fibre rope, in per cent, but not less than 30%. Where no data on δ_m are available, it is to be assumed equal to:
45% for polyamide ropes;
35% for polypropylene ropes;
F_t = actual breaking strength of the mooring rope specified in Table 3.1.3-1 or 3.1.3-2, in kN.

4.2 MOORING ROPES

4.2.1 Mooring ropes may be of steel wire, natural fibre or synthetic fibre material, with the exception of the ropes intended for ships carrying in bulk flammable liquids with the flash point 60°C and below. In these ships the operations with steel wire ropes are allowed only on the superstructure decks which are not the top of liquid cargo tanks and on condition that no pipelines for loading and unloading the cargo are carried through these decks.

Notwithstanding the breaking strength specified in Tables 3.1.3-1 or 3.1.3-2 or determined from the Formula (4.1.6), the diameter of the mooring rope made from natural or synthetic fibre material shall not be less than 20 mm.

4.2.2 Steel wire ropes are to have at least 144 wires and not less than 7 fibre cores. The exception is made for wire ropes for automatic mooring winches which may have only one fibre core but the number of wires in such ropes is to be not less than 216. The wires of the ropes are to have a zinc coating according to recognized standards.

In all other respects, the steel wire ropes are to meet the requirements of 3.15, Part XIII "Materials".

4.2.3 Natural fibre ropes are to be either manilla or sizal. The ships having equipment number 205 and less are permitted to use hemp ropes. The use of hemp ropes in ships with equipment number over 205 is subject to special consideration by the Register in each case.

In all other respects, the natural fibre ropes are to meet the requirements of 6.6, Part XIII "Materials".

4.2.4 The synthetic fibre ropes are to be manufactured from approved homogeneous materials (polypropylene, capron, nylon, etc.).

Combinations of synthetic fibres of approved different materials are subject to special consideration by the Register in each case.

In all other respects, the ropes of synthetic fibre material are to meet the requirements of 6.6, Part XIII "Materials".

4.3 MOORING APPLIANCES

4.3.1 The number and position of mooring bollards, fairleaders and other mooring appliances depend on the constructional features, purpose and general arrangement of the ship.

4.3.2 Bollards may be of steel or cast iron. Small ships equipped only with natural fibre or synthetic fibre ropes are permitted to use the bollards made of light alloys. As to the method of manufacture, the bollards may be welded or cast.

It is not permitted to use bollards cut directly in the deck which is the top of cargo tanks intended for carriage or stowage of flammable liquids with the flash point 60°C and below.

4.3.3 The outside diameter of the bollard column is to be not less than 10 diameters of the steel wire rope, not less than 5,5 diameters of the synthetic fibre rope, and not less than one circumference of the natural fibre rope for which the bollard is designed. The distance between the axes of bollard columns is not to be less than 25 diameters of the steel wire rope or 3 circumferences of the natural fibre rope.

4.3.4 Bollards, fairleaders and other parts of mooring appliances, with the exception of wire stoppers, as well as their beds are to be so designed that the stresses in the parts do not exceed 0,95 times the upper yield stress of their material when the mooring rope for which they are intended is subjected to the strain equal to the actual breaking strength of the rope.

The breaking load of the wire stopper shall be not less than 0,15 times the actual breaking strength of the whole mooring rope for which it is intended.

In glass-reinforced plastic ships the fastening of bollards, fairleaders and other parts of mooring appliances shall comply with the requirements of 3.6.1.4.

4.4 MOORING MACHINERY

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

4.4.2 The choice of the number and type of mooring machinery is within the owner's and designer's discretion, however, the rated pull of the machinery is not to exceed 1/3 of the actual breaking strength of the mooring ropes used in the ship and, besides, the requirements of 6.4, Part IX "Machinery" are to be satisfied.

5 TOWING ARRANGEMENT

5.1 GENERAL PROVISIONS

5.1.1 Each ship is to be provided with towing arrangement which satisfies the requirements of 5.2 and 5.3.

Besides, the ships having the notation "(tug)" added to the character of classification are to comply with the requirements of 5.4 to 5.6.

5.1.2 Oil tankers, oil tankers (>60°C), combination carriers, gas carriers and chemical tankers of 20 000 tons deadweight and over are to comply with the requirements of 5.7.

5.1.3 The towing arrangements of berth-connected ships shall comply with the requirements of 5.3, Part III "Equipment, Arrangements and Outfit" of Rules for the Classification and Construction of Inland Navigation Ships.

5.2 TOW LINE

5.2.1 The length and the actual breaking strength of the tow line are to be selected from Table 3.1.3-1 according to Equipment Number determined in compliance with 3.2.

For shipborne barges the actual breaking strength of the tow line F_b, in kN, is to be calculated by the formula

$$F_b = 16nBd \qquad (5.2.1)$$

where n = number of barges intended to be towed in the wake of the tug in tandem;
B = breadth of the barge, in m;
d = draught of the barge, in m.

The breaking strength of the tow line is used in the strength calculations of the towing appliances of the shipborne barges. At the discretion of the shipowner the tow lines of the shipborne barges may be stored in the barge carrier or tug, and they do not form a part of the equipment of the shipborne barge.

5.2.2 The tow lines may be of steel wire, natural fibre or synthetic fibre material. The requirements of 4.1.6, 4.2.1 to 4.2.4 for mooring ropes are also applicable to the tow line.

5.3 TOWING APPLIANCES

5.3.1 The number and location of towing bollards and chocks depend on the constructional features, purpose and general arrangement of the ship.

5.3.2 The requirements for mooring bollards and chocks as provided in 4.3.2, 4.3.3 and 4.3.4 are also applicable to towing bollards and chocks.

5.4 SPECIAL ARRANGEMENT FOR TUGS

5.4.1 The number and type of equipment and outfit forming special arrangement for tugs which ensures towing operations under different service conditions are determined by the Shipowner considering that such equipment and outfit shall satisfy the requirements of the present Chapter.

5.4.2 The main determining factor in providing the tugs with a special arrangement is the rated towing pull F acting on the tow hook. The rated towing pull is to be taken as:

for tugs of unrestricted service and of restricted areas of navigation **I** and **II**, the pull on the tow hook required for towing the prescribed tow at a prescribed speed, but not exceeding 5 knots;

for tugs of restricted area of navigation **III**, the bollard pull, but in no case the rated towing pull F, in kN, is to be taken less than:

$$F = 0{,}133 P_e \qquad (5.4.2)$$

where P_e = total power of the tug's main engines, in kW.

5.4.2.1 The numerical value of the rated towing pull under operating conditions specified in 5.4.2 is within the owner's and designer's discretion, and all calculations pertaining to the determination of this value are not subject to approval by the Register. Nevertheless, during mooring and sea trials of the tug, the Register will check this value, and, if the parts of the special arrangement prove to be calculated from a smaller value, the Register may require the strengthening of these parts or may introduce restriction of power during towing operations.

5.4.2.2 The actual breaking strength of the tow line F_1 , in kN, for towing operations on the hook is not to be less than:

$$F_1 = kF \qquad (5.4.2.2)$$

where F = rated towing pull, in kN, according to 5.4.2;
k = safety factor equal to:
5,0 for rated towing pull 98,1 kN and less;
3,0 for rated towing pull 294 kN and over.

For intermediate values of the rated towing pull the safety factor k is obtained by linear interpolation. The length of the tow line for towing operations on the hook is not to be less than 150 m.

The tow line for towing operations on the hook may be of steel wire, natural fibre or synthetic fibre material. The requirements of 4.2 for mooring ropes are also applicable to the tow line for towing operations on the hook.

5.4.3 All stressed parts of the towing arrangement (such as the tow hook, towing rails, etc.) as well as the fastenings for securing these parts to the ship's hull are to be designed to take the actual breaking load of the tow line. The stresses in these parts are not to exceed 0,95 times the upper yield stress of their material.

5.4.4 The cramp iron of the tow hook is to be calculated as a curvilinear bar. Where such calculations are not carried out, i.e. the formulae for a rectilinear bars are used, permissible stresses are to be reduced by 35 per cent.

5.4.5 All parts of the towing arrangement which are subjected to tension or bending under the hull of the tow line are not to be manufactured of cast iron.

5.4.6 The cramp iron of the tow hook is to be either solid forged or manufactured of a solid rolled blank. Percentage elongation of the cramp iron material is not to be less than 18 per cent on 5*D*.

5.4.7 Tow hooks are to be of slip-type and have a tow line releasing device operating efficiently in the range of loads on the tow hook from zero to three times the rated towing pull and at any practically possible deflection of the tow line from the centre line of the ship.

The device is to be controlled both at the tow hook and from the navigating bridge. Where the ship is fitted with a spare tow hook, in addition to the main one, this hook need not be of slip-type and have a device for releasing the tow line.

5.4.8 Each tow hook is to be provided with shock absorbers whose ultimate damping load is not to be less than 1,3 times the rated towing pull.

The tow hooks for tugs of less than 220 kW of restricted area of navigation III may have no shock absorbers.

5.4.9 Prior to installation on board the ship the tow hooks are to be tested by application of a proof load equal to twice the rated towing pull.

5.4.10 The wire stopper and its fastenings are to be such that their breaking load is not less than 1,5 times the rated towing pull.

5.4.11 The requirements of 3.7, Part IV "Stability" are to be taken into consideration when assigning the position of the tow hook and towing winch.

5.5 TOWING WINCHES

5.5.1 The requirements for the design of towing winches are specified in 6.5, Part IX "Machinery".

5.5.2 Provision is to be made for operating the towing winch from a site at the winch; it is recommended to allow for operating the towing winch from the navigating bridge.

5.6 TOW LINE FOR TOWING WINCH

5.6.1 The length of tow line for towing winch is not to be less than 700 m if the power of the tug's main engines is 2200 kW and over, and at least 500 m if that power is 1470 kW or less. In the tugs with the main engines having the power in the range from 1470 to 2200 kW the length of tow line for the towing winch is to be determined by linear interpolation.

5.6.2 In all other respects, the tow line for towing winch is to comply with the requirements set forth in 5.4.2.2.

5.7 EMERGENCY TOWING ARRANGEMENTS ON SHIPS

5.7.1 Ships referred to in 5.1.2 are to be fitted with emergency towing arrangements forward and aft of the ship. The arrangements shall be capable of rapid deployment in the absence of main power on the ship to be towed and easy connection to the towing vessel.

5.7.2 The components of the emergency towing arrangement are listed in Table 5.7.2.

см.Б1 Table 5.7.2

Components of emergency towing arrangement	Forward of ship	Aft of ship
Pick-up gear	*	Yes
Towing pennant	*	Yes
Chafing gear	Yes	Depending on design
Fairlead	Yes	Yes
Strongpoint	Yes	Yes
Roller pedestal	Yes	Depending on design

* Fitting of this component is subject to the special consideration of the Register.

5.7.3 Except the pick-up gear and roller pedestal, the components of the emergency towing arrangement specified in Table 5.7.2 shall have a working strength of at least:

1000 kN for ships of 20 000 t deadweight and over, but less than 50 000 t deadweight,

2000 kN for ships of 50 000 t deadweight and over.

Under the above forces, the stresses are not to exceed 0,5 of the ultimate strength.

The strength shall be sufficient for all relevant angles of towline, i.e. up to 90° from the ship's centreline to port and starboard and 30° vertically downwards.

5.7.4 The towing pennant shall have a length of at least twice the lightest seagoing ballast freeboard at the fairlead plus 50 m. The towing pennant shall have a hard eye-formed termination allowing connection to a standard shackle.

The bow and stern strongpoints and fairleads shall be located so as to facilitate towing from either side of the bow or stern and minimize the stress on the towing system.

The inboard end fastening shall be a stopper or bracket or other fitting of equivalent strength. The strongpoint can be designed integral with the fairlead.

5.7.5 Fairleads shall have an opening large enough to pass the largest portion of the chafing gear, towing pennant or towing line.

The fairlead shall give adequate support for the towing pennant during towing operation which means bending 90° to port and to starboard side and 30° vertically downwards. The bending ratio (towing pennant bearing surface diameter to towing pennant diameter) shall be not less than 7 to 1.

The fairlead shall be located as close as possible to the deck and, in any case, in such a position that the chafing chain is approximately parallel to the deck when it is under strain between the strongpoint and the fairlead.

5.7.6 As the chafing gear mentioned in 5.7.2, a chafing chain may be used or another design approved by the Register. The chafing chain shall be a stud link chain.

см.Б1 The chafing chain shall be long enough to ensure that the towing pennant remains outside the fairlead during the towing operation. A chain extending from the strongpoint to a point at least 3 m beyond the fairlead shall meet this criterion.

5.7.7 One end of the chafing chain shall be suitable for connection to the strongpoint. The other end shall be fitted with a standard pear-shaped open link allowing connection to a standard bow shackle.

The chafing chain shall be stowed in such a way that it can be rapidly connected to the strongpoint.

см.Б1 **5.7.8** The aft emergency towing arrangement shall be capable of being deployed in harbour conditions in not more than 15 min.

The pick-up gear for the aft towing pennant shall be designed for manual operation by one person taking into account the absence of power and the potential for adverse environmental conditions that may prevail during such emergency towing operations. The pick-up gear shall be protected against the weather and other adverse conditions that may prevail.

см.Б1 **5.7.9** The forward emergency towing arrangement shall be capable of being deployed in harbour conditions in not more than 1 h. To facilitate connection of the towing pennant to the chafing gear, a suitably positioned pedestal roller may be used.

Forward emergency towing arrangements which comply with the requirements for aft emergency towing arrangements may be accepted.

A typical emergency towing arrangement is shown in Fig. 5.7.9.

5.7.10 All emergency towing arrangements shall be clearly marked to facilitate safe and effective use even in darkness and poor visibility.

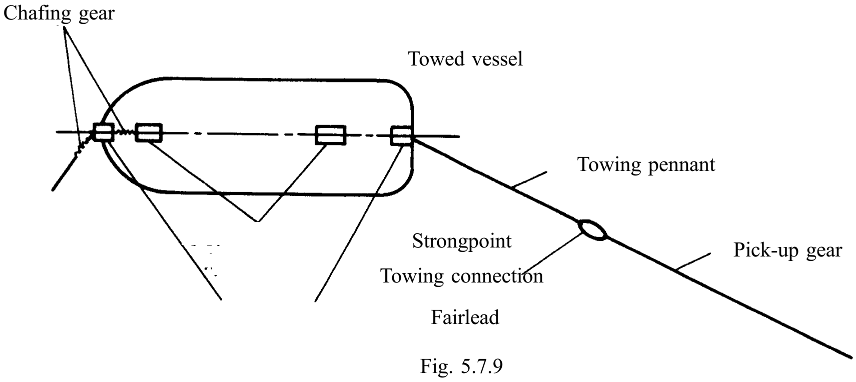


Fig. 5.7.9

6 SIGNAL MASTS

6.1 GENERAL PROVISIONS

6.1.1 The requirements given in the present Section refer only to the signal masts, i.e. the masts which are intended for carrying the signal means: navigation lights, day signals, aerials, etc. Where the masts or their parts carry derrick booms or other cargo handling gear in addition to the signal means, such masts or their parts are to comply with the requirements of Rules for the Cargo Handling Gear of Sea-Going Ships.

The requirements of 6.2 to 6.4 do not apply to berth-connected ships. The signal masts of berth-connected ships shall be designed to carry prescribed signal means.

6.1.2 Arrangement, height and provision of signal means on the signal masts are to comply with the requirements of Part III "Signal Means" of Rules for the Equipment of Sea-Going Ships.

6.1.3 If in ships of restricted areas of navigation **IIСП** and **IIIСП** the signal masts are collapsible, special machinery shall be installed for their operation or provision shall be made for appropriate connection with other deck machinery. The drive of the machinery may be hand-operated provided the machinery is self-braking and the load on the handle is not more than 160 N at any moment of jackknifing or hoisting the mast.

6.2 STAYED MASTS

6.2.1 The outside diameter d and the plate thickness t, in mm, at the heel of the masts made of steel having the upper yield stress from 215 up to 255 MPa and stayed by two shrouds on each side of the ship, are not to be less than:

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

$$t = 0{,}2l + 3 \qquad (6.2.1\text{-}2)$$

where l = mast length, in m, from the heel to the shroud eyeplates.

The diameter of the mast may be gradually decreased upwards to a value of $0{,}75d$ at the shroud eyeplates, while the thickness of the mast plates is maintained constant throughout the length l.

The mast length from the shroud eyeplates to the top is not to exceed 1/3 of l.

The mast is to be stayed by the shrouds as follows:

.1 horizontal distance a, in m, from the deck (or bulwark) stay eyeplate to the transverse plane through the mast stay eyeplate is not to be less than:

$$a = 0{,}15h \qquad (6.2.1.1)$$

where h = vertical distance, in m, from the mast stay eyeplate to the deck (or bulwark) stay eyeplate;

.2 horizontal distance b, in m, from the deck (or bulwark) stay eyeplate to the longitudinal plane through the mast stay eyeplate is not to be less than:

$$b = 0{,}30h; \qquad (6.2.1.2)$$

.3 the value a is not to exceed the value b.

6.2.2 The actual breaking strength F of the ropes, in kN, used for the mast shrouds as specified in 6.2.1 is not to be less than:

$$F = 0{,}49(l^2 + 10l + 25). \qquad (6.2.2)$$

In other respects, the ropes for shroud are to comply with the requirements of 3.15, Part XIII "Materials".

The loose gear of shrouds (shackles, turnbuckles, etc.) is to be such that their safe working load is not less than 0,25 times the actual breaking strength of the ropes referred to above.

6.2.3 Where:

the mast is made of high tensile steel, light alloys, glass-reinforced plastics or wood (the wood shall be of the 1st grade);

the mast is stayed in a way other than that specified in 6.2.1;

in addition to a yard arm, lights and day signals, the mast is fitted with other equipment having considerable weight, such as radar reflectors with platforms for their servicing, "crow's nests", etc., proceed as specified in 6.4.

6.2.4 The wires of shrouds are to have a zinc coating according to recognized standards.

6.3 UNSTAYED MASTS

6.3.1 The outside diameter d and the plate thickness t, in mm, at the heel of masts made of steel having the upper yield stress from 215 to 255 MPa are not to be less than:

$$d = 3l^2(0{,}674l+a+13) \times \left(1+\sqrt{1+\frac{51{,}5\cdot 10^4}{l^2(0{,}674l+a+13)^2}}\right)\cdot 10^{-2}; \qquad (6.3.1\text{-}1)$$

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

where l = length of the mast from heel to top, in m;
a = elevation of the mast heel above centre of gravity of the ship, in m.

The outside diameter of the mast may be gradually decreased upwards to a value $0{,}5d$ at the distance $0{,}75l$ from the heel.

In no case is the thickness of the mast plate to be less than 4 mm.

The mast heel shall be rigidly fixed in all directions.

6.3.2 Where:

the mast is made of high tensile steel, light alloys, glass-reinforced plastics or wood (the wood shall be of the 1st grade);

in addition to a yard arm, lights and day signals, the mast is fitted with other equipment having considerable weight, such as radar reflectors with platforms for their servicing, "crow's nests", etc., proceed as provided in 6.4.

6.4 MASTS OF SPECIAL CONSTRUCTION

6.4.1 In the cases specified in 6.2.3 and 6.3.2 as well as where bipod, tripod and other similar masts are installed, detailed strength calculations of these masts shall be carried out. These calculations are to be submitted to the Register for consideration.

6.4.2 The calculations are to be performed on the assumption that each part of the mast is affected by a horizontal force F_i, in kN

$$F_i = \left[m_i \frac{4\pi^2}{T^2}(\theta z_i + r\sin\theta) + m_i g\sin\theta + pA_i\cos\theta\right]\cdot 10^{-3} \qquad (6.4.2)$$

where m_i = mass of each part, in kg;

z_i = elevation of the centre of gravity of each part above that of the ship, in m;

A_i = projected lateral area of each part, in m^2;

T = rolling or pitching period, in s;

θ = amplitude of roll or pitch, in rad;

r = wave half-height, in m;

g = 9,81 m/s^2 — acceleration due to gravity;

p = 1960 Pa — specific wind pressure.

The calculations are to be carried out both for rolling and pitching of the ship, r being taken as equal to $L/40$ where L is the ship's length, in m, and θ, in rad., as corresponding to an angle of 40° at roll and of 5° at pitch.

6.4.3 Under the loads specified in 6.4.2, the stresses in the parts of the mast shall not exceed 0,8 times the upper yield stress of their material where they are made of metal, and 12 MPa where they are made of wood. The safety factor of the standing ropes under the same loads is not to be less than 3.

For glass-reinforced plastic masts under the loads specified in 6.4.2 the stresses in the parts of the mast shall not exceed the allowable stress value indicated in Table 3 of Appendix 3, Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats" for the case of short-time action of the load for the relevant type of deformation.

7 OPENINGS IN HULL, SUPERSTRUCTURES AND DECKHOUSES AND THEIR CLOSING APPLIANCES

7.1 GENERAL PROVISIONS

7.1.1 The requirements of the present Section apply to ships of unrestricted service as well as to ships of restricted areas of navigation **I**, **II**, **IIСП** and **IIIСП** engaged on international voyages. The requirements for ships of restricted areas of navigation **I**, **II**, **IIСП** and **IIIСП** not engaged on international voyages, as well as for ships of restricted area of navigation III may be relaxed, the extent of relaxation will be specially considered by the Register in each case, unless expressly provided otherwise.

7.1.2 The requirements of the present Section apply to ships to which a minimum freeboard is assigned. Departures from these requirements may be permitted for the ships to which a greater than minimum freeboard is assigned on condition that the Register is satisfied with safety conditions provided.

7.1.3 The arrangement of openings and their closing appliances in the hull, superstructures and deckhouses is also to comply with the requirements of Part VI "Fire Protection" and Part XI "Electrical Equipment".

7.1.4 As far as deck openings are concerned, the following two positions are distinguished in the present Section:

7.1.4.1 Position 1:

.1 upon exposed parts of:

freeboard deck;

raised quarter deck;

superstructure deck and deckhouse top of the first tier situated forward of 0,25 of the ship's length L from the forward perpendicular;

.2 upon the same parts within the superstructures and deckhouses which are not enclosed.

7.1.4.2 Position 2:

.1 upon exposed parts of superstructure decks and deckhouse tops of the first tier situated abaft 0,25 of the ship's length L from the forward perpendicular;

.2 upon the same parts within the superstructures and deckhouses of the second tier which are not enclosed.

7.1.5 The height of coamings specified in the present Section is measured from the upper surface of the steel deck plating or from the upper surface of the wood or other sheathing, if fitted.

7.1.6 In supply vessels the access to the spaces situated below the open cargo deck shall preferably be provided from the location inside the enclosed superstructure or deckhouse or from the location above the superstructure deck or deckhouse top. The arrangement of companion or other hatches on the open cargo deck leading to the spaces below this deck is subject to special consideration by the Register in each case, taking account of the degree of protection of these hatches from possible damage during cargo handling operations as well as the volume of spaces flooded in case of damage to the hatch.

7.1.7 The requirements of the present Section for floating docks apply to openings and their closing appliances arranged above the margin line at docking. Openings and their closing appliances arranged below the margin line at docking are subject to special consideration by the Register.

7.1.8 In docklift ships, regardless of the provisions of 7.4 to 7.7, it is not permitted to arrange openings for doors, companion hatches, skylights, ventilating trunks and other hatches in sides and boundary bulkheads of holds if their lower edges are below the margin line at docking, with the exception of the openings to the watertight spaces of a restricted volume not communicating with other spaces below the level of the margin line at docking.

7.1.9 Doors and hatchways in sides and boundary bulkheads of holds in docklift ships, if their sills are above the margin line at docking by less than 600 mm or 0,05 times the distance between the openings and the centre line whichever is the greater, shall be provided with the light signalling system comprising the indicators installed in the control post of the ship's docking operations. The light indicators shall clearly show the position of the door or hatch cover (secured or open).

7.1.10 The light signals specified in 7.1.9 need not be provided for doors and hatchways to the watertight spaces of a restricted volume not communicating with other spaces below the level which is by 600 mm or 0,05 times the distance between the opening and the centre line, whichever is the greater, above the margin line at docking.

7.1.11 In cargo ships covered by the requirements of Part V "Subdivision", the openings for access, piping, ventilation, electric cables, etc. in watertight internal bulkheads and decks shall be provided with watertight doors or hatch covers normally closed when at sea which, in their turn, are to be provided with indication means, positioned in their close proximity and on the bridge, to indicate whether such doors or hatch covers are open or closed. On each side of such a door or hatch cover there shall be an inscription to the effect the closure is not to be left open.

7.1.12 In ships mentioned under 7.1.11, all external openings which do not, by their location, conform to the requirements of 3.4.4, Part V "Subdivision" shall be fitted with strong enough watertight closures for which, except cargo hatch covers, provision shall be made for bridge indication.

The watertight closures of shell openings located below the bulkhead deck are to be permanently closed at sea are to be fitted with devices preventing their uncontrolled opening. Plates shall be attached to such closures with inscriptions to the effect the openings shall be permanently closed at sea.

7.1.13 In dry cargo ships not covered by the requirements of 7.1.11 and 7.1.12 all the doors of sliding or hinged type in watertight bulkheads should be fitted up with indication means positioned on the bridge to indicate whether such doors are open or closed. Similar indicators shall be provided for shell doors and other closing appliances which, if left open or not properly secured, can lead to solid flooding of the ship.

7.1.14 The requirements of Section 7 do not apply to berth-connected ships. For these ships, the following provisions apply:

the coaming height of openings of companion hatches, skylights, ventilation trunks and ventilation heads should not be less than 100 mm;

weathertight hatch covers shall be provided;

the external doors of superstructures shall be watertight, but where the lower edge of an external door is not less than 600 mm away from the waterline corresponding to the maximum draught, such doors may be weathertight;

the lower edge of a side light is not to be less than 150 mm away from the waterline corresponding to the maximum draught;

on the freeboard deck, the superstructure and deckhouse windows shall be watertight.

7.2 SIDE SCUTTLES

7.2.1 Position of side scuttles.

7.2.1.1 The number of side scuttles in the shell plating below the freeboard deck is to be reduced to a minimum compatible with the design and proper working of the ship.

Fishing vessels mooring alongside each other or other ships at sea shall not have side scuttles under freeboard deck in the mooring zone, wherever possible. If in this zone side scuttles are fitted in the shell plating, they shall be so positioned that the possibility of their damage during mooring operations is excluded.

No side scuttles are permitted within the boundaries of the ice belt of the shell plating specified in Part II "Hull" in icebreakers and ships with ice strengthening.

7.2.1.2 No side scuttle is to be fitted in a position so that its sill is below a line drawn parallel to the freeboard deck at side and having its lowest point located 0,025 of the ship's breadth *B* or 500 mm, whichever is the greater, above the summer load waterline or above the summer timber load waterline where timber load lines are assigned to the ship.

In ships of restricted areas of navigation **II**, **IIСП**, **IIIСП** and **III** not engaged on international voyages the specified distance 500 mm may be disregarded.

If the length of the ship is less than 24 m, the specified distance may be reduced to 300 mm for ships of restricted areas of navigation **II**, **IIСП** and **IIIСП** and to 150 mm for ships of restricted area of navigation **III**.

7.2.1.3 Side scuttles in the shell plating below the freeboard deck, in front bulkheads of enclosed superstructures and deckhouses of the first tier and also in front 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 and fitted with efficient deadlights hinged inside (see also 2.4.5, Part VI "Fire Protection").

In tugs of restricted areas of navigation **II** and **III** the side scuttles fitted below the bulkhead deck are to be not only of heavy but also of non-opening type.

In ships of restricted areas of navigation **II**, **IIСП** and **IIIСП** having the length below 24 m and in ships of restricted area of navigation **III** it is allowed to fit side scuttles of normal type instead of those of heavy type.

7.2.1.4 In ships to which the requirements of Part V "Subdivision" apply the side scuttles outside a floodable compartment or a specified group of compartments, fitted in a position so that their sills are by less than 0,3 m or $(0{,}1 + \frac{L-10}{150})$ m, whichever is less, above the corresponding damage waterline and the side scuttles in the floating cranes the sills of which are by less than 0,3 m above the waterline corresponding to the actual maximum statical heel in case the hook is under load, shall be not only of heavy but also of non-opening type.

In ships of restricted areas of navigation **II**, **IIСП** and **IIIСП** having the length below 24 m and in ships of restricted area of navigation **III** it is allowed to fit side scuttles of normal non-opening type instead of those of heavy non-opening type.

7.2.1.5 Side scuttles in enclosed superstructures and deckhouses of the first tier, except those in their front bulkheads, and also side scuttles in enclosed superstructures and deckhouses of the second tier within 0,25 of the ship's length *L* from the forward perpendicular, except those in their front bulkheads, may be of normal type.

In ships of restricted areas of navigation **II**, **IIСП** and **IIIСП** having the length below 24 m and in ships of restricted area of navigation **III** it is allowed to fit side scuttles of light type instead of those of normal type. Side scuttles are to be fitted with efficient deadlights hinged inside.

7.2.1.6 Side scuttles in enclosed superstructures and deckhouses of the second tier, except those fitted in a position within 0,25 of the ship's length from the forward perpendicular are to be as required in 7.2.1.5, provided these side scuttles give direct access to an open stairway leading to spaces situated below.

In cabins and similar spaces of enclosed superstructures and deckhouses of the second tier it is allowed that instead of side scuttles specified in 7.2.1.5, the side scuttles or windows could be fitted without deadlights.

7.2.1.7 On no account shall the side scuttles be fitted in the outer wall sides of the floating docks and in the sides of the docklift ships so that their sills are below the margin line at docking.

In the inner wall sides of the floating docks and in the boundary bulkheads of the docklift ships installation of the side scuttles is not permitted.

7.2.1.8 In the outer wall sides of the floating docks and in the sides of the docklift ships the side scuttles, the sills of which are above the margin line at docking by less than 300 mm or 0,025 times the ship's breadth, whichever is the greater, shall be of heavy type, fitted with hinged inside deadlights, and of non-opening type.

7.2.1.9 In the outer wall sides of the floating docks the side scuttles, the sills of which are above the margin line at docking by 300 mm or more, shall be of normal type and fitted with hinged inside deadlights.

7.2.1.10 Ships with distinguishing marks **П1** and **П2** in the class notation are to be fitted with side scuttles having deadlights permanently attached to their primary structure, wheelhouse windows are to be fitted with detachable screens, except side scuttles and windows in the wheelhouse, and search and rescue operation control station.

7.2.2 Construction and attachment of side scuttles and windows.

7.2.2.1 The Rules distinguish three types of side scuttle construction:

.1 heavy type with the glass thickness of not less than 10 mm for inner diameter of 200 mm and below, not less than 15 mm for inner diameter from 300 mm to 350 mm and not less than 19 mm for inner diameter of 400 mm. The inner diameter shall not exceed 400 mm. For intermediate inner diameters (from 200 mm to 300 mm and from 350 mm to 400 mm) the glass thickness is to be determined by linear interpolation.

In addition, heavy side scuttles if they are of the opening type are to have a nut (instead of one of the ear-nuts securing their frame) being screwed off with the aid of a special wrench;

.2 normal type with the glass thickness of not less than 8 mm for inner diameter of 250 mm and below, and not less than 12 mm for inner diameter of 350 mm and over, however, the inner diameter is not to exceed 400 mm. For intermediate inner diameters the thickness of the glass is to be determined by linear interpolation;

.3 light type with the glass thickness of not less than 6 mm for inner diameter of 250 mm and below and not less than 10 mm for inner diameter of 400 mm and over, however, the inner diameter is not to exceed 450 mm. For intermediate inner diameters the thickness of the glass is to be determined by linear interpolation.

7.2.2.2 Normal and heavy side scuttles may be of non-opening type, i.e. with the glass fixed in the main frame, or of opening type, i.e. with the glass fixed in the glazing bead efficiently hinged on the main frame. Exception is to be made for the cases specified in 7.2.1.3, 7.2.1.4 and 7.2.1.8 where the side scuttles shall be of non-opening type only.

The glasses of side scuttles are to be reliably and weathertight secured by means of a metal ring provided with screws or by other equivalent device and a gasket.

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 shall be capable of being effectively closed and secured weathertight by means of ear-nuts or nuts being screwed off with the aid of a special wrench.

7.2.2.4 The main frame, glazing bead, deadlight and ring for securing the glass are to be manufactured from steel, brass or other material approved by the Register.

The ear-nuts and nuts being screwed off by a special wrench are to be made of corrosion-resistant material.

Glass used for the side scuttles is to be hardened.

7.2.2.5 In glass-reinforced plastic ships side scuttles shall be attached to the outside plating and to the bulkheads of superstructures and deckhouses in accordance with the requirements of 1.7.4, Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats".

7.2.2.6 The construction of the windows shall comply with the requirements of 7.2.2.2, 7.2.2.3 and 7.2.2.4, except for the requirements for the deadlights.

The thickness of the window glass t, in mm, shall be not less than determined from the formula

$$t = 0{,}32kb\sqrt{p} \qquad (7.2.2.6\text{-}1)$$

where b = lesser clear size of the window, in m;

p = pressure head, in kPa, calculated according to 2.12.3, Part II "Hull"; distance z_1 being taken up to the middle of the window height;

k = factor determined from the formula

$$k = 13{,}42 — 5{,}125(b/a)^2; \qquad (7.2.2.6\text{-}2)$$

a = greater clear size of the window, in m.

7.3 FLUSH DECK SCUTTLES

7.3.1 Flush deck scuttles in positions 1 and 2 are to be provided with deadlights hinged or attached by other method (for example, by means of a chain) and capable of being easily and efficiently closed and secured.

7.3.2 The largest of clear dimensions of the flush deck scuttles is not to be over 200 mm, with the glass being at least 15 mm thick. The flush deck scuttles shall be attached to the metal deck plating by means of frames.

7.3.3 When secured, the deadlights of the flush deck scuttles are to be weathertight. The tightness is to be ensured by a rubber or other suitable gasket.

For the same purpose, along their contour the glasses of the flush deck scuttles are to be provided with a gasket made of rubber or other suitable material.

7.3.4 The strength and materials of the flush deck scuttles parts are governed by applicable requirements specified in 7.2.2.3 and 7.2.2.4. As regards attachment of flush deck scuttles in glass-reinforced plastic ships, see requirements of 7.2.2.5.

7.4 OPENINGS IN SHELL PLATING AND THEIR CLOSING APPLIANCES

7.4.1 General.

7.4.1.1 This Chapter gives requirements for the arrangement of bow, side and stern doors in the shell plating, strength of structural elements of the doors, securing, locking and supporting devices.

7.4.1.2 The number of doors is to be reduced to a minimum consistent with the structure and normal operational conditions of the ship.

7.4.1.3 When closed and secured, doors in the shell plating are to be weathertight. Weathertightness is to be ensured with a rubber or other suitable packing.

7.4.1.4 The plating thickness of the doors made of steel, irrespective of the fulfilment of the requirements given in 7.4.1.10, is to be not less than the thicknesses referred to in 2.2.4.8 and 2.12.4.1, Part II "Hull" for the appropriate position of the door; the minimum plating thickness of the doors made of other materials is subject to special consideration by the Register in each particular case.

7.4.1.5 Doors with a clear area of 12 m^2 and more are to be secured by means of a power system or by a hand gear used for securing the door from a readily accessible position.

7.4.1.6 When power-operated securing devices or devices with a hand gear are used, it is necessary to ensure that the doors shall remain tight in the secured position and shall remain secured in case of failure of any part of the power system or hand gear of the securing device.

Hydraulically operated securing devices are to be manually or mechanically lockable in the secured position.

7.4.1.7 When power-operated securing devices or devices with a hand gear are used, provision is to be made for the indicators which clearly show whether the door is totally secured or not.

These indicators are to be fitted in a position from which the securing operation is performed, and in case of the power-operated securing device, also on the navigating bridge.

7.4.1.8 If, due to the ship's purpose, it is specially provided to open and close the doors not only in ports but also at sea, arrangements approved by the Register are to be made (with regard to the operational conditions) to ensure closure and complete securing of the open door, even in case of failure of the door gear and securing device gear, or other arrangements approved by the Register are to be made to prevent penetration of water into the ship spaces when the door is open.

Provision is to be made for devices ensuring proper locking of the door in the open position.

The drives of such doors are to comply with the requirements of Part IX "Machinery" and Part XI "Electrical Equipment".

7.4.1.9 There must be a readily seen notice plate near each door, indicating that the door is to be closed and secured before the ship leaves the port; for doors referred to in 7.4.1.8 provision is to be also made for a notice plate indicating that at sea only the master is allowed to open the door.

7.4.1.10 When doors are under the action of the design loads determined in accordance with 7.4.2 and 7.4.3, except 7.4.2.5, stresses, in MPa, in the primary members of the doors as well as of securing, locking and supporting devices are not to exceed the following values:

bending stress

$$\sigma = 120/k; \qquad (7.4.1.10\text{-}1)$$

shear stress

$$\tau = 80/k; \qquad (7.4.1.10\text{-}2)$$

equivalent stress

$$\sigma_e = \sqrt{\sigma^2 + 3\tau^2} = 150/k \qquad (7.4.1.10\text{-}3)$$

where k = 1,0 for steel with upper yield stress of the material R_{eH} = 235 MPa;
k = 0,78 for steel with R_{eH} = 315 MPa;
k = 0,72 for steel with R_{eH} = 335 MPa.

7.4.2 Bow doors.

7.4.2.1 Bow doors are to be situated above the freeboard deck.

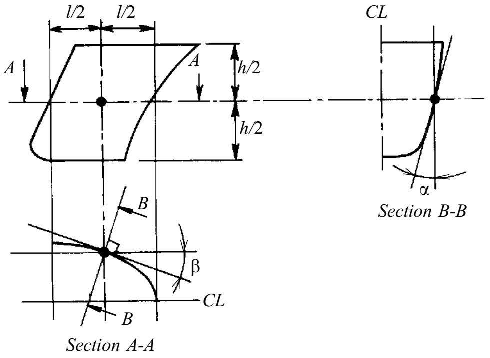
7.4.2.2 Where the bow door leads to a complete or long forward enclosed superstructure a weathertight inner door is to be installed as part of the collision bulkhead above the freeboard deck of the ship.

Bow 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 case of damage to or detachment of the bow door.

7.4.2.3 The design external pressure P_e , in kPa, for the scantlings of primary members, securing, locking and supporting devices of the bow doors is determined from the following formula:

$$P_e = C_H(0,6 + 0,41\mathrm{tg}\alpha)(0,4v\sin\beta + 0,6\sqrt{L})^2 \qquad (7.4.2.3)$$

where C_H is a coefficient equal to:
C_H = 0,0125L for ships less than 80 m in length;
C_H = 1,0 for ships 80 m and more in length;
v = contractual ship's forward speed, in knots;
α and β = angles to be obtained from Fig. 7.4.2.3.



Section A-A

Section B-B

Fig. 7.4.2.3

The design external pressure may be reduced by 20 per cent for ships of restricted service **IIСП** and **IIIСП** and by 40 per cent for ships of restricted service **III**.

In any case, the design external pressure P_e is not to be taken less than the values determined according to 1.3.2.2 or 2.8.3.3, Part II "Hull", whichever is the greater.

7.4.2.4 The design internal pressure P_i, in kPa, for scantlings of primary members, securing, locking and supporting devices of inner doors is to be determined from the formula

$$P_i = 10z \qquad (7.4.2.4)$$

where z = vertical distance from the centre of gravity of the door area to the deck above, in m.

In all cases, the value of the design internal pressure P_i is not to be less than 25 kPa.

7.4.2.5 The scantlings of primary members of visor doors are to be chosen in accordance with the requirements of 2.8.5.1, Part II "Hull".

7.4.2.6 Securing and locking devices of bow doors are to be designed to withstand the forces F_e or F_i, in kN, to be obtained from the following formulae:

for the doors opening inwards

$$F_e = AP_e + p_p l_p; \qquad (7.4.2.6\text{-}1)$$

for the doors opening outwards

$$F_i = AP_i + 10Q + p_p l_p \qquad (7.4.2.6\text{-}2)$$

where A = clear area of the door, in m^2;
for P_e, see 7.4.2.3;
for P_i, see 7.4.2.4;
p_p = pressure of the packing when it is compressed for the maximum depth possible, in kN/m, is assumed in calculations equal to at least 5 kN/m;
l_p = length of the packing, in m;
Q = mass of the door, in t.

7.4.2.7 Securing and locking devices, as well as supports of the visor doors are to be designed to withstand forces F_{xf}, F_{xa}, F_y and F_z, in kN.

The forces acting in the longitudinal direction are to be determined from the following formulae:

bow

$$F_{xf} = \frac{10Qc + P_{xe}a - P_z b}{d} \; ; \qquad (7.4.2.7\text{-}1)$$

stern

$$F_{xa} = \frac{10Qc - P_{xi}a}{d} \; . \qquad (7.4.2.7\text{-}2)$$

The force acting in the transverse direction is to be determined from the formula

$$F_y = P_e A_y . \qquad (7.4.2.7\text{-}3)$$

The force acting in the vertical direction is to be determined from the formula

$$F_z = P_z - 10Q \qquad (7.4.2.7\text{-}4)$$

or

$$F_z = 10(V - Q) \qquad (7.4.2.7\text{-}5)$$

where for Q, see 7.4.2.6;
for P_e, see 7.4.2.3;
P_{xe} = $P_e A_x$, in kN (7.4.2.7-6)
A_x = area of the transverse vertical projection of the door (see Fig. 7.4.2.7), in m^2;
P_z = $P_e A_z$, in kN; (7.4.2.7-7)
A_z = area of horizontal projection of the door (see Fig. 7.4.2.7), in m^2;
P_{xi} = $P_i A_x$, in kN; (7.4.2.7-8)
for P_i, see 7.4.2.4;
A_y = area of the longitudinal vertical projection of the door (see Fig. 7.4.2.7), in m^2;
a = vertical distance, in m, from visor pivot to the centroid of the transverse vertical projected area of the visor door (see Fig. 7.4.2.7);
b = vertical distance, in m, from visor pivot to the centroid of the horizontal projected area of the visor door (see Fig. 7.4.2.7);
c = horizontal distance, in m, from visor pivot to the centre of gravity of the visor mass (see Fig. 7.4.2.7);
d = vertical distance, in m, from visor pivot to the bottom of the door (see Fig. 7.4.2.7);
V = inner volume of the door, in m^3,

whichever is the greater.

7.4.2.8 For side-opening doors, thrust bearing is to be provided in way of girder ends at the closing of two leaves to prevent one leaf shifting towards the other one under effect of unsymmetrical pressure (see Fig. 7.4.2.8).

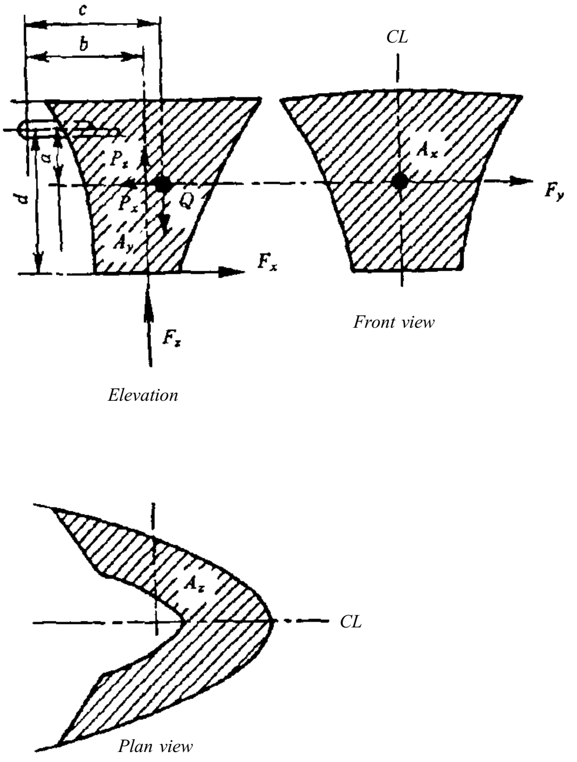


Fig. 7.4.2.7

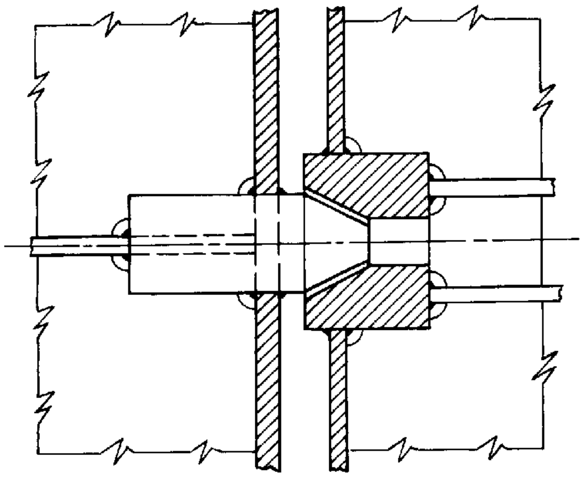


Fig. 7.4.2.8 Thrust bearing

Each part of the thrust bearing is to be kept secured on the other part by means of securing devices.

7.4.2.9 Lifting arms of the visor doors and thrust bearing are to be designed to withstand static and dynamic loads arising when the door is opened and closed with due regard to the minimum wind pressure 1,5 kN/m^2.

7.4.3 Side and stern doors.

7.4.3.1 The lower edge of the door openings is not to be lower than the line which is parallel to the freeboard deck and has its lowest point at the uppermost cargo waterline.

The deviation from this requirement may be allowed in exceptional cases for side doors of the ships which are not passenger ships, provided it is proved to the Register that safety will not be thus impaired.

In such cases, provision is to be made for: the second (inner) doors, strength and tightness of which is equivalent to those of the outer doors; a device enabling to determine water presence in the space between the doors; water drainage from this space to bilges or drain wells, controlled by a readily accessible valve or other arrangements approved by the Register.

7.4.3.2 The doors are to open outwards so that forces acting under the effect of the sea press the door against the supporting contour of the sill. Installation of the doors opening inside is subject to special consideration by the Register in each particular case.

7.4.3.3 The number of securing devices on each edge of the door is to be not less than two; a securing device is to be provided in the vicinity of each door corner. The distance between securing devices is not to exceed 2,5 m.

7.4.3.4 The design external pressure P, in kPa, for structural members of doors is to be determined in accordance with the requirements of 1.3.2, Part II "Hull". In any case, the value of P is not to be taken less than 25 kPa.

7.4.3.5 Securing and locking devices are to be designed to withstand the forces F_1 or F_2, in kN, determined from the formulae:

for doors opening inwards

$$F_1 = AP + p_p l_p; \qquad (7.4.3.5\text{-}1)$$

for doors opening outwards

$$F_2 = F_c + 10Q + p_p l_p \qquad (7.4.3.5\text{-}2)$$

where for A, p_p and l_p, see 7.4.2.6;
for P, see 7.4.3.4
F_c = an accidental force due to loose cargo, to be uniformly distributed over the area A and to be taken not less than 300 kN or $5A$, in kN, whichever is the greater.
For small doors, such as bunker doors or pilot doors, the value of F_c may be reduced upon special consideration by the Register. In case the second (inner) door is installed, which is capable to protect the external door from accidental forces due to loose cargoes, $F_c = 0$.
for Q, see 7.4.2.6.

Supporting structures of doors are to be designed to withstand forces F_3 and F_4, in kN, obtained from the formulae:

for doors opening inwards

$$F_3 = AP; \qquad (7.4.3.5\text{-}3)$$

for doors opening outwards

$$F_4 = F_c + 10Q. \qquad (7.4.3.5\text{-}4).$$

7.5 SUPERSTRUCTURES AND DECKHOUSES

7.5.1 Construction, openings and closing appliances.

7.5.1.1 Openings in the freeboard deck other than those defined in 7.3, 7.6 to 7.11 and 7.13 are to be protected by the enclosed superstructure or enclosed deckhouse.

The similar openings in the deck of enclosed superstructure or enclosed deckhouse are to be protected by enclosed deckhouse of the second tier.

7.5.1.2 Superstructures and deckhouses are considered enclosed if:

their construction complies with the requirements of 2.12, Part II "Hull";

all access openings comply with the requirements of 7.5.2 and 7.7;

all other openings in their outside contour comply with requirements of 7.2 to 7.4 and 7.7 to 7.10.

7.5.2 Doors in enclosed superstructures and enclosed deckhouses.

7.5.2.1 All access openings in the end bulkheads of enclosed superstructures and outside bulkheads of enclosed deckhouses are to be fitted with doors (see 2.4.4, Part VI "Fire Protection").

7.5.2.2 The height of the sills to access openings specified in 7.5.2.1 is to be at least 380 mm. However, the bridge or poop shall not be regarded as enclosed unless access is provided for the crew to machinery and other working spaces inside these superstructures from any place in the uppermost continuous open deck or above it by alternative means which are available at all times when bulkhead openings are closed; the height of the sills of the openings in the bulkheads of such bridge or poop is to be at least 600 mm in position 1 and at least 380 mm in position 2.

In ships of restricted area of navigation **III** having the length of 24 m and over (except for passenger ships) the specified height of the sills to access openings may be reduced from 600 mm down to 450 mm and from 380 mm down to 230 mm, respectively.

In ships of restricted areas of navigation **II**, **IIСП**, **IIIСП** and III having the length below 24 m the height of the above sills may be reduced to 230 mm for all open decks.

7.5.2.3 The doors shall be so designed as to withstand the pressure head p calculated according to 2.12.3, Part II "Hull", the distance z_1 being taken up to the middle of the door height. Under the pressure head p the stresses in the door elements shall not exceed 0,8 times the upper yield stress of the material.

Whatever the stresses, the thickness of the steel door plate shall be not less than that specified in 2.12.4.4, Part II

"Hull". For steel doors manufactured by stamping the minimum thickness of the door plate may be reduced by 1 mm.

The minimum thickness of the door plate made of other materials is subject to special consideration by the Register.

7.5.2.4 The doors are to be permanently and strongly attached to the bulkhead and fitted with clamping devices or other equivalent means for expeditiously opening, closing and securing them weathertight; such devices shall be so arranged that they can be operated from both sides of the bulkhead. The doors are to be opening outside, opening of doors inside the superstructure or deckhouse space will be specially considered by the Register in each case.

7.5.2.5 The doors are to be weathertight when secured. The tightness is to be ensured by a rubber or other suitable gasket.

7.5.2.6 The doors are to be made of steel or other material approved by the Register.

7.5.2.7 In glass-reinforced plastic ships the doors shall be attached to the bulkheads of superstructures and deckhouses in the same manner as the side scuttles, in accordance with the requirements of 7.2.2.5.

7.5.2.8 In floating docks the height of the sills to access openings in superstructures and deckhouses of the top deck shall be at least 200 mm if access is provided from these superstructures and deckhouses into the spaces situated below.

7.6 ENGINE AND BOILER CASINGS

7.6.1 Engine and boiler space openings in positions 1 and 2 are to be efficiently enclosed by casings of ample strength raised above decks to the extent, which is reasonable and practicable, and being in their turn decked or terminated in skylights. The construction of the casings is to meet the requirements of 2.13, Part II "Hull", and in case of glass-reinforced plastic ships, with the requirements of Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats".

7.6.2 Casings are to be made weathertight.

7.6.3 Casings are to be made of steel or other materials approved by the Register (see also 2.1.1.2, Part VI "Fire Protection").

7.6.4 The access openings in the casings are to be fitted with permanently attached doors complying with the requirements of 7.5.2.3 to 7.5.2.6. The height of the sills to the access openings is to be at least 600 mm in position 1 and at least 380 mm in position 2.

If the length of the ship is less than 24 m, the specified height of the sills may be reduced down to 300 mm for ships of restricted areas of navigation **II**, **IIСП**, **IIIСП** and **III**.

In ships of restricted area of navigation **III** having the length of 24 m and over (except passenger ships) the specified height of the sills may be reduced from 600 mm down to 450 mm and from 380 mm down to 230 mm, respectively.

7.6.5 In type "A" ships and also in type "B" ships which are permitted to have the tabular freeboard less than that prescribed by Table 4.1.3.2, 6.4.2.3 or 6.4.3.3 of the Load Line Rules for Sea-Going Ships, the engine and boiler casings are to be protected by enclosed poop or bridge of at least standard height, or by a deckhouse of equal height and equivalent strength. However, engine and boiler casings may be exposed if there are no openings giving direct access from the freeboard deck to the machinery space. A door complying with requirements of 7.5.2.3 to 7.5.2.6 may, however, be permitted in the machinery casing provided that it leads to a space or passageway which is as strongly constructed as the casing and is separated from the stairway to the engine and boiler room by a second similar door. The opening for the outside door is to be provided with a sill at least 600 mm in height, and that for the inside door with a sill of at least 230 mm in height.

7.6.6 In supply vessels the doors in the casings giving access to the engine or boiler rooms shall be located, where possible, inside the enclosed superstructure or deckhouse.

The door in the casing for access to the engine or boiler room may be fitted directly on the open cargo deck provided that, in addition to the first outside door, the second inside door is fitted; in this case, the outside and inside doors shall satisfy the requirements of 7.5.2.3 to 7.5.2.6, the height of the outside door sill shall be at least 600 mm, and of the inside door sill, at least 230 mm.

7.6.7 In floating docks the height of sills to the top deck access openings in the engine and boiler casings shall be at least 200 mm.

7.7 COMPANION HATCHES, SKYLIGHTS AND VENTILATING TRUNKS

см.Б1

7.7.1 Deck openings in positions 1 and 2 intended for stairways to the ship's spaces located below, as well as light and air openings to these spaces are to be protected by strong companion hatches, skylights or ventilating trunks.

Where the openings intended for stairways to the ship's spaces located below are protected by superstructures or deckhouses instead of companion hatches, these superstructures and deckhouses shall comply with the requirements of 7.5.

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

In ships of restricted area of navigation **III** having the length of 24 m and over (except passenger ships) the specified height of coamings may be reduced from 600 mm down to 450 mm and from 450 mm down to

380 mm, respectively. If the length of the ship is less than 24 m, the height of the coamings may be reduced down to 380 mm for ships of restricted areas of navigation **II**, **IIСП** and **IIIСП** and down to 300 mm for ships of restricted area of navigation **III**.

Construction of coamings is to comply with the requirements of 2.6.5.2, Part II "Hull" and in case of glass-reinforced plastic ships, with the requirements of Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats".

7.7.3 All the companion hatches, skylights and ventilating trunks are to be provided with covers made of steel or other material approved by the Register and being permanently attached to the coamings.

Where the covers are made of steel, the thickness of their plate is to be equal to at least 0,01 times the spacing of stiffeners, but not less than 6 mm.

The minimum required thickness of 6 mm may be reduced if the cover is made by stamping in accordance with Fig. 7.7.3 and Table 7.7.3.

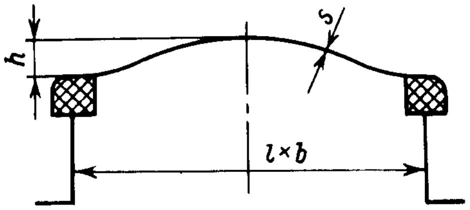


Fig 7.7.3

Table 7.7.3

Clear sizes of hatches $l \times b$, in mm	Material of cover	Height of stamping h, in mm	Minimum thickness s, in mm
450 × 600	Steel	25	4
	Light alloy		
600 × 600	Steel	28	4
	Light alloy		
700 × 700	Steel	40	4
	Light alloy		6
800 × 800	Steel	55	4
	Light alloy		6
800 × 1200	Steel	55	5
	Light alloy		6
1000 × 1400	Steel	90	5

In small ships having the deck thickness less than 6 mm the required minimum thickness 6 mm may be reduced down to the deck thickness regardless of whether the cover is made by stamping, but in no case is the plate thickness to be less than 4 mm.

7.7.4 Covers of companion hatches, skylights and ventilating trunks are to have securing devices workable at least from outside of the hatch. However, where the hatches are used as emergency exits in addition to their primary application, the securing device is to be capable of being operated from each side of the cover.

When secured, the covers are to be weathertight. The tightness is to be provided by a rubber or other suitable gasket.

7.7.5 The glass for windows in the covers of skylights is to be hardened and at least 6 mm thick if the inner diameter is 150 mm and below, and at least 12 mm with the inner diameter of 450 mm. For intermediate inner diameters, the thickness of glass is to be determined by linear interpolation. However, where wire-reinforced glass is used, its thickness may be 5 mm, and the requirement relating to its hardening will not be applicable.

Glass is to be efficiently attached to the covers by means of a frame and have on its contour a weathertight gasket of rubber or other equivalent material.

Windows in the covers of skylights fitted in machinery spaces shall comply with the requirements of 2.1.4.2, Part VI "Fire Protection".

7.7.6 Each window or group of adjacent windows is to be provided with portable shields of the same material as the cover being at least 3 mm in thickness and capable of being efficiently fastened outside the cover by means of ear-nuts; such portable shields are to be stowed adjacent to the skylights.

7.7.7 In floating docks the height of coamings of companion hatches, skylights and ventilating trunks situated on the top deck shall be at least 200 mm.

The portable shields mentioned in 7.7.6 need not be provided for covers of skylights situated on the top deck of the floating docks.

7.8 VENTILATORS

7.8.1 Ventilators to spaces below freeboard deck or deck of enclosed superstructures and deckhouses are to be fitted with coamings efficiently connected to the deck.

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

In ships of restricted area of navigation **III** having the length of 24 m and over (except passenger ships) the specified height of the coamings may be reduced from 900 mm down to 760 mm and from 760 mm down to 600 mm, respectively.

In ships of restricted areas of navigation **II**, **IIСП**, **IIIСП** and **III** having the length below 24 m the height of the coamings may be reduced down to 300 mm for all open decks.

Construction of coamings is to comply with the requirements of 2.6.5.2, Part II "Hull" and in case of glass-reinforced plastic ships, with the requirements of Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats".

The strength of ventilators, connections of ventilators to coamings and connections of ventilator parts, if any, shall be equivalent to that of the coaming.

7.8.2 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 closing appliances. In all other cases, each ventilator is to be fitted with a strong cover made of steel or other material approved by the Register.

In ships of less than 200 m in length, the covers are to be permanently attached; in ships of 100 m in length and over they may be conveniently stowed near the ventilators to which they are to be fitted.

7.8.3 When secured, the covers of ventilators are to be weathertight. The tightness is to be provided by a rubber or other suitable gasket.

7.8.4 In supply vessels, in order to minimize the possibility of flooding of the spaces situated below, the ventilators shall be positioned in the protected locations where the probability of their damage by cargo is excluded during cargo handling operations. Particular attention shall be given to the arrangement of ventilators of the engine and boiler rooms for which the location is preferable above the deck level of the first tier of superstructures or deckhouses.

7.8.5 In floating docks the height of coamings of ventilators situated on the top deck shall be at least 200 mm.

7.9 MANHOLES

7.9.1 The height of coamings of manholes for deep and other tanks, except for those indicated in 2.4.5.3, Part II "Hull", air spaces, cofferdams, etc. will not be regulated by the Register.

7.9.2 Covers of manholes are to be made of steel or other material approved by the Register.

The thickness of the covers is not to be less than that of the plating on which they are fitted. In sound cases, the Register may permit to decrease the thickness of the covers where the thickness of plating is greater than 12 mm.

7.9.3 The covers of manholes are to be efficiently attached to the coaming or doubling ring by means of bolts or pins with nuts.

7.9.4 When secured, the covers are to be tight both for water and liquid cargoes or stores for which the tanks are intended under the inner pressure corresponding to the test pressure of the tank under consideration.

The tightness is to be provided by a rubber or other suitable gasket. The gasket is to be resistant to the liquids referred to above.

7.10 HATCHWAYS OF DRY CARGO HOLDS

7.10.1 General.

The deck openings through which cargoes or ship's stores are loaded and unloaded are to be protected by strong hatchways. If these hatchways are situated in positions 1 and 2, the hatchway covers are to be weathertight. The tightness is to be provided by one of the following two methods:

.1 by portable covers and tarpaulins as well as battening devices;

.2 by weathertight covers made of steel or other equivalent material fitted with rubber or other suitable gaskets and clamping devices.

7.10.2 Coamings.

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

If the length of the ship is less than 24 m, the height of the coamings may be reduced down to 380 mm for ships of restricted area of navigation **II**, **IIСП** and **IIIСП** and down to 300 mm for ships of restricted area of navigation **III**. In fishing vessels the height of cargo hatchway coamings in position 2 may be reduced down to 300 mm.

In ships of restricted area of navigation **III** having the length of 24 m and over (except passenger ships) the specified height of cargo hatchway coamings may be reduced from 600 mm down to 450 mm and from 450 mm down to 380 mm, respectively.

Construction of coamings in positions 1 and 2 is to comply with the requirements of 2.6, Part II "Hull" and in case of glass-reinforced plastic ships, with the requirements of Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ships and Boats".

7.10.2.2 The height of coamings of the hatchways specified in 7.10.1.2 may be decreased in relation to that prescribed by 7.10.2.1 or the coamings may be omitted entirely where the efficiency of the cover tightness and securing means will satisfy the Register. In type "B" ships which are permitted to have the tabular freeboard less than that prescribed by Table 4.1.3.2 of Load Line Rules for Sea-Going Ships, such hatchways with coamings of a decreased height (or the hatchways without coamings) in case they are situated in the exposed parts of the free-board deck in way of 0,25 of the ship's length *L* from the forward perpendicular, are to be strengthened in accordance with 7.10.4.2.

7.10.3 Materials.

7.10.3.1 For steel of hatchway covers, see 1.6.

7.10.3.2 The wood of hatchway covers shall be of good quality and of the type and grade which proved to be satisfactory for this purpose. Wedges are to be of hard wood.

7.10.3.3 Canvas used for making tarpaulins is to be impregnated to make them moisture-resistant and shall not contain jute thread. Mass of 1 m^2 of canvas before impregnation is to be not less than 0,55 kg. Breaking stress of impregnated canvas band 200 × 50 mm in size is to be at least 3 kN and 2 kN in longitudinal and transverse directions, respectively. When tested for watertightness, the impregnated canvas shall not get wet under water head of 0,15 m acting for 24 hours.

Use of tarpaulins made of synthetic fibre will be specially considered by the Register in each case.

7.10.3.4 The rubber for packing gaskets of hatchway covers is to be elastic, strong, and resistant to atmospheric changes. The rubber is to be of sufficient hardness.

7.10.3.5 Adhesives for fastening the rubber in the grooves of hatchway covers are to meet the requirements of 6.5, Part XIII "Materials".

7.10.4 Design loads.

7.10.4.1 Hatchway covers are to be designed to sustain deck cargoes which are intended to be carried on these covers. Where operation of the cargo handling cars on hatchways covers is anticipated in the course of the ship's service, during cargo handling operations, the loads induced by such cars are to be taken into consideration. For hatchway covers in positions 1 and 2 it is additionally required that the value of the design deck load is not to be less than the product of the cover area by the load intensity given in Table 7.10.4.1.

For ships of more than 24 m, but less than 100 m in length the design load intensity is to be found by linear interpolation.

For ships of less than 24 m in length of restricted area of navigation engaged on international voyages and for all ships of restricted area of navigation not engaged on international voyages the load intensity reduced by:

15 per cent for ships of restricted areas of navigation **II**, **IIСП** and **III**;

30 per cent for ships of restricted area of navigation **III** may be taken in calculations instead of the values given in Table 7.10.4.1.

In any case, the design load for open-deck hatch covers is not to be adopted less than $0{,}5p_w$ determined in accordance with 1.3.2.2, Part II "Hull".

Table 7.10.4.1

Location of cargo hatchways	Design load intensity, in kPa, at ship's length *L*	
	24 m and less	100 m and over
Position 1	9,81	17,16
Position 2	7,35	12,75

7.10.4.2 In type "B" ships which are permitted to have the freeboard less than prescribed by Table 4.1.3.2 of Load Line Rules for Sea-Going Ships, if they are provided with hatchways without coamings in the exposed parts of the freeboard deck in way of 0,25 of the ship's length *L* from the forward perpendicular, the design load for covers of these hatchways is to be increased by 15 per cent over that given in Table 7.10.4.1. Where these hatchways are provided with coamings, but their height is less than given in 7.10.2.1, the percentage of the load increase is to be found by linear interpolation.

7.10.4.3 When deck cargo other than containers is carried, the design load on cargo hatch covers shall not be less than stipulated by 1.3.4.1, Part II "Hull".

7.10.4.4 When containers of international standard types are carried on hatch covers, the design load P_z, in kN, concentrated at the points where the corner fittings of the containers are installed is determined, for the purpose of calculating the deck cargo effect as stipulated by 7.10.4.1 and 7.10.4.3, by the following formula:

$$P_z = mg(1 + a_z) \qquad (7.10.4.4)$$

where m = maximum mass of container stack, in t;
g = gravity acceleration equal to 9,81 m/s^2;
a_z = dimensionless acceleration factor in accordance with 1.7.2.

Besides, the vertical components of the initial pull of the lashings (if fitted) securing containers shall be included in the calculation as an additional load.

7.10.4.5 Where cargo-handling cars and wheeled vehicles are to be used on hatch covers during cargo-handling operations, the loads upon hatch covers are determined in accordance with 3.2.3, Part II "Hull".

7.10.4.6 The hatch covers of lower decks not intended for the carriage of cargo shall be designed to bear:

evenly distributed load of 2 kPa intensity;

force of 3 kN applied to any point upon the hatch cover.

7.10.4.7 In strength and rigidity calculations of hatch covers, their own weight is ignored.

7.10.5 Strength and rigidity criteria.

7.10.5.1 Where hatch covers in positions 1 and 2 come under design loads, the stresses in the structural components are not to exceed the values of Table 7.10.5.1.

7.10.5.2 Where the hatch covers of lower decks come under design loads, the stresses in the structural components are not to exceed the values of Table 7.10.5.2.

7.10.5.3 For hatch covers in positions 1 and 2, the deflection under the design load mentioned in 7.10.4.1 and 7.10.4.2 is not to exceed the following values:

Table 7.10.5.1

Type of hatch covers	Design load according to	σ	τ	σ_{com}
Portable beams and pontoon hatch covers	7.10.4.1 7.10.4.2	$0,35R^*_{eH}$ or $0,2R_m$	$0,25R_{eH}$	—
	7.10.4.3 7.10.4.4 7.10.4.5	$0,5R_{eH}$	$0,35R_{eH}$	—
Hatch covers of other designs	7.10.4.1 7.10.4.2	$0,4R^*_{eH}$ or $0,235R_m$	$0,3R_{eH}$	—
	7.10.4.3 7.10.4.4	$0,65R_{eH}$	$0,4R_{eH}$	$0,7R_{eH}$
	7.10.4.5	$0,65R_{eH}$	$0,45R_{eH}$	$0,75R_{eH}$

*Whichever is less.

σ = normal stresses;
τ = tangential stresses;
σ_{com} = combined stresses, see 1.5.1;
R_{eH} = upper yield strength of hatch cover material;
R_m = ultimate strength of hatch cover material.

Table 7.10.5.2

Type of hatch covers	Design load according to	σ	τ	σ_{com}
Portable beams	7.10.4.3	$0,5R_{eH}$	$0,35R_{eH}$	—
Pontoon hatch covers and other hatch cover designs	7.10.4.4 7.10.4.5 7.10.4.6	$0,65R_{eH}$	$0,45R_{eH}$	$0,75R_{eH}$

for σ, τ, σ_{com} and R_{eH}, see 7.10.5.1.

0,0022 of the span for portable beams and pontoon covers;

0,0028 of the span for hatch covers of other designs.

7.10.6 Stability of structural components of hatch covers.

The stability of structural components of hatch covers is considered to be guaranteed provided the following conditions are met:

$$\sigma \leqslant 0,87\sigma_{cr}; \quad (7.10.6\text{-}1)$$

$$\tau \leqslant 0,87\tau_{cr} \quad (7.10.6\text{-}2)$$

where σ, τ = normal and tangential stresses in action, in MPa;
σ_{cr}, τ_{cr} = critical normal and tangential stresses, in MPa, determined in accordance with 1.6.5.3, Part II "Hull".

7.10.7 Construction of hatchway covers specified in 7.10.1.1.

7.10.7.1 These covers are to be so constructed as to prevent their accidental opening under the effect of sea and weather.

7.10.7.2 Portable beams are to be placed in sockets of the coamings and locked therein. Where portable beams are of sliding type, efficient devices are to be provided for locking them when the hatchway is either closed or open.

7.10.7.3 If the hatchway covers are jointed on the portable beam, a vertical flat bar of at least 60 mm in height is to be attached by welding to the upper flange of the beam.

7.10.7.4 The width of each bearing surface for hatchway covers is to be at least 65 mm.

7.10.7.5 Where the covers are made of wood, their finished thickness is to be at least 60 mm for a load intensity sustained by the cover equal to 17,16 kPa and less. If the load intensity exceeds this value, the above thickness is to be increased by 1,5 mm per 0,981 kPa of overload. In all cases, the portable beams of the hatchway provided with wooden covers are to be spaced not more than 1,5 m apart.

Independently of the provisions of 7.10.5, all covers made of steel are to have the thickness of their plating at least 0,01 times the spacing of stiffeners or 6 mm, whichever is the greater.

If the covers are made of light alloys, the minimum thickness of their top plating will be specially considered by the Register in each case.

7.10.7.6 The hatchways in positions 1 and 2 are to be protected by at least two layers of tarpaulins.

Tarpaulins are to be tightly pressed against the hatchway coamings with the aid of battens and wedges, for which purpose the coamings, as well as horizontal stiffeners, if fitted, are to be provided with cleats of at least 65 mm wide and 10 mm thick; edges of the cleats shall be rounded so that the possibility of cutting the wedges is brought to the minimum. Cleats are to be spaced not more than 600 mm centre to centre; the cleats along each side or end are to be not more than 150 mm from hatch corners. The cleats are to be so mounted as to provide setting of wedges in them in the fore to aft direction on the side coamings, and from the sides to centre line direction on the end coamings.

Wedges are to be not less than 200 mm in length and 50 mm in width with a taper of not more than 1:6, and a thickness not less than 13 mm at the thinnest point.

7.10.7.7 Steel bars or other equivalent means are to be provided in order to efficiently and independently secure each section of hatchway covers after the tarpaulins are battened down. Sections of hatchway covers of more than 1,5 m in length shall be secured by at least two such securing appliances.

7.10.8 Construction of hatchway covers specified in 7.10.1.2.

7.10.8.1 These covers are to be so constructed as to prevent their accidental opening under the effect of sea and weather.

When secured, the covers shall be pressed against the bearing surface of the coaming without further deformation of the packing gasket.

7.10.8.2 The scantlings of components of hatch covers made of steel are determined in conformity with the requirements of 7.10.4 to 7.10.6.

For primary members and webs, the effective flange width is determined in accordance with 1.6.3.3 and 1.6.3.4, Part II "Hull", the effective flange thickness is determined in accordance with 1.6.3.2 of the same Part. The application of light alloys is in each case subject to special consideration by the Register.

7.10.8.3 Irrespective of the provisions of 7.10.8.2 being complied with, the top plating thickness t, in mm, of steel hatch covers shall not be less than determined from the formula

$$t = 10a \qquad (7.10.8.3)$$

where a = distance between the stiffeners, in m.

In any case, the top plating thickness is not to be less than 6 mm.

7.10.8.4 Where cargo-handling cars are to be used on hatch covers, the top plating thickness shall not be less than stipulated by 3.2.4.1, Part II "Hull".

7.10.8.5 The hatchway covers on which containers are carried shall be provided, in way of corner fittings of containers, with structural elements ensuring immediate load transfer from the containers to the cover framing.

If the above-mentioned structural elements are not coincident with the cover stiffeners in way of fitting the former, the additional stiffeners shall be provided having section modulus equal to 0,8 times that of main stiffeners of the cover. In this case, structural bonding of main and additional stiffeners shall be ensured.

7.10.8.6 Where dry cargo holds are adapted for transportation of dangerous goods (see 1.2, Part VI "Fire Protection"), cargo hatch covers of the upper deck are to be made of steel; the cargo hatch covers of upper and lower decks are to be provided with drives ensuring smooth movement (without striking) of covers and all parts of hatch covers. The design of the drives shall be such that in the case of their failure no dropping of the covers could occur during closing or opening operations; reliable securing of covers kept open shall be provided. Measures are to be taken to prevent the ingress of working fluid of the drives for these hatch covers into cargo holds (see also 2.8.2 and 2.8.15, Part VI "Fire Protection").

7.10.8.7 Each hatch cover or section of hatch covers should be fitted with proper securing devices along its transverse and longitudinal sides, which would ensure the weathertightness of the cover.

The number of securing devices is not to be less than two on each side of the section, and the securing devices should be spaced not more than 6 m apart.

The securing device fitted in close proximity to the corner of the section is considered to be the device both for the transverse and longitudinal sides of the sections, and the securing device fitted in way of two jointed sections and pressing the corners of the two sections against the coaming is considered to be the device both for the transverse and longitudinal sides of the two sections adjacent to the device.

7.10.8.8 Each securing device of the hatchway cover shall be calculated for the action of force F, in N, determined from the formula

$$F = (1/n)[mg(8a_y — K) + pl_p] \qquad (7.10.8.8)$$

where m = total mass of covers of the hatchway under consideration, in kg;
n = total number of securing devices along the perimeter of the hatchway under consideration;
l_p = clear perimeter of the hatchway under consideration, in m;
p = pressure of the packing gasket when compressed to the maximum depth possible for the accepted design, in N/m. Where the value p is less than 5000 N/m in calculations performed according to the Formula (7.10.8.6), p is taken equal to 5000 N/m;
g = acceleration due to gravity equal to 9,81 m/s^2;
a_y = dimensionless acceleration to be determined in accordance with 1.7 as applied to the centre of gravity of the considered hatchway covers;
K = coefficient to be determined from the formula

$$K = 0{,}947 - 20{,}7/L$$

where L = ship's length, in m.

In any case, F shall not be taken less than 40 kN.

7.10.8.9 When the securing device is under the effect of the design force specified in 7.10.8.8, the stresses in its parts shall not exceed 0,8 times the upper yield stress of material.

7.10.8.10 Irrespective of the results calculated in accordance with 7.10.8.8, the free sectional area A, in cm^2, of the securing device shall not be less than determined from the formula

$$A = \frac{1{,}4a}{f} \qquad (7.10.8.10)$$

where a = distance between securing devices, in m, which in any case shall not be adopted less than 2 m;
f = factor determined from the formula

$$f = \left(\frac{R_{eH}}{235}\right)^e$$

where R_{eH} = the upper yield strength of the securing device material, in MPa, and should not be adopted greater than 0,7 of the tensile strength of the material;
e = index equal to:
0,75 for $R_{eH} > 235$ MPa;
1,00 for $R_{eH} \leqslant 235$ MPa.

For hatch covers and hatch cover sections having an area in excess of 5 m^2, the active diameter of bars and bolts of the securing devices shall not be less than 19 mm.

7.10.8.11 Where the packing gasket is compressed to the maximum depth possible and its pressure exceeds 5000 N/m, the area of securing devices as determined in accordance with 7.10.8.10 shall be increased in a relevant proportion.

7.10.8.12 The stiffness of the cover corners is to be sufficient to maintain an adequate pressure of the packing gasket between the securing devices. The cross-sectional inertia moment of the corner members of the covers I, in cm^4, is to be not less than that determined from the formula

$$I = 6pa^4 \cdot 10^{-3} \qquad (7.10.8.12)$$

where p = pressure of the packing gasket when compressed to the maximum depth possible for the accepted design, in N/m, but not less than 5000 N/m;
a = distance between securing devices, in m.

7.10.8.13 Covers on which cargoes are to be carried are to be provided with securing devices preventing the cover sections from shifting relative to the hatchway coaming during rolling or prolonged statical heel. These securing devices are to be calculated to take up the loads induced therein when the common centre of gravity of the cover with the cargo thereon is affected by the loads directed perpendicular to the centre plane of the ship P_y and parallel to the centre plane P_x obtained in N, using the following formulae:

$$P_y = mga_y; \qquad (7.10.8.13\text{-}1)$$

$$P_x = mga_x \qquad (7.10.8.13\text{-}2)$$

where m = total mass of the cover and cargo secured thereon, in kg;
g = acceleration due to gravity equal to 9,81 m/s^2;
a_y, a_x = dimensionless accelerations obtained in accordance with 1.7 as applied to the common centre of gravity of the considered cover with cargo thereon. For hatchway covers of shipborne barges, when determining a_y and a_x, to be taken as L and B are the length and the breadth of the barge carrier (on which the considered shipborne barge is transported), and as x and z the maximum possible distances between the centre of gravity of the cover, and the midship frame and the summer load waterline of the barge carrier, respectively, are to be taken.

Stresses arising in the parts of securing devices are not to exceed 0,8 times the upper yield stress of the material of which these devices are made.

7.10.8.14 In ships having large hatchways for which considerable deformation of the hatchway coamings is possible in seaway:

.1 the design of the securing device shall allow for possible horizontal shifting of the point of attachment of this device to the coaming by a value equal to possible horizontal shifting of the cover section from the coaming;

.2 in the hinged joints of the cover sections to each other and to the hatchway coaming provision shall be made for clearances adequate for possible horizontal relative shifting of the sections without obstruction;

.3 over the lower bearing edges of cover sections, an appropriate metal contact surface shall be provided allowing for free gliding of sections over hatch coamings;

.4 the horizontal stiffener of hatch coaming on which the covers rest shall be properly stiffened to ensure a permanent contact of the cover section and coaming.

7.10.8.15 Hydraulic drives of hatch covers shall comply with the requirements of Part IX "Machinery".

The hatchway covers and the drives are to be so designed as to make it possible to close the hatch kept open before and to secure it even in case of the main power drive failure. The device for reliable locking of the covers kept open shall be provided. The direction of the cover opening shall ensure, wherever possible, maximum protection of open hatches from exposure to sea.

7.10.9 Hatch cover designs for lower decks.

The hatch cover designs for lower decks shall comply with the requirements of 7.10.7 and 7.10.8.

7.11 HATCHWAYS OF CARGO TANKS IN TYPE "A" SHIPS

7.11.1 Openings for hatchways of the cargo tanks on tankers are to be of round or oval form. Height of the coamings of cargo tank hatchways will not be regulated by the Register. Construction of the coamings of cargo tank hatchways is to comply with the requirements of 3.5.5.1, Part II "Hull".

7.11.2 Covers of hatches and tank cleaning openings are to be made of steel, bronze or brass. Use of other materials is subject to special consideration by the Register in each case.

In ships carrying flammable liquids in bulk use of light alloys for covers of hatches and tank cleaning openings is not permitted.

7.11.3 Covers of the cargo tank hatchways are to be permanently attached and tight, when secured, under the inner pressure of liquid carried in tanks to a head of at least 2,5 m. Tightness is to be provided by a rubber or other suitable gasket being resistant to the liquids which are carried in the cargo tanks.

7.11.4 The plate of the cargo tank hatchway covers is to be at least 12 mm in thickness if it is of steel. The cover plate is to be reinforced by stiffeners made of flat bars not less than 80 × 12 mm in size, and spaced at every 600 mm of the cover length, or the cover is to be of spherical shape.

7.11.5 The hatchway cover is to be provided with a sighting port having an inner diameter of 150 mm and closed by a cover of similar construction.

7.11.6 Materials and designs of cargo tank hatchway covers in ships intended to carry flammable liquids are to be so selected as to preclude spark formation during opening and closing the covers.

7.12 OPENINGS IN WATERTIGHT SUBDIVISION BULKHEADS AND THEIR CLOSING APPLIANCES

7.12.1 General provisions.

7.12.1.1 Unless expressly provided otherwise, the present Chapter covers ships to which the requirements of Part V "Subdivision" apply.

For other ships, the requirements of this Chapter apply to bulkheads only, provided in accordance with 2.7.1.3, Part II "Hull"; for these ships, the requirements may be relaxed, and the degree of relaxation will be specially considered by the Register in each case.

In ships indicated in 7.12.6.1, the requirements of 7.12.2 to 7.12.5 may be relaxed for doors fitted in watertight subdivision bulkheads dividing a cargo space from an adjoining cargo space provided the requirements of 7.12.6 are met.

7.12.1.2 The number of openings in watertight bulkheads shall be reduced to a minimum compatible with the design and normal service conditions of the ship.

7.12.1.3 Where piping and electric cables are carried through watertight subdivision bulkheads, the requirements of 5.1, Part VIII "System and Piping" and of 16.8.6, Part XI "Electrical Equipment" shall be taken into consideration.

7.12.2 Doors in watertight subdivision bulkheads. General provisions.

7.12.2.1 The doors are to be made of steel. The use of other materials will be specially considered by the Register in each case.

см.Б1 **7.12.2.2** Doors and to withstand the pressure of a water head of the height measured from the lower edge of doorways at the place of their location on the ship to the underside of bulkhead deck plating or freeboard, or to the margin damage waterline, whichever is greater. Doors may be tested at specialized enterprises prior to installation on board.

7.12.2.3 Under the effect of water head specified in 7.12.2.2, the stresses in the door frame and door plate are not to exceed 0,6 times the upper yield stress of their material.

7.12.2.4 When closed, the doors are to be tight under the pressure of a water head of the height specified in 7.12.2.2.

7.12.2.5 Each means of operation of the doors should alone ensure closure of the door with the ship listed 15° either way and with a trim up to 5°. Doors closed by dropping or by the effect of a dropping weight are not permitted. Portable plates secured by bolts only are not permitted.

7.12.3 Regulations concerning the positioning of doors.

7.12.3.1 No doors are permitted in:

collision bulkhead below the bulkhead deck of ships having a subdivision distinguishing mark in the class notation and below the freeboard deck of all other ships;

watertight subdivision bulkheads dividing a cargo space from an adjoining cargo space except where the Register is satisfied that such doors are essential. In this case, the doors may be hinged, sliding or of another equivalent type, but they shall not be remotely controlled.

In passenger ships and special-purpose ships, as well as in ships with subdivision distinguishing mark in the class notation, the outboard vertical edges of the doors are not to be located at less than 0,2 of the ship breadth. This distance is to be measured at right angles to the centre line of the ship at the level of the deepest subdivision loadline.

7.12.3.2 In addition to doors at entrances to propeller shaft tunnels, not more than one door may be provided in each watertight subdivision bulkhead within spaces containing main engines, boilers and auxiliary machinery.

Where two or more propeller shafts are fitted, their tunnels are to be connected by a passageway. In a twin-screw ship, there shall only be one door between the engine room and tunnel spaces, and if the propellers are more than two, only two doors shall be provided. All the doors are to be located as high as practicable.

Hand gear for operating the doors from above the bulkhead deck and for operating doors at entrances to shaft tunnels shall be fitted outside the engine room.

7.12.4 Doors in cargo ships.

7.12.4.1 The requirements of 7.12.4 apply to doors fitted in the subdivision bulkheads of cargo ships except the doors of special purpose ships and those mentioned under 7.12.6.

7.12.4.2 The doors shall be sliding doors with horizontal or vertical motion, they shall be both hand- and power-operated.

If hand-operated, it shall be possible to open and close the door from both sides of the bulkhead.

If power-operated, closing of the doors from the control station on the navigating bridge shall be possible.

7.12.4.3 At the door control stations, visual indicators shall be provided to show whether the doors are open or closed. An alarm shall be provided to control the door closing.

Power source, control station and indicators shall be operable in the case of main power source failure. Special attention shall be paid to minimizing the effects of the control system failure.

7.12.5 Doors in passenger ships and special purpose ships.

7.12.5.1 The requirements of 7.12.5 apply to doors fitted in the subdivision bulkheads of passenger ships and special purpose ships except those mentioned in 7.12.6.

7.12.5.2 The doors shall be sliding doors with horizontal or vertical motion, they shall be both hand- and power-operated.

The maximum width of the door aperture is not to exceed 1,2 m. Fitting of doors with the aperture width in excess of 1,2 m is subject to special consideration by the Register in each case.

7.12.5.3 If hand-operated, it shall be possible to open and close the door from both sides of the bulkhead and, in addition, from an accessible position above the bulkhead deck by means of a hand wheel, knob or another similar gear. The force applied to the hand wheel, knob or similar gear while the door is in motion is not to exceed 157 N.

If the door is not visible from the position above the bulkhead deck where the gear is fitted, indicators should be provided showing the positions of the hand wheel, knob and similar gear at which the door is open or closed.

When hand-operated, the time necessary for a complete closure of the door is not to exceed 90 s with the ship upright.

7.12.5.4 Door control knobs shall be fitted on either side of the bulkhead at a minimum height of 1,6 m above deck plating and so arranged as to enable persons passing through the doorway to hold both the knobs in a position preventing door closure.

7.12.5.5 The power gear shall be controllable (i.e. door opening and closing shall be possible) by local control stations on either side of the bulkhead.

Besides being controlled directly at the door, the power gear shall also be controllable (for door closure) from the main control station.

Remote opening of any door from the main control station shall not be possible.

The main control station for doors shall be located in the wheelhouse.

7.12.5.6 The power gear shall ensure door closure in not more than 40 s and not less than 20 s with the ship upright, as well as a simultaneous closure of all doors within not more than 60 s.

7.12.5.7 The power gear of the doors shall have either:

a centralized hydraulic system with two independent power sources each consisting of a motor and pump capable of simultaneously closing all doors. In addition, there shall be for the whole installation hydraulic accumulators of sufficient capacity to operate all the doors at least three times, i.e. closed — open — closed; or

an independent hydraulic system for each door with each power source consisting of a motor and pump capable of opening and closing the door. In addition, there shall be a hydraulic accumulator of sufficient capacity to operate the door at least three times, i.e. closed — open — closed; or

an independent electrical system and motor for each door with each power source consisting of a motor capable of opening and closing the door. The power source shall be capable of being automatically supplied by a transitional source of emergency electrical power, as required by 19.1.2.7, Part XI "Electrical Equipment" in the event of failure of either the main or emergency source of electrical power and with sufficient capacity to operate the door at least three times, i.e. closed — open — closed.

7.12.5.8 Door controls, including hydraulic piping and electric cables, shall be kept as close as practicable to the bulkhead in which the doors are fitted, in order to minimize the likelihood of them being involved in any damage which the ship may sustain.

7.12.5.9 Each door shall be provided with an audible alarm, distinct from any other alarm in the area, which will sound whenever the door is closed remotely by power and which shall sound for at least five seconds, but not more than ten seconds, before the door begins to more, and shall continue sounding until the door is completely closed. In the case of remote hand operation it is sufficient for the audible alarm to sound only when the door is moving.

7.12.5.10 The central operating console at the navigating bridge shall have a switch with two modes of control:

a "local control" mode which shall allow any door to be locally opened and closed without automatic closure and

a "doors closed" mode which shall allow doors to be opened locally and shall automatically reclose the doors upon release of the local control mechanism.

The switch shall normally be in the "local control" position. The "doors closed" position shall only be used in an emergency or for testing purposes.

7.12.5.11 The central operating console at the navigating bridge shall be provided with a diagram showing the location of each door, with visual indicators to show whether each door is open or closed. A red light shall indicate a door fully open and a green light shall indicate a door fully closed. When a door is closed remotely, the red light shall indicate the intermediate position by flashing. The indicating circuit shall be independent of the control circuit for each door.

7.12.5.12 Where trunkways or tunnels for access from crew accommodation to the stokehold, for piping, or for any other purpose are carried through main transverse watertight bulkheads, they shall be watertight. The access to at least one end of each such tunnel or trunkway, if used as a passage at sea, shall be through a trunk extending watertight to a height sufficient to permit access above the margin line. The access to the other end of the trunkway or tunnel may be through a watertight door of the type required by its location in the ship. Such trunkways or tunnels shall not extend through first subdivision bulkhead abaft the collision bulkhead.

7.12.5.13 Where ventilating trunks in connection with refrigerated cargo and ventilation or forced draught trunks are carried through more than one watertight bulkhead, the means of closure at such openings shall be operated by power and be capable of being closed from a central position situated above the bulkhead deck.

7.12.6 Doors in ships designed for the carriage of vehicles.

7.12.6.1 The requirements of 7.12.6 apply to doors fitted in watertight subdivision bulkheads separating a cargo space from an adjacent cargo space in ships designed for the carriage of vehicles and covered by the requirements of Part V "Subdivision", if the total number of persons on board (excluding the master and the members of the crew or other persons employed or engaged in any capacity on board a ship on the business of that ship, and also a child under one year of age) is not greater than the value N determined from the formula

$$N = 12 + 0{,}04A \qquad (7.12.6.1)$$

where A = total deck area, in m^2, of spaces available for the stowage of vehicles where the clear height at the stowage position and at the entrances to such spaces is not less than 4 m.

7.12.6.2 The doors specified in 7.12.6.1 may be fitted at any level if the Register is satisfied that such doors are essential for the movement of the vehicles in the ship.

The number and arrangement of these doors are subject to special consideration by the Register.

7.12.6.3 The doors specified in 7.12.6.1 shall be fitted as far from the shell plating as practicable, but in no case shall the outboard vertical edge of the door be situated at a distance from the shell plating that is less than 0,2 of the breadth of the ship, such distance being measured at right angles to the centre line of the ship at the level of the subdivision loadline.

7.12.6.4 The doors specified in 7.12.6.1 may be of the following types: hinged, sliding or rolling but they should not be controlled remotely.

The doors shall be fitted with devices ensuring watertightness, securing and locking.

When the sealing material of the door is not classed as non-combustible (see 1.6.1, Part VI "Fire Protection"), the gasket shall be suitably protected from the effects of fire by a method approved by the Register.

The doors shall be fitted with a device which prevents unauthorized opening.

7.12.6.5 The doors specified in 7.12.6.1 shall be so designed that they could be opened and closed both in case of unloaded and loaded decks, the deck deflections under the effect of the stowed cargo being taken into account.

The securing devices of the door shall be so designed that account is taken of the deck deflections under the effect of the stowed cargo resulting in relative displacement of the structural elements of the bulkhead and the door.

7.12.6.6 Where watertightness is ensured by rubber or other suitable gaskets and securing devices, at each corner of the door or door section (if any) the securing devices shall be fitted.

The securing devices of such doors shall be designed to withstand the following forces, in kN:

F_1 for securing devices fitted at the lower edge of the door;

F_2 for securing devices fitted at the upper edge of the door;

F_3 for securing devices fitted at the vertical edge of the door.

These forces are to be obtained from the formulae:

$$F_1 = \frac{9{,}81A}{n_1}\left(\frac{H_1}{2} - \frac{h}{6}\right) + 29{,}42; \qquad (7.12.6.6\text{-}1)$$

$$F_2 = \frac{9{,}81A}{n_2}\left(\frac{H_1}{2} - \frac{h}{3}\right) + 29{,}42; \qquad (7.12.6.6\text{-}2)$$

$$F_3 = \frac{a}{A}[F_1(n_1 - 1)h_i + F_2(n_2 - 1)(h - h_i)] \qquad (7.12.6.6\text{-}3)$$

where A = clear area of the door, in m^2;

H_1 = vertical distance from the lower edge of the door opening to the lower edge of the plating of the bulkhead deck at the centre line of the ship, in m, but not less than 5 m;

h = clear height of the door, in m;

h_i = vertical distance from the securing device considered to the upper edge of the door, in m;

a = half the sum of the vertical distances from the securing device considered to the nearest upper and lower securing devices, in m;

n_1 = number of the securing devices fitted on the lower edge of the door;

n_2 = number of the securing devices fitted on the upper edge of the door.

When the securing device is under the effect of the design force F_1, F_2 or F_3, the stresses in its parts shall not exceed 0,5 times the upper yield stress of material.

7.12.6.7 The operation of the doors specified in 7.12.6.1 shall be by means of local control only. On the bridge indicators shall be provided to show automatically that each door is closed and all door fastenings are secured.

7.12.6.8 The requirements of 7.12.2.1 to 7.12.2.4 are also applicable to doors specified under 7.12.6.1.

7.12.7 Manholes in watertight subdivision bulkheads.

7.12.7.1 The requirements of 7.9 relating to the manholes located on the freeboard deck, raised quarter deck or the first tier of superstructures are generally applicable to the manholes fitted in the watertight subdivision bulkheads.

No manholes are permitted:

.1 in the collision bulkhead below the bulkhead deck for ships having subdivision distinguishing mark in the class notation, and below the freeboard deck for other ships;

.2 in watertight subdivision bulkheads separating a cargo space from an adjacent cargo space or a fuel oil tank.

см.Б1 7.13 CARGO HATCHWAYS OF HOLDS DESIGNED FOR ALTERNATE CARRIAGE OF DRY AND LIQUID CARGOES IN BULK

7.13.1 The requirements of this Chapter cover the cargo hatchways of holds designed for alternate carriage of liquid cargoes in bulk with the density of not over 1,025 t/m^3 and of dry cargoes; the requirements are applicable in case of carriage of liquid cargoes in bulk in the hold filled to not less than 90 per cent of its volume.

When liquid cargoes are carried in bulk in the hold filled to less than 90 per cent, the cargo hatchways are subject to special consideration by the Register.

7.13.2 Cargo hatchways of holds designed for alternate carriage of dry and liquid cargoes in bulk shall comply with the requirements of 7.10.1, 7.10.2, 7.10.3.4, 7.10.3.5, 7.10.4 to 7.10.6, 7.10.8, 7.11.5 and 7.11.6.

7.13.3 Hatchway covers shall be made of steel. The use of other materials for this purpose is subject to special consideration by the Register in each case.

7.13.4 Hatchway covers, except for the cases specified in 7.13.5, shall be designed to withstand the inner pressure of liquid carried in the hold, the design load being taken depending on the framing system of the cover.

7.13.4.1 For transverse framing system of the cover (stiffeners are perpendicular to the centre line of the ship) the uniformly distributed load with the intensity p, in kPa, determined from the following formula, shall be taken as the design load acting upon the whole area of the cover:

$$p = 0{,}7P_0 + 1{,}275(b + 2r) + 0{,}245l + 2{,}55K. \qquad (7.13.4\text{-}1)$$

7.13.4.2 For longitudinal framing system of the cover (stiffeners are parallel to the centre line of the ship) and also for combined framing system of the cover the variable load shall be taken as the design load acting upon the whole area of the cover.

The law of changing the intensity p, in kPa, is determined from the formula

$$p = 0{,}7P_0 + 1{,}275(b + 2r + 2y) + 2{,}55K \qquad (7.13.4\text{-}2)$$

where b = clear width of the hatchway, in m;

l = clear length of the hatchway, in m;

r = value taken equal to:

distance between longitudinal (parallel to the centre line of the ship) axes of symmetry of hatchways, in m, for twin hatchways arranged symmetrically about the centre line of the ship where no longitudinal tight wash bulkhead is provided in the hold;

zero for central hatchways and for twin hatchways where the centre line tight wash bulkhead is provided in the hold;

y = distance from longitudinal (parallel to the centre line of the ship) axis of symmetry of the hatchway to the point of the cover under consideration, in m.

At r>0 the value y is taken to be positive in the direction of the nearest side of the ship from the axis of symmetry of the hatchway and is taken to be negative in the opposite direction.

At the design value of $r = 0$ two variants of the design load shall be considered:

for positive values of y in one direction and negative values in the other direction from the axis of symmetry of the hatchway;

with the rule of signs for the value y opposite to that of the first variant;

P_0 = maximum pressure of the pressure/vacuum valve opening, in kPa, (see 9.7.1.1, Part VIII "Systems and Piping");

K = value determined from the formula

$$K = C - 2{,}4h \qquad (7.13.4\text{-}3)$$

where C = value taken equal to:

distance measured at the deck level from the side coaming of the hatchway positioned at the ship's side to the shell plating or to the inner longitudinal bulkhead of the side tank, if any, in m, for central hatchways and for twin hatchways if no longitudinal tight wash bulkhead is provided in the hold;

distance measured at the deck level from the side coaming of the hatchway positioned at the ship's side to the shell plating or to the inner longitudinal bulkhead of the side tank, if any, in m, or distance measured at the deck level from the side coaming of the hatchway positioned at the centre line to the tight wash bulkhead or to the central tank longitudinal bulkhead nearest to this coaming, if any, in m, whichever of the two distances is greater, for twin hatchways where the tight wash bulkhead is provided in the hold in the centre line;

h = distance between inner edges of the deck plating and cover plating, in m.

If the value of K determined from the Formula (7.13.4-3) is negative, the value of $K = 0$ shall be taken in the calculations.

7.13.5 When two or more hatchways are arranged one after another throughout the hold length, the design loads for cargo hatchway covers are subject to special consideration by the Register.

7.13.6 When the hatchway cover is under the design load, stresses in its parts shall not exceed 0,7 times the upper yield stress of material.

7.13.7 The sealing parts of the hatchway covers being secured shall be tight under the inner pressure of the liquid carried in the hold not less than 24,5 kPa or double value of the load determined from the Formula (7.13.4-2), whichever is the greater.

The tightness shall be provided by rubber or other suitable gaskets being resistant to the liquid carried in the hold.

The securing devices shall be equally spaced, where possible.

7.13.8 Each securing device of the hatchway cover shall be calculated for the action of the greater force F_1 or F_2, in kN, determined from the formulae:

$$F_1 = \frac{1}{n}[4{,}4Q + 294bl(b + 2r + 2K_1)]\cdot 10^{-2}; \qquad (7.13.8\text{-}1)$$

$$F_2 = \frac{34{,}3bl}{n} + 44 \qquad (7.13.8\text{-}2)$$

where Q = total mass of covers of the hatchway under consideration, in kg;

n = total number of securing devices along the perimeter of the hatchway under consideration;

K_1 = value determined from the formula

$$K_1 = C - 0{,}75h. \qquad (7.13.8\text{-}3)$$

If the value of K_1 determined from the Formula (7.13.8-3) is negative, the value of $K_1 = 0$ shall be taken in the calculations;

for b, l, r, C and h, see 7.13.4.

7.13.9 Each securing device of the side coaming of the hatchway shall be calculated for (in addition to the force specified in 7.13.8) the action of force F_3, in kN, determined from the formula

$$F_3 = ab(1{,}13b + 1{,}72r + 1{,}72K_2) + 35{,}3 \qquad (7.13.9\text{-}1)$$

where a = distance between securing devices, in m;

K_2 = value determined from the formula

$$K_2 = C - 2{,}14h. \qquad (7.13.9\text{-}2)$$

If the value of K_2 determined from the Formula (7.13.9-2) is negative, the value of $K_2 = 0$ shall be taken in the calculations;

for b, r, C and h, see 7.13.4.

7.13.10 When the securing device is subjected to the design force specified in 7.13.8 and 7.13.9, stresses in its parts shall not exceed 0,7 times the upper yield stress of material.

7.13.11 Independently of the provisions of 7.10.8.2 and 7.13.6, for all covers made of steel the thickness of their plating shall be not less than 8 mm or the value s, in mm, determined from the Formula (7.13.11), whichever is the greater

$$s = 25a_1\sqrt{p/R_{eH}} \qquad (7.13.11)$$

where p = load, kPa, determined from the Formula (7.13.4-2), with the value y measured from the longitudinal (parallel to the centre line of the ship) axis of symmetry of the hatchway to the edge of the plate under consideration most distant from this axis, in m;

a_1 = distance between the cover stiffeners of the main direction, in m;

R_{eH} = upper yield stress of the cover plating material, in MPa.

7.13.12 Where the hatchway cover is provided with openings for access to the hold, for hold cleaning or cargo sampling or with other similar openings, the closing appliances of these openings shall comply with the requirements of 7.11.

7.13.13 When closed and secured, the hatchway covers of holds intended for carriage of flammable liquids shall be earthed (see 2.5, Part XI "Electrical Equipment").

Special earthing need not be used in case reliable electrical contact is ensured between the covers and ship's hull when the hatchway is closed and secured.

7.14 CARGO HATCHWAYS OF HOLDS DESIGNED FOR CARRIAGE OF CARGOES IN BULK

7.14.1 Hatchway covers on the ships intended for carriage of cargoes in bulk shall comply with the requirements of 7.10.1 to 7.10.8.

Moreover, hatchway covers at 0,25 length of ship from the forward perpendicular shall comply with the requirements of 7.14.2 to 7.14.7.

7.14.2 Hatchway covers shall be designed to withstand the load P (kPa) determined from the formula

$$P = 19{,}6\sqrt{H} \qquad (7.14.2\text{-}1)$$

where H is determined from the formula

$$H = 0{,}14A_i\sqrt{VL/C_b} - d_f \qquad (7.14.2\text{-}2)$$

A_i = factor, which value depends on the location of the middle length of hatchway cover in relation to the forward perpendicular, is defined from the Table 7.14.2;

V = design headway speed (knots) is taken not less than 13 knots;

L = ship length, in m;

C_b = coefficient of fullness at the summer loadline draught;

d_f = vertical distance, in m, between the summer loadline and the higher edge of the hatchway coaming.

Table 7.14.2

Distance from the forward perpendicular*	A_i
Forward perpendicular	2,70
0,05L	2,16
0,10L	1,70
0,15L	1,43
0,20L	1,22
0,25L	1,00

*For intermediate positions A_i is defined by linear interpolation.

7.14.3 Normal and tangential stresses (σ and τ, in MPa) arising in the stiffeners of hatchway covers, main load carrying structural and plating elements shall not exceed the following values:

$$\sigma = 0{,}80R_{eH}; \qquad (7.14.3\text{-}1)$$

$$\tau = 0{,}45R_{eH} \qquad (7.14.3\text{-}2)$$

where

R_{eH} = upper yield stress of material, in MPa.

Whilst defining σ and τ stresses one shall use design dimensions of transverse sections.

For determination of the section modulus of the main load carrying structural elements, the effective rider's width shall not exceed values defined in 7.14.5.

7.14.4 The design plate thickness t, in mm, of the hatchway cover plating is determined from the formula

$$t = 17{,}9a\sqrt{P/R_{eH}} \qquad (7.14.4)$$

where

a = distance between stiffeners, in m;

P = load according to 7.14.2.;

for R_{eH}, see 7.14.3.

7.14.5 The effective rider's width of the main framing which is parallel to stiffeners b_1, in m, is determined from the formula

$$b_1 = k_1 c \qquad (7.14.5\text{-}1)$$

where k_1 = factor defined by the following formulae:
$k_1 = 1{,}8/f - 0{,}8/f^2$ at $f > 1{,}0$;
$k_1 = 1{,}0$ at $f \leqslant 1{,}0$;
$f = 10^3 c/t\sqrt{R_{eH}/E}$;
for c, see below;
for R_{eH}, see 7.14.3;
E = elastic modulus of the material, in N/mm^2. For steel it is assumed for $2{,}06 \cdot 10^5$.

The effective rider's width of the main framing which is perpendicular to stiffeners b_2, in m, is determined from the formula

$$b_2 = k_2 d \qquad (7.14.5\text{-}2)$$

where k_2 = factor defined by the following formula:
$k_2 = k_1 c/d + 0{,}115(1 - c/d)(1 + 1/f^2)^2 < 1{,}0$;
d, c = the larger and the smaller plate sides (m), respectively;
for K_1, f, see above.

7.14.6 For ships with no forecastle or breakwater, coamings' thickness of the forward hold are to be not less than those required by 2.12.4.3 and 2.12.4.4, Part II "Hull" for end bulkheads or deckhouses of this region.

7.14.7 The corrosion increment to the plating and stiffeners' thickness of any type of hatchway covers (excluding pontoon hatchway cover) is to be taken at the rate of 2 mm.

For the pontoon hatchway covers the corrosion increment is to be taken at the rate of:

2 mm for upper and lower plating;

1,5 mm for inner structures.

7.15 ACCESS TO SPACES IN THE CARGO AREA OF TYPE "A" SHIPS

7.15.1 Access to cofferdams, ballast tanks, cargo tanks and other spaces in the cargo area shall be directly from the open deck and such as to ensure their complete inspection. Access to double bottom spaces may be through a cargo pump room, pump room, deep cofferdam, pipe tunnel or similar compartments, subject to consideration of ventilation aspects.

7.15.2 For access through horizontal openings, hatches or manholes, the dimensions shall be sufficient to allow a person wearing a self-contained air-breathing apparatus and protective equipment to ascend or descend any ladder without obstruction and also to provide a clear opening to facilitate the hoisting of an injured person from the bottom of the space. The minimum clear opening shall be not less than 600 × 600 mm.

7.15.3 For access through vertical openings or manholes providing passage through the length and breadth of the space, the minimum clear opening shall be not less than 600 × 800 mm at a height of not more than 600 mm from the bottom shell plating unless gratings or other footholds are provided.

7.15.4 For ships of less than 5000 t deadweight, smaller dimensions may be approved as compared to those stipulated by 7.15.2 and 7.15.3, subject to the special consideration of the Register in each case.

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7.16 ADDITIONAL REQUIREMENTS FOR OPENINGS AND THEIR CLOSING APPLIANCES IN RO-RO SHIPS

7.16.1 Where vehicle ramps are installed in the ship to give access to spaces below the bulkhead deck, their openings in the bulkhead deck shall be able to be closed weathertight to prevent ingress of water below, alarmed and indicated to the navigating bridge.

7.16.2 Where fitting of particular accesses to spaces below the bulkhead deck is necessary for the essential working of the ship (e.g. the movement of machinery and stores, etc.) such accesses shall be provided with watertight closures, alarmed and indicated to the navigating bridge.

7.16.3 Subject to provisions of paragraphs 7.16.1 and 7.16.2 all accesses that lead to spaces below the bulkhead deck shall have a lowest point which is not less than 2,5 m above the bulkhead deck.

7.16.4 Indicators shall be provided on the navigating bridge for all shell doors, loading doors and other closing appliances which, if left open or not properly secured, could lead to flooding of a special category space or ro-ro cargo space. The indicator system shall be designed on the fail safe principle and shall show by light alarms if the door is not fully closed or if any of the securing arrangements is not in place and fully locked, and by audible alarms if such door or closing appliances become open or the securing arrangements become unsecured.

The indicator panel on the navigating bridge shall be equipped with a mode selection function "harbour/sea voyage" so arranged that an audible alarm is given on the navigating bridge if the ship leaves harbour with the bow doors, inner doors, stern ramp or any other side shell doors not closed or any closing device not in the correct position. The power supply for the indicator system shall be independent of the power supply for operating and securing the doors.

7.16.5 Television surveillance and a water leakage system shall be arranged to provide an indication to the navigating bridge and to the engine control station of any leakage through inner and outer bow doors, stern doors or any other shell doors which could lead to flooding of special category spaces or ro-ro cargo spaces.

7.16.6 Special category spaces and ro-ro cargo spaces shall be continuously patrolled or monitored by effective means, such as television surveillance, so that any movement of vehicles in adverse weather conditions and unauthorized access of passengers thereto can be detected whilst the ship is underway.

7.16.7 Documented operating procedures for closing and securing all shell doors, loading doors and other closing appliances which, if left open or not properly secured could lead to flooding of special category space or ro-ro cargo space, shall be kept on board and posted at an appropriate place.

см.Б1 **7.16.8** In ships constructed before 1 July 1997 all accesses from the ro-ro deck that lead to spaces below the bulkhead deck shall be made weathertight and means shall be provided on the navigating bridge, indicating whether the access is open or closed.

The said requirement shall apply not later than the date of the first periodical survey after 1 July 1997.

8 ARRANGEMENT AND EQUIPMENT OF SHIP'S SPACES, VARIOUS EQUIPMENT, ARRANGEMENTS AND OUTFIT

8.1 GENERAL PROVISIONS

8.1.1 The requirements for the arrangement and equipment of machinery spaces are specified in Part VII "Machinery Installations" and those relating to refrigerating machinery spaces, refrigerant storerooms, as well as refrigerated cargo spaces are set forth in Part XII "Refrigerating Plants".

8.1.2 In berth-connected ships, the arrangement and equipment of spaces, various devices and equipment must comply with the relevant requirements of 8.5 and 8.6.

Furthermore, berth-connected ships which are used as hotels or hostels shall comply with the requirements set out in 8.5 as in the case of passenger ships.

Besides, a berth-connected ship shall have at least two companion ladders fitted as far away from each other as possible. The companion ladders are to be not less than 0,2 m wide where the total of passengers and crew on board does not exceed 50.

For each 10 persons above 50, the companion ladder breadth is to be increased by 5 cm.

8.2 LOCATION OF SPACES

8.2.1 The chart room is to be located in a space adjacent to the wheelhouse. The chart room and the wheelhouse may be situated in a common space.

8.2.2 No accommodation spaces are to be arranged forward of the collision bulkhead and abaft of the afterpeak bulkhead below the bulkhead deck (see also 2.1.5.1, 2.1.14, 2.8.14, Part VI "Fire Protection").

8.3. NAVIGATING BRIDGE

8.3.1. General provisions.

8.3.1.1 The ship's control station is to be located in an enclosed space of the wheelhouse on the navigating bridge. The navigating bridge is to be located so as to ensure:

proper visual control of the ship's running;

good visibility with maximum view of water surface;

good audibility of sound signals of the approaching ships;

for tugs, possibility of visual control of tow line during towing operations.

It is recommended to arrange the steering control station at the ship's centre line.

8.3.2 Visibility from the navigating bridge on the ships of length of 45 metres and more.

8.3.2.1 The view of the water surface from the ship's control station shall not be shadowed for a distance of more than two ship lengths or 500 metres whichever is less and in the direction to the ship bow the view shall not be shadowed by 10° on each side with no regard of the type of deck cargo, draught and trim. Shadowed sectors of no more than 5° are allowed.

8.3.2.2 Any shadowed sector incurred by cargo, cargo arrangement or other hindrances in front of the wheelhouse worsening the view of the water surface from the ship's control point shall not exceed 10°. The total of the shadowed sector shall not exceed 20°. Sectors of clear view between shadowed sectors shall not be less than 5°.

8.3.2.3 Horizontal view from the ship's control point shall be not less than 225°, i.e. 22,5° abaft each side's beam.

From each wing of the bridge the view shall be not less than 225° , i.e. not less than 45° to the other side and further from the bow to the stern.

From the main rudder control station the view shall be not less than 60° to each side.

8.3.2.4 Ship side shall be visible from the bridge wing. The lower edge of windows in the front bulkhead of the navigating bridge is to be as close as possible to the bridge deck and it shall not close the view.

The upper edge of windows of the front bulkhead of the navigating bridge shall be at such level which provides an unhindred view from the ship's control point for a man whose eyes are at the height of 1800 mm from the bridge deck at a heavy pitch. By the special Register approval the said height may be reduced to 1600 mm in certain cases.

8.3.2.5 Construction and lay-out of windows in the wheelhouse shall meet the following requirements:

the space between windows is to be minimal and not to be located directly in front of the watchkeeper's working place;

deckhouse front windows' upper edge is to have a ledge declining inside by not less than 10° and not more than 25° to avoid reflection;

polarized or toned glasses shall not be fitted;

a clear view through the front two windows of the deckhouse and if provided by its construction through the additional windows is to be provided with no regard of the weather.

8.3.2.6 Ships of exceptional design which by their design characteristics are not able to comply with the requirements of 8.3.1.1 to 8.3.2.5 shall be fitted with appropriate arrangements and means which as far as it is efficient and practically possible meet the requirements of the present Chapter.

8.4 EQUIPMENT OF DRY CARGO HOLDS

8.4.1 When in ships not having double bottom wooden ceiling is placed on top of the floors, it shall be solid and shall extend up to the bilge. The ceiling is recommended to be made of portable sections of such dimensions and so constructed as to allow of their ready removal at any place.

The thickness of a ceiling is to be:

at least 40 mm for ships of 30 m in length and less;

at least 60 mm for ships over 30 m in length;

at least 70 mm under cargo hatchways.

8.4.2 When in ships having double bottom wooden ceiling is fitted, it shall have a thickness as follows:

at least 50 mm for ships of 60 m in length and less;

at least 65 mm for ships over 60 m in length.

The application of the ceiling made from synthetic material is subject to special consideration by the Register in each case.

8.4.3 Where cargo is discharged by grabs or other mechanisms, the thickness of the wooden ceiling fitted under cargo hatchways is to be doubled.

8.4.4 In holds intended for carriage of grain and other bulk cargoes the wooden ceiling on the inner bottom or, in case the latter is omitted, on the top of floors, is to be fitted so as to prevent wells, bilges and suction pipes of the bilge system from clogging.

8.4.5 The wooden ceiling is not to be laid directly on the inner bottom metal plating, but is to be embedded in a bituminous or epoxy composition approved by the Register, or placed on battens of 25 to 30 mm in thickness along the floors. The wooden ceiling over the bilges is to be placed so as to be readily removable (see also 7.6.9, Part VIII "Systems and Piping").

8.4.6 It is recommended that the cargo battens made of wood or metal shall be fitted on sides in holds and spaces intended for carriage of general cargoes. The thickness of wooden battens is to be as follows:

at least 40 mm for ships of 70 m in length and less;

at least 50 mm for ships of length exceeding 70 m.

The distance between adjacent battens is not to exceed 305 mm.

The battens are to be attached to side framing so as to be readily removable and replaceable.

8.4.7 All projecting parts of various equipment in the holds (manholes, air pipes, sounding pipes, etc.) are to be protected with wooden screens, grids, chutes, etc. in places subject to impacts of cargoes, grabs or other hoisting devices. Requirements for laying pipe lines in cargo holds are given in 5.3, Part VIII "Systems and Piping".

8.4.8 Cellular guide members for the carriage of containers in holds.

8.4.8.1 The requirements of 8.4.8 apply to the cellular guide members used for the carriage of containers, manufactured in accordance with Rules for the Construction of Containers, in the holds of cargo ships.

8.4.8.2 Cellular guide members comprise uprights and horizontal shores arranged breadthwise and lengthwise. In the holds, the cellular guide members may be removable or permanent.

8.4.8.3 Cellular guide members shall not be integrated in the hull structure. They are to be so designed that no stresses are exerted on them when the hull comes under bending or torsion.

8.4.8.4 Cellular guide members shall be designed to withstand stresses due to the forces F_x and F_y affecting the gravity centre of each container, which are to be determined from the formulae:

lengthwise

$$F_x = mga_x, \text{ in N}; \qquad (8.4.8.4\text{-}1)$$

breadthwise

$$F_y = mga_y, \text{ in N} \qquad (8.4.8.4\text{-}2)$$

where m = maximum gross mass of container, in kg;
g = gravity acceleration, g = 9,81 m/s^2;
a_x, a_y = dimensionless accelerations to be determined in accordance with 1.6, the coordinates of x and z being determined up to the gravity centre of each container volume.

The forces F_x and F_y are to be determined for each container, and through the four relevant corner fittings of the end or side wall they are uniformly distributed among the uprights. By way of simplification, maximum F_x and F_y values may be adopted for each container. Where a number of adjoining containers are supported by a pair of uprights, the F_x and F_y values for the particular container tier shall be summed up and distributed among the respective uprights.

Friction forces arising where the corner fittings of containers touch each other or the inner bottom are to be ignored.

8.4.8.5 The forces resultant from loads to be determined in accordance with 8.3.8.4, where the container corner fittings rest upon the uprights, shall not exceed 150 kN per fitting breadthwise or 75 kN per fitting lengthwise.

8.4.8.6 Where the attachment of uprights to the hull structures is not considered as firm fixing (free resting, flexible fixing, etc.), the cellular guide members shall be calculated as three-dimensional frames.

Where the attachment of uprights to the hull structures can be considered as firm fixing, particular vertical surfaces of cellular guide members may be calculated as plane frames.

The stresses in the cellular guide member components are not to exceed 0,8 times the upper yield stress of their material.

The terms of calculating the stability of cellular guide member components are to be found under 8.4.8.14.

8.4.8.7 In view of the requirements under 8.4.8.6, the displacement of the resting points of corner fittings upon the uprights is not to exceed 25 mm breadthwise or 10 mm lengthwise.

8.4.8.8 When determining the thickness of the uprights components, the thickness of those especially subject to wear shall be increased by 5 mm to equal 12 mm at least.

8.4.8.9 Where the uprights comprise separate angular sections, they are to be firmly secured to each other with horizontal plates at the resting points of container corner fittings and at least halfway between those points.

8.4.8.10 At the upper ends of the uprights, devices shall be fitted to facilitate the insertion of containers into the stowage frames.

8.4.8.11 Uprights shall, so far as possible without notches, be attached to transverse and longitudinal bulkheads by means of shear- and bend-stiff members.

8.4.8.12 The total margin between the external scantlings of containers and the internal uprights surfaces shall not exceed 25 mm breadthwise or 40 mm lengthwise.

When fitting the uprights, the deviation from the straight line shall not exceed 5 mm.

8.4.8.13 Transverse horizontal and longitudinal horizontal shores serve to connect the stand-alone uprights to each other and to secure them to vertical hull structures. The horizontal shores shall, as far as possible, be fitted on the level of the corner fitting rest points and be torsion- and bend-stiff connected to the uprights.

8.4.8.14 The stability of transverse horizontal and longitudinal horizontal shores and, where necessary, that of uprights shall be checked by a procedure approved by the Register.

When determining the permissible buckling stresses, the relevant safety factor may be adopted equal to 2,0.

The free length of buckling shall be adopted span-equal in the case of a bolted joint or 0,7 times the shore or uprights span in the case of a welded joint. The flexibility is not to exceed 250.

For other types of bar-end fixing, the free length is to be established on agreement with the Register.

8.4.8.15 The container rest points on the inner bottom and areas containing the connections and attachments of container stowage frames in way of hull structures shall be strengthened in conformity with the requirements of Part II "Hull".

8.4.9 Movable decks, platforms, ramps and other similar structures.

8.4.9.1 The requirements of 8.4.9 apply to the movable decks, platforms, ramps and other similar structures designed to be installed in two positions:

in working position when they are used for carriage, loading or unloading of vehicles or other cargoes;

in non-working position when they are not used for carriage, loading or unloading of vehicles or other cargoes.

8.4.9.2 The movable decks, platforms, ramps and other similar structures and also their supporting elements at ship's sides, decks and bulkheads. the pillars or suspensions for decks and platforms ensuring their proper installation in the working position shall be designed in accordance with the requirements of Part II "Hull".

8.4.9.3 Arrangements shall be provided for reliable securing of the movable decks, platforms ramps and other similar structures in the non-working position.

8.4.9.4 When the movable decks, platforms, ramps and other similar structures are secured in the non-working position, the hoisting gear and elements thereof shall not generally be kept under the load.

It is not permitted to secure the movable decks, platforms, ramps and other similar structures by suspending them on ropes.

8.4.9.5 The structural elements of the arrangements mentioned in 8.4.9.3 and also the associated supporting structures shall be designed to withstand the forces resulting form the application of the loads P_x, P_y, P_z, as obtained from the formulae given below, to the centres of gravity of the considered section of the deck, platform, ramp or other similar structures:

$$P_x = mga_x; \quad (8.4.9.5\text{-}1)$$

$$P_y = mga_y; \quad (8.4.9.5\text{-}2)$$

$$P_z = m \cdot g(1 + a_z) \quad (8.4.9.5\text{-}3)$$

where P_x = horizontal load parallel to the centre plane of the ship, in N. Consideration shall be given to the cases when the load P_x is directed both forward and aft;

P_y = horizontal load parallel to the midstation plane, in N. Consideration shall be given to the cases when the load P_y is directed both to the nearest ship's side and to the opposite side;

P_z = vertical load directed downward, in N;

m = mass of the considered section of the deck, platform, ramp or other similar structure, in kg;

g = acceleration due to gravity equal to 9,81 m/s^2;

a_x, a_y, a_z = dimensionless accelerations to be determined in accordance with 1.7.

8.4.9.6 When determining the forces affecting the structural elements of the arrangements specified in 8.4.9.3 and the associated supporting structures with regard to the provisions of 8.4.9.5, the loads P_x, P_y and P_z are regarded as separately applied, i.e. no account is taken of their combined action and of the frictional forces originating on the surfaces of the considered sections of decks, platforms, ramps or other similar structures which are in contact with the associated supporting structures.

8.4.9.7 When the structural elements of the arrangements specified in 8.4.9.3 and the associated supporting structures are under the effect of the loads determined according to the provisions of 8.4.9.5 and 8.4.9.6, the stresses in their parts shall not exceed 0,8 times the upper yield stress of material.

Under the effect of these loads the safety factor of the wire ropes in relation to their actual breaking strength shall be not less than 4; the safety factor of the chain cables in relation to the proof load of the chain shall be not less than 2; the margin of safety against buckling of the elements subjected to the compression stress shall be not less than 2.

8.4.9.8 Wire ropes used in the arrangements specified in 8.4.9.3 shall satisfy the requirements of 3.15 and chain cables, those of 7.1, Part XIII "Materials".

8.5 EXITS, DOORS, CORRIDORS, STAIRWAYS AND VERTICAL LADDERS

8.5.1 General.

Location and arrangement of exits, doors, corridors, stairways and vertical ladders are to ensure ready access of persons from spaces to the places of embarkation into lifeboats and liferafts.

8.5.2 Exits and doors.

8.5.2.1 In passenger ships and in special purpose ships each watertight compartment or similarly restricted space or group of spaces situated below the bulkhead deck shall have at least two means of escape, in any case one of which shall be independent of the door in the subdivision bulkhead.

Two means of escape shall be provided from a machinery control room located within a machinery space, at least one of which will provide continuous fire shelter to a safe position outside the machinery space (see 2.1.4.5 and 2.2, Part VI "Fire Protection").

8.5.2.2 In passenger ships and in special purpose ships above the bulkhead deck each main vertical fire zone (see 1.2, Part VI "Fire Protection") or similarly restricted space or group of spaces shall have at least two means of escape one of which shall give access to a stairway forming a vertical means of escape to the places of embarkation into lifeboats and liferafts.

8.5.2.3 In passenger ships the number and location of means of escape from special category spaces (see 1.5.9, Part VI "Fire Protection") are subject to special consideration by the Register, and the degree of safety for escape from these spaces to the places of embarkation into lifeboats and liferafts shall at least correspond to that specified in 8.5.2.1 and 8.5.2.2.

For cargo ships in all ro-ro cargo spaces where the crew is normally employed the number and locations of escape routes to the open deck are subject to special consideration by the Register, but shall in no case be less than two and shall be widely separated.

8.5.2.4 In cargo ships of 500 gross tonnage and upwards at each level of accommodation spaces there shall be at least two means of escape, as widely separated as possible, from each restricted space or group of spaces; from the spaces situated below the open deck the main means of escape shall be formed by a stairway, the other means of escape may be formed by a casing with a vertical ladder or by a stairway; from the spaces situated above the open deck the means of escape shall be formed by doors of stairways leading to the open deck or combination thereof.

8.5.2.5 Exceptionally, the Register may dispense with one of the means of escape specified in 8.5.2.1 or 8.5.2.4, due regard being paid to the purpose and location of spaces and to the number of persons who normally might be quartered or employed there.

8.5.2.6 Stairways serving only a space and a balcony in that space, as well as lifts shall not be considered as means of escape specified in 8.5.2.1 to 8.5.2.4 and 8.5.2.6.

8.5.2.7 Each cinema hall is to be provided with at least two means of escape. Both exits are to be spaced from each other as wide as practicable. A readily seen inscription "Exit" or "Emergency exit" is to be provided above every such exit.

8.5.2.8 The wheelhouse is to have two exits, one to each side of the navigation bridge, with a passageway through the house from side to side.

8.5.2.9 The total width of exits from cinema halls shall be determined on the basis of 0,8 m per 50 persons, however, the width of each exit shall be not less than 1,1 m, when the number of seats is more than 50, and not less than 0,8 m when the number of seats is not more than 50.

The width of each exit from accommodation and service spaces shall be not less than 0,6 m. The sizes of the ladderways from cargo holds shall be not less than 0,6 × 0,6 m.

8.5.2.10 The exit doors and ladderway covers are to be so arranged that they can be operated from both sides.

Doors are to open as follows:

.1 doors of accommodation and service spaces giving access to a corridor inside the spaces;

.2 doors of public rooms, outside or each side;

.3 doors in the end bulkheads of superstructures and in external transverse bulkheads of deckhouses, outside in the direction of the nearest side;

.4 doors in the external longitudinal bulkheads of deckhouses, outside in the forward direction.

In cargo ships the inner doors duplicating the doors specified in 8.5.2.10.3 and 8.5.2.10.4 may open inside the space.

In ships of 31 m in length and less the doors indicated in 8.5.2.10.1 may open outside (to the corridor) if they are situated at the end of blind corridors and do not hinder the exits from other spaces.

No sliding doors are to be fitted at exits and means of escape, except for doors of the wheelhouse.

The doors referred to in 8.5.2.10.1 shall not be provided with hooks for holding the door open. It is permitted that such doors be fitted with buffers and spring catchers to fix the door in the open position and to allow for its closure without entering the space.

8.5.2.11 Doors of accommodation spaces specified in 1.5.2.1 and 1.5.2.2, Part VI "Fire Protection" are to have in their lower portions detachable panels 0,4 × 0,5 m in size, these panels of the passenger cabin doors shall be provided with the following inscription: "Means of escape — knock out in case of emergency".

The detachable panels need not be fitted where the spaces are provided with opening type side scuttles of at least 400 mm in diameter of windows the smaller side of which being at least 400 mm and on condition that persons may get to the corridor or open deck through these side scuttles or windows. The appropriate means shall be provided, if necessary, to facilitate exit through side scuttles or windows.

8.5.3 Corridors and passageways.

8.5.3.1 All corridors and passageways are to ensure free movement of persons along them. On passenger ships and special purpose ships carrying more than 50 special personnel, a lobby, corridor or part of a corridor should have more than one means of escape.

Cargo ships and special purpose ships carrying not more than 50 special personnel should have no dead-end corridors more than 6 m long. By a dead-end corridor, a corridor or part of a corridor is meant which has only one means of escape.

Corridors used as means of escape on cargo ships shall be at least 700 mm wide and shall be fitted with a handrail on either side. Corridors with a width of 1800 mm and more shall be fitted with handrails on each side. Width of a corridor is determined as a distance between a handrail and opposite bulkhead or as a distance between handrails.

8.5.3.2 The width of main corridors in way of passengers' and crew's accommodation spaces is not to be less than 0,9 m, and that of side corridors is to be at least 0,8 m. Where the number of passengers and crew using the corridor surpasses 50 persons, the widths referred to above are to be increased by 0,1 m.

In ships (including the tugs) below 500 gross tonnage and in tugs of less than 370 kW the width of the main corridors and side corridors may be reduced down to 0,8 and 0,6 m, respectively.

8.5.3.3 The widths of passageways in the cinema hall and in the entrance hall are not to be less than 1,1 m and 1,4 m, respectively.

The width of the main passageways in the restaurant or dining room and also the messroom is not to be less than 0,9 m and that of the side passageways is to be at least 0,65 m. In ships of less than 500 gross tonnage the width of main passageways in the messroom may be reduced down to 0,65 m.

8.5.3.4 The width of the main passageway in the seating passenger space is to be at least 1 m with number of passengers up to 50 and at least 1,1 m with number of passengers in excess of 50.

8.5.3.5 In passenger ships the main corridors adjacent to engine and boiler casings are to be at least 1,2 m in width, however, in ships of less than 500 gross tonnage this width may be reduced down to 0,9 m.

8.5.3.6 The width of passageway on the bridge is not to be less than 0,8 m in ships of 500 tons gross tonnage and over and at least 0,6 m in ships of less than 500 gross tonnage.

8.5.3.7 In passenger ships and special purpose ships the width of the deck passageways providing access to the lifeboat and liferaft embarkation deck is not to be less than:

0,9 m if the number of seats in lifeboats is not more than 50 on each side of ship;

1,0 m if the number of seats in lifeboats is 50 and over, but less than 100 on each side of ship;

1,2 m if the number of seats in lifeboats is 100 and over, but less than 200 on each side of ship.

If number of seats in lifeboats is 200 and over on each side of ship, the width of the passageways will be specially considered by the Register in each case.

In other ships the width of the passageways referred to above is not to be less than 0,8 m.

8.5.4 Stairways and vertical ladders.

8.5.4.1 All between deck stairways shall be of steel frame construction or of equivalent material on agreement with the Register (see 1.2, Part VI "Fire Protection"). Special requirements for arrangement of stairway enclosures and protection of means of escape are specified in 2.1.4.3, 2.1.4.5, 2.2.2.4, and Table 3.1.2.1, Part VI "Fire Protection".

8.5.4.2 On passenger ships and special purpose ships carrying more than 50 special personnel, the following conditions are to be met:

.1 the width of stairways should be not less than 900 mm, with handrails on each side.

the minimum width of stairways is to be increased by 10 mm for every one person in excess of 90 persons.

The maximum width between handrails where stairways are wider than 900 mm is to be 1800 mm. The total number of persons to be evacuated by such stairways shall be assumed to be two-thirds of the crew and the total number of passengers in the areas served by such stairways;

.2 all stairways sized for more than 90 persons are to be aligned fore and aft;

.3 the doorways, corridors and intermediate landings included in means of escape shall be sized in the same manner as stairways;

.4 stairways shall not exceed 3,5 m in vertical rise without the provision of a landing and shall not have an angle of inclination greater than 45°;

.5 landings at each deck level shall not be less than 2 m^2 in area and shall increase by 1 m^2 for every 10 persons provided for in excess of 20 persons but need not exceed 16 m^2, except for those landings servicing public spaces having direct access onto the stairway enclosure;

см.Б1 **.6** in any case, the stairway width is to be in accordance with the requirements of the Appendix to this Part of the Rules.

8.5.4.3 Stairways used as means of escape on cargo ships shall be at least 700 mm wide and shall be fitted with a handrail on either side. Stairways with a width of 1800 mm and more shall be fitted with handrails on each side. Angle of slope of ladders shall be usually 45° but not greater than 50°, in the machinery and in small spaces — not greater than 60°. The size of doors providing an access to any stairway shall be of the same size as the stairway.

8.5.5 Low location lighting (LLL) on passenger ships carrying more than 36 passengers and special purpose ships carrying more than 200 special personnel.

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8.5.5.1 In addition to the emergency lighting stipulated by 19.1.2, Part XI "Electrical Equipment", the means of escape, including stairways and exits, of passenger ships carrying more than 36 passengers and special purpose ships carrying more than 200 special personnel shall be marked by LLL at all points of the escape route including angles and intersections.

8.5.5.2 Provision shall be made for the following LLL systems:

.1 photoluminescent system which uses photoluminescent material containing a chemical (example: zinc sulfide) that has the quality of storing energy when illuminated by visible light (see also 6.7, Part XIII "Materials");

.2 electrically powered systems which use incandescent bulbs, light emitting diodes, electroluminescent strips or lamps, electrofluorescent lamps, etc. (see also 19.1.4, Part XI "Electrical Equipment").

8.5.5.3 The LLL system shall function at all times for at least 1 hour after its activation. All systems, including those automtically activated or continuously operating, are to be capable of being manually activated by a single action from the central control station.

8.5.5.4 In all passageways, the LLL shall be continuous except as interrupted by corridors and cabin doors in order to provide a visible delineation along the escape route. The LLL shall be installed at least on one side of the corridor, either on the bulkhead within 300 mm of the deck, or on the deck within 150 mm of the bulkhead. In corridors more than 2 m wide, LLL shall be installed on both sides. In dead-end corridors, LLL shall have arrows placed at intervals of no more than 1 m, or equivalent direction indicators, pointing away from the dead-end.

8.5.5.5 In all stairways, LLL shall be installed on at least one side at a height less than 300 mm above the steps. LLL shall be installed on both sides if the width of the stairway is two metres or more. The top and bottom of each set of stairs shall be identified to show that there are no further steps.

8.5.5.6 In all passenger cabins, a placard explaining the LLL system shall be installed on the inside of the cabin door. It shall also have a diagram showing the location of, and the way to, the two closest exits with respect to the cabin.

Materials used in the manufacture of LLL products shall not contain radioactive or toxic materials.

8.5.5.7 LLL shal indicate the exit door handle; other doors shall not be indicated so.

Sliding, fire-proof and watertight doors shall be provided with LLL sign showing the way of the door opening.

LLL signs shall be also provided at all doors and means of escape. The signs shall be located at a height of 300 mm above the deck or the bottom of the door and be contrast in colour to the background on which they are marked.

All exit door and escape route signs shall be of photoluminescent materials or marked appropriately by lighting.

8.5.6 Additional requirements for means of escape on ro-ro passenger ships.

8.5.6.1 Handrails or other handholds shall be provided in all corridors along entire escape route, so that a firm handhold is available every step of the way, where possible, to the assembly stations and embarkation stations. Such handrails shall be provided on both sides of longitudinal corridors more than 1,8 m in width and transverse corridors more than 1 m in width. Particular attention shall be paid to the need to be able to cross lobbies, atriums and other large open spaces along escape routes. Handrails and other handholds shall be of such strength as to withstand a distributed horizontal load of 750 N/m applied in the direction of the centre of the corridor or space, and a distributed vertical load of 750 N/m applied in downward direction. There is no need to apply the two loads simultaneously.

8.5.6.2 Means of escape shall not be obstructed by furniture and other obstructions, with the exception of tables and chairs which may be cleared away to provide open space. Cabinets and other heavy pieces of furniture in public spaces and along escape routes shall be secured in place to prevent shifting if the ship rools or lists. Floor coverings shall also be secured in place. When the ship is underway, means of escape shall be kept clear of obstructions.

8.5.6.3 Means of escape shall be provided from every normally occupied space on the ship. These means of escape shall be arranged so as to provide the shortest route possible to the assembly stations and survival craft embarkation stations and shall be marked with appropriate symbols.

8.5.6.4 Where enclosed spaces adjoin an open deck, openings from the enclosed space to the open deck shall, where it is practicable, be capable of being used as an emergency exit.

8.5.6.5 Decks shall be sequentially numbered, starting with "1" at the tank top or the lowest deck. These numbers shall be prominently displayed at stair landings and lifts in the lobbies. Decks may also be named, but the deck number shall always be displayed along with the name.

8.5.6.6 Simple and clear plans showing the "you are here" position and means of escape marked by arrows shall be prominently displayed on the inside of each cabin door and in public spaces.

8.5.6.7 Cabin and stateroom doors shall not require keys to be unlocked from the inside. Neither shall there be any doors along any designed escape route which require keys to be unlocked.

8.5.6.8 The lowest 0,5 m of bulkheads along escape routes shall be able to sustain a load of 750 N/m to allow them to be used as walking surfaces with the ship at large angles of heel.

8.5.6.9 The escape routes from cabins to stairway enclosures shall be as direct as possible, with a minimum number of direction changes. It shall not be necessary to cross from one side of the ship to the other to reach means of escape. It shall not be necessary to climb more than two decks up or down to reach an assembly station or open deck from any passenger space.

8.5.6.10 External means of escape to the survival craft embarkation stations shall be provided from all open decks, referred to in 8.5.6.9.

8.6 GUARD RAILS, BULWARK AND GANGWAYS

8.6.1 All exposed parts of the freeboard decks, superstructure decks and deckhouse tops are to be provided with efficient guard rails or bulwarks; in case of ships intended for carriage of timber deck cargo collapsible railing or storm rails are to be fitted on this cargo.

8.6.2 The height of the bulwark or guard rails above the deck is not to be less than 1 m. However, where this height would interfere with the normal operation of the ship, a lesser height may be approved provided the adequate protection of passengers and crew is ensured to the satisfaction of the Register.

8.6.3 The distance between the stanchions of the guard rails shall be not more than 1,5 m. At least every third stanchion shall be supported by a stay.

Removable and hinged stanchions shall be capable of being locked in the upright position.

8.6.4 The gunwale, hand rails and guard rails shall be generally of rigid construction; wire ropes may only be accepted in lieu of guard rails in special circumstances and then only in limited lengths; wire ropes shall be made taut by means of turn-buckles.

Lengths of chains may only be accepted in lieu of rigid guard rails if they are fitted between two fixed stanchions or between the fixed stanchion and bulwark.

8.6.5 The opening below the lowest course of the guard rails is not to exceed 230 mm. The other courses of rails are not to be more than 380 mm apart. An exception is made for the guard rails above the timber deck cargo where the height from the base to the lowest course and other course spacings are not to exceed 330 mm. In the case of ships with rounded gunwale, the guard rail supports are to be placed on the flat of the deck.

8.6.6 Type "A" ships with bulwarks as well as type "B" ships with a freeboard reduced to that required for type "A" ships are to have open rails fitted for at least half the length of the exposed parts of the weather deck, or other effective water freeing arrangements. The upper edge of the sheerstrake is to be kept as low as practicable.

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

8.6.7 The bulwark, if arranged, is to comply with the requirements of 2.14, Part II "Hull".

8.6.8 Satisfactory means (in the form of life lines, gangways, underdeck passages, etc.) are to be provided for the protection of the crew in getting to and from their quarters, the machinery space and all other parts used in the necessary work of the ship.

8.6.9 A fore and aft permanent gangway is to be provided on type "A" ships at the level of the superstructure deck between the poop and the midship superstructure or deckhouse, where fitted, or equivalent means of access are to be provided to carry out the purpose of the gangway, such as underdeck passages.

The width of the passages is to be not less than 1 m. The gangways over the entire length of the plating on either side are to be fitted with longitudinal guarding bars. Reliable guard rails, the dimensions of which are to comply with the requirements of 8.6.2, 8.6.3 and 8.6.5 of this Part, and 3.5.5.2, Part II "Hull" are to be provided.

The gangways are to be constructed of a fire-resisting material, and the plating is to be made, in addition, of a nonslip material.

In ships not having a midship superstructure arrangements to the satisfaction of the Register are to be made to safeguard the crew in reaching all parts of the ship while at sea.

8.6.10 Safe and convenient ladders from the level of the gangways to the deck are to be provided; they are not to be spaced more than 40 m apart.

Where the length of the deck is more than 70 m, special tripartite shelters (bow — sides) are to be provided along the gangways or other means of access for protection of the crew from bad weather. Such shelters are to be designed for at least one person and are to be spaced not more than 45 m apart. Pipes or other deck equipment are not to impede safe passage.

8.6.11 Requirements of 8.6.1 to 8.6.5 and 8.6.9 are not applied to the shipborne barges. In such case, at least guard rails are to be provided.

8.7 HOISTING GEAR OF SHIPBORNE BARGES

8.7.1 The elements of the hoisting gear of the shipborne barges to be lifted by the crane on board the barge carrier (lugs, eye plates, rings, shackles, grips, etc.) are to be designed to withstand the forces resulting from lifting the shipborne barge uniformly loaded with the specification cargo and gripped in two points diagonally positioned. Under these forces the stresses in the elements of the hoisting gear are not to exceed 0,7 times the upper yield stress of material.

9 EMERGENCY OUTFIT

9.1 GENERAL PROVISIONS

9.1.1 The items listed in Tables 9.2.1, 9.2.2-1, 9.2.2-2 and 9.2.3 available in the ship, but intended for other purposes may be included into the emergency outfit, provided these items have corresponding markings and their permanent storage places are situated above the bulkhead deck.

9.2 ITEMS REQUIRED

9.2.1 All ships exept those specified in 9.2.4 and 9.2.6 shall have emergency outfit in the scope not less than listed in Table 9.2.1.

For the unmanned non-self-propelled ships no emergency outfit is required. The manned non-self-propelled ships are to be supplied with the emergency outfit in accordance with 9.2.10 like floating docks with no permanent direct communication with the shore.

9.2.2 Additional set of emergency outfit, above that listed in Table 9.2.1, shall be provided:

in accordance with Table 9.2.2-1 for passenger and special purpose ships, of 70 m in length and over, except those of glass-reinforced plastics;

in accordance with Table 9.2.2-2 for glass-reinforced plastic ships.

9.2.3 The sets of rigging and fitter's tools specified in Table 9.2.1 are to be completed according to Table 9.2.3.

9.2.4 For ships of restricted areas of navigation **I**, **IICП** and **IIICП** except those specified in 9.2.5, equipment with emergency outfit and materials may be laid down as for the nearest lower group of ship's division depending on their length according to Table 9.2.1.

The minimum amount of emergency outfit for ships of restricted area of navigation **III** will be specially considered by the Register in each case.

9.2.5 For ships with ice strengthening of **ЛУ5, ЛУ6, ЛУ7, ЛУ8** and **ЛУ9** categories, equipment with emergency outfit and materials are to be established as for the nearest higher group of ship's division according to their length as per Table 9.2.1.

9.2.6 For glass-reinforced plastic ships provision of emergency outfit listed under 6, 9, 17, 21 to 24, 26 to 29, 31, 35, 36, 39, and 40 of Table 9.2.1 is not required.

9.2.7 In ships intended to carry flammable and explosive cargoes tools of emergency outfit are to be made of sparkless materials wherever practicable.

9.2.8 The tugs of restricted area of navigation **III** need not be equipped with emergency outfit, except for the sets of rigging and fitter's tools required in accordance with Table 9.2.3.

9.2.9 For tugs of unrestricted service and restricted area of navigation **I** with ice strengthening of **ЛУ5** category equipment with emergency outfit and materials shall be established as for the nearest higher group according to Table 9.2.1.

9.2.10 The floating docks which are not in permanent direct communication with the shore shall have emergency outfit as indicated under items 5, 6, 19 to 26, 32 to 34 and 37 of Table 9.2.1, length of the floating dock *L* being taken in this case instead of the ship's length *L*.

The floating docks which are in permanent direct communication with the shore need not be provided with emergency outfit.

9.2.11 For berth-connected ships, the emergency outfit is to be chosen by the owner.

9.2.12 Ships having a distinguishing mark **П1**, **П1В**, **П2**, **П2В** and **П3В** in the class notation are to have two searchlights capable of providing an efficient horizontal and vertical range of illumination of a surface not less than 10 m in diameter at a distance up to 250 m at the minimum illumination intensity up to 50 lx at dark time and clear atmosphere.

Table 9.2.1

Nos	Item, unit	Size	Quantity for ships of length L, in m				Quantity for tankers
			150 and over	from 150 to 70 incl.	from 70 to 24 incl.	below 24	
1	Armoured collision mat, pc	4,5 × 4,5 m	1	—	—	—	—
2	Lightened collision mat, pc	3,0 × 3,0 m	—	1	—	—	1
3	Thrummed collision mat, pc	2,0 × 2,0 m	—	—	1	—	—
4	Thrummed pad, pc	0,4 × 0,5 m	4	3	2	1	2
5	Set of rigging tools	as per Table 9.2.3	1	1	1	1	1
6	Set of fitter's tools	as per Table 9.2.3	1	1	1	1	1
7	Pine bar, pc	150 × 150 × 4000 mm	8	6	—	—	—
8	Pine bar, pc	80 × 100 × 2000 mm	2	2	4	—	4
9	Pine plank, pc	50 × 200 × 4000 mm	8	6	2	—	—
10	Pine plank, pc	50 × 200 × 2000 mm	4	2	2	—	2
11	Pine wedge, pc	30 × 200 × 200 mm	10	6	4	—	4
12	Birch wedge, pc	60 × 200 × 400 mm	8	6	4	—	4
13	Pine plugs for ships with side scuttles, pc	side scuttle diameter	6	4	2	2	4
14	Pine plugs, pc	10 × 30 × 150 mm	10	6	4	2	4
15	Unbleached canvas, m^2	—	10	6	4	2	—
16	Coarse felt, m^2	10 mm in thickness	3	2	1	—	—
17	Rubber plate, m^2	5 mm in thickness	2	1	0,5	—	0,5
18	Tarred tow, kg	—	50	30	20	10	5
19	Wire (low-carbon steel), pc	3 mm in dia, coils, 50 m each	2	2	1	—	1
20	Construction shackles, pc	12 mm in dia	12	8	4	—	4
21	Hexagon-head bolt, pc	M16 × 400 mm	10	6	2	—	—
22	Hexagon-head bolt, pc	M16 × 260 mm	4	2	2	2	—
23	Hexagonal nut, pc	M16	16	10	6	4	—
24	Washer for bolt, pc	M16	32	20	12	8	—
25	Construction nails, kg	70 mm long	4	3	2	1	1
26	Construction nails, kg	150 mm long	6	4	2	1	1
27	Cement (quick setting), kg	—	400	300	100	100	100
28	Sand, natural, kg	—	400	300	100	100	100
29	Accelerator for concrete setting, kg	—	20	15	5	5	5
30	Minium, kg	—	15	10	5	5	5
31	Technical fat, kg	—	15	10	5	—	5
32	Carpenter's axe, pc	—	2	2	1	1	1
33	Saw, cross-cut, pc	1200 mm in length	1	1	1	—	—
34	Hack-saw, pc	600 mm in length	1	1	1	1	1
35	Shovel, pc	—	3	2	1	1	1
36	Bucket, pc	—	3	2	1	1	1
37	Sledge hammer, pc	5 kg	1	1	1	—	—
38	Lantern of explosion-proof type, pc	—	1	1	1	1	1
39	Stop of telescopic type, pc	—	3	2	1	1	1
40	Emergency screw clamp, pc	—	2	1	1	—	—[1]

[1] Whatever the ship length, ice class and navigation area are.

Table 9.2.2-1

Nos	Item	Quantity
1	Portable autogenous cutting torch complete with set of fully charged gas cylinders	1
2	Hand jack, hydraulic	1
3	Blacksmith's sledge hammer	1
4	Forge chisel with haft	1
5	Crowbar	2
6	Jack 9,8 kN	1
7	Jack 19,6 kN	1

Table 9.2.2-2

Nos	Item	Quantity
1	Glass fabric	25 m^2
2	Glass roving	3 kg
3	Resin binder with hardener	5 kg

9.3 STORAGE OF EMERGENCY OUTFIT

9.3.1 The emergency outfit indicated in 9.2 shall be stored at least in two emergency stations, one of which shall be situated in the machinery space. Emergency stations may be special spaces, boxes or places allocated on the deck or in spaces.

In the emergency station of the machinery space the outfit necessary for carrying out the emergency operations inside the space shall be stored; the rest of the emergency outfit shall generally be stored in the emergency stations located above the bulkhead deck; in ships of less than 45 m in length it is allowed to locate the emergency station below the bulkhead deck on condition that free access to this station is provided at all times.

Table 9.2.3

Nos	Item	Size	Quantity per set	
			rigging	fitter's
1	Tape measure	2000 mm long	1	—
2	Bench hammer	0,5 kg	1	1
3	Sledge hammer	3,0 kg	—	1
4	Rigger's mallet	—	1	—
5	Puncher (dumb iron)	—	1	—
6	Chisel	20 mm wide, 200 mm long	1	1
7	Marline spike	300 mm long	1	—
8	Carpenter's chisel	20 mm wide	1	—
9	Screw auger	18 mm in dia	1	—
10	Tongs	200 mm long	1	—
11	Hollow punch	18 mm in dia	—	1
12	Hollow punch	25 mm in dia	—	1
13	Triangular file	300 mm long	—	1
14	Half-round file	300 mm long	—	1
15	Multi-purpose tongs	200 mm long	—	1
16	Screw driver	10 mm wide	—	1
17	Adjustable wrench	Jaw width up to 36 mm	—	1
18	Wrench	Jaw width of 24 mm	—	1
19	Rigger's knife	—	1	—
20	Hack-saw frame	—	—	1
21	Hack-saw blade	—	—	6
22	Kit-bag	—	1	1

In ships of 31 m in length and below it is allowed to store the emergency outfit only in one emergency station.

9.3.2 A free passage shall be provided in front of the emergency station; the passage width shall be selected depending on the overall dimensions of the outfit stored in the station but not less than 1,2 m. In ships of less than 70 m in length the passage width is allowed to be reduced to 0,8 m and in ships of 31 m in length and below to 0,6 m.

The passages to the emergency stations shall be as straight and short as practicable.

9.4 MARKING

9.4.1 Items of the emergency outfit and cases for their storage (apart from collision mats) are to be painted blue either entirely or in a stripe. The cases for emergency equipment storage shall have the distinct inscription to indicate the name of the material, weight and warranted storage period.

9.4.2 The emergency stations are to be provided with distinct inscriptions "Emergency Station". Moreover, in the passages and on the decks notices shall be posted showing location of the emergency stations.

9.5 COLLISION MATS

9.5.1 Collision mats are to be made of water-resistant canvas or other equivalent fabric and be provided with either a soft or wire interlayer depending on the type of the collision mat. The collision mats are to be edged by a leech rope with four thimbles fitted into its corners. Moreover, cringles are to be provided according to the number of ropes specified in Table 9.5.1.

Basic data on the collision mats are given in Table 9.5.1 and Fig. 9.5.1.

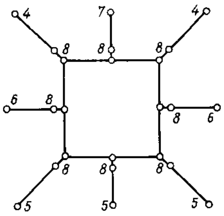

Fig. 9.5.1

9.5.2 The pads are to be made of natural fibre rope strands and be thrummed with natural fibre spun yarn. A canvas shall be sewn on the bottom side of the pad.

9.5.3 Sheets and guys of armoured collision mats shall be made of flexible steel wire ropes, control lanyards — of natural fibre ropes and hogging lines for all collision mats — of flexible steel wire ropes or chains having suitable diameter.

Wires of steel ropes shall have heavy zinc coating in accordance with the national standards.

The length of the sheets is to be chosen so that a hole may be shut up in any place of the shell plating and the ends of the ropes may be efficiently secured on the deck.

The actual breaking load of the whole sheets is to exceed that of the leech ropes by not less than 25 per cent.

9.5.4 The blocks of emergency outfit may have hooks as hangers. The permissible load of the shackles joining the ropes is not to be less than 0,25 times the actual breaking load of the whole ropes referred to above.

Table 9.5.1

Nos	Item	Quantity		
		Armoured collision mat, 4,5 × 4,5 m	Lightened collision mat, 3,0 × 3,0 m	Thrummed collision mat, 2,0 × 2,0 m
1	Canvas layers	4	2	2
2	Interlayer	1 wire net with leech rope	1 felt padding	1 pad
3	Fastening of stiffeners	—	In pockets (pieces of wire rope or pipes)	—
4	Sheets	2	2	2
5	Hogging lines	3	2	2
6	Guys	2	2	—
7	Control lanyard with marking	1	1	1
8	Shackles	12	9	6
9	Tackles (safe working load)	4 (14,7 kN)	2 (9,8 kN)	2 (9,8 kN)
10	Snatch blocks (safe working load)	4 (14,7 kN)	2 (9,8 kN)	2 (9,8 kN)

10 ANCHORS см.Б1

10.1 MANUFACTURE

10.1.1 Anchors may be of forged, cast or welded construction.

10.1.2 Anchor parts are to be free from cracks, cavities and other defects affecting the strength of the parts. The external defects may be repaired by electric welding. Welding procedure is to be agreed with the Register.

10.1.3 The pins of the heads shaft and the pin of the anchor shackle are to be efficiently locked against axial displacement. The locking may be effected by electric welding.

10.1.4 The necessity of heat treatment of the anchors after their manufacture as well as heat treatment conditions are defined by the manufacturer. Heat treatment, if the anchors are subjected to it, is to be performed before testing.

10.2 TESTING

10.2.1 All cast or welded anchors or their parts are to be tested by dropping on a steel plate not less than 100 mm in thickness. The height of dropping is given in Table 10.2.1.

The flukes of Hall's, Gruson's, high holding power and super high holding power anchors are to be dropped onto the plate with the crown downwards; the shanks of Hall's, Gruson's, high holding power and super high holding power anchors and also the shanks with the flukes of admiralty stocked anchor are to be dropped in the horizontal position.

Table 10.2.1

Anchor mass m, in kg	Height of dropping (measured from plate up to lower edge of anchor or its part), in m
$m<750$	4,5
$750 \leqslant m<1500$	4,0
$1500 \leqslant m<5000$	3,5
$m \geqslant 5000$	3,0

10.2.2 Moreover, each cast or welded shank with flukes of the admiralty stocked anchor is to be suspended in a vertical position, the flukes downwards, and dropped on two steel blocks put on the plate in such a manner that the distance between them is half the span of the flukes (Fig. 10.2.2). The thickness of the blocks is to be such as to prevent the anchor crown from striking against the plate.

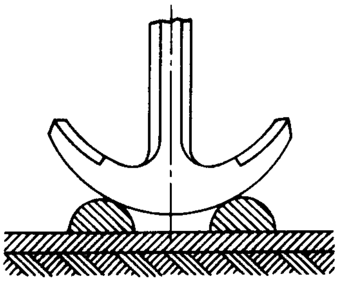

Fig. 10.2.2

10.2.3 After the drop test the anchors or their parts are to be suspended and subjected to a hammer test with a hammer having mass of not less than 3 kg. They shall give out a clear ringing sound.

If the sound is not clear, the crack detection of the part shall be carried out by the non-destructive method, the defects shall be eliminated, if necessary, and the test shall be repeated.

10.2.4 Anchor shackles shall be tested together with the anchors. When tested by proof load, no fractures or permanent deformation shall be detected.

10.2.5 Each anchor, irrespective of the method of its manufacture, shall be subjected to tensile test by application of a proof load either on a chain testing machine or by a load suspended to the flukes.

10.2.6 Hall's, Gruson's, high holding power and super high holding power anchors are to be tested by simultaneous gripping of both flukes (Fig. 10.2.6), first turned to one side and then to the other.

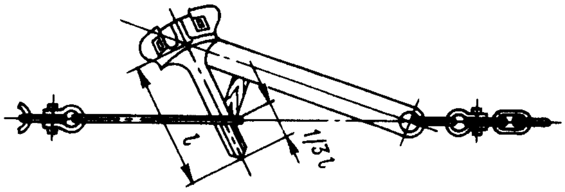

Fig. 10.2.6

10.2.7 The admiralty stocked anchors are to be tested by applying the load to each fluke in succession (Fig. 10.2.7). The test may be carried out both with or without the stock.

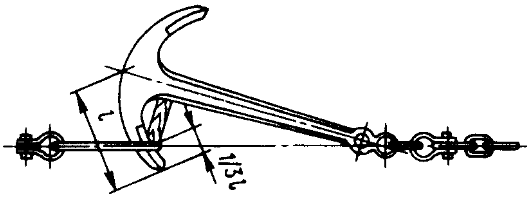

Fig. 10.2.7

10.2.8 In all cases, the proof load is to be applied to the regular shackle on one side and to flukes (Hall's, Gruson's, high holding power and super high holding power anchors) on the other side or fluke (admiralty stocked anchors) at a distance of one-third of the fluke length *l*, apart from the bill (see Figs 10.2.6 and 10.2.7).

10.2.9 The value of the proof load F_1 which the anchor shall withstand is not to be less than that specified in Table 10.2.9.

10.2.10 Prior to the proof testing, a punch mark is to be made on the anchor shank and also on each bill of flukes. Then Hall's, Gruson's, high holding power and super high holding power anchors are subjected to a preliminary 5-minute tension by a load equal to $0,5F_1$.

The load is then reduced down to $0,1F_1$ and the distances between the punch marks are measured. After this the load is increased to the proof test value and maintained during 5 min. Then the load is reduced to $0,1F_1$ and the distances between the punch marks are measured again.

The admiralty stocked anchors are not subjected to the preliminary tension. The distance between the punch marks is measured before and after the application of the proof load which is to be applied during 5 min. No residual deformation is allowed.

10.2.11 After Hall's, Gruson's, high holding power and super high holding power anchors has been subjected to the proof load, the free rotation of their flukes through the complete angle is to be controlled. In case the rotation of the flukes is impeded or they rotate through an incomplete angle, the defects shall be found and eliminated and the test repeated. The results of the repeated test are considered final.

10.2.12 On completion of the proof load tests all anchors are to be visually inspected to ascertain that they have no defects and are to be weighed. On agreement with the Register it is permitted to weigh only 5 per cent of the total number of the anchors of one series, but not less than two anchors manufactured according to one and the same model.

Table 10.2.9

Anchor mass, in kg	Proof load, in kN	Anchor mass, in kg	Proof load, in kN	Anchor mass, in kg	Proof load, in kN	Anchor mass, in kg	Proof load, in kN
50	23	1250	239	5000	661	12500	1130
55	25	1300	247	5100	669	13000	1160
60	27	1350	255	5200	677	13500	1180
65	29	1400	262	5300	685	14000	1210
70	31	1450	270	5400	691	14500	1230
75	32	1500	278	5500	699	15000	1260
80	34	1600	292	5600	706	15500	1270
90	36	1700	307	5700	713	16000	1300
100	39	1800	321	5800	721	16500	1330
120	44	1900	335	5900	728	17000	1360
140	49	2000	349	6000	735	17500	1390
160	53	2100	362	6100	740	18000	1410
180	57	2200	376	6200	747	18500	1440
200	61	2300	388	6300	754	19000	1470
225	66	2400	401	6400	760	19500	1490
250	70	2500	414	6500	767	20000	1520
275	75	2600	427	6600	773	21000	1570
300	80	2700	438	6700	779	22000	1620
325	84	2800	450	6800	786	23000	1670
350	89	2900	462	6900	794	24000	1720
375	93	3000	474	7000	804	25000	1770
400	98	3100	484	7200	818	26000	1800
425	103	3200	495	7400	832	27000	1850
450	107	3300	506	7600	845	28000	1900
475	112	3400	517	7800	861	29000	1940
500	116	3500	528	8000	877	30000	1990
550	125	3600	537	8200	892	31000	2030
600	132	3700	547	8400	908	32000	2070
650	140	3800	557	8600	922	34000	2160
700	149	3900	567	8800	936	36000	2250
750	158	4000	577	9000	949	38000	2330
800	166	4100	586	9200	961	40000	2410
850	175	4200	595	9400	975	42000	2490
900	182	4300	604	9600	987	44000	2570
950	191	4400	613	9800	998	46000	2650
1000	199	4500	622	10000	1010		
1050	208	4600	631	10500	1040		
1100	216	4700	638	11000	1070		
1150	224	4800	645	11500	1090		
1200	231	4900	653	12000	1110		

Notes: 1. Proof load for intermediate values of the anchor mass is determined by linear interpolation.
2. For high holding power anchors the proof load is taken depending on the anchor mass increased by 35 per cent.
3. For super high holding power anchors the proof load is taken equal to double mass of the anchor.

см.Б1

APPENDIX

CALCULATION OF THE WIDTH OF STAIRWAYS FORMING MEANS OF ESCAPE ON PASSENGER SHIPS AND ON SPECIAL PURPOSE SHIPS CARRYING MORE THAN 50 SPECIAL PERSONNEL

1. The calculation method considers evacuation from enclosed spaces within each main vertical zone individually and takes into account all of the persons using the stairway enclosures in each zone, even if they enter that stairway from another main vertical zone.

2. For each main vertical zone the calculation should be completed for the night time (case 1) and day time (case 2) and the largest dimension from either case used for determining the stairway width for each deck under consideration.

3. For multi-deck ships, the total stairway width W, in mm, which allows for the timely flow of persons evacuating from adjacent decks is determined using the following calculation method:

when joining two decks

$$W = (N_1 + N_2)\cdot 10; \quad (3\text{-}1)$$

when joining three decks

$$W = (N_1 + N_2 + 0{,}5N_3)\cdot 10; \quad (3\text{-}2)$$

when joining four decks

$$W = (N_1 + N_2 + 0{,}5N_3 + 0{,}25N_4)\cdot 10 \quad (3\text{-}3)$$

where N_1 = the number of persons to be evacuated from deck with the largest number of persons using the stairway;

N_2 = the number of persons to be evacuated from the deck with the next largest number of persons directly entering the stairway etc., i.e. $N_1 > N_2 > N_3 > N_4$.

When joining five or more decks, the total stairway width shall be determined from the Formula (3-3) with regard for the number of tiers and their capacity (see Fig. 3.1).

The calculated value of W may be reduced where available landing area is provided in stairways at the deck level (Fig. 3.2).

The doors to the muster station shall have an aggregate width of at least D = 900 + 9355 = 10255.

4. The stairway shall not decrease in width in the direction of evacuation to the muster station, except in the case of several muster stations in one main vertical zone the stairway width shall not decrease in the direction of the evacuation to the most distant muster station.

5. Where the passengers and crew are held at a muster station which is not at the survival craft embarkation position the dimensions of stairway width and doors from the muster station to this position shall be based on the number of persons in the controlled groups. The width of these stairways and doors need not exceed 1500 mm unless larger dimensions are required for evacuation from these spaces under normal conditions.

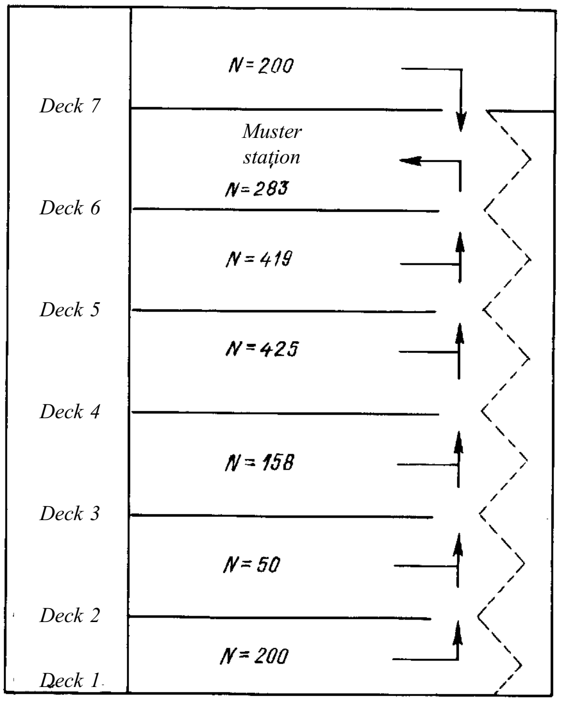

Fig. 3.1 Minimum stairway width calculation example:

Deck 1: N_1 = 200,
W = 200·10 = 2000;
Deck 2: N_1 = 200, N_2 = 50,
W = (200 + 50)·10 = 2500;
Deck 3: N_1 = 200, N_2 = 158, N_3 = 50,
W = (200 + 158 + 0,5·50)·10 = 3830;
Deck 4: N_1 = 425, N_2 = 200, N_3 = 158, N_4 = 50,
W = (425 + 200 + 0,5·158 + 0,25·50)·10 = 7165;
Deck 5: N_1 = 425, N_2 = 419, N_3 = 158, N_4 = 50,
W = (425 + 419 + 0,5·158 + 0,25·50)·10 = 9355;
Deck 7: N_1 = 200,
W = 900.

6. The calculations of stairway width shall be based upon the crew and passenger load on each deck. For the purpose of the calculation the maximum capacity of a public space shall be defined by either of the following two values: the number of seats or similar arrangements, or the number obtained by assigning 2 m^2 of gross deck surface area to each person.

7. The dimensions of the means of escape shall be calculated on the basis of the total number of persons expected to escape by the stairway and through doorways, corridors and landing (Fig. 7.1).

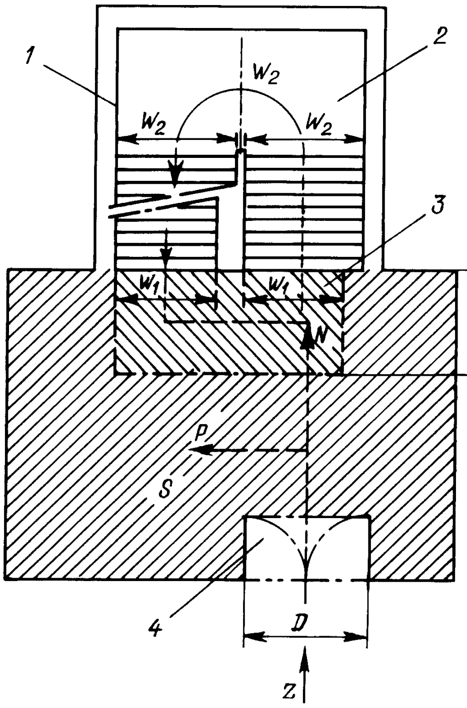

Fig. 3.2 Landing calculation for stairway width reduction:

1 — handrail on both sides of the stairway;
2 — intermediate landing;
3 — necessary flow area for accessing the flow on the stairs;
4 — door area

$P = S \times 3$ persons/m^2 = the number of persons taking refuge on the landing to a maximum of $P = 0{,}25Z$;

$N = Z - P$ = the number of persons directly entering the stairway flow from a given deck;

Z = the number of persons to be evacuated from the deck considered;

S = available landing area, in m^2, after subtracting the surface area necessary for movement and subtracting the space taken by the door swing area;

D = width of exit doors to the stairway landing area, in mm.

Calculations shall be made separately for the two cases of occupancy of the spaces specified below. For each component part of the escape route, the dimension taken shall not be less than the largest dimension determined for each case:

Case 1:

passengers in cabins with maximum berthing capacity fully occupied;

members of the crew in cabins occupied to 2/3 of maximum berthing capacity;

service spaces occupied by 1/3 of the crew;

Case 2:

passengers in public spaces occupied to 3/4 of maximum capacity;

members of the crew in public spaces occupied to 1/3 of maximum capacity;

service spaces occupied by 1/3 of the crew;

crew accommodation occupied by 1/3 of the crew.

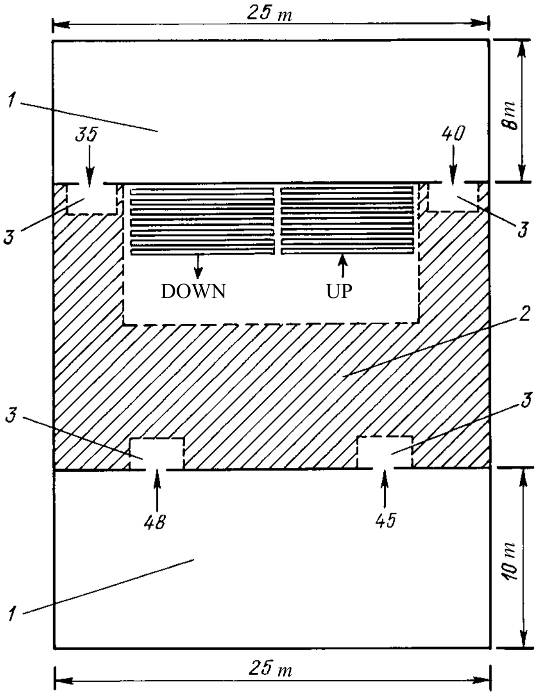

Fig. 7.1 Occupant loading calculation example:

1 — public space;
2 — landing credit area;
3 — door area;
DOWN, UP = stairway flow path

for upper space:

$$Z_{(\text{pers.})} = \frac{25\ \text{m} \cdot 8\ \text{m}}{2\ \text{m}^2} = 100;\ N_{(\text{pers.})} = 100 \cdot 0{,}75 = 75;$$

for lower space:

$$Z_{(\text{pers.})} = \frac{25\ \text{m} \cdot 10\ \text{m}}{2\ \text{m}^2} = 125;\ N_{(\text{pers.})} = 125 \cdot 0{,}75 = 93.$$

8. The maximum number of persons contained in a vertical zone including persons entering stairways from another main vertical zone shall not be assumed to be higher than the maximum number of persons authorized to be carried on board for the calculation of the stairway width only.

ADDITIONAL REQUIREMENTS

1. The aggregate width of stairway exit doors to the muster station shall not be less than the aggregate width of stairways serving this deck.

2. Means of escape plans shall be provided indicating the following:

.1 the number of crew and passengers in all normally occupied spaces;

.2 the number of crew and passengers expected to escape by the stairway and through doorways, corridors and landing;

.3 muster stations and survival craft embarkation positions;

.4 primary and secondary means of escape;

.5 width of stairways, doors, corridors and landing areas.

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3. Means of escape plans shall be accompanied by detailed calculations for determining the width of escape stairways, doors, corridors and landing areas

PART IV. STABILITY

1 GENERAL

1.1 APPLICATION

1.1.1 The present Part of the Rules applies to decked ships[1] sailing in displacement condition. As to hydrogliders and sailing ships navigating under sails the requirements of this Part apply to them as far as it is reasonable and practicable.

1.1.2 Unless expressly provided otherwise, the present Part of the Rules applies to ships in service as far as it is reasonable and practicable, but it is, however, compulsory for ships which undergo reconstruction, major repair, alteration or modification if their stability is impaired as a result.

Stability of ships under 24 m in length after reconstruction, major repair, alteration or modification is to comply either with the requirements of this Part or with the requirements applied to such ships before reconstruction, major repair, alteration or modification.

1.1.3 The requirements set forth in this Part of the Rules do not extend to the light-ship condition, except for the provisions given in 2.3.1.

1.2 DEFINITIONS AND EXPLANATIONS

Definitions and explanations concerning the general terminology of the Rules are given in Part I "Classification".

For the purpose of the present Part of the Rules the following definitions have been adopted.

Moulded depth is the vertical distance measured amidships from the top of plate keel or from the point where the inner surface of shell plating abuts upon the bar keel to the top of the beam of the uppermost continuous deck, i.e. of the deck below which the volume of the ship's hull is taken into account in stability calculations. In ships having a rounded gunwale, the moulded depth is measured to the point of intersection of moulded lines of the uppermost continuous deck and side, the lines extending so as if the gunwale were of angular design. If the uppermost continuous deck is stepped and the raised part of the deck extends over the point at which the moulded depth is to be determined, the moulded depth shall be measured to a line of reference extending from the lower part of the deck along a line parallel with the raised part.

A hopper barge is a ship intended for the transportation of spoil.

Length of ship is to be taken as 96 per cent of the total length on the summer load waterline or as the length from the fore side of the stem to the axis of the rudder stock on that waterline, if that be greater.

A vessel of dredging fleet is a vessel intended for extraction or transportation of spoil.

Liquid cargoes are all liquids on board, including tanker cargo, the ship's liquid stores, ballast water, water in the antirolling tanks and in the swimming pool, etc.

Stores are fuel, fresh water, provision, oil, expendable supplies, etc.

A dredger is a ship extracting spoil by any appliances and having no hoppers for its transportation.

Grain means wheat, maize (corn), oats, rye, barley, rice, pulses, seeds and processed forms thereof whose behaviour is similar to that of grain in its natural state.

Well is an open space on the upper deck not longer than 30 per cent of the length of the ship, bounded by superstructures and a continuous bulwark provided with freeing ports.

Weather criterion is a ratio of the capsizing moment to the heeling moment due to wind pressure.

A timber carrier is a ship designed to carry deck timber cargo.

Bulk cargo is grain and non-grain cargo constituted by separate particles and loaded without packaging.

Superstructure is a decked structure on the uppermost continuous deck, extending from side to side of the ship or with the side plating not being inboard of the shell plating more than 4 per cent of the greatest breadth of the ship. A raised quarter deck is regarded as a superstructure.

Homogeneous cargo is cargo having constant stowage rate.

Openings considered to be open are openings in the upper deck or hull sides, as well as in decks, sides and bulkheads of superstructures and deckhouses whose closures do not comply with the requirements of Section 7, Part III "Equipment, Arrangements and Outfit" as to their strength, weathertightness and efficiency. Small openings, such as discharges of ship's systems and pipes which actually have no effect on stability in dynamical heeling of a ship are not considered to be open.

Passage is navigation of a ship outside the prescribed area of navigation.

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[1] In Section 1 of the present Part of the Rules the term "ship" also includes a floating crane, crane ship dock, transport pontoon and berth-connected ship, unless expressly provided otherwise.

Voyage is navigation of a ship belonging to the technical fleet within the prescribed area of navigation.

Windage area is the projected lateral area of the above-water portion of the ship (except for a floating crane or crane ship) on the centre line plane with the ship in the upright position.

Deckhouse is a decked structure on the upper deck or superstructure deck with its side plating, on one side at least, being inboard of the shell plating by more than 4 per cent of the greatest breadth of the ship measured amidships to the outside of frames and having doors, windows and other similar openings in external bulkheads.

Light ship is a fully ready ship less deadweight. Water ballast is included in the deadweight.

A pontoon is a non-self-propelled vessel unmanned and designed to carry only deck cargo and having no hatchways in the deck, except small manholes closed with gasketed covers.

A hopper dredger is a ship extracting spoil by any appliances and having a hopper for its transportation.

Angle of flooding is the angle of heel at which the ship's interior spaces are flooded by water through openings considered to be open or openings which may be opened as required by operation conditions of the ship in working position.

Breadth of ship is the maximum breadth measured on the summer load line from outside of frame to outside of frame in a ship with metal shell and to the outer surface of the hull in a ship with the shell of any other material.

For the purpose of the present Part of the Rules the following explanations have been adopted.

Amplitude of roll is an assumed rated amplitude of roll.

Hydrostatic curves are curves of the ship's lines plan particulars.

Wind pressure is an assumed rated pressure of wind.

Diagram of limiting moments is a diagram of limiting statical moments, on the abscissa of which ship's displacement, deadweight or draught is plotted and on the ordinate, limiting values of the vertical statical moments of masses meeting the complex of various requirements of this Part of the Rules for ship's stability.

Inclining Test Instructions are instructions for determination of the ship's displacement and position of the centre of gravity from the inclining test.

Instructions for Free Surfaces are instructions for taking into account the effect of free surfaces of liquid cargoes on ship's stability.

Information is Information for the master (stability booklet).

Heeling moment due to wind pressure is an assumed rated moment caused by wind pressure.

Amidships is at the middle of the ship's length.

Capsizing moment is an assumed rated minimum heeling moment by which the ship is capsized.

Correction for free surfaces is a correction allowing for a decrease in the ship's stability due to the effect of free surfaces of liquid cargoes.

Sister ships are ships built at the same yard according to the same drawings

A special facility is a system permanently installed in the ship for rapid estimation of her initial stability (e.g. heeling tanks with angle-of-inclination indicators) and approved by the Register for measurement of angles of inclination during the inclining test.

Universal diagram is a diagram of ship's stability with a non-uniform scale of abscissae proportional to the heeling angle sines, a set of curves for arms of the form stability for various displacements and a scale of metacentric heights (or of heights of the ship's centre of gravity) along the axis of ordinates for constructing straight half-lines determining the weight stability.

Various symbols used in this Part of the Rules are given in the Table (see pp. 334 — 335).

1.3 SCOPE OF SURVEY

1.3.1 General provisions pertaining to the procedure of classification and surveys, as well as the requirements for the technical documentation submitted to the Register for consideration and approval are contained in General Regulations for the Classification and Other Activity and in Part I "Classification".

1.3.2 For every ship subject to the requirements of this Part of the Rules, the Register shall carry out the following:

.1 prior to the commencement of ship's construction and conversion:

consideration and approval of technical documentation relating to ship's stability;

.2 during ship's construction, conversion and trials:

supervision of the inclining test and light-weight check;

consideration and approval of the Information on Stability;

consideration and approval of Guidelines on the Safe Ballast Water Exchange at Sea;

.3 during special surveys for the purpose of class renewal and after repair or modernization:

inspections to check for changes in the light-ship condition in order to conclude whether the Information on Stability is still applicable;

for passenger ships and fishing vessels, determination of light-ship weight experimentally and supervision of the inclining test and light-weight check.

1.4 GENERAL TECHNICAL REQUIREMENTS

1.4.1 All calculations shall be made by the methods generally accepted in naval architecture. When using a computer, the methods of computation and programme shall be approved by the Register.

1.4.2 Calculation of form stability.

1.4.2.1 Arms of form stability shall be calculated for the waterline parallel to the design waterline.

For ships operating with permanent considerable initial trim, arms of form stability shall be calculated with due regard for this trim upon agreement with the Register.

Arms of form stability shall be calculated with due regard to the accompanying trim.

1.4.2.2 When calculating the arms of form stability, full account may be taken of those tiers of superstructure which:

.1 meet the requirements of 7.5, Part III "Equipment, Arrangements and Outfit" for the first tier of superstructure (counting from the freeboard deck); side scuttles as concerns the efficiency of their closures shall be in compliance with 7.2.1.3 to 7.2.1.5 of the said Part;

.2 have an access for the crew from the above deck to the working spaces inside these superstructures, as well as to the machinery space by other means during the whole period when the openings in the superstructure bulkheads are closed.

If a midship bridge or poop complies with the requirements of 7.5, Part III "Equipment, Arrangements and Outfit", but the doors in their bulkheads provide the only exits to the deck, and the upper edge of the sills of the superstructure doors in a fully loaded ship immerses at a heeling angle less than 60°, the effective height of superstructures shall be assumed to be half their actual height and the superstructure doors assumed to be closed. If the upper edge of the door sills of a fully loaded ship immerses at a heeling angle equal to or over 60°, its effective height above the freeboard deck is taken to be its actual height.

1.4.2.3 When calculating the arms of form stability, account may also be taken of those tiers of deckhouse which:

.1 meet the requirements of 7.5, Part III "Equipment, Arrangements and Outfit" for the first tier of deckhouse (counting from the freeboard deck); side scuttles as concerns the efficiency of their closures shall be in compliance with 7.2.1.3 to 7.2.1.5 of the said Part;

.2 have an additional exit to the deck above.

With the aforesaid conditions satisfied, account is taken of full height of the deckhouses. If they meet the requirements of 7.5, Part III "Equipment, Arrangements and Outfit", but there is no additional exit to the deck above, such deckhouses shall not be taken into account in calculations of the arms of form stability, however, any deck openings inside such deckhouses are assumed as closed, irrespective of whether they are fitted with closures or not.

The deckhouses whose closures do not comply with the requirements set forth in 7.5, Part III "Equipment, Arrangements and Outfit" shall not be considered in calculations of the arms of form stability. Any deck openings inside them are regarded as closed only if their coamings and means of closing comply with the requirements of 7.3, 7.7 to 7.10, Part III "Equipment, Arrangements and Outfit".

1.4.2.4 In ships with hatch covers meeting the requirements of Section 7, Part III "Equipment, Arrangements and Outfit", the volumes of hatches located on the freeboard deck may be taken into account.

1.4.2.5 The interpolation curves of the arms of form stability shall have a small-scaled scheme of superstructures and deckhouses taken into account, specifying the openings considered to be open and portions of the upper deck where the deck planking is taken into consideration.

The point shall be indicated in relation to which the arms of form stability are calculated.

1.4.3 Arrangement of compartments.

A drawing of watertight compartments shall contain data necessary to calculate the positions of the centres of gravity for individual tanks filled with liquid cargoes and values of corrections for the effect of free surfaces of liquid cargoes on stability.

1.4.4 Deck plan.

1.4.4.1 Deck plans shall include all data necessary to determine the centres of gravity of deck cargoes.

1.4.4.2 The deck plans for passenger ships shall indicate the deck area on which passengers can walk freely and maximum permissible crowding of passengers on free areas of the deck, with passengers moving to one side of the ship (see 3.1.2).

1.4.5 Arrangement of doors, companionways and side scuttles. Angle of flooding.

1.4.5.1 The arrangement plan of doors and companionways shall include all doors and companionways to exposed decks, as well as ports and hatches in the shell plating with appropriate references to their design.

1.4.5.2 The arrangement plan of side scuttles shall incorporate all side scuttles located below the uppermost continuous deck, as well as the side scuttles in the superstructures and deckhouses taken into account when calculating the arms of form stability.

1.4.5.3 A curve of angles of flooding for the lowest opening in the ship's side, deck or superstructure, assumed to be open, shall be appended to the calculations of arms of form stability for each ship.

Openings for ventilation of machinery spaces, openings for ventilation of passenger spaces and other openings, which shall be open to allow air inside the ship when navigating in rough weather, shall be assumed open even if fitted with weathertight covers.

1.4.6 Calculation of windage area of a ship (except for a floating crane or crane ship).

1.4.6.1 The windage area shall include the projections of all continuous surfaces of the ship's hull, superstructures and deckhouses on the centre line plane, as well as projections of masts, ventilators, boats, deck machinery, all tents that might be stretched in stormy weather as also the projections of side surfaces of deck cargoes, including timber cargo, if the ship design makes the carriage of it possible.

For ships having auxiliary sails, the projected lateral areas of rolled up sails shall be taken into account separately according to the ship's profile plan and included in the total projected lateral area of the continuous surfaces.

It is recommended that projected lateral areas of discontinued surfaces of rails, spars (except for masts) and rigging of ships having no sails and those of various small objects be taken into account by increasing the total projected lateral area of continuous surfaces calculated for draught d_{min} by 5 per cent and the statical moment of this area by 10 per cent with respect to the base plane.

The projected lateral areas of discontinued surfaces of ships subjected to icing is taken into account by increasing the projected lateral area and its statical moment of continuous surfaces calculated for draught d_{min} under icing conditions by 10 and 20 per cent or 7,5 and 15 per cent, respectively, depending upon the rates of icing stated in 2.4. In this case, the value of the projected lateral area of discontinued surfaces and the position of its centre of gravity with respect to the base plane are assumed to be constant for all loading conditions.

For container ships the projected lateral area shall be taken into account as a continuous surface having no regard to the clearances between containers.

1.4.6.2 The application of the said approximate methods for taking into account the projected lateral areas of discontinued surfaces and small objects is not obligatory. These components of windage area can be determined in a more precise way, if deemed necessary by the designer.

For this purpose when calculating the projected lateral area of discontinued surfaces, such as spars and rigging of ships having no sails, rails, crane trusses of lattice type, etc., the overall areas taken into consideration, shall be multiplied by filling factors whose values are taken as follows:

	No icing	Icing
For rails covered with meshed wire	0,6	1,2
For rails without meshed wire	0,2	0,8
For crane trusses of lattice type	0,5	1,0

For spars, tackle and shrouds of ships with no sails, values of the filling factors shall be adopted in compliance with Table 1.4.6.2 depending upon the ratio z_0/b_0 where z_0 is the height of the point of shrouds fastening to the mast over the bulwark; b_0 is the distance between the shrouds at bulwark.

The projections of the hull above the waterline, deckhouses and superstructures shall be taken into account with a flow coefficient 1,0. The projections of circular section structures located separately on the deck (funnels, ventilators, masts) shall be assumed to have a flow coefficient of 0,6. When calculating in detail, the projected lateral areas of small objects, discontinued surfaces, spars, rigging, rails, shrouds, tackle, etc., a flow coefficient shall be taken equal to 1,0. If the projections of individual components of the windage area overlap one another fully or in part, the areas of only one of the overlapping projections shall be included in the computation.

If the overlapping projections have different flow coefficients, those with higher coefficients shall be taken for the computation.

1.4.6.3 The arm of windage area z for determining the heeling moment due to wind pressure in accordance with 2.1.2.1 shall be defined as a distance, in metres, between the centre of the windage area and the actual waterline plane for an upright ship in smooth water. The position of the centre of windage area is determined by a method generally applied for determining the coordinates of the centre of gravity for a plane figure.

1.4.6.4 The widnage area and its statical moment shall be calculated for the ship's draught d_{min}. These components for other draughts are determined by calculation. The use of linear interpolation is permissible if the second point is assumed at the draught corresponding to the summer load line.

1.4.7 Computation of the liquid cargo effect.

1.4.7.1 Tanks for each kind of liquid, including those for water ballast, which depending on the service conditions may simultaneously have free surfaces as well as tanks of stabilizer systems irrespective of their

Table 1.4.6.2

Filling factors

z_0/b_0	3	4	5	6	7	8	9	10	11	12	13	14
Filling factors:												
no icing	0,14	0,18	0,23	0,27	0,31	0,35	0,4	0,44	0,48	0,52	0,57	0,61
icing	0,27	0,34	0,44	0,51	0,59	0,66	0,76	0,84	0,91	1,0	1,0	1,0

type are to be taken into account when determining the free surfaces effect of liquids on ship's stability at large angles of heeling. To allow for the free surface effect, one design combination of single tanks or their combinations for each kind of liquid cargo shall be drawn up. Considering the number of tank combinations for the individual kinds of liquid cargo or single tanks, likely to occur under service conditions, only those developing the greatest total heeling moment ΔM_{30} due to liquid overflow at the ship's heel of 30° and for a floating crane ΔM_{15} at the crane's heel of 15° shall be selected. In all cases, except for those expressly provided in 3.2.2 and 3.4.2 the correction for free surfaces shall be calculated for a tank filled by 50 per cent of its capacity.

It is permissible to choose the tanks to be taken into account in compliance with the Instructions on Loading and Consuming of Liquid Cargoes.

1.4.7.2 The tanks complying with the following condition are not included in the computation:

$$\bar{l}_{30} v_t b_t \gamma \sqrt{C_b} < 0{,}01\Delta_{\min} \qquad (1.4.7.2\text{-}1)$$

where $\bar{l}_{30}$ = non-dimensional factor determined from Table 1.4.7.2.

Table 1.4.7.2

Factor $\bar{l}_{30}$

b_t/a_t	$\bar{l}_{30}$	b_t/a_t	$\bar{l}_{30}$
20	0,111	1	0,049
10	0,113	0,5	0,024
5	0,114	0,2	0,010
2	0,094	0,1	0,005

For floating cranes the tanks meeting the following condition are not included in the computation:

$$\Delta M_{15} = 0{,}0216 v_t b_t \gamma \sqrt{C_b}\,\frac{b_t}{a_t} < 0{,}02\Delta_{\min}. \qquad (1.4.7.2\text{-}2)$$

Total correction ΔM_{15} for tanks not included in the calculation shall not exceed $0{,}05\Delta_{\min}$. Otherwise, appropriate corrections shall be taken into account in the computation.

1.4.7.3 Selection of tanks included in the design combination to allow for the free surface effect on initial stability shall be carried out in compliance with the directions of 1.4.7.1, with the difference that, proceeding from initial stability, the tanks shall be selected from the maximum value of Δm_h equal to the product of the intrinsic moment of inertia of free surface for a ship in the upright position by the density of the liquid cargo.

1.4.7.4 The tanks complying with the following condition are not included in the computation:

$$\Delta m_h = 0{,}0834 v_t b_t \gamma \sqrt{C_b}\,\frac{b_t}{a_t} < 0{,}01\Delta_{\min}. \qquad (1.4.7.4)$$

Usual residues of liquids in emptied tanks are not taken into account in the computation.

For floating cranes the tanks with Δm_h being less than $0{,}1\Delta_{\min}$ are not included in the computation. In this case, the total correction Δm_h for tanks not allowed for in the computation shall not exceed $0{,}25\Delta_{\min}$. Otherwise, appropriate corrections shall be taken into account in the computation.

1.4.7.5 In those cases when the coamings are mounted on the open space on the deck of the tankers for prevention of cargo spillage forming an enclosed space (well), such space is to be treated as if filled with the outboard water and it is to be considered in calculation of correction to the initial metacentric height in accordance with 1.4.7.4.

1.4.8 Loading conditions.

1.4.8.1 Stability shall be checked in all loading conditions specified in Sections 3 and 4 for various types of ships.

1.4.8.2 For the types of ships which are not covered by special provisions of Section 3, the loading conditions to be examined shall be as follows:

.1 ship in fully loaded condition with full stores;

.2 ship in fully loaded condition with 10 per cent of stores;

.3 ship without cargo, with full stores;

.4 ship without cargo, with 10 per cent of stores.

1.4.8.3 If the loading conditions anticipated in normal service of a ship as regards stability are less favourable than those listed in 1.4.8.2 or specified in Section 3, stability shall also be checked for these conditions.

1.4.8.4 If there is solid ballast on board, its mass shall be included in the light-ship condition.

1.4.8.5 In all cases of loading which might occur in the ship's service, except those specified in 1.4.8.2.1 and expressly provided in Section 3, the weight of ballast water may be included in the deadweight of the ship, where necessary.

1.4.9 Curves of stability.

1.4.9.1 Stability curves calculated with due allowance for the corrections of free surfaces shall be plotted for all loading conditions under consideration.

1.4.9.2 If there are openings considered to be open in the ship's sides, upper deck or superstructures through which water can penetrate inside the hull, the stability curves are considered effective up to the angle of flooding. At the inclinations of the ship exceeding the angle of flooding, the ship may be regarded to have entirely lost her stability and the curves of stability at this angle are cutting short.

1.4.9.3 If the spread of water coming to a superstructure through openings considered to be open is limited only by this superstructure or a part thereof, such superstructure or its part shall be considered as non-existent at the angles of heel exceeding the angle of flooding. In this case, the statical stability curve becomes stepped and that of dynamical stability broken.

1.4.10 Design data relating to stability checking and summary tables.

1.4.10.1 For ships under investigation, all design data relating to stability checking (calculations of loading, initial stability, curves of stability, windage area, amplitudes of roll, heeling due to crowding of passengers on one side, heeling when turning as also that due to icing, etc.) shall be submitted to the Register for consideration.

1.4.10.2 For all design loading conditions, summary tables presenting the results of calculations of displacement, position of the centre of gravity, initial stability and trim, as well as summary tables of results of stability checking for the compliance with the requirements of the present Part of the Rules shall be drawn up.

1.4.11 Requirements for Information on Stability.

1.4.11.1 To provide adequate stability of ships in service, the Information on Stability approved by the Register and containing the following data shall be issued for each ship:

.1 particulars of ship;

.2 information on how the ship conforms to stability criteria and directions based on the Register requirements for stability, to prevent the ship capsizing;

.3 recommendations concerning stability and other instructions for safe service;

.4 stability data for typical, predetermined loading conditions;

.5 advice and documents necessary to estimate trim and stability of the ship for any cases of full and partial loading which might occur in the ship's service.

The trim and stability of the ship shall be determined by calculation.

The Information on Stability shall be drawn up strictly in accordance with the provisions of Appendix 1 to the present Part.

1.4.11.2 Where the ship trim and stability is determined by using software, the latter is to be approved by the Register (see Appendix 4, Part II "Hull").

Availability of the Register software on board to control the ship stability and trim shall not be considered a ground for deleting any section of the Information on Stability.

The input and output data shall be easily comparable, as far as practicable, to the Information on Stability as to their contents and format, so the operators may familiarize themselves with the stability calculations in the shortest time.

The procedure for using software shall be specified in the relevant software operation manual. The software operation manual shall be clearly formulated, it shall be drawn up in the user mother tongue and translated into English. The manual shall contain a statement that the accuracy of the computers and systems prior to their use is to be checked by the crew.

1.4.11.3 The Information shall be compiled with regard to the ship's inclining test data, except for the cases stated in 1.5.7.

For the group of the ships specified in 1.5.2.1, the Information shall be prepared on the basis of the inclining test data of the first ship of the group. The Information compiled for the first ship of any group may be extended to ships of another group, provided that based on the inclining test results for the first ship of this group the light-ship displacement changes by not more than 2 per cent, and the height of the centre of gravity increases by not more than the value obtained as per 1.5.2.2 and the requirements of this Part of the Rules are not violated.

In this case, to be indicated in the Information are the displacement and centre of gravity coordinates for the light condition of the ship as obtained on the basis of the inclining test results for the first ship of the group concerned.

For ships for which inclining test may be omitted in compliance with 1.5.7 design light-ship displacement shall be specified, and the centre of gravity height of light ship is calculated according to 1.5.7. It shall be simultaneously stated in the Information that the ship has not been inclined and the centre of gravity height of the light ship has been calculated in accordance with 1.5.7.

1.4.11.4 Where bulk cargoes other than grain are carried, special Information on Stability and Strength during Loading, Unloading and Stowage of Bulk Cargoes Other Than Grain is to be available on board, which shall be drawn in accordance with 1.4.9.7, Part II "Hull".

1.4.11.5 When ships in service call ports which require exchange of the water ballast at sea in advance, they are to have Guidelines on the Safe Ballast Water Exchange at Sea which shall contain the following:

.1 information on the authorized method of ballast exchange (exchange by full dewatering of tanks with further ballasting and/or continuous tank pumping);

.2 the detailed instructions as regards operation of pumps, ballast system, preparation of tanks and air pipes to ballasting operations, instructions in respect of the ballast exchange procedure and instructions as regards of the hull impermeability after completion of ballast exchange operations;

.3 instructions for prevention of over and under pressurization of ballast tanks;

.4 information on free surface effects on stability and on "dead" residues in tanks which can have free surfaces;

.5 information on weather conditions admissible for ballast exchange;

.6 weather routing in areas affected by cyclones, typhoons and hurricanes;

.7 instructions for maintenance of adequate intact stability in accordance with an approved Instruction on Stability;

.8 information on permissible seagoing strength limits of shear forces and bending moments;

.9 information on torques, where relevant;

.10 accepted values of minimum/maximum forward and aft draughts;

.11 information on wave induced hull vibration;

.12 instructions for documented record of ballasting operations;

.13 instructions for contingency procedures for situations which may affect the water ballast exchange at sea (including worsening of weather conditions, pump failure, de-energization of ship, etc);

.14 information on time necessary to complete the water ballast exchange or an appropriate sequence thereof, taking into account that the amount of ballast water may represent 50 per cent of the total cargo capacity for some ships;

.15 instructions for monitoring the amount of ballast water;

.16 assessment of application of "priming" considering construction of air pipes;

.17 number of full tank changes during "priming" (at least 3 changes);

.18 list of manholes which may be left opened during exchange of ballast with a notification that they are to be closed after completion of exchange;

.19 instructions for ballast exchange under low temperatures (usually it shall not be carried out);

.20 if necessary, a requirement of availability on ship of the load control instrument for comparison of actual shear forces and bending moments with accepted values;

.21 list of conditions and circumstances which do not allow the ballast water exchange.

1.5 INCLINING TESTS AND LIGHT-WEIGHT CHECKS

1.5.1 To be inclined are:

.1 series-built ships as per 1.5.2;

.2 every ship of non-series construction;

.3 every ship after reconstruction;

.4 ships after major repair, alteration or modification as per 1.5.3;

.5 ships after installation of permanent solid ballast as per 1.5.4;

.6 ships whose stability is unknown or gives rise to doubts;

.7 passenger ships in service at intervals not exceeding five years if stipulated by 1.5.5.

.8 fishing vessels in service (of 30 metres length and less) at intervals not exceeding fifteen years and fishing vessels over 30 metres length if stipulated by 1.5.5.

1.5.2 Out of the series of ships under construction at each shipyard the following ships are to be inclined:

.1 the first ship, then every fifth ship of the series (i.e. sixth, eleventh, etc.). The light-weight check shall be carried out for other series-built ships in accordance with 1.5.14.

Depending on the seasonal conditions during the delivery of the ship and subject to special agreement with the Register, the inclining test of the next ship of the series may be permitted instead of the ship to be delivered. Beginning from the twelfth ship of the series, the Register may require the inclining of the smaller number of ships if it is demonstrated to the satisfaction of the Register that in the process of constructing the ships of the series stability of their mass and centre of gravity position is ensured within the limits stated in 1.5.2.2;

.2 a series-built ship if structural alterations therein compared with the first ship of the series, as shown by the calculation, result in:

.2.1 the changes in the light-ship displacement by more than 2 per cent; or

.2.2 the increase of the light-ship centre of gravity height exceeding simultaneously 4 cm (10 cm in the case of floating cranes and crane ships) and the value determined by the formulae:

$$\delta z_g = 0{,}1\,\frac{\Delta_1}{\Delta_0}\,l_{\max}, \qquad (1.5.2.2.2\text{-}1)$$

$$\delta z_g = 0{,}05\,\frac{\Delta_1}{\Delta_0}\,h \qquad (1.5.2.2.2\text{-}2)$$

where Δ_0 = light-ship displacement, in t;
Δ_1= ship's displacement under the most unfavourable loading condition as regards the value of h or $l_{\max}$, in t;
$l_{\max}$ = maximum arm of statical stability curve under the most unfavourable design loading condition as regards its value;
h = corrected metacentric height under the most unfavourable design loading condition as regards its value,

whichever is the less;

.2.3 violation of the requirements of this Part of the Rules for design loading conditions with $z_g = 1{,}2z_{g2} — 0{,}2z_{g1}$, where z_{g1} (z_{g2}) is design light-ship centre of gravity height prior to (after) structural changes; z_g is an assumed light-ship centre of gravity height.

Such ship shall be considered the first ship of a new series as regards stability, and the inclining test procedure of the subsequent ships shall comply with the requirements of 1.5.2.1.

1.5.3 After major repair, alteration and modification to be inclined are ships, in which structural changes, as shown by calculation, result in:

.1 change of load (total mass of loads removed or added) by more than 6 per cent of the light-ship displacement;

.2 change in the light-ship displacement by more than 2 per cent;

см.Б1 **.3** increase in the light-ship centre of gravity height by more than the value obtained as per 1.5.2.2;

.4 violation of the requirements of this Part of the Rules for design loading conditions as specified in 1.5.2.2.3.

If no inclining test is required upon results of the calculation, the light-weight check shall be carried out in accordance with 1.5.14.

Irrespective of the calculations submitted, the Register may require in compliance with 1.5.1.6 the inclining test of the ship to be performed, proceeding from the technical condition of the ship.

1.5.4 After installation of the permanent solid ballast each ship is to be inclined.

The inclining test of the ship may be dispensed with if the Register is satisfied that when installing the ballast, efficient control is effected to ensure the design values of mass and centre of gravity position, or these values can be properly confirmed by calculation.

1.5.5 Light-weight check (experimental determination of the light-ship displacement and the longitudinal centre of gravity) shall be effected periodically for finding whether according to the 1.5.1.7 and 1.5.1.8 the inclining test is required for:

.1 passenger ships;

.2 fishing vessels over 30 metres length after 10 years in service from the date of build or last inclining test.

Light-weight check is to be carried out at intervals not more than five years.

If a change in the light-ship displacement by more than 2 per cent or in longitudinal gravity-centre position by more than 1 per cent of the ship's length as compared to the approved Information on Stability is found out as a result of the light-weight check then the ship is to be inclined.

1.5.6 Where the inclining test results for the ship built show that the light-ship centre of gravity height exceeds design value to the extent that involves the violation of the requirements of the present Part of the Rules, calculations with explanation of the reasons of such differences are to be attached to the Inclining Test Records.

Based on the investigation analysis of the documents submitted, or in case such documents are not available, the Register may require the repeated (check) inclining test of the ship to be performed. In this case, both Inclining Test Records are to be submitted to the Register for consideration.

1.5.7 Except for the ships engaged on international voyages a newly built ship may be exempted by the Register from the inclining test provided an increase of a light-ship centre of gravity height by 20 per cent as against the design value will not result in the violation of the requirements of this Part of the Rules.

1.5.8 Ship's loading during the inclining test shall be as far as practicable close to the light-ship displacement. The mass of missing loads shall be not more than 2 per cent of the light-ship displacement, and the mass of surplus loads less inclining ballast and ballast according to 1.5.9, 4 per cent.

1.5.9 The metacentric height of the ship in the process of the inclining test shall be at least 0,20 m. For this purpose necessary ballast may be taken. When water ballast is taken, the tanks shall be carefully pressed up.

1.5.10 To determine angles of inclination during the inclining test not less than three pendulums at least 3 m long or at least two devices approved by the Register shall be provided, or a special facility approved by the Register for use in the inclining test shall be employed.

For ships under 30 m in length only two pendulums at least 2 m long may be used.

1.5.11 In well performed inclining test the value of the metacentric height obtained may be used in calculations with no deduction for probable error of the test.

The inclining test is considered to be satisfactory performed, provided:

.1 for each measurement the following condition is fulfilled:

$$|h_i — h_k| \leqslant 2\sqrt{\frac{\Sigma(h_i — h_k)^2}{n — 1}}$$

where h_i = metacentric height obtained by individual measurement;
$h_k = \Sigma h_i/n$ is metacentric height obtained in inclining the ship;
n = number of measurements.

Measurements not meeting the above condition are excluded when treating the results with appropriate change of the total number n and repeated calculation of the metacentric height h_k.

No more than one measurement is excluded from the calculation (greater number of measurements may be excluded only in well-grounded cases on agreement with the Register).;

.2 probable error of the test

$$t_{\alpha n}\sqrt{\frac{\Sigma(h_i — h_k)^2}{n(n — 1)}}$$

fulfils the condition

$$t_{\alpha n}\sqrt{\frac{\Sigma(h_i — h_k)^2}{n(n — 1)}} \leqslant 0{,}02(1 + h_k) \text{ if } h_k \leqslant 2 \text{ m}$$

and

$$t_{\alpha n}\sqrt{\frac{\Sigma(h_i — h_k)^2}{n(n — 1)}} \leqslant 0{,}01(4 + h_k) \text{ if } h_k > 2 \text{ m.}$$

Factor $t_{\alpha n}$ is taken from Table 1.5.11;

см.Б1 **.3** the following condition is fulfilled:

$$t_{\alpha n}\sqrt{\frac{\Sigma(h_i — h_k)^2}{n(n — 1)}}\,\frac{\Delta_0}{\Delta_1} \leqslant \varepsilon, \text{ where } \varepsilon = 0{,}05h \text{ or } 0{,}10 l_{\max},$$

whichever is less.

Table 1.5.11

Factor $t_{\alpha n}$

n	$t_{\alpha n}$	n	$t_{\alpha n}$
8	5,4	13	4,3
9	5,0	14	4,2
10	4,8	15	4,1
11	4,6	16	4,0
12	4,5		

The values of $0{,}05h$ and $0{,}10l_{\max}$ are not to be assumed less than 4 cm;

.4 total number of satisfactory measurements is not less than 8.

1.5.12 Where the requirements of 1.5.11 are not fulfilled, the value of the metacentric height less the probable error of the test obtained as per 1.5.11.2 may be taken for calculations upon agreement with the Register.

см.Б1 **1.5.13** The inclining test shall be performed in accordance with the Instructions on Inclining Test (Appendix 3) and shall be witnessed by a Surveyor to the Register.

Other methods of experimentally determining the light-ship weight and the coordinates of its centre of gravity may be permitted, provided that it is demonstrated to the satisfaction of the Register that the accuracy of the inclining test results meets the present requirements.

см.Б1 **1.5.14** The light-weight check is conducted in order to control the light-ship displacement and the coordinates of its centre of gravity on the basis of:

experimental determination of the light-ship displacement and an abscissa of the centre of gravity;

results of inclining test of the previous series-built ship (prototype) used for ships under construction;

calculation results (provided the structural changes related to displacement and coordinates of centre of gravity are precisely known) for existing ships as well as for ships under construction, which structural changes do not result in necessity of inclining test in accordance with the present Chapter.

Results of light-weight check and the centre of gravity height for the prototype or its calculated value are taken for the light-ship displacement provided:

the deviation in the light-ship displacement found as a result of light-weight check does not exceed 2 per cent of respective value of the prototype or design value;

the deviation in the light-ship longitudinal gravity-centre position does not exceed 1 per cent of the ship length between perpendiculars from respective value of prototype or from design value.

If the deviation exceeds at least one of the said limitations, the ship shall be subjected to inclining test.

The light-weight check is to be conducted in accordance with Appendix 4 to the present Part of the Rules.

1.6 DEPARTURES FROM THE RULES

1.6.1 If doubts arise with regard to stability of any ship when the requirements of this Part of the Rules are complied with or the requirements set forth in this Part of the Rules are considered to be too severe, the Register may permit, on a well-grounded statement of design and service bodies, appropriate departures from the requirements of this Part of the Rules for the ship concerned.

1.6.2 When a ship navigating in a particular area does not comply with the requirements of this Part of the Rules, the Register may, in each particular case, either restrict the ship's area of navigation or place other limitations depending upon the ship's stability characteristics, service conditions and purpose the ship is intended for.

1.7 CONDITIONS OF SUFFICIENT STABILITY

1.7.1 Under the most unfavourable loading conditions with regard to stability, the ship's stability, except for floating cranes, crane ships, pontoons, floating docks and berth-connected ships shall comply with the following requirements:

.1 the ship shall withstand, without capsizing, simultaneously the effect of dynamically applied wind pressure and rolling the parameters of which are determined in compliance with the directions given in Section 2;

.2 numerical values of the parameters of the statical stability curve for the ship on still water and the values of the corrected initial metacentric height shall not be below those specified in Section 2;

.3 the effect of consequences of probable icing upon stability shall be taken into account in compliance with Section 2;

.4 stability of a ship shall comply with additional requirements of Section 3.

1.7.2 The stability of floating cranes, crane ships, transport pontoons, floating docks and berth-connected ships shall comply with the requirements of Section 4.

1.7.3 For ships to which the requirements of Part V "Subdivision" are applicable, the intact stability shall be sufficient to meet these requirements in damaged condition.

1.7.4 Stability of ships which have distinguishing marks of provision with means for fighting fires on board other ships in their class notation is to meet the requirements of this Part in the course of fire fighting operations on the assumption that all monitors operate simultaneously with the maximum supply rate in the direction corresponding to the minimum stability of the ship.

1.8 PASSAGE OF SHIPS FROM ONE PORT TO ANOTHER

1.8.1 When passing from one port to another, the ship's stability shall meet the requirements imposed upon ships navigating in a region through which the passage is expected to be undertaken.

1.8.2 The Register may permit the passage of a ship which stability cannot be raised up to that required by 1.8.1 provided that the weather restrictions correspond to its stability.

2 GENERAL REQUIREMENTS FOR STABILITY

2.1 WEATHER CRITERION[1]

2.1.1 The requirements for stability set forth in this Part of the Rules are differentiated depending upon the ship's area of navigation.

Definitions of restricted areas of navigation are given in 2.2.5, Part I "Classification".

2.1.1.1 Stability of ships of unrestricted service and of restricted areas of navigation **I** and **II** shall be considered sufficient as to weather criterion K, if the dynamically applied heeling moment M_v due to wind pressure in the most unfavourable loading condition as to stability equals or is below the capsizing moment M_c, that is:

$M_v \leqslant M_c$ or

$$K = M_c/M_v \geqslant 1{,}0. \tag{2.1.1.1}$$

For ships specially intended for operation in heavy seas (for example, meteorological ships) the value of weather criterion K is subject to special consideration by the Register in each particular case; it is recommended that this value shall not be less than 1,5.

2.1.1.2 At the discretion of the Register, the ships whose stability with respect to the weather criterion does not comply with the requirements for the ships of restricted area of navigation **II**, may be allowed to operate as ships of restricted area of navigation **III** with additional restrictions, taking into account the peculiarities of the area and the nature of service.

The requirements for stability for floating cranes and crane ships are stipulated in 4.1.

2.1.2 Calculation of the heeling moment due to wind pressure.

2.1.2.1 The heeling moment M_v, in kN·m, is assumed to be equal to the product of wind pressure p_v by windage area A_v and by the distance z between the centre of windage area and the actual waterline plane

$$M_v = 0{,}001 p_v A_v z. \tag{2.1.2.1}$$

The value of the heeling moment is assumed to be constant during the whole period of the ship's inclination.

2.1.2.2 The values of wind pressure p_v, in Pa, shall be taken from Table 2.1.2.2 depending upon the ship's area of navigation and arm of windage area.

2.1.3 Calculation of the amplitude of roll.

2.1.3.1 The amplitude of roll, in deg., of a round-bilged ship having no bilge and bar keels is calculated using the formula

$$\theta_{1r} = X_1 X_2 Y \tag{2.1.3.1}$$

where X_1, X_2 = non-dimensional factors;
Y = factor, in deg.

The values of factor Y shall be taken from Table 2.1.3.1-1 depending on the ship's area of navigation and the ratio $\sqrt{h_0}/B$.

The values of factor X_1 shall be taken from Table 2.1.3.1-2 depending upon the ratio B/d.

The values of factor X_2 shall be taken from Table 2.1.3.1-3 depending upon ship's block coefficient C_B.

Table 2.1.2.2

Wind pressure p_v, in Pa

Area of navigation	z, in m													
	0,5	1,0	1,5	2,0	2,5	3,0	3,5	4,0	4,5	5,0	5,5	6,0	6,5	7,0 and over
Unrestricted	—	706	785	863	922	971	1010	1049	1079	1108	1138	1167	1196	1216
Restricted **I**	0,567 of the wind pressure value adopted for unrestricted service													
Restricted **II**	0,275 of the wind pressure value adopted for unrestricted service													

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[1] The requirements of 2.1.1.1 to 2.1.4 cover ships, which keels are laid before 1 July 2002.

The requirements of 2.1.1.2 and 2.1.5 to 2.1.8 cover ships, which keels are laid or which modernization is commenced on or after 1 July 2002.

Table 2.1.3.1-1

Factor Y

Area of navigation	$\sqrt{h_0}/B$									
	0,04 and below	0,05	0,06	0,07	0,08	0,09	0,10	0,11	0,12	0,13 and above
Unrestricted	24,0	25,0	27,0	29,0	30,7	32,0	33,4	34,4	35,3	36,0
Restricted **I** or **II**	16,0	17,0	19,7	22,8	25,4	27,6	29,2	30,5	31,4	32,0

Table 2.1.3.1-2

Factor X_1

B/d	X_1	B/d	X_1
2,4 and below	1,0	3,0	0,90
		3,1	0,88
2,5	0,98	3,2	0,86
2,6	0,96	3,3	0,84
2,7	0,95	3,4	0,82
2,8	0,93	3,5 and above	0,80
2,9	0,91		

Table 2.1.3.1-3

Factor X_2

C_B	0,45 and below	0,5	0,55	0,6	0,65	0,7 and above
X_2	0,75	0,82	0,89	0,95	0,97	1,0

2.1.3.2 If a ship is provided with bilge keels, or a bar keel or both, the amplitude of roll, in deg., shall be calculated using the formula

$$\theta_{2r}=k\theta_{1r} \qquad (2.1.3.2)$$

where values of factor k shall be taken from Table 2.1.3.2 depending upon the ratio A_k/LB where A_k is a total overall area of bilge keels, or an area of the lateral projection of the bar keel, or a sum of these areas, in m^2.

Bilge keels are not to be taken into consideration where ships having ice category marks **ЛУ4** to **ЛУ9** in their class notation are concerned.

Table 2.1.3.2

Factor k

$\frac{A_k}{LB}$, in per cent	0	1,0	1,5	2,0	2,5	3,0	3,5	4,0 and above
k	1,00	0,98	0,95	0,88	0,79	0,74	0,72	0,70

2.1.3.3 The amplitude of roll for a ship having sharp bilges shall be assumed to be equal to 70 per cent of that calculated from the Formula (2.1.3.1).

2.1.3.4 The amplitude of roll for ships provided with anti-rolling devices shall be determined taking no account of operation of these devices.

2.1.3.5 The values of amplitudes of roll shall be rounded off to whole degrees.

2.1.4 Determination of the capsizing moment.

The capsizing moment may be determined by any method approved by the Register.

The recommended procedure of the capsizing moment determination is given in Appendix 2.

2.1.5 For ships, which keels are laid or which modernization is commenced on or after 1 July 2002, the stability with respect to the weather criterion K is considered to be sufficient, if the requirements of 2.1.5.5 are met under the assumed effects of wind and seas, and:

.1 the ship is under the effect of a wind of steady speed and direction perpendicular to the ship centre plane, to which the lever l_{w1} of wind heeling moment corresponds (see Fig. 2.1.5-1);

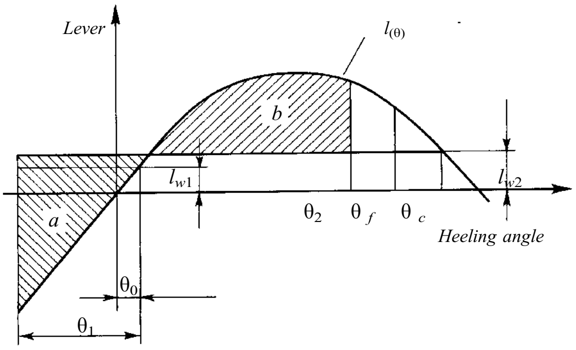

Fig. 2.1.5-1

.2 by the static heeling angle θ_0 resulting from steady wind and corresponding to the first point of intersection between the horizontal straight line l_{w1} and the curve of righting levers $l(\theta)$, the ship heels to the weather side under the effect of waves, to an angle equal to the roll amplitude θ_1 (see Fig. 2.1.5-1);

.3 the heeled ship comes, under the dynamic effect of a wind gust to which the heeling lever l_{w_2} corresponds;

.4 the areas a and b are determined and compared, which are shaded in Fig. 2.1.5-1.

The area b is formed by the righting lever curve $l(\theta)$, a horizontal straight line corresponding to the heeling lever l_{w2} and the heeling angle $\theta_2 = 50°$, or the angle of flooding θ_f or the heeling angle corresponding to the second point of intersection between the straight line l_{w2} and the righting lever curve, whichever angle is less. The area a is formed by the righting lever curve, straight line l_{w2} and heeling angle equal to $\theta_0 - \theta_1$;

.5 the ship stability is considered sufficient by the weather criterion $K=b/a$, provided the area b is equal to or greater than the area a, i.e. $K \geqslant 1$. For meteorological ships, the weather criterion K is specially considered by the Register in each case; it is recommended this value shall be not less than 1,5.

2.1.6 The static heeling angle θ_0 due to steady wind is not to exceed 16° or and angle equal to 0,8 of the open deck edge immersion angle, whichever is less. The stability of timber carriers is to be verified by the ultimate value of 16° only, the standard of 0,8 of the deck edge immersion angle is not applicable in this case.

2.1.7 Calculation of heeling lever due to wind pressure.

2.1.7.1 The heeling lever l_{w1}, in m, is to be adopted constant for all heeling angles and shall be determined from the formula

$$l_{w1}=\frac{p_v A z_v}{1000 g \Delta} \qquad (2.1.7.1\text{-}1)$$

where p_v = wind pressure, in Pa, to be determined from Table 2.1.7.1 proceeding from the area of navigation;
z_v = arm of windage area to be adopted equal to the vertical distance between the windage area centre A and the centre of the underwater hull lateral area projected on the centre plane or, approximately, the half of the ship draught;
A = windage area, in m^2, to be determined in accordance with 1.4.6;
Δ = ship displacement, in t;
g = 9,81 m/s^2.

Table 2.1.7.1

Wind pressure p_v

Area of navigation	p_v, in Pa
Unrestricted	504
Restricted **I**	353
Restricted **II**	252

The heeling lever l_{w2} is to be determined from the formula

$$l_{w2}=1{,}5\, l_{w1}. \qquad (2.1.7.1\text{-}2)$$

2.1.7.2 For fishing vessels having a length between 24 m and 45 m, the wind pressure value in the Formula (2.1.7.1-1) may be ascertained from Table 2.1.7.2 proceeding from the distance z_v between the windage area centre and the waterline.

Table 2.1.7.2

z_v, in m	1	2	3	4	5	$\geqslant 6$
P_v, in Pa	316	386	429	460	485	504

2.1.8 Calculation of roll amplitude.

2.1.8.1 The roll amplitude, in deg, for a round-bilged ship is to be determined from the formula

$$\theta_1=109 k X_1 X_2 \sqrt{rS} \qquad (2.1.8.1)$$

where k = factor taking into account the effects of bilge and/or bar keels and determined in accordance with 2.1.8.2; K is to be adopted equal to 1 where the keels are not mounted;
X_1 = dimensionless factor to be determined from Table 2.1.8.1-1 proceeding from the breadth-to-draught (B/d) ratio;
X_2 = dimensionless factor to be determined from Table 2.1.8.1-2 proceeding from the block coefficient (C_B) of the ship;
r = $0{,}73+0{,}6(Z_g - d)/d$, while r is not to be adopted greater than 1;
S = dimensionless factor to be adopted from Table 2.1.8.1-3 proceeding from the area of navigation and the roll period T to be calculated from the formula

$$T = 2cB/\sqrt{h}$$

where c = $0{,}373+0{,}023B/d-0{,}043L/100$;
h = effect metacentric height corrected for free surfaces of liquid cargoes.

Table 2.1.8.1-1

Factor X_1

B/d	$\leqslant 2{,}4$	2,6	2,8	3,0	3,2	3,4	3,5	3,6	4,0	4,5	5,0	5,5	6,0	$\geqslant 6{,}5$
X_1	1,00	0,96	0,93	0,90	0,86	0,82	0,80	0,79	0,78	0,76	0,72	0,68	0,64	0,62

Table 2.1.8.1-2

Factor X_2

$C_в$	$\leqslant 0{,}45$	0,50	0,55	0,60	0,65	$\geqslant 0{,}70$
X_2	0,75	0,82	0,89	0,95	0,97	1,00

Table 2.1.8.1-3

Factor S

Area of naviga-tion	T, in s									
	$\leqslant 5$	6	7	8	10	12	14	16	18	$\geqslant 20$
Unre-stricted	0,100	0,100	0,098	0,093	0,079	0,065	0,053	0,044	0,038	0,035
Restricted **I** and restricted **II**	0,100	0,093	0,083	0,073	0,053	0,040	0,035	0,035	0,035	0,035

2.1.8.2 For ships with bilge keels or bar keel, or both, the factor k is to be adopted from Table 2.1.8.2 proceeding from the A_k/LB ratio, in which A_k denotes the total area, in m^2, of bilge keels or the lateral projected area of the bar keel, or the sum of both areas.

Table 2.1.8.2

Factor k

A_k/LB,%	0	1,0	1,5	2,0	2,5	3,0	3,5	$\geqslant 4{,}0$
k	1,00	0,98	0,95	0,88	0,79	0,74	0,72	0,70

The bilge keels for ships having the **ЛУ4** to **ЛУ9** ice category mark in their class notations shall be ignored.

2.1.8.3 When calculating the roll amplitude by the Formula (2.1.8.1), coefficient k for sharp-bilged ships shall be adopted equal to 0,7.

2.1.8.4 The roll amplitudes of ships equipped with anti-rolling devices dampers shall be determined without regard for the operation of the latter.

2.1.8.5 In Tables 2.1.8.1-1 to 2.1.8.1-3 and 2.1.8.2, the intermediate values shall be determined by linear interpolation. The calculated roll amplitude values shall be rounded to integer degrees.

2.2 CURVE OF STATICAL STABILITY

2.2.1 The maximum lever of the statical stability curve $l_{\max}$ shall be not less than 0,25 m for ships with $L \leqslant 80$ m and 0,20 m for ships with $L \geqslant 105$ m at the heeling angle $\theta_m > 30°$. For intermediate values of L, $l_{\max}$ shall be determined by linear interpolation.

On agreement with the Register, the angle corresponding to the maximum of the statical stability curve can be reduced to 25°.

Where the statical stability curve has two maxima due to the influence of superstructures or deckhouses, the first maximum from the upright position shall occur at the angle of heel not less than 25°.

The limit of positive statical stability (the angle of vanishing stability) shall be not less than 60°. However, for ships of restricted area of navigation **IIIСП** it may be lowered to 50°, provided that every lowering by 1° is accompanied by an increase of the maximum lever of statical stability curve by 0,01 m above the specified value.

For the ships, which keels are laid or modernization is commenced on or after 1 July 2002, the area covered by the positive section of statical stability curve is not to be less than 0,055 m rad up to the heeling angle of 30° and not to be less than 0,09 m rad up to the heeling angle of 40°. Besides, the area between the heeling angles of 30° and 40° is not to be less than 0,03 m·rad.

2.2.2 Ships with ratio $B/D > 2$ are allowed to navigate having the angle of vanishing stability and the angle corresponding to the maximum lever of the curve less than those required by 2.2.1 by the following values:

.1 angle of vanishing stability, by a value $\Delta\theta_v$ determined from the formula

$$\Delta\theta_v = 40° \left(\frac{B}{D} - 2\right)(K - 1). \qquad (2.2.2.1)$$

Where $B/D > 2{,}5$ and $K > 1{,}5$, the ratio $B/D = 2{,}5$ and $K = 1{,}5$ shall be adopted. The value of $\Delta\theta_v$ is to be rounded off to the nearest integer;

.2 angle corresponding to the maximum lever of the curve, by a value equal to half the decrease in the angle of vanishing stability. The angle is not to be assumed less than 25º.

2.2.3 A ship shall comply with the aforesaid requirements when the correction for free surfaces is taken into account in curves of statical stability in accordance with the provisions of 1.4.7.

2.2.4 For ships failing to comply with the requirements of this Chapter with respect to the angle of vanishing stability because of the curve cut short at the angle of flooding, navigation may be permitted as for ships of restricted service depending upon the value of wind pressure endured when checking stability for compliance with the weather criterion. It is necessary, however, that the conventional angle of vanishing stability determined on the assumption of weathertight closures of the openings through which flooding occurs shall be not less than that required by this Chapter.

2.2.5 The requirements for the statical stability curve of floating cranes and crane ships, see 4.1.

2.3 METACENTRIC HEIGHT

2.3.1 The corrected initial metacentric height for all ships in all loading conditions, except for the light-ship condition, shall be positive.

For ships, which keels are laid or modernization is commenced on or after 1 July 2002, its value is not to be less than 0,15 m except where expressly provided otherwise.

For all ships, except for fishing vessels, whale factory ships, fish factory ships and other ships used for processing the living resources of the sea and not engaged in catching the same, negative initial metacentric height for a light ship is subject to special consideration by the Register in each case.

For all ships, the initial metacentric height in the light-ship condition may be determined taking trim into consideration.

2.3.2 Initial stability of well-deck ships shall be checked for the case of water penetration into the well.

Amount of water in the well and its free surface shall correspond to the water level up to the lower edge of the freeing ports for a ship in upright position allowing for the deck camber.

Should a ship have two or more wells, stability shall be checked for the case of flooding of the largest one.

2.4 ALLOWANCE FOR ICING

2.4.1 For ships intended for winter navigation within winter seasonal zones set up by Load Line Rules for Sea-Going Ships, stability with due regard for icing, as specified in this Chapter, shall be checked in addition to the main loading conditions. In the calculation, account shall be taken of increase in displacement, height of the centre of gravity and windage area due to icing. The stability calculation under icing shall be carried out for the worst loading condition as to stability. When checking stability under icing, the mass of the ice is considered as an overload and is not included in the ship's deadweight.

When verifying the stability of floating cranes and crane ships, the allowance for icing shall be made in accordance with 4.1.

2.4.2 When determining the heeling and capsizing moments for ships navigating in winter seasonal zones to the north of latitude 66°30′ N and to the south of latitude 66°00′ S, as also in winter in the Bering Sea, the Sea of Okhotsk and in the Tatarski Strait, the assumed rates of icing shall be as specified in 2.4.3 and 2.4.4.

2.4.3 The mass of ice per square metre of the total area of horizontal projection of exposed weather decks shall be assumed to be 30 kg. The total horizontal projection of decks shall include horizontal projections of all exposed decks and gangways, irrespective of the availability of awnings. The vertical moment due to this loading is determined for heights of the centre of gravity of the corresponding areas of decks and gangways.

The deck machinery, arrangements, hatch covers, etc. are included in the projection of decks and not taken into account separately.

For ships with framing fitted above open deck sections, allowance shall be made for an additional mass of ice having the thickness equal to the main framing height.

2.4.4 The mass of ice per square metre of the windage area shall be assumed to be 15 kg. In this case, the windage area and the height of the centre of gravity shall be determined for a draught $d_{\min}$, as specified in 1.4.6, but without the allowance for icing.

2.4.5 In other areas of the winter seasonal zone, the rates of icing for winter time shall be assumed to be equal to half those specified in 2.4.3 and 2.4.4, except for the areas where, on agreement with the Register, icing need not be taken into account.

2.4.6 The mass of ice and vertical moment computed in compliance with 2.4.3 to 2.4.5 cover all loading conditions when drawing up the Information.

2.4.7 For the statical stability curves plotted with the allowance for icing, the angle of vanishing stability shall be not less than 55° and the maximum lever of statical stability for ships of restricted service shall be at least 0,2 m at an angle of heeling not less than 25°.

For ships with ratio $B/D>2$, an additional reduction of the angle of vanishing stability θ_v is permissible by the values equal to half those determined from the Formula (2.2.2.1).

2.4.8 For ships navigating in winter in the regions of the Black and Asov Seas northwards of the parallel of latitude 44°00′ N, as well as in the region of the Caspian Sea northwards of the parallel of latitude 42°00′ N the icing is to be taken into account in compliance with 2.4.5.

3 ADDITIONAL REQUIREMENTS FOR STABILITY[1]

3.1 PASSENGER SHIPS

3.1.1 Stability of passenger ships shall be checked for the following loading conditions:

.1 ship in the fully loaded condition, with full number of class and unberthed passengers and their effects, and full stores without liquid ballast;

.2 ship in the fully loaded condition, with the full number of class and unberthed passengers and their effects, but with 10 per cent of stores;

.3 ship without cargo, but with the full number of class and unberthed passengers and their effects and with full stores;

.4 ship in the same loading condition as in 3.1.1.3, but with 10 per cent of stores;

.5 ship without cargo and passengers, but with full stores;

.6 ship in the same loading condition as in 3.1.1.5, but with 10 per cent of stores;

.7 ship in the same loading condition as in 3.1.1.2, but with 50 per cent of stores.

When checking stability for the compliance with the weather criterion, class passengers shall be assumed to be in their accommodation and unberthed passengers on their decks. The stowage of cargo in holds, 'tween decks and on decks is assumed as for normal service conditions of the ship. Stability with an allowance for icing shall be checked with no passengers on exposed decks.

3.1.2 Initial stability of passenger ships shall be such that in the eventual case of crowding of passengers to one side on the upper deck accessible for passengers, as near to the bulwark as possible, the angle of statical heel is not more than the angle at which the freeboard deck immerses or the angle at which the bilge comes out of water, whichever is less; in any case, the angle of heel shall not exceed 10°.

3.1.3 The angle of heel due to the combined effect of heeling moments M_{h1} (as a result of crowding of

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[1] For additional requirements for ships under 24 m in length, see 3.9.

passengers to one side on the promenade decks) and M_{h2} (on steady turning) shall not exceed the angle at which the freeboard deck immerses, or the angle at which the bilge comes out of water, whichever is less, but in any case the angle of heel shall not exceed 12°.

см.Б1 **3.1.4** The heeling moment, in kN·m, on turning circle shall be determined using the formula

$$M_R = 0{,}02\frac{V_0^2\Delta}{L}(Z_g - d/2) \qquad (3.1.4)$$

where V_0 = ship service speed, in m/s.

3.1.5 When calculating ship's stability on turning and for heeling caused by crowding of passengers to one side, no account shall be taken of wind and rolling effects.

3.1.6 When determining admissible distribution of passengers crowding to one side on their promenade decks, it is to be assumed that the ship's normal operating conditions are duly observed with an allowance for the position of the equipment and arrangements and the regulations concerning the access of passengers to a particular deck area.

3.1.7 When determining the area where crowding of passengers may be permitted, the passages between benches shall be included in the computation with factor 0,5. The area of narrow external passages between the deckhouse and the bulwark or railing up to 0,7 m wide shall be included with factor 0,5.

3.1.8 For the purpose of determination of the angle of heel caused by crowding of passengers to one side, the mass of each passenger shall be assumed to be 75 kg. The assumed density of distribution of passengers is 6 persons per square metre of the free area of the deck. The height of the centre of gravity for standing passengers shall be assumed equal to 1,1 m above the deck level and that for sitting passengers 0,3 m above the seats.

3.1.9 All computations of the statical angle of heel caused by passengers crowding to one side and by turning shall be carried out taking no account of icing, but with a correction for free surfaces of liquid cargoes as specified in 1.4.7.

3.2 DRY CARGO SHIPS

3.2.1 Stability of cargo ships shall be checked for the following loading conditions:

.1 ship having a draught to the summer load line with homogeneous cargo filling cargo holds, 'tween decks, coaming spaces and trunks of cargo hatches, with full stores, but without liquid ballast;

.2 ship in the same condition as in 3.2.1.1, but with 10 per cent of stores and, where necessary, with liquid ballast;

.3 ship without cargo, but with full stores;

.4 ship in the same condition as in 3.2.1.3, but with 10 per cent of stores.

3.2.2 Where cargo holds of a ship in the loading conditions as under 3.2.1.3 and 3.2.1.4 are used to additionally take liquid ballast, ship's stability with liquid ballast in these holds shall be checked. The effect of free surfaces in ship's store tanks is taken into account in compliance with the provisions of 1.4.7 and that in holds with liquid ballast in accordance with their actual filling.

3.2.3 Where ships are normally engaged in carrying deck cargoes, their stability shall be checked for the following additional conditions:

.1 ship having a draught to the summer load line (with regard to 3.2.1.1); with holds and 'tween decks filled by homogeneous cargo, with deck cargo, full stores and liquid ballast, if necessary;

.2 ship in the same loading condition as in 3.2.1.1, but with 10 per cent of stores.

3.2.4 The corrected initial metacentric height of ro-ro ships in the loaded condition, with icing disregarded, shall not be less than 0,2 m.

3.2.5 If, during stability verification, it is found out that the value of one of the parameters $\sqrt{h}/B$ and B/d at least exceeds 0,08 and 2,5, respectively, the ship's stability is to be checked additionally on the basis of the acceleration criterion K^* in accordance with 3.12.3. In so doing, if the calculated acceleration value a_{cal} (in fractions of g) is in excess of the maximum permissible one, the possibility of operating the ship under appropriate loading conditions shall be specially considered by the Register. Particular loading conditions under which the ship is permitted to proceed to sea with a_{cal}>0,30 shall be specified in the Information on Stability.

In the case of a ship in the ballast condition no check of the acceleration criterion may be effected.

3.3 TIMBER CARRIERS

3.3.1 Stability of timber carriers shall be checked for the following loading conditions:

.1 ship carrying timber cargo with a prescribed stowage rate (if stowage rate of timber cargo is not specified, the calculation of stability shall be made assuming μ=2,32 m^3/t) in holds and on deck and having a draught to the timber summer load line, without ballast (taking account of 3.2.1.1), with full stores;

.2 ship in the same loading condition as in 3.3.1.1, but with 10 per cent of stores and, where necessary, with liquid ballast;

.3 ship with timber cargo, having the greatest stowage rate specified, in holds and on deck, with full stores, without ballast;

.4 ship in the same loading condition as in 3.3.1.3, but with 10 per cent of stores and, where necessary, with liquid ballast;

.5 ship without cargo, but with full stores;

.6 ship in the same loading condition as in 3.3.1.5, but with 10 per cent of stores.

3.3.2 The stowage of timber cargo in timber carriers shall comply with the requirements of the Load Line Rules for Sea-Going Ships as well as with the provisions of the Information on Stability or special instructions.

3.3.3 When calculating the lever of form stability for timber carrier, the volume of timber cargo on deck may be included in the calculation with full breadth and height and permeability of 0,25.

3.3.4 Information on Stability shall include data to enable the master to estimate the ship's stability when carrying a timber cargo on deck the permeability of which differs substantially from 0,25. Where the approximate permeability is not known, at least three values shall be adopted, namely, 0,25, 0,4 and 0,6.

3.3.5 The corrected initial metacentric height under the first and third loading conditions stated in 3.3.1 shall be not less than 0,1 m, the second and fourth — not less than 0,05 m and the fifth and sixth — not less than 0,15 m.

For ships, which keels are laid or modernization is commenced on or after 1 July 2002, the corrected initial metacentric height shall be not less than 0,1 m all through the voyage with loading conditions as mentioned under 3.3.1.1 to 3.3.1.4, or not less than 0,15 m with loading conditions as mentioned in 3.3.1.5 and 3.3.16.6.

With loading conditions as mentioned under 3.3.1.1 to 3.3.1.4, the statical stability curve of timber carriers shall be in compliance with the following specific requirements:

the area covered by righting lever curves up to the angle of 40° is not to be less than 0,08 m·rad;

the maximum lever of the curve is not to be less than 0,25 m.

3.3.6 When the effect of icing is calculated, the upper surface of deck timber cargo shall be considered as if it were the deck, and its side surfaces above the bulwark — as if they were part of the designed windage area. The icing rate for these surfaces shall be three times that specified in 2.4.

3.3.7 For timber carriers intended to operate in areas in which the icing is not required to be taken into account as well as for those navigating in summer within winter seasonal zones, the stability calculation shall be made for the most unfavourable loading conditions out of those indicated in 3.3.1.1 to 3.3.1.4 with regard to possible addition in mass of the deck cargo due to absorption of water.

Where no appropriate data on the extent of water absorption by different kinds of wood are available, it is recommended that the addition in mass of the deck cargo be assumed equal to 10 per cent. This addition is considered as an overload and is not included in the ship's deadweight.

3.3.8 If timber carriers are used for the carriage of other kinds of cargo, their stability shall be checked according to the provisions of 3.2. In such a case, computation of the lever of form stability and the windage area shall be carried out taking no account of deck timber cargo.

3.3.9 The requirements of this Chapter apply to other types of ships when they are used for the carriage of deck timber cargo.

The requirements of 3.3.2 (concerning the need for compliance with the requirements of Load Line Rules for Sea-Going Ships) and of 3.3.3 do not apply to the ships for which the buoyancy of timber deck cargo is not included in the calculation of stability.

3.3.10 Double bottom tanks of timber carriers where fitted within the midship half-length of the ship shall have adequate watertight longitudinal subdivision.

3.4 TANKERS

3.4.1 Stability of tankers carrying liquid cargoes shall be checked for the following loading conditions:

.1 ship having draught up to summer load line (with regard to 3.2.1.1), fully loaded and with full stores;

.2 ship fully loaded, but with 10 per cent of stores;

.3 ship without cargo, but with full stores;

.4 ship in the same loading condition as in 3.4.1.3, but with 10 per cent of stores.

3.4.2 For refuelling tankers, stability shall be checked for additional loading condition: a ship with 75 per cent of cargoes and free surfaces in tanks for each kind of cargo, and 50 per cent of stores without liquid ballast.

Account of the free surface effect in ship's stores tanks shall be taken as specified in 1.4.7 and in cargo tanks according to the extent of their actual filling.

3.4.3 The requirements of 3.4.2 apply to oil recovery ships as well.

3.4.4 Stability of tankers having cargo tank or ballast tank breadths more than 60 per cent of the ship's breadth shall comply with the following additional requirements during cargo loading/unloading operations, including the intermediate stages thereof.

3.4.4.1 When the cargo loading/unloading operations are performed in port the corrected initial metacentric height is not to be less than 0,15 m and the extent of positive intact stability is not to be less than 20°.

3.4.4.2 When the cargo loading/unloading operations are performed at sea and on roadstead all requirements of this Part of the Rules shall be met.

3.4.4.3 When determining correction for the effect of free surfaces of liquids an allowance shall be simultaneously made for maximum free surface effects in all cargo, ballast and consumable tanks.

3.4.4.4 If the requirements of 3.4.4.1 and 3.4.4.2 are not met, due to application of the requirements of 3.4.4.3, instructions covering the operational restrictions to satisfy the said requirements may be included into the Information on Stability upon agreement with the Register.

3.4.4.5 Instructions referred to in 3.4.4.4 shall be formulated with consideration for the following:

they shall be in a language understood by the crew member in charge of loading/unloading operations and shall be translated into English;

they shall not require more complicated mathematical calculations than those provided in the other sections of the Information on Stability;

they shall indicate the list of cargo and ballast tanks which may simultaneously have free surfaces at any stage of loading/unloading operations;

they shall include typical versions of loading/unloading operations to satisfy the stability requirements under any load condition specified in the Information on Stability. The versions shall contain lists of cargo and ballast tanks which may simultaneously have free surfaces during various stages of loading/unloading operations;

they shall provide instructions necessary for independent pre-planning loading/unloading operations, including:

maximum heights of the ship's centre of gravity in graphical and/or tabular form which enables control of compliance with the requirements of 3.4.4.1, 3.4.4.2;

the method of expeditious assessment of effect produced on the stability by the number of tanks which simultaneously have free surfaces at any stage of loading/unloading operations;

description of means available on board for control and monitoring loading/unloading operations from the viewpoint of the effects on stability;

the method used to monitor loading/unloading operations and to give early warning of possible impeding the stability criteria;

description of means available to suspend loading/unloading operations if the stability criteria are under the threat of being impeded;

information on the possibility and procedure of using shipboard computer and various automated systems to monitor loading/unloading operations (including systems of monitoring tank filling, shipboard computer software by which calculations of trim and stability are performed, etc.);

they shall provide for corrective actions to be taken in case of unexpected technical difficulties which can emerge in the course of loading/unloading operations and in case of emergency.

3.4.4.6 Provisions of the instructions formulated in accordance with 3.4.4.5 shall be specified in the Information on Stability and also in the computer software available on board, by which trim and stability calculations are performed. A copy of the instructions shall be kept at the loading/unloading control station.

3.4.5 The following requirements are applied to tankers of deadweight 5000 and more:

the contract for construction was concluded on 1 February 1999 or later; or

in default of contract for construction which keels were laid or they are at similar stage of construction on 1 August 1999 or later; or

construction has been completed by 1 February 2002; or

which has undergone substantial conversion:

in respect of which the contract was concluded after 1 February 1999; or

in default of the contract, the work on substantial conversion began after 1 August 1999; or

which was completed after 1 February 2002.

The requirements of 3.4.4 do not apply to the ships mentioned above.

3.4.5.1 Each oil tanker is to comply with requirements set forth in 3.4.5.1.1 to 3.4.5.1.2 (considering instructions in 3.4.5.1.3) for any operation draught under the worst possible loading and ballasting conditions (in accordance with good operation practice) including intermediate stages of operations with liquids. Under all conditions it is considered that there is a free surface of liquid in ballast tanks.

3.4.5.1.1 At port the corrected initial metacentric height is to be not less than 0,15 m.

3.4.5.1.2 At sea:

.1 corrected initial metacentric height is to be not less than 0,15 m;

.2 the diagram of the static stability is to comply with the requirements of 2.2.1.

3.4.5.1.3 While calculating stability, each tank is considered to be fully loaded up to the level, at which the sum of the cargo volume moment in relation to the main plain and the inertia moment of free surface at the heel of 0° reach their maximum. The density of cargo shall fit the cargo carrying capacity at which the rise of the transverse metacentre over the main plain reaches its minimum at 100 per cent of stores and ballast (equal to 1 per cent of all ballast tanks). In calculations is to be accepted the maximum value of inertia moment of the liquid free surface in ballast tanks. In calculations of the initial metacentric height, the correction for free surface of liquids is to be based on the respective inertia moments of the free surfaces at upright ship position.

The lever of stability diagrams may be corrected on the basis of actual corrections for the effect of free surfaces of liquids for each angle of heeling.

3.4.5.2 Implementation of the requirements in 3.4.5.1 is to be ensured by design measures. For the combination carriers additional simple operation instructions may be allowed. This instructions are to:

.1 be approved by the Register;

.2 contain the list of cargo and ballast tanks which may have free surfaces during any operations with liquids and in the range of possible densities of cargo, still the above mentioned stability criteria are met;

.3 be easily understandable for the officer responsible for operations with liquids;

.4 provide possibility of planning the sequence of operations with cargo and ballast;

.5 enable to compare real stability figures with the required criteria presented in graphics and tables;

.6 do not require comprehensive mathematical calculations from the officer responsible for operations with liquids;

.7 contain instructions in respect of corrective actions to be fulfilled by the officer responsible for the operations with liquids in case of deviations from recommended figures and in case of accidents;

.8 be highlighted in Information on Stability and hang out in the cargo operations control station and put into the ship software performing stability calculations.

3.5 FISHING VESSELS

3.5.1 Stability of fishing vessels shall be checked in service for the following loading conditions:

.1 departure for fishing grounds with full stores;

.2 arrival at a port from fishing grounds with full catch in holds and on deck, if provision is made for the deck cargo in the design, and with 10 per cent of stores;

.3 arrival at a port from fishing grounds with 20 per cent of catch in holds or on deck (if provision is made in the design for stowage of cargo on deck), 70 per cent of ice and salt rating and 10 per cent of stores;

.4 departure from fishing grounds to transfer the catch with full catch and amount of stores ensuring the ship's draught up to the load line.

3.5.2 The amount of full catch is determined depending on the ship's type, capacity of cargo spaces and stability characteristics. It shall correspond to the load line position approved by the Register and shall be specified in stability calculations, as well as in the Information.

3.5.3 For net fishing vessels, allowance is to be made for wet fishing nets on deck in the second, third and fourth loading conditions.

3.5.4 Stability of a ship, while being on fishing grounds, shall be checked for compliance with the weather criterion for the following loading conditions: a vessel engaged in fishing, with no catch in holds and the hatches of the holds open, catch and wet nets stowed on deck, 25 per cent of stores and full amount of ice and salt. For vessels where nets and catch are hauled in with the help of cargo booms, account shall also be taken of cargo which is hoisted, with the cargo weight equal to the boom safe working load. The amount of catch allowed to be stowed on deck shall be specified both in the vessel's design and the Information.

3.5.5 The ship's amplitude of roll in the loading condition specified in 3.5.4 is assumed to be 10° and the angle of heel at which the coaming of a cargo hatch immerses is regarded as the angle of the ship's flooding through openings considered open. Wind pressure in this loading condition for vessels of unrestricted service is assumed as that for ships of restricted area of navigation **I**, the wind pressure for vessels of restricted area of navigation **I** as that for ships of restricted area of navigation **II**, the wind pressure for vessels of restricted area of navigation **II** as that for these ships reduced by 30 per cent.

For ships having a length between 24 m and 45 m, which keels are laid or modernization is commenced on or after 1 July 2002, the initial wind pressure shall be adopted from Table 2.1.7.1.

3.5.6 The curve of statical stability for ships in the loading condition of 3.5.4 limited by the angle of flooding cutting it short need not comply with the requirements set forth in 2.2.1.

For ships, which keels are laid (modernization is commenced) on or after 1 July 2002 and for which the statical stability curve requirements cannot be met in case when relevant fish holds partially or fully flooded, the heeling angle at which progressive flooding of fish holds may occur through hatches remaining open during fishing operations is not to be less than 20°.

3.5.7 For fishing vessels, the corrected initial metacentric height, including the light ship condition, is not to be less than 0,05 m or 0,003 of the ship's breadth, whichever is the greater.

For single-deck ships, which keels are laid or modernization is commenced on or after 1 July 2002, the corrected initial metacentric height is not to be less than 0,35 m. However, in case of ships with continuous superstructures and those which length exceeds 70 m, the corrected initial metacentric height can be reduced to 0,15 m.

3.5.8 Under all loading conditions, the ship's stability is to conform to 3.1.2 to 3.1.5, 3.1.7 to 3.1.9 where the ships are used for processing fish and other living resources of the sea and have a crew on board of more than 12 persons engaged in catching and processing only. From the point of the above requirements the crew members in question are regarded as passengers.

3.5.9 In the case of icing the parameters of the static stability curve are to be in conformity with 2.2.

For ships designed prior to the present Rules being enforced, if they undergo reconstruction, major repair, alteration or modification, the requirements of 2.4.7 apply.

3.5.10 The catch shall be duly secured in order to prevent its shifting which may cause the dangerous heel or trim of the ship. The detachable bulkheads of fish holds, if fitted, shall be of approved type.

3.6 SPECIAL PURPOSE SHIPS

3.6.1 The stability of whale factory ships, fish factory ships and other ships used for processing the living resources of the sea and not engaged in catching the same is to be checked for the following loading conditions:

.1 ship with special personnel, full stores, and full cargo of tare and salt on board;

.2 ship with special personnel, 10 per cent of stores, and full cargo of its production on board;

.3 ship in the same loading condition as in 3.6.1.2, but with 20 per cent of production and 80 per cent of tare and salt on board;

.4 ship in the same loading condition as in 3.6.1.1, but with 25 per cent of stores and the cargo being processed on board.

3.6.2 The stability of research, expeditionary, hydrographic, training and similar ships is to be checked for the loading conditions below:

.1 ship with special personnel and full stores on board;

.2 ship in the same loading condition as in 3.6.2.1, but with 50 per cent of stores on board;

.3 ship in the same loading condition as in 3.6.2.1, but with 10 per cent of stores on board;

.4 ship in the same loading conditions as in 3.6.2.1, 3.6.2.2 and 3.6.2.3, but with full cargo on board if the carriage of the latter is envisaged.

3.6.3 The stability of special purpose ships is to be in accordance with 3.1.2 to 3.1.5, 3.1.7 to 3.1.9. From the point of view of the above requirements special personnel is to be regarded as passengers.

3.6.4 For special purpose ships that are similar to supply vessels, on agreement with the Register, the requirements for the static stability curve may be reduced, as stated in 3.11.5.

3.6.5 For whale factory ships, fish factory ships and other ships used for processing the living resources of the sea, the requirements of 3.5.7 concerning the initial metacentric height apply.

3.6.6 For whale factory ships, fish factory ships and other ships used for processing the living resources of the sea, the requirements of 3.5.9 for the static stability curve in the case of icing apply.

3.7 TUGS

3.7.1 General.

3.7.1.1 Stability of tugs shall be checked for the following loading conditions:

.1 ship with full stores;

.2 ship with 10 per cent of stores and for tugs provided with cargo holds, additionally;

.3 ship with full cargo in holds and full stores;

.4 ship with full cargo in holds and 10 per cent of stores.

3.7.1.2 In addition to compliance with the requirements of Section 2, the tugs shall have sufficient dynamic stability to withstand the heeling effect of an assumed transverse jerk of the tow line under the same loading conditions, that is the angle of dynamic heeling θ_{d1} due to assumed jerk of the tow line shall not exceed the limits given below.

3.7.2 Tugs for inner and outer road.

3.7.2.1 The angle of dynamic heel for tugs shall not be greater than the angle of flooding or capsizing, whichever is less.

To meet this requirement, the following condition is to be satisfied:

$$K_1=\sqrt{l_{d\,caps}/l_{d\,h}} \geqslant 1{,}00 \qquad (3.7.2.1)$$

where $l_{d\,caps}$ = arm of dynamical stability defined as an ordinate of the dynamic stability curve for a tug at the angle of heel equal to the angle of flooding (see 3.7.2.3) or capsizing θ_{caps} determined disregarding roll, whichever is less, in m;

$l_{d\,h}$ = dynamic heeling arm characterizing the assumed jerk effect of the tow line, in m.

3.7.2.2 The dynamic heeling arm $l_{d\,h}$, in m, shall be determined from the formula

$$l_{d\,h}=l'_v\left(1+2\,\frac{d}{B}\right)\frac{b^2}{(1+c^2)(1+c^2+b^2)} \qquad (3.7.2.2\text{-}1)$$

where l'_v = the height of the velocity hydraulic pressure head, in m. The values of l'_v are obtained from Table 3.7.2.2 depending on the power N_e of the ship's main engines;

$$c=4{,}55x_H/L; \qquad (3.7.2.2\text{-}2)$$

$$b=\frac{(z_H/B)-a}{e}; \qquad (3.7.2.2\text{-}3)$$

a and e are determined from the formulae:

$$a=\frac{0{,}2+0{,}3(2d/B)^2+\frac{z_g}{B}}{1+2\,\frac{d}{B}}; \qquad (3.7.2.2\text{-}4)$$

$$e = 0{,}145 + 0{,}2\frac{z_g}{B} + 0{,}06\frac{B}{2d}. \qquad (3.7.2.2\text{-}5)$$

Table 3.7.2.2

Height of velocity hydraulic pressure head l'_v

N_e, in kW	l'_v, in m	N_e, in kW	l'_v, in m
0 — 150	0,0862	900	0,147
300	0,0903	1050	0,18
450	0,096	1200	0,22
600	0,104	1350	0,268
750	0,122	1500 and over	0,319

3.7.2.3 When checking stability of tugs for the tow line jerk effect, the angle of flooding shall be determined assuming that all doors leading to engine and boiler casings and to the upper deck superstructures, as well as the doors of all companionways to the spaces below the upper deck, irrespective of their design, are open.

3.7.2.4 When checking stability of tugs for the tow line jerk effect, no account shall be taken of icing and free surfaces of liquid cargoes.

3.7.2.5 If special appliances are available for shifting the tow hook downwards or abaft, with the tow line athwartships, the assumption of x_H and z_H differing from values given above is subject to special consideration by the Register in each particular case.

3.7.3 Tugs for ocean towage.

3.7.3.1 The angle of heel for tugs due to the tow line jerk under rolling shall not exceed the angle corresponding to the maximum of the statical stability curve or the angle of flooding, whichever is less. (The requirements of 3.7.2.3 are not applicable to tugs for ocean towage).

To satisfy this condition the following requirement is to be met:

$$K_2 = \sqrt{l_{d\,\max}/l_{d\,h}} - \Delta K \geqslant 1{,}0 \qquad (3.7.3.1\text{-}1)$$

where $l_{d\max}$ = ordinate of the dynamical stability curve at an angle of heel corresponding to the maximum of the statical stability curve or the angle of flooding, whichever is less, in m;

l_{dh} = dynamic heeling arm determined in compliance with 3.7.2.2, with l'_v assumed to be 0,20 m;

ΔK = component of K_2 used to allow for the effect of rolling on resultant angle of heel and determined from the formula

$$\Delta K = 0{,}03\theta_{2r}\left[\frac{1+c^2}{b} - \frac{1}{e}\left(a - \frac{z_g}{B}\right)\right]\sqrt{\frac{h_0}{1+2\dfrac{d}{B}}} \qquad (3.7.3.1\text{-}2)$$

where θ_{2r} is obtained in compliance with 2.1.3, or with 2.1.8, as applicable, in deg.;

c, b, a, e are determined in accordance with 3.7.2.2.

3.7.3.2 When checking stability of tugs:

.1 3.7.2.5 is valid;

.2 for curves of statical stability with two maxima or an extended horizontal region, the value of the angle at the first maximum or that corresponding to the middle of the horizontal region should be taken as the angle of maximum specified in 3.7.3.1;

.3 stability for the tow line jerk effect is to be checked taking no account of the free surfaces of liquid cargoes.

3.7.3.3 When checking stability of tugs for compliance with the requirements of Section 2 and this Chapter, the icing rates are assumed to be:

.1 for tugs specially designed for salvage operations, twice as much those given in 2.4;

.2 for other tugs, in accordance with 2.4.

3.7.3.4 Where a tug for ocean towage may be used for inner and outer road operations as well, compliance of such a tug with 3.7.2 is subject to special consideration by the Register.

3.8 VESSELS OF DREDGING FLEET

3.8.1 Working conditions.

"Working conditions" means operation of a vessel according to its purpose within the prescribed operation zones:

.1 Zone 1 — coastal zone up to 20 miles from the coast;

.2 Zone 2 — zone including the prescribed area of navigation of a vessel.

3.8.2 Loading conditions.

Depending on the type of a vessel of dredging fleet and its dredging gear the following conditions of loading are to be considered.

3.8.2.1 For vessels of dredging fleet of all types during voyages:

.1 vessel with full stores, without spoil, dredging gear being secured for sea;

.2 vessel in the same loading condition as in 3.8.2.1.1, but with 10 per cent of stores.

3.8.2.2 In operating conditions for hopper dredgers and hopper barges:

.1 vessel with full stores, with spoil in the hopper, dredging gear being secured for sea;

.2 vessel in the same loading condition as in 3.8.2.2.1, but with 10 per cent of stores.

For hopper dredgers equipped with grab cranes additional loading conditions, such as with grab cranes operating from one side and crane boom being in the athwartship plane, with spoil in the grab, with maximum loading moment and also with the highest position of the boom with due regard to initial heel are to be considered. These conditions are to be considered for a vessel with 10 per cent of stores and full stores, both with spoil and without it.

Notes: 1. The mass of spoil in the grab is taken to be 1,6*V* t where *V* is the volume of the grab, in m^3.

2. The quantity of spoil in the hopper and the position of the centre of gravity is to be determined assuming that the hopper is filled with homogeneous spoil up to the level of the upper discharge holes or the upper coaming edge, if the discharge holes are not provided, with the vessel having a draught up to the load line permitted when dredging.

3.8.2.3 In operating conditions for dredgers equipped with bucket ladder:

.1 vessel with full stores, with spoil in buckets, ladder being secured for sea;

.2 vessel in the same loading condition as in 3.8.2.3.1, but with 10 per cent of stores.

Note. Spoil is taken into the buckets of the upper part of the ladder (from upper to lower drum). The mass of spoil in each bucket is taken to be 2*V* t where *V* is the full volume of the bucket, in m^3.

3.8.2.4 In operating conditions for dredgers, other than those equipped with bucket ladder:

.1 vessel with full stores, with dredging gear in the highest position possible in normal operation;

.2 vessel in the same loading condition as in 3.8.2.4.1, but with 10 per cent of stores.

For dredgers equipped with grab cranes the additional loading conditions are to be considered in compliance with 3.8.2.2.

Notes: 1. Spoil pipeline within the vessel is assumed to be filled with spoil having density equal to 1,3 t/m^3.

2. The mass of spoil in the grab (bucket) is assumed to be 1,6*V* t where *V* is the volume of the grab (bucket), in m^3.

3.8.3 Form stability calculation and inclining test.

3.8.3.1 When determining the lever of form stability for vessels of dredging fleet, the manholes of air spaces may be considered closed irrespective of the coaming height if they are fitted with covers conforming to 7.9, Part III "Equipment, Arrangements and Outfit".

3.8.3.2 Hopper barges, dredgers and other vessels in which the watertight integrity of their hoppers cannot be achieved due to the structural peculiarities may be inclined with water in the hoppers which communicates easily with sea water.

3.8.4 Checking of stability in working conditions and during voyages.

3.8.4.1 Stability of vessels of dredging fleet during voyages is to be calculated having regard to the area of navigation prescribed to the vessel concerned. To be stated both in the specification and in the Information on Stability are the conditions of voyages, if any (ballast water available, extent to which the dredging gear is dismantled, the position of the ladder, the possibility of spoil transportation in the hopper beyond the limits of 20-mile coastal zone, etc.). The dredgers equipped with a ladder may undertake voyages in the unrestricted area of navigation only with the bucket chain dismantled.

3.8.4.2 When calculating stability of vessels of dredging fleet under working conditions, the following is assumed:

.1 in zone 1 wind pressure is to be taken: for vessels of unrestricted service as for ships of restricted area of navigation I; for vessels of restricted area of navigation **I** as for this area, but reduced by 25 per cent; for other areas of navigation, as for restricted area of navigation **II**; amplitude of roll, as for restricted areas of navigation;

.2 in zone 2 wind pressure and amplitude of roll are to be taken in accordance with area of navigation prescribed for the vessel concerned.

3.8.4.3 The amplitude of roll of vessels of dredging fleet having no cut-out in the hull, bilge keels, bar keel is determined by the Formula (2.1.3.1) and Tables 2.1.3.1-1, 2.1.3.1-3 and 3.8.4.3-1.

For restricted areas of navigation **I** and **II** the amplitude of roll obtained from the Formula (2.1.3.1) is to be multiplied by the factor X_3 whose values are given in Table 3.8.4.3-2.

The bilge keels or bar keel are to be taken into account in compliance with 2.1.3.2.

For vessels with sharp bilges the provisions of 2.1.3.3 shall be taken into consideration.

For hopper dredgers and hopper barges having bottom recesses for flaps factor X_1 is determined from the ratio *B/d* multiplied by coefficient $(\nabla+\nabla_B)/\nabla$ where ∇

Table 3.8.4.3-1

Factor X_1

Type of vessel	*B/d*												
	2,5	2,75	3,0	3,25	3,5	3,75	4,0	4,25	4,5	4,75	5,0	5,25	5,5
Dredger	1,08	1,06	1,04	1,02	1,0	0,99	0,98	0,96	0,94	0,91	0,9	0,9	0,9
Hopper dredger and hopper barge	1,12	1,09	1,06	1,03	1,01	0,98	0,96	0,94	0,92	0,9	0,88	0,85	0,83

Table 3.8.4.3-2

Factor X_3

$\sqrt{h_0}/B$	0,04 and less	0,05	0,06	0,07	0,08	0,09	0,1	0,11	0,12	0,13	0,14	0,15	0,16	0,17	0,18	0,19	0,2 and more
X_3	1,27	1,23	1,16	1,08	1,05	1,04	1,03	1,02	1,01	1,0	1,0	1,01	1,03	1,05	1,07	1,10	1,13

is the volume displacement of the vessel with no regard to recess, in m^3; ∇_B is the volume of bottom recess, in m^3.

The roll amplitudes of dredgers, which keels are laid or modernization is commenced on or after 1 July 2002 and which have no dredging cut-out in the hull, bilge keels and bar keel are to be determined from the Formula (2.1.8.1) and Tables 2.1.8.1-1, 2.1.8.1-2 and 2.1.8.1-3. For ships with sharp bilges the provision of 2.1.8.3 shall be considered.

3.8.4.4 Stability of dredgers and hopper dredgers equipped with grab cranes when additional loading conditions (see 3.8.2.2) are considered is to meet the requirements of 4.1.

3.8.4.5 Stability of hopper dredgers and hopper barges whose construction of bottom flaps and their drive does not prevent the possibility of spoil discharge from one side shall be checked with due regard to such discharge only for compliance with weather criterion as specified in 3.8.4.6 and 3.8.4.7 for the most unfavourable loading condition out of first and second (see 3.8.2.2):

.1 where spoil in the hopper, having density less than 1,3 t/m^3 with static heeling angle θ_{BC_1}, and amplitude of roll 10°;

.2 where spoil in the hopper, having density equal to, or more than, 1,3 t/m^3 with regard to dynamic character of discharge, with amplitude of roll equal to the sum of 10° and the maximum amplitude of vessel's rolling θ_{3r} with respect to statical inclination just after the spoil discharge.

The value of θ_{3r}, in deg., is determined from the formula

$$\theta_{3r} = 0{,}2\theta_{BC_1}. \qquad (3.8.4.5.2)$$

The recommended procedure for determination of capsizing moment is given in 1.2 of Appendix 2.

3.8.4.6 The value of horizontal shifting of the vessel's centre of gravity y_g, in m, when discharging half the spoil from one side out of fully loaded hopper, is determined from the formula

$$y_g=Py/(2\Delta) \qquad (3.8.4.6\text{-}1)$$

where P = total mass of spoil in the hopper, in t;
y = distance from the centre of gravity of spoil discharged from one side to the centre plane, in m;

$$\Delta = \Delta_{\max} - P/2 \qquad (3.8.4.6\text{-}2)$$

where $\Delta_{\max}$ = vessel's displacement prior to spoil discharge, in t.

3.8.4.7 The vessel's curves of statical and dynamical stability, in m, are calculated from the formulae:

$$l_1=l - y_g \cos\theta; \qquad (3.8.4.7\text{-}1)$$

$$l_{d1}=l_d - y_g \sin\theta \qquad (3.8.4.7\text{-}2)$$

where l and l_d = arms of statical and dynamical stability with the vessel's displacement $\Delta_{\max}$ calculated assuming that the vessel's centre of gravity coincides with the centre plane.

3.8.4.8 When spoil is discharged by long chute or conveyor methods, stability of a dredger shall be checked for the case of statical action of the moment due to the mass forces of the long chute or the conveyor (in the athwartship plane) filled with spoil (with no regard to the waves and wind effects). In this case, the vessel's stability is considered to be adequate, if maximum statical heel is not more than the angle of flooding or the angle at which the freeboard becomes equal to 300 mm, whichever is less.

3.8.5 Effect of liquid cargoes.

When calculating the effect of liquid cargoes as specified in 1.4.7 for hopper dredgers and hopper barges, it shall be assumed that:

.1 for a vessel with spoil having density over 1,3 t/m^3, the spoil is regarded as solid non-overflowing cargo; the lever of statical and dynamical stability is determined for the constant displacement and position of the spoil centre of gravity in the hopper;

.2 for a vessel with spoil having density equal to, or less than 1,3 t/m^3 the spoil is regarded as liquid cargo; the lever of statical and dynamical stability is determined at the variable displacement and position of the spoil centre of gravity, taking account of the spoil flowing overboard and reduction of the vessel's draught.

No such calculation is carried out if the vessel is provided with a longitudinal bulkhead in the hopper, the spoil in the latter case being regarded as solid cargo;

.3 for a vessel without spoil, the hopper is in communication with sea water, that is flaps or valves are open. The lever of statical and dynamical stability is determined for the constant displacement (as for a damaged vessel).

3.8.6 Effect of dredging gear icing.

When estimating the effect of icing of vessels of dredging fleet, the horizontal projection of dredging gear is added to the area of horizontal projection of decks (the centre plane projection being included in the windage area). The vertical moment due to this additional ice load is determined by the centre of gravity elevation of the projection of the dredging gear in its working or secured for sea position to the centre line.

3.8.7 Curve of statical stability.

3.8.7.1 The curve of statical stability of hopper dredgers and hopper barges during voyages and under working conditions is to meet the requirements of 2.2.

3.8.7.2 The curve of statical stability of dredgers equipped with bucket ladder for all loading conditions specified in 3.8.2, as well as when taking account of icing, shall comply with the following requirements:

.1 the angle of vanishing stability θ_v shall be not less than 50°;

.2 the maximum lever of the curve with angle θ_m of not less than 25° is to be:

when vessels are operating in zone 1, not less than 0,25 m;

during voyages, passages and when operating in zone 2, not less than 0,4 m.

3.8.7.3 For bucket dredgers having B/D>2,50, angles θ_v and θ_m may be reduced as compared to those required in 3.8.7.2 by the following values:

.1 for the angle of vanishing stability, by the value $\delta\theta_v$ to be determined from the following formula depending on the B/D ratio and the weather criterion K and provided the reduction by every 1° is accompanied with an increase of $l_{\max}$ by 0,01 m as compared to its normative value:

$$\delta\theta_v = 25^\circ(B/D - 2{,}5)(K - 1). \qquad (3.8.7.3.1)$$

Where B/D > 3,0, B/D=3,0 shall be adopted, and where K >1,5, K = 1,5 shall be adopted. The value of $\delta\theta_v$ is rounded off to the nearest integer;

.2 for the angle corresponding to the maximum lever of the curve, by a value equal to half the reduction value of the angle of vanishing stability;

.3 for dredgers of unrestricted service the reduction of angles θ_m and θ_v is not permitted.

3.9 SHIPS UNDER 24 M IN LENGTH

3.9.1 When determining the lever of form stability, it is possible to take into consideration deckhouses of the first tier only which conform to 1.4.2.3.1 and from which there is either an additional exit to the deck above or exits to both the sides.

3.9.2 Stability as to weather criterion is not to be checked. However, for the operation of the ships, restrictions on the distance to the port of refuge and the sea state shall be introduced.

For small ships, restrictions on the area and conditions of navigation shall be set down and included in the Information on Stability.

3.9.2.1 For ships of less than 15 m in length and passenger ships of less than 20 m in length restricted area of navigation **III** may be prescribed.

For ships 15 m to 20 m in length, other than passenger ships, an area of navigation not higher than **II** may be prescribed.

For ship 20 to 24 m in length, other than passenger ships, an area of navigation not higher than **I** may be prescribed.

3.9.2.2 Non-passenger ships of less than 15 m in length may proceed to sea and be en route at sea state not more than 4, ships 15 m to 20 m in length — not more than 5; ships 20 to 24 m — not more than 6;

3.9.2.3 Passenger ships of less than 20 m in length may proceed to sea and be en route at sea state not more than 3; ships 20 to 24 m — not more than 4;

3.9.2.4 Having regard to stability and seaworthiness of ships and depending on the reliable provision of the area of navigation concerned with forecasts, as well as on the operating experience for ships of similar type and the same or approximately the same dimensions, available for this area of navigation, the Register may change the restrictions on the area of navigation and permissible sea state specified in 3.9.2.1 to 3.9.2.3.

3.9.2.5 When determining maximum permissible sea state for small craft carried on depot ships (for example, small fishing boats carried on mother ships), in addition to the provisions of 3.9.2.2 and 3.9.2.3, maximum sea state at which the craft can be safely lifted on board the depot ship shall be taken into account.

3.9.2.6 At the discretion of the Register, additional restrictions shall be introduced in zones of special sea conditions.

Referred to such zones are:

zones of surf (breaking) waves;

zones of local abrupt increase in wave height and steepness (bars in estuaries, tossing, etc.).

Zones of special sea conditions are set on the basis of the data of local hydrometeorological and hydrographic offices.

3.9.3 For ships having B/D>2 the permissible reduction of the angle of vanishing stability is to be determined from the Formula (2.2.2.1) for the constant K = 1,5.

3.9.4 Cutting the static stability curve short at the angle of flooding permitted by 2.2.4 is prohibited at heeling angles less than 40°.

3.9.5 The static stability curve of a fishing vessel, when on fishing grounds, under the loading conditions stated in 3.5.4 may not conform to the requirements of 2.2.1 for the maximum lever and the requirements of 2.2.4 for the conventional angle of vanishing stability. Under those loading conditions, the maximum lever of the static stability curve is not to be less than 0,2 m.

3.9.6 Under all loading conditions, the corrected initial metacentric height is not to be less than 0,5 m, except for the light ship condition (see 2.3.1) and the fishing vessels when under loading conditions stated in 3.5.4 for which it is not to be less than 0,35 m.

3.9.7 The initial stability of fishing vessels hauling in the nets and catch with cargo booms is to be sufficient (under loading conditions stated in 3.5.4 as well) to ensure that the static heel angle of the ship when handling the nets and operating the cargo boom at its maximum outreach would not exceed 10° or the angle at which the deck is immersed (whichever is less).

3.9.8 Operation of the ships under conditions of eventual icing is not, in general, to be permitted.

Where due to the mode of operation and purpose the possibility of sailing into regions where icing might occur cannot be completely rulled out for a ship, the values of initial metacentric height and other parameters of static stability curves drawn taking icing into consideration are not to be less than those stated in 2.2, 3.9.3, 3.9.4 and 3.9.6.

3.9.9 Information on Stability is to include indications of the permissible speed and angle of rudder shifting in turning. The permissible values of initial turning speed and angle of rudder shifting are to be determined by tests during acceptance trials of the leading ship assuming that the list of the ship in steady turning shall not exceed:

.1 for non-passenger ships, the angle at which the freeboard deck is immersed or 12°, whichever is less;

.2 for passenger ships, taking account additionally of the effect of the simulated heeling moment due to passengers crowding to one side (to be determined in accordance with 3.1.2), the angle at which the freeboard deck is immersed or 15°, whichever is less.

The Register may apply the provisions of 3.9.9.2 to the stability of non-passenger ships (for instance, when persons not belonging to the ship's crew are on board).

The requirements of 3.1.3 and 3.1.4 are not applicable to ships of less than 24 m in length.

3.9.10 The initial stability of passenger ships is to be checked for conformity with 3.1.2. The angle of heel due to passengers crowding to one side is not to be greater than the angle corresponding to 0,1 m freeboard before the deck is immersed or 12°, whichever is less.

If necessary, the Register may apply the requirements of 3.1.2 to the stability of non-passenger ships (for instance, when persons are on board who are not members of the regular crew). In this case, the heel is determined on the assumption that all persons crowd to one side who are not engaged in handling the ship.

3.9.11 In the Information on Stability it shall be specified that when the ship is under way in following seas, with the wave length equal to, or exceeding the length of the ship, its speed v_s, in knots, is not to be greater than obtained from the formula

$$v_s = 1{,}4\sqrt{L} \qquad (3.9.11)$$

where L = length of the ship, in m.

3.9.12 Application of the requirements of 3.7 to the stability of tugs under 24 m in length is subject to special consideration by the Register in each case.

3.10 CONTAINER SHIPS

3.10.1 In calculating stability of container ships, the vertical centre of gravity position of each container shall be taken equal to half the height of the container of the type concerned.

3.10.2 Stability of container ships shall be checked for the following loading conditions:

.1 ship with maximum number of containers, each loaded container having the mass equal to one and the same part of the maximum gross mass for each type of containers, with full stores at the draught up to the summer load line;

.2 ship in the same loading condition as in 3.10.2.1, but with 10 per cent of stores;

.3 ship with maximum number of containers, each loaded container having the mass equal to 0,6 of the maximum gross mass for each type of containers, with full stores;

.4 ship in the same loading condition as in 3.10.2.3, but with 10 per cent of stores;

.5 ship with containers, each loaded container having the mass equal to the maximum gross mass for each type of containers, with full stores at the draught up to the summer load line;

.6 ship in the same loading condition as in 3.10.2.5, but with 10 per cent of stores;

.7 ship with maximum number of empty containers, but with full stores;

.8 ship in the same loading condition as in 3.10.2.7, but with 10 per cent of stores;

.9 ship with no cargo, but with full stores;

.10 ship in the same loading condition as in 3.10.2.9, but with 10 per cent of stores.

When determining the arrangement of containers on board under the loading conditions mentioned above, the allowable loads upon the hull structures shall be considered.

3.10.3 If other loading conditions different from those listed in 3.10.2 are provided in the technical assignment, stability calculations are also to be made for such conditions with full stores and 10 per cent of stores.

3.10.4 Stability of container ships for any loading condition with containers shall be such that a heeling angle on steady turning or under the effect of continuous beam wind as determined from the statical stability curve does not exceed half the angle at which the freeboard deck immerses; in any case, the heeling angle shall not exceed 15°.

Where the deck cargo of containers is located on cargo hatch covers only, on agreement with the Register, the angle at which the hatch coaming edge or a container is immersed, whichever angle is less, may be adopted instead of the angle at which the upper deck edge is immersed (provided the containers protrude beyond the coaming in question).

3.10.5 The heeling moment on steady turning is determined, in kN·m, from the formula

$$M = \frac{0{,}037\Delta v_s^2}{L}\left(z_g - \frac{d}{2}\right) \qquad (3.10.5)$$

where v_s = ship's speed before entering into manoeuvre, in knots;
Δ = displacement, in t.

3.10.6 The heeling moment due to wind pressure used to determine the heeling angle in conformity with

3.10.4 shall be calculated by the Formula (2.1.2.1) in which p_v is taken equal to 0,6 of the values given in Table 2.1.2.2 for ships of unrestricted service.

3.10.7 All calculations of statical heeling angle under the effect of beam wind or turning shall be made with no regard for icing, but having regard for the free surface effect of liquid cargoes as required by 1.4.7.

3.10.8 The corrected initial metacentric height of container ships under loading conditions with containers on board and icing disregarded is not to be less than 0,15 m.

3.10.9 Container ships shall be equipped with tanks or other specific facilities approved by the Register, which permit to check the initial stability of the ship, bearing in mind the Register approved requirements for the in-service inclining test.

3.10.10 The requirements of this Part are applicable to ships of other types appropriated for the carriage of cargoes in containers on deck.

Where, acting in line with 3.10.2.1 and 3.10.2.5, it is not possible to load the ship to the summer load line the ship may be considered for the relevant loading conditions at the maximum draft possible.

3.11 SUPPLY VESSELS

3.11.1 The present Chapter applies to supply vessels 24 to 100 m in length. If the length of the supply vessel is over 100 m, the requirements for its stability are to be specially considered by the Register.

3.11.2 The stability of supply vessels is to be checked considering the trim that accompanies the inclination.

3.11.3 In addition to the loading conditions listed in 1.4.8.2, the stability of supply vessels is to be checked for the following loading conditions:

.1 ship with full stores and full deck cargo having the greatest volume per weight unit, prescribed by the technical assignment in the most unfavourable case of distribution of the rest of the cargo (when pipes are carried as deck cargo — taking the water entering the pipes into consideration);

.2 ship in the same loading condition as under 3.11.3.1, but with 10 per cent of stores.

3.11.4 The volume of water V_a lingering in the pipes carried on deck is to be determined by the Formula (3.11.4) proceeding from the total volume of the pipe pile V_{at} and the ratio of the freeboard amidships f to the ship's length L. The volume of a pipe pile is to be regarded as the sum of the inner volumes of the pipes and spaces between them

$$V_a = \begin{cases} 0{,}3\,V_{at} & \text{if } \dfrac{f}{L} \leqslant 0{,}015; \\ \left(0{,}5 - \dfrac{40}{3}\dfrac{f}{L}\right)V_{at} & \text{if } 0{,}015 < \dfrac{f}{L} < 0{,}03; \\ 0{,}1\,V_{at} & \text{if } \dfrac{f}{L} \geqslant 0{,}03. \end{cases} \qquad (3.11.4)$$

Reducing of the design value for the volume of water in the pipes, where they are plugged or where the pipe pile is higher than 0,4 of the draught, shall be determined on agreement with the Register.

3.11.5 In the case of supply vessels having B/D>2, the angle corresponding to the maximum lever of the curve of statical stability may be reduced to 25° and the angle of vanishing stability may be reduced to 50°; the maximum lever $l_{\max}$, in m, and the weather criterion K values are not to be less than the greatest values determined from the following formulae:

$$l_{\max} \geqslant 0{,}25 + 0{,}005(60^\circ - \theta_v)$$

or

$$l_{\max} \geqslant 0{,}25 + 0{,}01(30^\circ - \theta_m); \qquad (3.11.5\text{-}1)$$

$$K \geqslant 1 + 0{,}1(30^\circ - \theta_m)$$

or

$$K \geqslant 1 + 0{,}05(60^\circ - \theta_v). \qquad (3.11.5\text{-}2)$$

3.11.6 When the effect of icing is computed, the upper surface of the deck cargo is to be considered as the deck, and its lateral area projection above the bulwark — as a part of the design windage area. The icing allowance is to be assumed in accordance with 2.4.

3.11.7 For supply vessels operating in areas where icing is possible, the ice and water in the pipes should be considered simultaneously when making stability calculations for the carriage of pipes on deck. The icing of pipes carried on deck should be determined as follows: the mass of ice M_{ice} inside the pipe pile is determined from the formula

$$M_{ice} = \sum_{i=1}^{k} m_{icei}\, n_i \qquad (3.11.7)$$

where m_{ice_i} = mass of ice per one pipe, obtained from Table 3.11.7;
n_i = quantity of pipes of the i-th diameter;
k = number of standard pipe sizes with regard to diameter.

When calculating the mass of ice on the outer surfaces of a pipe pile, the area of the upper and the side

Table 3.11.7

Pipe diameter, in m	0,05	0,1	0,2	0,3	0,4	0,5	0,6
Ice mass per one pipe, in kg	0,2	2,1	26,7	125	376	899	1831
Note. For pipes of intermediate diameters, the mass of ice is determined by interpolation.							

surfaces should be determined taking the curvature of the pipe surface in the pile into consideration. The rate of icing is adopted in accordance with 2.4.

3.11.8 Supply vessels which may be engaged in towing operations as well are to comply with 3.7.

Besides, arrangements for quick releasing of the tow line are to be provided on board.

3.11.9 Supply vessels which may be engaged in operation of lifting the anchors of mobile offshore drilling units as well are to comply with the requirements of 4.1 of the present Part.

3.12 SHIPS OF RIVER-SEA NAVIGATION

3.12.1 Stability of ships of river-sea navigation (restricted areas of navigation **IICП** and **IIICП** according to 2.2.5, Part I "Classification") shall meet the requirements of Sections 1 and 2, as well as additional requirements of Section 3 (depending on the purpose of the ship).

Besides, the stability of dry cargo ships shall be checked by acceleration criterion in compliance with 3.12.3.

3.12.2 The stability of dry cargo ships of the restricted area of navigation **IICП** shall be checked for the loading conditions listed in 3.2, as well as for the case of holds partly filled with heavy cargoes (ore, scrap metal, etc.) at the draught to the load line.

3.12.3 The stability as concerns the acceleration criterion K^* is considered satisfactory if in the loading condition under consideration the calculated acceleration (in fractions of g) does not exceed the permissible value, i.e. the following condition is fulfilled:

$$K^* = 0{,}3/a_{cal} \geqslant 1 \qquad (3.12.3)$$

where a_{cal} = calculated value of acceleration (in fractions of g) obtained from the formula

$$a_{cal} = 1{,}1 \cdot 10^{-3} B m^2\ \theta_r;$$

$m = m_0/\sqrt{h_0}$ = regulated frequency of natural oscillations of the ship;

m_0 = coefficient obtained from Table 3.12.3 depending on $\frac{h_0}{\sqrt[3]{\nabla}}\ \frac{B}{z_{g;}}$;

θ_r = calculated amplitude of roll determined in accordance with 2.1.3 and 3.12.5, in deg.;

∇ = displacement of the ship, in m^3.

Table 3.12.3

Coefficient m_0

$\frac{h_0}{\sqrt[3]{\nabla}}\ \frac{B}{z_g}$	m_0	$\frac{h_0}{\sqrt[3]{\nabla}}\ \frac{B}{z_g}$	m_0
0,10 and less	0,34	1,0	1,96
0,15	0,42	1,5	2,45
0,25	0,64	2,0	2,69
0,50	1,13	2,5	2,86
0,75	1,58	3,0 and more	2,94

3.12.4 In certain cases, upon well-grounded presentation by the shipowner, Register may allow the operation of the ship with the the critetion $K^*<1$. In this case, an additional wave height restriction is to be introduced. The permissible wave height with 3 per cent probability of exceeding level is estimated proceeding from the value of the criterion K^* as given in Table 3.12.4.

The specific loading conditions with $K^*<1$ shall be stated in the Information on Stability.

Table 3.12.4

K^*	1,0 and more	1,0 — 0,75	0,75 and less
Permissible wave height with 3 per cent probability of exceeding level, in m	6,0	5,0	4,0

3.12.5 When calculating the roll amplitudes for ships of river-sea navigation with parameters $\sqrt{h_0}/B > 0{,}13$ and $B/d > 3{,}5$, the values of factors Y and X_1 shall be taken from Tables 3.12.5-1 and 3.12.5-2, respectively.

In sound cases the roll amplitude for ships of the restricted area of navigation **IIICП** may be reduced on agreement with the Register.

Table 3.12.5-1

Factor Y

$\sqrt{h_0}/B$	0,13	0,14	0,15	0,16	0,17	0,18	0,19	0,2 and over
Y	32,0	32,5	33,0	33,5	34,0	34,2	34,5	34,8

Table 3.12.5-2

Factor X_1

B/d	<2,4	2,6	2,8	3,0	3,2	3,4	3,5	3,6	4,0	4,5	5,0	5,5	>6,0
X_1	1,00	0,96	0,93	0,90	0,86	0,82	0,80	0,80	0,80	0,86	0,92	0,97	1,00

4 REQUIREMENTS FOR THE STABILITY OF FLOATING CRANES, CRANE SHIPS, TRANSPORT PONTOONS, DOCKS AND BERTH-CONNECTED SHIPS

4.1 FLOATING CRANES AND CRANE SHIPS[1]

4.1.1 General.

4.1.1.1 The requirements of the Chapter cover floating cranes and crane ships for which the hook load mass exceeds 0,02Δ, in t, under one type of loading conditions at least, as stipulated in 4.1.3.1, or at least one of the following conditions is met:

$$|y_g|>0,05h \qquad (4.1.1.1\text{-}1)$$

or

$$|x_g-x_c|>0,025H. \qquad (4.1.1.1\text{-}2)$$

Compliance with the requirements of the Chapter may be demanded by the Register even where the above conditions are not met.

4.1.1.2 As far as unique (single-time, episodical) cargo-handling operations are concerned, particular requirements for the stability of floating cranes and crane ships may be omitted or lowered, if a project of the operations is developed and it is demonstrated to the satisfaction of the Register that special technical and organizational measures have been taken to avoid certain dangerous situations (load drop, etc.).

4.1.1.3 The design centre of gravity position of the load on the hook is assumed to be at the point of its suspension from the boom is to be considered. If cargo-handling operations are carried out using a compound catenary suspension, i.e. two hooks (bifilar suspension), three hooks (trifilar suspension), etc., or the crane structure has an anti-swaying device, or the movement of suspended cargo is limited within the considered range of the floating crane/crane ship inclination angles, the stability is to be verified bearing in mind the actual shift of the cargo mass centre at inclination.

Boom radius is the distance between a vertical line drawn through the cargo suspension point with the floating foundation in the upright position and trimmed on an even keel, and

axis of the slewing crane structure rotation;

axis of rotation joint of the non-slewing crane structure boom.

For non-slewing crane structures intended for boom operation in the longitudinal plane, the stability is to be verified with regard for the possibility of unsymmetrical loading on the hooks.

4.1.2 Design conditions:

.1 working condition (cargo-handling operations and carriage of cargo in the assigned area of navigation and with the boom not secured for sea);

.2 voyage (navigation and lay-up within assigned area of navigation including both with cargo on deck and/or in hold and with the boom secured for sea);

.3 non-working condition (lay-up in port with machinery out of operation under the most unfavourable loading conditions in respect of stability and with the boom positions when there is no load on the hook);

.4 passage (navigation outside the assigned area of navigation by special permission of the Register after conversion on the basis of the Register-approved project).

4.1.3 Loading conditions.

4.1.3.1 Under working condition stability is to be verified without regard for icing and with liquid ballasting where necessary, for the following loading conditions:

.1 maximum hook load with the maximum jib radius for the load at the specified slewing angle of the crane structure φ with regard to the centre plane of the floating crane/crane ship:

with full load and full stores;

with full load and 10 per cent of stores;

without load and with full stores;

without load and with 10 per cent of stores;

.2 no hook load, highest position of the crane structure boom at the specified slewing angle of the boom φ:

with full load and full stores;

with full load and 10 per cent of stores;

without load and with full stores;

without load and with 10 per cent of stores;

.3 load drop, i.e. a quick release of the crane structure boom from the load suspended from the hook. In case of load drop, to be verified are the most unfavourable loading conditions with regard to stability, taking into consideration the possibility of unsymmetrical cargo stowage on deck and/or in the hold.

4.1.3.2 During a voyage the stability is to be verified (taking up liquid ballast where necessary) for the following loading conditions:

with full load and full stores;

with full load and 10 per cent of stores;

without load and with full stores;

without load and with 10 per cent of stores.

Where a deck cargo of hollow structures or pipes is carried, the mass of water therein shall be considered assuming the caves in the structures (taking account of

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[1] Relevant paragraphs of the Chapter contain precise instructions concerning the applicability of the paragraphs to both floating cranes and crane ships, exclusively to floating cranes or exclusively to crane ships respectively. In the absence of such instructions in the paragraph headings and texts, the requirements will be equally applicable to floating cranes and crane ships.

their possible icing) and the pipes to be filled with water, in accordance with 3.11.4 and 3.11.7.

4.1.3.3 Under non-working condition stability is to be verified for the most unfavourable loading conditions with regard to stability out of those mentioned under 4.1.3.1.2.

4.1.3.4 For floating cranes/crane ships engaged in winter traffic in winter seasonal zones established by the Load Line Rules for Sea-Going Ships, stability during a voyage/passage and under non-working condition shall be verified with due regard for icing and for the most unfavourable loading conditions as regards stability out of those mentioned under 4.1.3.1.2 and 4.1.3.2. In this case, the allowance for icing is to be adopted in accordance with 4.1.7.

4.1.4 Stability diagram calculation.

On agreement with the Register, the levers of stability diagrams can be calculated taking into account the hook load immersing in water during the inclinations of the floating crane/crane ship.

4.1.5 Calculation of windage area.

4.1.5.1 The designed windage area component A_{vi}, in m^2, is:

.1 a projected area restricted by the outline of a structure, item of machinery, arrangement, etc., in the case of bulk structures, deck machinery, arrangements, etc.;

.2 a projected area restricted by the structure outline with apertures between girders deducted, in case of a lattice type structure;

.3 projected area of fore beam where the beam spacing is less than the fore beam height, in the case of the structure of a boom, crane body frame, etc. comprising several beams of equal height located one after another (see Fig. 4.1.5.1.3), or

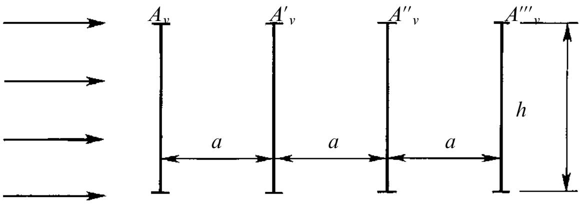

Fig. 4.1.5.1.3

$a < h$: $A_{vi} = A_v = A'_v = A''_v = A'''_v$;

$h \leqslant a < 2h$: $A_{vi} = A_v + 0{,}5(A'_v + A''_v + A'''_v)$;

$a \geqslant 2h$: $A_{vi} = A_v + A'_v + A''_v + A'''_v$

total projected area of the fore beam plus 50 per cent of the areas of subsequent beams, if the beam spacing is equal to, or greater than, the beam height, but is not less than the double height of the beam; or

total projected area of all beams, if the beam spacing is equal to, or greater than, the beam double height.

If the beams are not equal in height, parts of subsequent beams not overlapped by those lying in front of them shall be fully taken into account;

.4 for a number of ropes of the same diameter arranged one after another at the distance a (see Fig. 4.1.5.1.4-1), the projected area is to be determined from the formula

$$A_{vi}=A_v\frac{1-K_a^N}{1-K_a} \qquad (4.1.5.1.4\text{-}1)$$

where A_v= projected area of a single rope;
N = number of ropes;
K_a = factor to be taken from Table 4.1.5.1.4 on the basis of the a/d_r relationship (where d_r is the rope diameter).

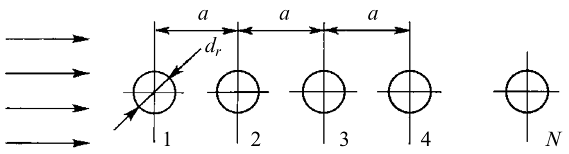

Fig. 4.1.5.1.4-1

Table 4.1.5.1.4

Factor K_a

a/d_r	3	4	5	6	7	8	9	10	20	30	40	50
K_a	0,444	0,492	0,531	0,564	0,592	0,616	0,638	0,657	0,780	0,844	0,883	0,909

Where the angle α between the rope axis and the wind velocity vector is not equal to 90° (see Fig. 4.1.5.1.4-2)

$$A_{vi}=A_v \sin^2\alpha \qquad (4.1.5.1.4\text{-}2)$$

is to be adopted.

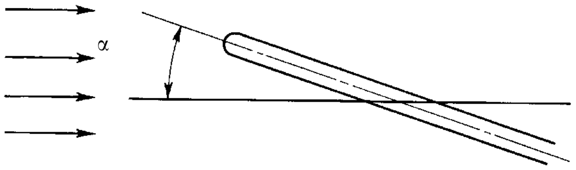

Fig. 4.1.5.1.4-2

4.1.5.2 The design arms of windage area z_v, z'_v, in m, are to be determined from the formulae:

under the effect of constant wind

$$z_v=\frac{\Sigma k_i n_i A_{vi} z_i}{\Sigma k_i n_i A_{vi}}; \qquad (4.1.5.2\text{-}1)$$

under the effect of squall

$$z'_v=\frac{\Sigma k_i A_{vi} z_i}{\Sigma k_i A_{vi}} \qquad (4.1.5.2\text{-}2)$$

where i = number of the windage area component A_{vi};
z_i = elevation of the centre of gravity of area component A_{vi} above waterline, in m;
k_i = aerodynamic flow coefficient for component A_{vi};
n_i = zone coefficient for component A_{vi}.

The values of A_v, z_v, z'_v may be determined taking trim into consideration.

4.1.5.3 For some windage area components, the aerodynamic flow coefficients k_i are to be found in Table 4.1.5.3.

Table 4.1.5.3

Aerodynamic flow coefficient K_i

Windage area components	k_i
Trusses and continuous beams	1,4
Above-water part of the hull, superstructures, deckhouses, rectangular cabins, balance weights of crane structure and other box structures with smooth outside surfaces	1,2
Isolated truss structures (crane, boom) made of:	
beams	1,5
tubular components	1,3
Tubular structures (depending on the product of the calculated dynamic wind velocity head q, in Pa, and by the square of the tube diameter d_p, in m) at:	1,2
$qd_p^2 \leqslant 10$ N;	1,2
$qd_p^2 \geqslant 15$ N.	0,7
Cargo ropes at:	
$d_r \leqslant 20$ mm;	1,2
$d_r > 20$ mm.	1,0
Deck machinery and small items on deck	1,4
Cargo (if no data are available for substantiated flow coefficient)	1,2

Notes. 1. The dynamic wind velocity head q is related to the wind pressure p by the ratio $p=k_iq$ where k_i is the aerodynamic flow coefficient.

2. For intermediate values of qd_p^2, the k_i values shall be determined by linear interpolation.

3. The values of k_i for structural elements not specified in the Table are subject to special consideration of the Register in each case.

4. The value of q corresponds to the design condition of the floating crane/crane ship under consideration according to Table 4.1.8.6-1 or Table 4.1.10.2.

4.1.5.4 The height (zone) coefficient $n_i=(V_{hi}/V_v)^2$ with regard to the increase of wind velocity V_{hi}, in m/s, according to the height of the upper border of the zone above the waterline, in which the i-th component of the windage area A_{vi} lies is to be determined from the formula

$$n_i=(V_{hi}/V_v)^2=[1+2{,}5\ln(h_{vi}/10)\sqrt{(0{,}71+0{,}071V_v)\cdot 10^{-3}}\,]^2, \qquad (4.1.5.4)$$

where V_v = design wind velocity, in m/s (average wind velocity during 10 min at a height of 10 m above sea surface);

V_{hi} = wind velocity, in m/s, within the zone at the height h_{vi} above sea surface;

h_{vi} = above-water height, in m, of the upper border of the zone in which the i-th component of the windage area A_{vi} lies (where $h_{vi} < 10$ m, the coefficient n_i = 1,00).

For particular wind velocities corresponding to different service regimes of floating sea structures, the values of the n_i coefficient can be found in Table 4.1.5.4.

4.1.5.5 For each design condition of the floating crane/crane ship (working condition, non-working condition, voyage, passage), it is recommended that the windage area of non-continuous surfaces (rails, spars, rigging and various miscellaneous surfaces) shall be taken into account by increasing the maximum total windage area of continuous surfaces by 2 per cent with regard to coefficients k_i and n_i, and by increasing the static moment of this area by 5 per cent.

Table 4.1.5.4

Height (zone) coefficient n_i

Height above sea level, in m	V_v, m/s		
	25,8	36,0	51,5
10	1	1	1
20	1,182	1,208	1,242
30	1,296	1,339	1,396
40	1,379	1,435	1,510
50	1,446	1,513	1,602
60	1,502	1,578	1,680
70	1,550	1,633	1,746
80	1,592	1,682	1,805
90	1,630	1,726	1,858
100	1,664	1,766	1,905
110	1,695	1,802	1,949
120	1,723	1,836	1,990
130	1,750	1,867	2,027
140	1,775	1,896	2,062
150	1,798	1,924	2,095
160	1,820	1,949	2,126
170	1,840	1,973	2,155
180	1,860	1,996	2,183
190	1,879	2,018	2,209
200	1,896	2,039	2,235
210	1,913	2,059	2,259
220	1,929	2,078	2,282
230	1,945	2,097	2,304
240	1,960	2,114	2,326
250	1,974	2,131	2,346

Under icing conditions this increase shall be taken 4 per cent and 10 per cent or by 3 per cent and 7,5 per cent, respectively, depending on the icing rate for areas lying up to 30 m above the waterline.

The values of non-continuous surface windage areas and of static moments of these areas are to be calculated for minimal draught and, where necessary, be recalculated for particular loading conditions and the relevant condition of the floating crane/crane ship.

4.1.5.6 The design windage area of the cargo on hook is determined by its actual outline with due regard for its aerodynamic coefficient and maximum lifting height, i.e. as stipulated in 4.1.5.1 taking account of the provisions of 4.1.5.3 and 4.1.5.4.

The centre of the wind pressure to the cargo on the hook shall be assumed at the point of the load suspension to the boom.

With no actual data available, the design windage area of cargo on the hook is adopted from Table 4.1.5.6.

4.1.6 Roll amplitude calculation.

4.1.6.1 General.

The roll amplitude shall be obtained from model tests or determined in accordance with 4.1.6.2, 4.1.6.3, 4.1.6.4[1].

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[1] The roll amplitude is obtained from model tests with 1,1 per cent probability of exceeding level.

Table 4.1.5.6

Windage area of cargo $k_i A_{vi}$

Cargo mass, in t	$k_i A_{vi}$, in m^2	Cargo mass, in t	$k_i A_{vi}$, in m^2
10	12	300	81
20	18	350	88
30	22	400	96
40	26	500	108
50	29	600	120
60	33	700	130
80	38	800	140
100	44	900	150
120	48	1000	159
140	53	1500	200
160	57	2000	235
180	61	2500	265
200	64	3000	295
225	69	3500	322
250	73	4000	348
275	77	5000	380

Note. For intermediate values of cargo mass, the values of k_i, A_{vi} shall be determined by linear interpolation.

Model tests to obtain roll amplitudes shall be carried out and their results shall be processed in accordance with the Register-approved procedures.

Where the hook load mass exceeds 0,1Δ for particular loading conditions, the Register may require the roll amplitude to be determined with regard for the effect of cargo swinging.

Wave height with 3 per cent probability of exceeding level $h_{3\%}$, in m, shall be adopted as follows:

from Table 4.1.8.6-2 in working condition on the basis of wave intensity at which cargo-handling operations are permitted;

from Table 4.1.10.2 during the voyage or passage of a floating crane proceeding from the area of navigation assigned.

The roll amplitude of a crane ship during a voyage or passage is to be determined in accordance with 4.1.6.4.

Calculated roll amplitude values determined in accordance with 4.1.6 shall be rounded to the tenth part of a degree in working condition and to whole degrees during voyage or passage.

4.1.6.2 The roll amplitude of a floating crane in a working condition, during the voyage or passage of a floating crane/crane ship.

4.1.6.2.1 The roll amplitude θ_r, in deg., of a floating crane in its calculated conditions as mentioned under 4.1.2.1, 4.1.2.2 and 4.1.2.4 (i.e. in working condition, during voyage and passage), and of a crane ship in working condition shall, under all loading conditions under consideration, be determined from the formula

$$\theta_r = \theta_{ro} X_4 X_5 \qquad (4.1.6.2.1)$$

taking into consideration the instructions given in 4.1.6.2.2 to 4.1.6.2.9 and 4.1.6.3.

4.1.6.2.2 The function θ_{ro}, in deg., is to be obtained from the formula

$$\theta_{ro} = (Y + \delta\theta_r)Z. \qquad (4.1.6.2.2)$$

The function θ_{ro} and calculated roll amplitude are to be assumed equal to zero where the parameter $W = h_{3\%}/\sqrt{C_B B d} \leqslant 0{,}1$.

4.1.6.2.3 The values of the function Y shall be adopted from Table 4.1.6.2.3-2 proceeding from the parameters W and K. The K parameter is to be obtained from the formula

$$K = [G - 0{,}505(P - 2{,}4)]/P^2. \qquad (4.1.6.2.3\text{-}1)$$

The parameter G is to be obtained from the formula

$$G = \frac{z_g - d}{\sqrt{C_B B d}}. \qquad (4.1.6.2.3\text{-}2)$$

The parameter P is to be adopted from Table 4.1.6.2.3-1 proceeding from the values of expression $(z_m - d)/\sqrt{C_B B d}$.

Table 4.1.6.2.3-1

Parameter *P*

$\frac{z_m - d}{\sqrt{C_B B d}}$	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1,0	1,2
P	1,89	1,99	2,07	2,15	2,23	2,30	2,37	2,44	2,56
$\frac{z_m - d}{\sqrt{C_B B d}}$	1,4	1,6	1,8	2,0	2,5	3,0	3,5	4,0	4,5
P	2,67	2,77	2,87	2,96	3,17	3,36	3,52	3,67	3,82

Note. z_m metacentre height, in m.

Table 4.1.6.2.3-2

Function *Y*, in deg.

Parameter W	Parameter K					
	0,00	0,04	0,08	0,10	0,12	0,14
0,1	0,24	0,10	0,05	0,04	0,04	0,04
0,2	2,83	1,58	0,40	0,27	0,23	0,23
0,6	21,60	22,90	13,85	7,71	3,41	1,14
1,0	28,15	37,53	38,73	26,07	12,74	5,93
1,4	30,18	42,31	53,37	45,02	28,05	13,61

4.1.6.2.4 The function $\delta\theta_r$, in deg., is to be determined from the formula

$$\delta\theta_r = \{[(A_4 X + A_3)X + A_2]X + A_1\}X \qquad (4.1.6.2.4\text{-}1)$$

where X = a factor to be determined from the formula

$$X = 10(F + 0{,}813K - 0{,}195) \qquad (4.1.6.2.4\text{-}2)$$

where the parameter F is to be determined from the formula

$$F = n\frac{\sqrt{h}}{B}\sqrt[4]{C_B B d} \qquad (4.1.6.2.4\text{-}3)$$

where n = factor depending on the slewing angle of the crane structure φ (see 4.1.3.1) and determined from the formula

$$n = \frac{0{,}414}{\sqrt{1 + 0{,}564\sin^2\varphi}}\ , \qquad (4.1.6.2.4\text{-}4)$$

as well as in accordance with 4.1.6.2.9-1.

The factors A_1, A_2, A_3, A_4 are to be adopted from Table 4.1.6.2.4 proceeding from the parameters W and K.

Table 4.1.6.2.4

Factors A_1, A_2, A_3, A_4

Parameter W	A_i	Parameter K					
		0,00	0,04	0,08	0,10	0,12	0,14
0,1	A_1	0,61	0,18	0,08	0,08	0,09	0,10
	A_2	0,65	0,07	0,12	0,07	−0,02	0,08
	A_3	−1,00	−0,33	0,51	0,15	−0,47	0,09
	A_4	−2,30	−0,53	0,65	0,15	−0,65	0,12
0,2	A_1	2,21	4,14	1,23	0,61	0,58	0,57
	A_2	−2,82	−4,83	3,62	0,94	−0,14	1,02
	A_3	2,88	−31,90	8,57	2,06	−3,57	3,74
	A_4	4,66	−31,44	7,76	2,19	−4,84	5,60
0,6	A_1	−17,51	−0,48	22,15	20,28	16,27	4,90
	A_2	14,25	−37,97	−18,40	6,86	−16,30	19,34
	A_3	123,01	68,09	−16,97	72,58	−204,08	52,58
	A_4	−83,49	112,34	13,24	168,08	−264,50	43,24
1,0	A_1	−36,34	−42,33	−0,84	51,49	27,78	19,65
	A_2	38,54	45,08	−220,45	−61,11	14,01	−52,77
	A_3	110,50	108,83	−58,65	−329,54	198,88	−231,50
	A_4	123,15	−220,03	348,71	−390,73	371,65	−200,83
1,4	A_1	−40,61	−60,76	−55,09	14,98	39,93	29,55
	A_2	50,44	103,44	−185,31	−184,15	−132,82	−66,33
	A_3	117,86	67,17	170,10	−9,26	−224,91	32,57
	A_4	194,79	−230,32	250,47	247,05	−37,89	356,57

4.1.6.2.5 The function Z is to be adopted from Table 4.1.6.2.5 proceeding from the parameters K, P and W.

Table 4.1.6.2.5

Function Z

Parameter P	Parameter W	Parameter K					
		0,00	0,04	0,08	0,10	0,12	0,14
2,1	0,1	2,17	1,59	1,56	1,95	2,71	4,51
	0,2	2,23	1,55	1,35	1,58	2,11	4,38
	0,6	3,44	1,59	1,10	1,08	1,06	3,52
	1,0	4,34	1,73	1,28	1,33	1,28	2,56
	1,4	2,30	1,65	1,25	1,28	1,51	2,05
2,5	0,1	1,22	1,21	1,47	1,89	2.36	3,15
	0,2	1,27	1,20	1,28	1,55	1,96	2,81
	0,6	1,32	1,23	1,03	0,97	1,00	1,77
	1,0	1,26	1,27	1,19	1,05	0,72	1,09
	1,4	1,26	1,24	1,16	1,02	0,68	0,51
2,9	0,1 — 1,4	1	1	1	1	1	1
3,3	0,1	0,77	0,85	0,87	0,81	0,68	0,58
	0,2	0,89	0,88	0,91	0,92	0,84	0,62
	0,6	0,84	0,88	0,93	1,03	1,06	0,81
	1,0	0,84	0,81	0,83	0,91	0,94	0,99
	1,4	0,87	0,84	0,87	0,92	0,91	1,02
3,7	0,1	0,61	0,77	0,84	0,75	0,49	0,37
	0,2	0,64	0,82	0,94	0,97	0,87	0,49
	0,6	0,70	0,82	0,98	1,21	1,41	1,04
	1,0	0,72	0,69	0,78	1,00	1,13	1,44
	1,4	0,77	0,77	0,84	1,00	1,00	1,46

4.1.6.2.6 The factor X_4 is to be adopted from Table 4.1.6.2.6 proceeding from the ratio $\theta_{ro}/(\theta_v-\theta_o)$ where $\theta_v-\theta_o$ is the angle range of positive static stability.

4.1.6.2.7 The factor X_5 is to be adopted from Table 4.1.6.2.7 proceeding from the ratio C_{CL}/C_{WL} where C_{CL} is the lateral area coefficient, and C_{WL} is the waterline area coefficient.

Table 4.1.6.2.6

Factor X_4

$\frac{\theta_{ro}}{\theta_v-\theta_o}$	X_4
0	1,000
0,2	0,878
0,4	0,775
0,6	0,668
0,8	0,615
1,0	0,552
1,2	0,449
1,4	0,453
1,6	0,413
1,8	0,379
2,0	0,349
2,2	0,323
2,4	0,300
2,6	0,279
2,8	0,261
3,0	0,245

Table 4.1.6.2.7

Factor X_5

$\frac{C_{CL}}{C_{WL}}$	X_5
0,60	0,326
0,65	0,424
0,70	0,553
0,75	0,646
0,80	0,756
0,85	0,854
0,90	0,932
0,95	0,983
1,00	1,000
1,05	0,983
1,10	0,932
1,15	0,854
1,20	0,756
1,25	0,646
1,30	0,553
1,35	0,424

4.1.6.2.8 Where the floating crane/crane ship has bilge keels, the roll amplitude θ'_r, in deg., is to be obtained from the formula

$$\theta'_r=K_{BK}\theta_r \qquad (4.1.6.2.8\text{-}1)$$

The factor K_{BK} shall be adopted from Table 4.1.6.2.8 proceeding from the parameter m_{BK}, to be obtained from the formula

$$m_{BK}=\frac{1}{2}\frac{A_k}{C_B LBd}\sqrt{(z_g+d)^2+B^2} \qquad (4.1.6.2.8\text{-}2)$$

where A_k = total (on both sides) area of bilge keels, in m^2;
L = hull length of floating crane/crane ship, in m.

Table 4.1.6.2.8

Factor K_{BK}

m_{BK}	K_{BK}
0	1,00
0,025	0,882
0,050	0,779
0,075	0,689
0,100	0,607
0,125	0,535
0,135 and over	0,500

In the case of crane ships having the ice category mark **ЛУ4** to **ЛУ9** in their class notations, the bilge keels are to be ignored.

4.1.6.2.9 In well-grounded cases, the peculiarities of floating crane/crane ship mass distribution and those of the area of navigation may be considered on agreement with the Register when determining the roll amplitude:

.1 where the inertia coefficient c is known in the formula of the roll period $T = 2cB/\sqrt{h}$, the value of the factor n in the Formula (4.1.6.2.4-3) can be replaced by a value determined as:

$$n = 1/(4{,}6c); \qquad (4.1.6.2.9\text{-}1)$$

.2 where the frequency of the maximum of wave spectral density ω_m, in s^{-1}, in known, which is characteristic of a particular area of navigation with the specified wave height with 3 per cent probability of exceeding level $h_{3\%}$, the roll amplitude θ_r, in deg., obtained from the Formula (4.1.6.2-1) can be specified using the formula

$$\theta_r = \theta_{ro} X_4 X_5 K_C, \qquad (4.1.6.2.9\text{-}2)$$

where K_C, in $m \cdot s^{-2}$, is to be obtained from the formula

$$K_C = 0{,}27\omega_m^2 h_{3\%}, \qquad (4.1.6.2.9\text{-}3)$$

while in Tables 4.1.6.2.3-2, 4.1.6.2.4 and 4.1.6.2.5, the value $(1/K_C)(h_{3\%}/\sqrt{C_B Bd}) = (1/K_C)W$ is to be used instead of the value $W = h_{3\%}/\sqrt{C_B Bd}$.

4.1.6.3 Corrections to the roll amplitude of a floating crane during the voyage/passage.

Where the roll amplitude θ_r or θ'_r of a floating crane during the voyage/passage, obtained in accordance with 4.1.6.2 or 4.1.6.2.8, respectively exceeds the angle of deck immersion or the angle θ_b, at which the middle of bilge at amidships frame comes out of water the design roll amplitude θ''_r, in deg., shall be determined from the following formulae:

at $\theta_d < \theta_r \leqslant \theta_b$

$$\theta''_r = (\theta_d + 5\theta_r)/6; \qquad (4.1.6.3\text{-}1)$$

at $\theta_b < \theta_r \leqslant \theta_d$

$$\theta''_r = (\theta_b + 5\theta_r)/6; \qquad (4.1.6.3\text{-}2)$$

at $\theta_r > \theta_b$ and $\theta_r > \theta_d$

$$\theta''_r = (\theta_d + \theta_b + 4\theta_r)/6. \qquad (4.1.6.3\text{-}3)$$

4.1.6.4 Roll amplitude of a crane ship during voyage/passage.

The roll amplitude of a crane ship during voyage/passage under any loading conditions considered is to be determined in accordance with 2.1.8.

The roll amplitude of a crane ship equipped with anti-rolling devices shall be determined without regard for their operation.

4.1.7 Allowance for icing.

For areas lying up to 30 m above the waterline, allowance for icing is to be made on the basis of the provisions of 2.4.1to 2.4.6 and 2.4.8. For areas lying higher than 10 m above the waterline, the standard of icing shall be adopted at half the value stated under 2.4.3 and 2.4.4.

The windage area and the height of the centre of the windage area above the waterline shall be determined as follows:

in accordance with 4.1.3.2 under loading conditions with the smallest draught out of those verified;

in accordance with 4.1.3.3 under loading conditions chosen for stability verification purposes.

When pipes or other deck cargoes are carried, their icing is to be considered in accordance with 3.11.6 and 3.11.7 adopting the icing standard stated above.

4.1.8 Stability of a floating crane/crane ship in working condition.

4.1.8.1 Stability is to be considered adequate provided that:

.1 the heeling angle θ_{d2}, in deg., due to the combined effect of the initial heeling moment (from hook load, balance weight, anti-heel ballast, etc.) θ_o, in deg., due to wind θ_s (see 4.1.8.4) and roll θ_r, in deg., does not exceed the angle of deck edge immersion or the middle of the bilge emergence in way mid-section, whichever is less. In any case, the following conditions are to be observed:

$$\theta_o + \theta_s \leqslant \begin{cases} 0{,}2(\theta_v - \theta_o) + 2^\circ \\ 10^\circ \end{cases} \qquad (4.1.8.1.1\text{-}1)$$

and

$$\theta_r \leqslant \begin{cases} 0{,}15(\theta_v - \theta_o) - 1^\circ \\ 5^\circ \end{cases}. \qquad (4.1.8.1.1\text{-}2)$$

The above acceptable heel angles static ($\theta_o + \theta_s$) and dynamic (θ_r) are not to exceed relevant angles at which reliable operation of the crane structure is ensured. These angles shall be in conformity with the delivery specifications of the crane structure and/or with its maintenance manual.

For floating cranes/crane ships, which crane structure operates reliably at large angles of heel, the acceptable angle of heel is subject to special consideration by the Register in each case;

.2 the vertical distance between the lower edges of openings by which the flooding angle is determined in operation and the waterline corresponding to the static heel and trim is not less than 0,6 m or 0,025B, whichever is greater;

.3 the area A_m, in m·rad, of the static stability diagram, between the angles θ_o and θ_m is in conformity with the following conditions:

$$A_m \geqslant \begin{cases} 0{,}115 - 0{,}00075(\theta_v - 20^\circ) \\ 0{,}100 \end{cases}; \qquad (4.1.8.1.3)$$

.4 if $\theta_m - \theta_o \geqslant 10^\circ$ and $\theta_v - \theta_o \geqslant 20^\circ$;

.5 if maximum arm $l_{\max}$ of static stability curve of a floating crane/crane ship equipped with an automatic anti-heel system is not less than 0,25 m where this system fails to operate;

.6 if capsizing moment M'_c (see 4.1.9.1.3) determined with regard to the combined effect of load drop and roll is at least twice the heeling moment M'_v due to wind pressure. The value of $g\Delta l_m$ shall be twice as great as the heeling moment M_v at least. In the case of floating cranes/crane ships equipped with an anti-heel system, the system is to be considered non-working after load drop, and the anti-heel ballast is to be considered to remain in the same position in which it was at the moment of load drop;

.7 the lower edges of openings considered to be open during the operation of the floating crane/crane ship are above the waterline by the value of h_f (being not less than 0,6 m or 0,025B, whichever is greater) under conditions of dynamic heel θ_{d3}, in deg., due to the combined effect of load drop, wind and roll.

The height h_f is to be obtained from the formula

$$h_f=(z_f-d)\cos\theta_{d3}-y_f\sin\theta_{d3} \qquad (4.1.8.1.7)$$

where y_f, z_f = the ordinate and the applicate, in m, respectively, of the lower edge of the opening in question;
d = draught after load drop, in m.

4.1.8.2 If a floating crane/crane ship is to be engaged in handling a submerged cargo having a mass greater than 0,1Δ, in t, under particular loading conditions, the Register may require calculations to be made to demonstrate that the safety of the floating crane/crane ship against capsizing is ensured for the case of submerged load drop.

4.1.8.3 Where a floating crane/crane ship does not comply with the above requirements when it has a hook load of a mass equal to the full cargo-lifting capacity of the crane structure, the cargo-lifting capacity may be limited by a value at which the requirements of the present Section are met.

4.1.8.4 The heeling angle of a floating crane/crane ship θ_{d2} due to the combined effect of initial heeling moment, wind and roll is to be obtained from the Formulae (4.1.8.4.1-2) or (4.1.8.4.2-2) proceeding from the critical value of the parameter G_{cr} to be obtained from the formula below with C = 1,0:

$$G_{cr}=1/f_2[(z'_v-0{,}34z_v/\sqrt{C_BBd})-0{,}34Cf_1-f_3] \qquad (4.1.8.4)$$

where f_1, f_2, f_3 = factors to be adopted from Tables 4.1.8.4-1, 4.1.8.3-2.

4.1.8.4.1 If the parameter

$$G\leqslant 0{,}9G_{cr} \qquad (4.1.8.4.1\text{-}1)$$

it is inherent in pontoon cranes; then

$$\theta_{d2}=\theta_o+\theta_s+\theta_r,\ \text{in deg} \qquad (4.1.8.4.1\text{-}2)$$

where θ_o, θ_s are to be obtained from the formulae:

$$\theta_o=57{,}3y_g/h, \qquad (4.1.8.4.1\text{-}3)$$

$$\theta_s=57{,}3M_v/g\Delta h; \qquad (4.1.8.4.1\text{-}4)$$

M_v is to be obtained from Formula the (4.1.8.5-1), and the angle θ_r shall be determined in accordance with 4.1.6.2.

Table 4.1.8.4-1

Factor f_1

Parameter P	θ_o, in deg.					
	0	2	4	6	8	10
2,0	0,43	0,44	0,42	0,36	0,27	0,18
2,2	0,64	0,67	0,62	0,47	0,33	0,22
2,4	0,88	0,96	0,92	0,58	0,39	0,26
2,6	1,18	1,28	1,02	0,69	0,46	0,31
2,8	1,53	1,68	1,22	0,80	0,52	0,35
3,0	1,95	2,06	1,43	0,91	0,58	0,39
3,2	2,43	2,48	1,64	1,02	0,64	0,43
3,4	2,99	2,89	1,87	1,13	0,71	0,48
3,6	3,62	3,30	2,09	1,24	0,77	0,52
3,8	4,32	3,71	2,33	1,35	0,83	0,56

Note. The intermediate values of f_1 are to be determined by linear interpolation.

Table 4.1.8.4-2

Factors f_2, f_3

P^2	Factors		P^2	Factors	
	f_2	f_3		f_2	f_3
4,0	0,600	0,027	9,0	0,750	0,214
4,5	0,625	0,051	9,5	0,759	0,229
5,0	0,646	0,073	10,0	0,767	0,243
5,5	0,663	0,095	10,5	0,774	0,256
6,0	0,682	0,115	11,0	0,781	0,269
6,5	0,693	0,133	11,5	0,787	0,282
7,0	0,708	0,152	12,0	0,792	0,295
7,5	0,720	0,167	13,0	0,803	0,320
8,0	0,731	0,185	14,0	0,813	0,344
8,5	0,741	0,198			

Note. The intermediate values of f_2 and f_3 are to be determined by linear interpolation.

4.1.8.4.2 If the parameter

$$G\geqslant 1{,}1G_{cr} \qquad (4.1.8.4.2\text{-}1)$$

it is inherent in crane ships, which lines are similar to those of conventional ships; then

$$\theta_{d2}=\theta_o+\theta'_s+\theta_r,\ \text{in deg.,} \qquad (4.1.8.4.2\text{-}2)$$

where θ'_s is to be obtained from the formula

$$\theta'_s=100M'_v/g\Delta h; \qquad (4.1.8.4.2\text{-}3)$$

M'_v is to be obtained from the Formula (4.1.8.5-2).

The directions of the angles θ_o, θ_s, θ'_s, θ_r shall be assumed to coincide. For a floating crane/crane ship, which is not to operate at rough sea, the angle θ_r shall be adopted equal to zero.

4.1.8.5 The heeling moments M_v, M'_v, in kN·m, shall be obtained from:

.1 the Formula (4.1.8.5-1) where the value of the parameter G is in compliance with condition (4.1.8.4.1-1):

$$M_v=0{,}6q(z_v+f_1\sqrt{C_BBd})\Sigma k_in_iA_{vi}; \qquad (4.1.8.5\text{-}1)$$

.2 the Formula (4.1.8.5-2) where the value of the parameter G is in compliance with condition (4.1.8.4.2-1):

$$M'_v = q[z'_v - f_2(z_g - d) - f_3\sqrt{C_B B d}]\Sigma k_i A_{vi}; \qquad (4.1.8.5\text{-}2)$$

.3 either of the Formulae (4.1.8.5-1) or (4.1.8.5-2) which yields the greater heeling angle, provided the following condition is met:

$$0{,}9G_{cr} < G < 1{,}1G_{cr}. \qquad (4.1.8.5\text{-}3)$$

4.1.8.6 The values of the rated wind velocity head q and the wave height with 3 per cent probability of exceeding level $h_{3\%}$ shall be adopted from Tables 4.1.8.6-1 and 4.1.8.6-2 according to the weather restrictions assigned.

Table 4.1.8.6-1

Design wind velocity head q in squall

Wind restriction assigned, in numbers	q, in kPa
1	0,02
2	0,03
3	0,05
4	0,09
5	0,15
6	0,23
7	0,35
8	0,50

Table 4.1.8.6-2

Wave height with 3 per cent probability of exceeding level $h_{3\%}$

Wave restriction assigned, in numbers	$h_{3\%}$, in m
1	0,25
2	0,75
3	1,25
4	2,00
5	3,50
6	6,00

4.1.8.7 Recommendations concerning the capsizing moment and dynamic heeling angle determination for a floating crane/crane ship in working condition with load drop are to be found in 1.3.1, Appendix 2.

The heeling angle before load drop shall be adopted, equal to

$$\theta'_{d2} = \theta_o + \theta_r. \qquad (4.1.8.7)$$

4.1.8.8 The effect of anchoring and mooring upon the stability of a floating crane/crane ship in working condition may be considered using the Register-approved procedure.

4.1.8.9 When the crane structure is tested by the hook load with the mass exceeding the design one, the stability of the floating crane/crane ship shall be verified with regard to the actual mass of the test load. It shall be demonstrated to the satisfaction of the Register that the floating crane/crane ship safety against capsizing is ensured by the development of special procedures at least, including weather restrictions.

4.1.9 Stability of a floating crane/crane ship during voyage.

4.1.9.1 Stability is to be considered sufficient (bearing 4.1.3.4 in mind) if:

.1 the range of stability between the angles θ_o and θ_v is 40° at least;

.2 the area of static stability curve is not less than 0,160 m·rad, between the angles θ_o and θ_1, the latter angle being obtained from the relationship

$$\theta_1 \geqslant 15^\circ + 0{,}5(\theta_v - 40^\circ); \qquad (4.1.9.1.2)$$

.3 the capsizing moment determined with regard to roll and flooding angle is not less than the heeling moment, i.e. $M_c \geqslant M_v$.

For recommendations concerning the capsizing moment determination procedure during voyage, refer to 1.3.2, Appendix 2.

The capsizing moment M'_c shall be determined by the same procedure as the capsizing moment M_c for transports and fishing vessels, following the directions of 1.1, Appendix 2.

4.1.9.2 The heeling moments M_v, M'_v, in kN·m, are to be obtained from:

.1 the Formula (4.1.9.2-1) where the value of the parameter G is in conformity with condition (4.1.8.4.1-1) at its critical value obtained from the Formula (4.1.8.4-1) with C = 0,5:

$$M_v = 0{,}6q(z_v + 0{,}5f_1\sqrt{C_B B d})\Sigma k_i n_i A_{vi}; \qquad (4.1.9.2\text{-}1)$$

.2 the Formula (4.1.8.5-2) where the value of the parameter G is in conformity with condition (4.1.8.4.2-1) at its critical value obtained from the Formula (4.1.8.4-1) with C=0,5;

.3 either of the Formulae (4.1.9.2-1) or (4.1.8.5-2) which yields the greater heeling angle, provided condition (4.1.8.5-3) is met with C=0,5.

4.1.9.3 Factor f_1 is to be adopted from Table 4.1.8.4-1 proceeding from the value of the parameter P and with regard for the angle θ_q. The values of factors f_2 and f_3 shall be adopted from Table 4.1.8.4-2.

4.1.9.4 For a floating crane, the wind velocity head q and the wave height with 3 per cent probability of exceeding level $h_{3\%}$ shall be adopted from Table 4.1.10.2. If the floating crane is to operate in a particular geographical region, q and $h_{3\%}$ may be specially adopted for that region on agreement with the Register.

4.1.9.5 For a crane ship, the wind velocity head q is to be adopted from Table 4.1.10.2.

4.1.10 Stability of a floating crane/crane ship during passage.

4.1.10.1 Where a floating crane/crane ship is to undertake a passage through sea regions lying beyond the prescribed area of navigation, a plan of such passage shall be prepared, which is subject to special consideration by the Register in each case.

4.1.10.2 Stability is to be checked with due regard for 4.1.3.4 under loading conditions stipulated in 4.1.3.2 and taking into account the preparation arrangements specified in the passage plan (including possible partial or complete dismantling of the crane structure), and is considered to be adequate, if the requirements of 4.1.9 for conditions of passage areas are met.

The design wind velocity head q and wave height with 3 per cent probability of exceeding level $h_{3\%}$ shall to be adopted from Table 4.1.10.2.

Table 4.1.10.2

Wind velocity head q and wave height with 3 per cent probability of exceeding level $h_{3\%}$

Area of navigation through which voyage or passage is made	q, in kPa	$h_{3\%}$, in m
Unrestricted	1,40	11,0
Restricted **I**	1,00	6,0
Restricted **II**	0,80	6,0
Restricted **III**	0,60	At the Register discretion in each case

4.1.11 Stability of a floating crane/crane ship in non-working condition.

4.1.11.1 Stability is considered adequate, if the capsizing moment is at least 1,5 times greater than the heeling moment under loading conditions in accordance with 4.1.3.3 and in the absence of rolling (θ_r=0°) giving regard to 4.1.3.4.

4.1.11.2 The capsizing and heeling moments shall be determined in accordance with 4.1.9.2 for q=1,4 kPa. In case mentioned under 4.1.9.2.1, the capsizing moment shall be determined in accordance with 1.3.3, Appendix 2, and in case mentioned under 4.1.9.2.2, it shall be determined in accordance with 1.1, Appendix 2 with θ_r=0°.

4.2 PONTOONS

4.2.1 This Chapter applies to pontoons with the ratio $B/D \geqslant 3$ and the block coefficient $C_B \geqslant 0,9$.

4.2.2 Loading conditions.

4.2.2.1 Stability of a pontoon shall be checked for the following loading conditions:

.1 with full load:

.2 without load;

.3 with full load and icing.

4.2.2.2 When carrying timber cargo, the stability calculation shall be made with regard to possible addition in mass of timber cargo due to water absorption as under 3.3.7.

4.2.2.3 When carrying pipes, the stability calculation should be made with regard to trapped water in the pipes as under 3.11.4.

4.2.3 Calculation of form stability.

When calculating the lever of form stability for a pontoon carrying timber cargo, the volume of timber cargo may be included in the calculation with full breadth and height and permeability of 0,25.

4.2.4 Allowance for icing.

4.2.4.1 Rates of icing shall be adopted as under 2.4.

4.2.4.2 When carrying timber cargo, rates of icing shall be adopted as under 3.3.7.

4.2.4.3 When carrying pipes, icing is determined as under 3.11.7.

4.2.5 Stability of a pontoon.

4.2.5.1 Stability of a pontoon shall be considered sufficient:

.1 if the area under the curve of statical stability up to the angle of heel θ_m is not less than 0,08 m·rad;

.2 if the static angle of heel due to wind heeling moment determined according to 4.2.5.2 does not exceed half the angle of immersion of the deck;

.3 if the range of stability is not less than:

20° for $L \leqslant 100$ m;

15° for $L > 150$ m.

For intermediate values of L, the range of stability is determined by linear interpolation.

4.2.5.2 The heeling moment is calculated by the formula

$$M_v = p_v z A_v \tag{4.2.5.2}$$

where p_v = wind pressure equal to 0,54 kPa;

$z = z_w - d/2$ (z_w = distance from the centre of the windage area to the base plane);

A_v = windage area as under 1.4.6.

4.3 FLOATING DOCKS

4.3.1 Stability of floating docks shall be checked for the following loading conditions:

.1 floating dock when supporting a ship;

.2 floating dock during submersion and emersion.

4.3.2 Calculation of liquid cargo effect is to be made in conformity with 1.4.7. The correction factor for the effect of free surfaces of liquid ballast shall be calculated at tank filling levels corresponding to the actual ones under loading condition in question.

4.3.3 Stability of a floating dock when supporting a ship.

4.3.3.1 Stability shall be checked of fully emersed dock with a supported ship under conditions of maximum lifting capacity and moment of sail of the dock — ship system without icing.

4.3.3.2 Stability is considered to be adequate provided:

.1 angle of heel with dynamically applied heeling moment due to wind pressure according to 4.3.3.5 or 4.3.3.6 does not exceed the permissible heeling angle for dock cranes in non-operating condition or 4°, whichever is less;

.2 angle of heel with dynamically applied heeling moment due to wind pressure according to 4.3.4.4 does not exceed the angle at which safe operation of cranes is ensured;

.3 angle of trim with statically applied trimming moment due to crane weight with maximum load for the most unfavourable service case of their arrangement does not exceed the angle at which efficient operation of cranes is ensured or the angle of pontoon deck immersion, whichever is less.

4.3.3.3 The angle of heel of a floating dock, in deg., if it does not exceed the angle of immersion of the pontoon deck, is to be determined from the formula

$$\theta = 1{,}17 \cdot 10^{-2} p_v A_v z/(\Delta h). \qquad (4.3.3.3)$$

4.3.3.4 An angle of heel of floating dock, if it exceeds the angle of immersion of the pontoon deck, is determined from statical or dynamical stability curve when the dock is affected by the heeling moment, in kN·m, obtained from the formula

$$M_v = 0{,}001 p_v A_v z. \qquad (4.3.3.4)$$

4.3.3.5 Specific wind pressure is assumed to be 1700 Pa.

4.3.3.6 Specific wind pressure may be taken from Table 4.3.3.6-1 depending upon the prescribed geographical area of the floating dock operation according to Fig. 4.3.3.6.

To account for the increase of specific wind pressure with regard to the elevation of some top zones of windage area in the dock — ship system above the actual waterline the wind pressure values from Table 4.3.3.6-1 are multiplied by the relevant zone coefficients from Table 4.3.3.6-2.

In this case, the values of p_v, A_v and z are determined for each zone separately, the sum of their products for all height zones comprising windage area of the dock — ship system is included in the Formulae (4.3.3.3) and (4.3.3.4).

Table 4.3.3.6-1

Specific wind pressure for top zone of 0 — 10 m above the actual waterline P_v, in Pa

Geographical area of floating dock service (Fig. 4.3.3.6)	2	3	4	5	6	7
Specific pressure p_v, in Pa	460	590	730	910	1110	1300

Table 4.3.3.6-2

Zone coefficient n_i

Height above the waterline (zone boundary), in m	n_i	Height above the waterline (zone boundary), in m	n_i
До 10	1,0	50 — 60	1,75
10 — 20	1,25	60 — 70	1,84
20 — 30	1,4	70 — 80	1,94
30 — 40	1,55	80 — 90	2,02
40 — 50	1,69	90 — 100	2,1

4.3.3.7 With geographical service area of the floating dock prescribed, the specific wind pressure may be taken for this particular area.

4.3.3.8 With several geographical service areas of the floating dock prescribed, maximum specific wind pressure for these areas is to be taken.

4.3.3.9 The angle of trim, in deg., of the floating dock is to be obtained from the formula

$$\psi = 57{,}3 M_\psi/(\Delta H). \qquad (4.3.3.9)$$

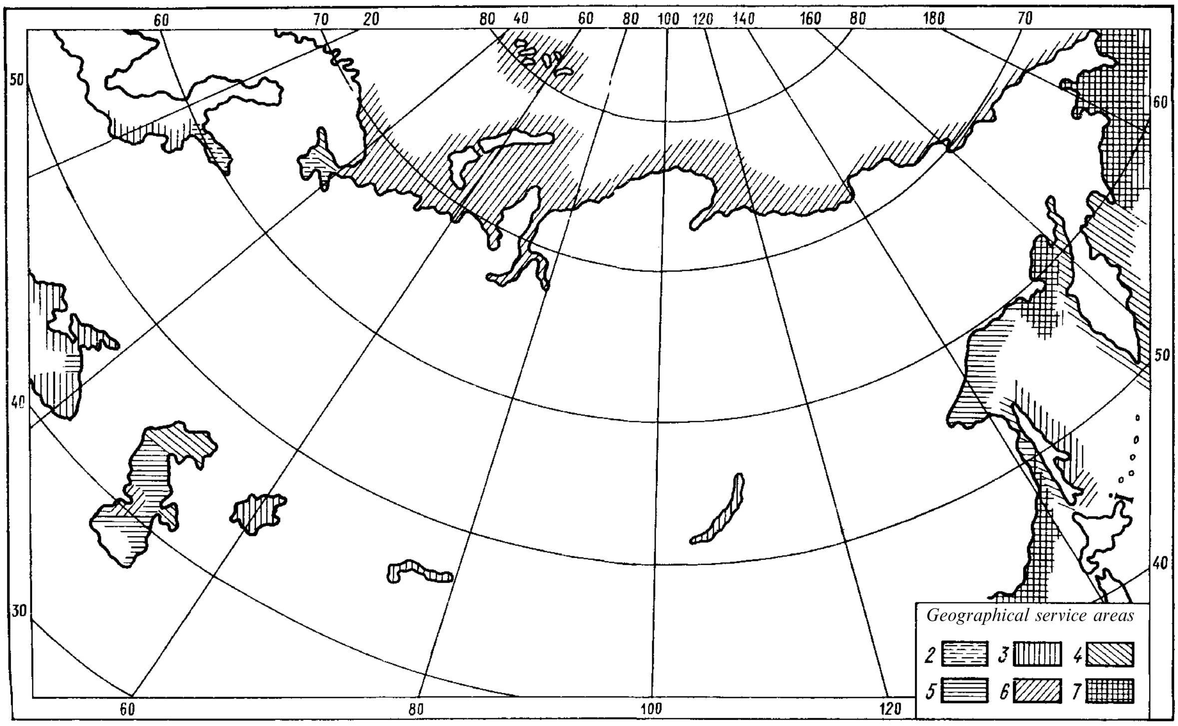


Fig. 4.3.3.6

4.3.4 Stability of a floating dock during submersion or emersion.

4.3.4.1 Stability of a floating dock is to be checked in the process of submersion or emersion for the most unfavourable case, as regards stability, of the supported ship displacement, moment of windage area of the dock — ship system and dock ballasting with the cranes not in operation, without icing.

4.3.4.2 Stability is considered to be adequate if the angle of heel with dynamically applied heeling moment due to wind pressure does not exceed the permissible heeling angle for dock cranes in non-operating condition or 4°, whichever is less.

4.3.4.3 The angle of heel of the floating dock is to be determined in conformity with 4.3.3.3 and 4.3.3.4.

4.3.4.4 Specific wind pressure is assumed to be 400 Pa.

4.3.5 The arm of windage area is to be determined according to 1.4.6.3. On agreement with the Register, in each particular case the arm of windage area z may be assumed as the elevation of the windage area centre of the dock — ship system above the supporting point of the floating dock in the system of its restraint.

4.3.6 These requirements apply to floating docks having sufficiently reliable system of restraint.

4.4 BERTH-CONNECTED SHIPS

4.4.1 The stability of a berth-connected ship is considered sufficient provided:

.1 the metacentric height complies with the requirements of 2.3 with due regard for the distribution of passengers among decks likely to occur in service;

.2 the angle of heel under dynamically applied wind heeling moment as determined from the Formula (4.3.3.3) with due regard for the provisions of 4.3.3.5 to 4.3.3.8 (for the case of a berth-connected ship) does not exceed the maximum permissible value.

4.4.2 Under dynamically applied wind heeling moment, the ship stability is checked for the most unfavourable loading conditions as regards stability.

4.4.3 As the maximum permissible heel, the angle is assumed at which the freeboard deck or fender edge immerses or the middle of the bilge comes out from water, whichever is less.

These angles are determined considering the immersion or emergence of the ship when inclined to final angles of heel and the actual position of deck edge, fenders and the middle of the bilge. The maximum permissible angle is not to exceed 10°.

APPENDIX 1

INSTRUCTIONS ON DRAWING UP INFORMATION ON STABILITY

1 GENERAL

1.1 Each ship shall be provided with the Information on Stability[1] in order to assist the master and the control authorities in maintaining stability of the ship during service in compliance with the requirements of international agreements, Maritime Administrations and the present Rules.

Formal observance of the provisions contained in the Information does not relieve the Master of the responsibility for the stability of the ship.

1.2 The present Instructions contain provisions concerning the form and contents of the Information.

The scope of the Information may vary depending on the type, purpose, stability reserve and service area of a ship. It shall be selected most carefully and agreed with the Register.

The form of the Information shall comply with the present Instructions.

1.3 The Information shall contain the following sections:

.1 Particulars of ship;

.2 Guidance to the master;

.3 Technical information;

.4 Reference information.

The contents of the sections are given below.

1.4 The Information shall have an identification number.

1.5 Each sheet (page) of the Information shall be marked with the identification number of the Information, the number of the sheet (page) and the total number of sheets (pages). The numbering of sheets (pages) shall be continuous, including plans and drawings.

Tables, plans and drawings are not allowed to have identical numbers.

1.6 The front page shall contain:

.1 name of the document: Information on Stability;

.2 identification number;

.3 name of ship;

.4 IMO number.

1.7 The front page shall be succeeded by a table of contents.

1.8 For ships engaged on international voyages, the Information and the drawings and plans included shall be translated into English. The pages containing the original text and those containing the translation shall alternate. It is not allowed to draw up the translation as a separate volume.

1.9 The Information shall list the documents on the basis of which it was drawn up.

2 PARTICULARS OF SHIP

The Section shall contain the following information:

.1 ship's name;

---

[1] Hereinafter referred to as "the Information".

.2 type of ship (dry cargo ship, oil tanker, etc.);

.3 purpose of ship (for what kind of cargo the ship is designed according to specification);

.4 name of builder and hull number;

.5 date on which the keel was laid, date of completion of construction, date of conversion;

.6 ship's class, classification society and RS number;

.7 ship's flag;

.8 port of registry;

.9 principal dimensions (length, breadth, depth; where the bulkhead deck does not coincide with the upper deck, the depth up to the bulkhead deck shall be stated);

.10 service area and restrictions imposed (sea state, distance to port of refuge, seasons, geographical service areas, etc.).

For dredgers and floating cranes, restrictions for both operating and voyage conditions shall be stated;

.11 draughts to the summer loadline and summer timber loadline, diagram of the load line marks and the corresponding displacement and deadweight;

.12 speed;

.13 type of anti-rolling devices; dimensions of bilge keels, if any;

.14 inclining test data on which the Information is based (displacement and centre-of-gravity coordinates for light-ship condition, place and date of the inclining test, reference to the Register inspectorate or another body which approved the Inclining Test Report; if the data for the light-ship condition have been assumed based on the results of the inclining test performed on a sister ship, the name and serial number of the ship which was subjected to inclining test shall be additionally stated).

.15 a sketch showing the quantity and location of solid ballast, if any, on board;

.16 ship inertia coefficient C in the Formula for obtaining the roll period $\tau = Cb/\sqrt{h_0}$ to be calculated on the basis of the roll period, if determined, during the inclining test;

.17 other data deemed necessary by the developer of the Information (for instance, carrying capacity of the ship, designed trim, stores endurance).

3 GUIDANCE TO THE MASTER

3.1 General.

The Chapter shall contain the following information.

3.1.1 Statement of the purpose of the document, i.e. to provide the necessary information to the master for ensuring the ship's trim and stability during loading, unloading, ballasting and other operations for which the ship is intended, and to provide guidance on and methods for satisfying the requirements of normative documents.

3.1.2 List of normative documents (IMO, IACS, Maritime Administrations, Rules of RS and other classification societies) on the basis of which the Information was drawn up.

3.1.3 List of stability criteria applicable to the ship with sketches (where necessary) and indication of criteria (criterion) limiting the ship's stability, damage stability criteria included, where these are applicable to the ship and limiting with regard to intact stability.

3.1.4 General instructions to the master to exercise good maritime practice, having regard to the season of the year, the navigational area and weather forecasts, and to take the appropriate action as to speed and course warranted by the prevailing conditions.

3.1.5 General instructions to the effect that the stability criteria (except for the criteria relevant to the carriage of grain and non-cohesive bulk cargoes) do not take possible cargo shifting into consideration and to prevent such cargo shifting one shall be guided by approved documents regulating the securing and stowage of cargo.

3.1.6 Explanations on the use of optional information included in the document at the discretion of the shipowner. It shall be stated that such information falls under the responsibility of the shipowner.

3.2 Terms, symbols and units.

The Chapter shall contain the following information.

3.2.1 A table of symbols showing the terms and symbols used in the Information, relevant explanations (where necessary) and the units of measurement. The unit system shall be uniform throughout the document and it shall be the same as the unit system adopted for Information on Damage Trim and Stability.

The main symbols to be used in the Information are given in Table 3.2.1.

Table 3.2.1

Main symbols

Term	Symbol
Length	L
Breadth	B
Depth	D
Draught	d
Freeboard	f
Displacement volume	∇
Displacement weight	Δ
Center of gravity:	G
abscissa	Xg (XG)
ordinate	Yg (YG)
applicate	KG
Center of buoyancy:	C
abscissa	XB
applicate	KB
abscissa of centre of flotation	Xf (XF)
Elevation of metacenter above base line:	
transverse	KMT
longitudinal	KML
Metacentric height:	
transverse	GM
longitudinal	GML
Righting lever	GZ
Cross curve lever	l_K (KL)

3.2.2 A sketch (see Fig. 3.2.2) explaining the main symbols.

3.3 General explanations to the Information.

The Chapter shall contain explanations and guidance pertinent to all the sections of the Information concerning the use of the following technical data.

3.3.1 Coordinate system. The coordinate system for determining mass moments, volumes, buoyancy, draughts, shall be uniform throughout the Information, and it shall be the same as the coordinate system adopted for the Information on Damage Trim and Stability and the design documentation.

3.3.2 Rules for the signs of heel and trim.

3.3.3 Applicability of hydrostatic data with regard to trim.

3.3.4 Applicability of stability limits with regard to trim.

3.3.5 Permissible windage area of deck cargo.

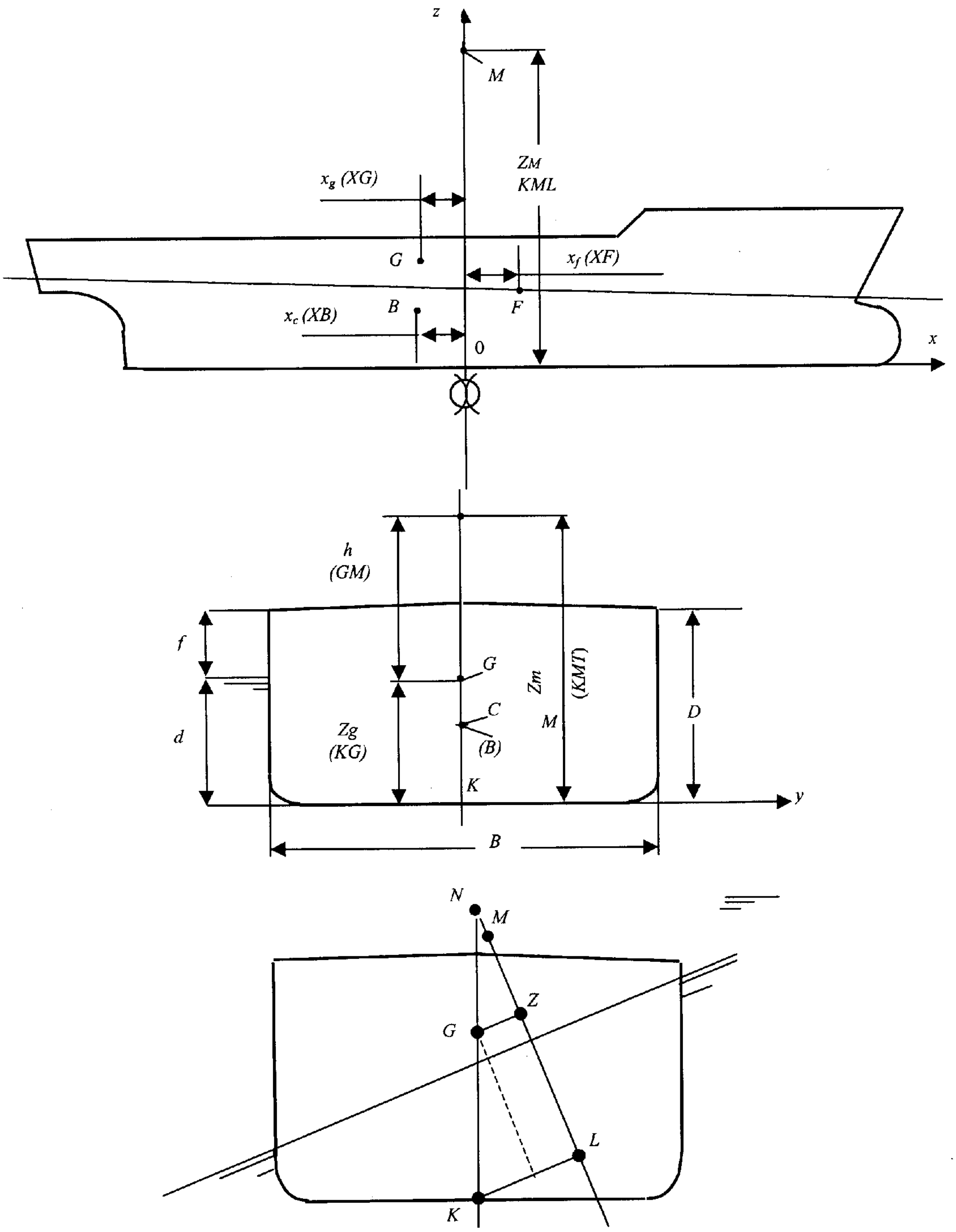


Рис. 3.2.2

3.3.6 Accuracy of calculations and interpolation, and other guidance proceeding from the contents of the Information.

3.4 Operation of the ship.

The Chapter shall contain the following information.

3.4.1 Data on the lightship with regard to its trim, stability and strength. If the lightship has a heel and a trim due to asymmetrical distribution of equipment, instructions shall be given on stowing the ballast, stores and cargo so as to eliminate the heel and reduce the trim. It shall be stated that elimination of heel by appropriate stowage of solid bulk cargo is not permitted.

3.4.2 Principles on the basis of which instructions on consuming the stores were drawn up; distribution of 50 per cent and 10 per cent of stores; effect of stores consumption on the vertical centre of gravity of the ship; specific instructions on consuming the stores with indication of conditions proceeding from which the consumption pattern is to be applied (stability, trim and damage stability requirements).

3.4.3 The procedure for taking ballast during voyage for the compensation of increase of the vertical centre of gravity due to stores consumption; instructions on weather conditions under which ballasting is permitted.

3.4.4 The principal ballast patterns for the carriage of heavy deck cargo, like containers, or light cargo in the hold, like ro/ro-vehicles, and explanations to the patterns.

3.4.5 Information regarding the effect of hoisted crane booms, filled swimming pool or other heavy top masses on the ship's stability.

3.4.6 Operating limits concerning loading, unloading, ballasting and distribution of cargo shall be listed and explained, as for example:

.1 draught limits and, in particular, statement that the ship's draught shall not exceed the value corresponding to the freeboard according to the ship's Load Line Certificate;

.2 statement that the height of the ship's centre of gravity shall not exceed the maximum allowable value;

.3 statement that the shear forces and bending moments shall not exceed the maximum allowable values;

.4 numerical values of deck cargo dimensions with regard to bridge visibility;

.5 minimum draught forward and aft with regard to seakeeping;

.6 maximum draught forward due to minimum bow height requirement;

.7 maximum stack loads for container stacks;

.8 permissible load for plating, decks and hatch covers on which cargo is stowed;

.9 maximum load per hold for bulk cargo;

.10 ship's speed on the turn;

.11 permissible quantities of fish on the deck of fishing vessels;

.12 deck areas of passenger ships to which the access of passengers is prohibited;

.13 restrictions to the application of anti-rolling devices;

.14 directions for the use of anti-heeling tanks;

.15 other limitations proceeding from the ship's purpose and construction.

3.4.7 List of openings which are to be closed when at sea to prevent the flooding of spaces in hull, superstructures or deckhouses which are to be taken into consideration for stability calculation purposes. Where necessary, a diagram of the openings shall be attached;

3.4.8 Instructions for the case of damage to bilge keels.

3.4.9 General instructions concerning tanks which shall be either emptied or pressed up, except for those tanks out of which or into which liquid is taken. An instruction to the effect that the number of tanks with free surfaces shall be reduced to a minimum.

3.4.10 General instructions to the effect that the heeling of a ship adversely effects stability and, therefore, efforts shall be made to maintain the ship in the upright position.

3.4.11 Instructions to the effect that the cargo shall be secured in accordance with the approved Cargo Securing Manual.

3.4.12 Measures to ensure stability when, during a voyage or passage, the ships enter a region where the navigating conditions are more severe than those specified when assigning the area of navigation to the ship (provided such measures are necessary).

3.4.13 Instructions for preserving ship's stability when water is used for fire extinguishing.

3.4.14 Restrictions and instructions aimed at insuring an intact stability sufficient to satisfy the damage trim and stability requirements of the Register where these are compulsory for the ship in question.

3.4.15 Recommendations to the master which shall include recommendations for choosing the direction and speed with regard to the seaway having regard to the danger of parametric resonance of rolling when carrying deck cargo and/or at low initial stability, for minimum draught forward, manoeuvring directions (for instance, permissible speed with regard to heel on the turn for ships carrying containers on deck), recommendations for icing control, scale of forward and aft draught variations as a result of taking cargo on board the ship, directions for operating of heavy derricks (if installed on board the ship), etc.

Recommendations to the master for maintaining sufficient stability, including information deemed useful by the developer. They shall not be overburdened with well-known provisions of good maritime practice.

3.5 Typical loading conditions.

The Chapter shall contain the following information:

3.5.1 Plan of tanks, cargo spaces, machinery space, spaces intended for crew and passengers; the numbers and names shall be the same as in the ship documentation.

3.5.2 Tables showing the distribution of stores and ballast among tanks under typical loading conditions with indication of mass and centre of gravity coordinates of the tanks as well as of relevant moments. The numbers and names of the tanks shall be the same as those to be found in plan referred to in 3.5.1. The tanks with regard to which corrections for free surfaces were made, taken into consideration for typical loading conditions at 100 per cent, 50 per cent and 10 per cent filling, shall be indicated in the tables.

3.5.3 Mass and centre of gravity position, adopted for calculation purposes, of mass groups, such as passengers with their luggage and crew with their luggage, mass and centre of gravity position of cargo items (vehicles, containers, etc.).

3.5.4 Typical loading conditions including the following:

.1 lightship condition;

.2 docking condition;

.3 loading conditions required by the Rules, loading conditions for all cargoes mentioned in the specification; marginal conditions of the ship operation in accordance with its purpose to be encountered in practice and conditions of commencement of ballasting during the voyage for the purpose of maintaining stability.

3.5.5 A summary table of typical loading conditions. The summary table shall include:

.1 name of the loading condition;

.2 displacement;

.3 trim parameters of the ship (forward and aft draught, draught at perpendiculars, mean draught, trim);

.4 coordinates of the centre of gravity;

.5 free surface correction value to the initial metacentric height;

.6 initial metacentric height with regard to the free surface correction;

.7 height of the centre of gravity of the ship with regard to the free surface effect;

.8 permissible values of the height of the ship's centre of gravity;

.9 standardized parameters and stability criteria (weather criterion, static stability curve parameters, angle of heel due to passengers crowding to one side or angle of heel on the turn, etc.) and their permissible values;

.10 angle of flooding through opening considered to be open in accordance with the present Part of the Rules.

3.5.6 As typical loading conditions are used to assess the cargo carrying capabilities of the ship, a limited number of conditions with 50 per cent stores shall be included in the typical loading conditions.

3.5.7 As a rule, the stability calculation for typical loading conditions shall be made for mean draught with initial trim disregarded.

3.5.8 Typical loading conditions shall be presented on special forms. In one and the same form, two or more loading conditions may be entered which may differ in the quantity of stores and ballast, characterizing the variations of loading during the voyage.

3.5.9 A form shall contain:

.1 description (name) of typical loading condition;

.2 drawing showing the location of basic mass groups on the ship that are to be included in the displacement; a plan and directions for the stowage of deck cargo;

.3 table for determining the ship's weight, coordinates of its centre of gravity and relevant mass moments with regard to coordinate planes including the weight moments and centre of gravity positions of particular mass groups and of the light ship, and where icing is concerned, taking the ice weight into consideration; correction for the free surface effect of liquid stores and ballast shall be given in the table;

.4 displacement;

.5 ship's draught at forward and aft perpendiculars, mean draught, draught at centre of waterline area, draught at draught marks; draught statements shall refer to bottom of keel, which shall be clearly indicated;

.6 moment to change trim one unit;

.7 longitudinal position of centre of buoyancy;

.8 longitudinal position of centre of gravity;

.9 longitudinal position of centre of waterline area;

.10 trim over perpendiculars;

.11 total correction for the effect of free surfaces of liquids;

.12 vertical position of the transverse metacentre (for trimmed condition if trim exceeds 1 per cent of the length of the ship);

.13 height of the ship's centre of gravity, its correction to free surface effect and the corrected value;

.14 initial metacentric height adopted with regard for free surface effect;

.15 permissible value of the height of the ship's centre of gravity or of the metacentric height determined on the basis of the Rules, and the comparison with the corresponding value obtained;

.16 stability criteria required for the ship in question by the Rules (weather criterion for the particular loading condition, standardized parameres of static stability curve, heel angles due to passengers crowding to one side, etc.);

.17 table of levers of the static stability curve;

.18 static stability curve plotted with regard for free surface effect, the flooding angle indicated (the scales used in the diagrams shall be the same for all loading conditions);

.19 statement of the ship's stability under the particular loading condition;

.20 information, where applicable, with regard to operating limits, ballasting during voyage, water soaking of deck cargo, limitations to stowage factor of cargo, limitations to average container masses per tier; restrictions to the usage of heavy equipment and of swimming pools; and any other important aspects.

3.5.10 Notwithstanding the fact that for the carriage of grain a ship is to have a separate Information on Ship Stability and Grain Loading drawn up in accordance with the Rules for the Carriage of Grain, typical loading conditions shall contain grain loading conditions, without regard to the shifting (where applicable).

3.6 Evaluation of stability for non-typical loading conditions.

3.6.1 Where an approved computer and programs for the evaluation of stability are available on board the ship, general data regarding the computer, the programs and the programmer, and the information on the approval of the programs shall be given (by whom, when and for what period they were approved).

3.6.2 Notwithstanding a computer being available on board the ship, the "manual" method of calculation and evaluation of stability shall be explained in detail. The explanation shall contain a description of the calculations sequence. As a rule, the description shall include six sections.

3.6.2.1 The first Section shall contain:

.1 calculation of displacement and of the coordinates of the ship's centre of gravity;

.2 determination of mean draught and comparison with permissible draught according to load line;

.3 determination of correction for free surface effect of liquid stores;

.4 height of the centre of gravity corrected for free surface effect of liquid stores;

.5 comparison of the value obtained for the height of the centre of gravity with the permissible value and condition of sufficient stability;

.6 actions and measures to be taken if the condition of sufficient stability is not fulfilled.

A note shall be made when describing the method of calculation adopted for this Section that the calculation is to be presented in the form of a table. The constants adopted (for instance, lightship weight, crew, etc.) shall be specified and entered in the table. The numbers of the tables, diagrams, etc. from which data for the calculation are taken shall be indicated in the text. The recommended table form is given below (see Table 3.6.2.1.6).

If containers, vehicles, etc., are carried, auxiliary table forms for determining the weight and the coordinates of the centre of gravity of the cargo and explanations with regard to the use of the tables shall be given.

Instructions concerning allowance for icing shall be given.

3.6.2.2 The second Section shall contain:

.1 calculation of trim;

.2 actions and measures to be taken if the trim exceeds permissible values;

.3 calculation of draughts at draught marks.

Calculations sequence, adopted formulae, tables, curves, charts, diagrams and references to their numbers shall be given in the text of the Section.

3.6.2.3 The third Section shall contain instructions for the calculation of the static stability curve, formulae, references to the numbers of tables, curves, charts and diagrams.

The calculations shall be tabulated. The recommended table form is given below (Table 3.6.2.3).

Table 3.6.2.1.6

STABILITY VERIFICATION AND DRAUGHT CALCULATION

Nos	Type of loading	Mass, in t	Abscissa, x_g, in m	Moment, M_x, in t·m (3) x (4)	Applicate, Z_g, in m	Moment, M_z, in t·m (3) x (6)	Moment of free surface of liquid, $M_{f.s}$, in t m
1	2	3	4	5	6	7	8
1	Lightship	1937	7,0	13559	4,0	7748	—
2	Stores						
3	Ballast						
4	Cargo						
5	Miscellaneous						
6	Displacement	Δ		ΣM_x		ΣM_z	$\Sigma M_{f.s}$
7	Abscissa of ship centre of gravity $x_g = \Sigma M_x / \Delta = (5)/(3)$						________ m
8	Centre of gravity elevation above moulded base plane, $Z_g = \Sigma M_z / \Delta = (7)/(3)$						________ m
9	Corrected centre of gravity elevation above moulded base plane, $Z_{gcorr} = Z_g + \Sigma M_{f.s} / \Delta$						________ m
10	Permitted centre of gravity elevation above moulded base plane						________ m
11	By the value of Mx as per diagram (table) of forward and aft draughts: draught at forward perpendicular, d_f draught at aft perpendicular, d_a draught amidships, $d \ = (d_f + d_a)/2$						 ________ m ________ m ________ m

Table 3.6.2.3

TABLE FOR STATIC STABILITY CURVE CALCULATION

Angle of heel, $\theta°$	5	10	15	20	30	40	50	60	70	80
$\sin\theta°$										
Arm of form l_f										
$Z_{gcorr}\sin\theta°$										
Arm of static stability curve $l = l_f - Z_{gcorr.}\sin\theta°$										

Provision shall be made for a form for plotting the static stability curve (Fig. 3.6.2.3).

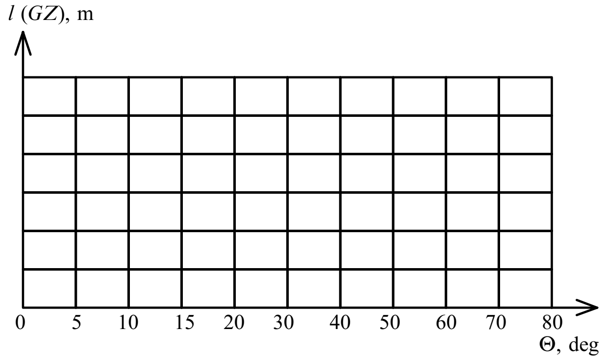


Fig. 3.6.2.3

Where an approved computer and programs for the evaluation of stability are available on board the ship, this Section is optional.

3.6.2.4 The fourth Section shall contain:

explanation, in the text and graphic form, for determining the weather criterion;

instructions for the calculation, formulae, references to the numbers of tables, curves, charts and diagrams used.

This Section may be optional in the following cases:

the weather criterion is not a limiting one;

an approved computer and programs enabling the calculation of the weather criterion are available on board the ship.

3.6.2.5 The fifth Section shall contain instructions for calculating the angle of heel due to the effect of wind and/or angle of heel on the turn (if applicable). The formulae and norms adopted in the calculations shall be given.

3.6.2.6 The sixth Section shall contain a calculated example and a detailed explanation of the calculation and the evaluation of stability for a non-typical loading condition.

3.6.2.7 If the ship is equipped with an approved installation for performing in-service inclining tests, a guidance for performing such inclining tests shall be given in accordance with the Operation manual of the installation.

Guidance for determining the ship's stability in service shall enable the master to determine the actual stability of the ship with adequate accuracy and without undue loss of time. This Section shall contain:

.1 instructions on the conditions and procedure for carrying out the in-service inclining test using the facilities available on board the ship (automatic systems for measuring and control of stability and trim, equalizing tanks, calibrated tanks for measuring stability and heel by means of a load the weight of which is known, etc.);

.2 data to assess the precision of measurements during the in-service inclining test and to estimate the quality of the test as a whole;

.3 instructions and materials to control initial metacentric height by measuring the roll period;

.4 explanations for the master concerning the assessment of the ship's stability by means of the above procedures.

3.6.2.8 The Section shall contain forms on which independent calculations can be made.

4 TECHNICAL INFORMATION

All drawings, diagrams, curves and tables shall be named and numbered.

The Section shall contain the following information.

4.1 The ship's general arrangement plan.

4.2 Capacity plan.

The capacity plan shall show the layout of cargo spaces, tanks, stores, machinery spaces and crew and passenger accommodation. Cargo spaces and tanks shall bear names and numbers adopted on board the ship. In addition, the plan shall present:

.1 coordinate axes;

.2 frames, frame spacing and numbering;

.3 location of draught marks;

.4 diagram of the load line marks showing the position of the deck line relative to the ship, draught to the summer load waterline, draught to the summer - timber load waterline (if any) and corresponding freeboards;

.5 deadweight scale.

It is permitted to incorporate the general arrangement plan and the capacity plan into a single plan.

4.3 Cargo space information.

Information on each cargo space shall include:

.1 name and number;

.2 location (frames);

.3 volume at 100 per cent filling;

.4 coordinates of the centre of volume;

.5 bale cargo capacity and grain capacity;

.6 permissible load for plating;

.7 on bulk carriers, permissible weight of cargo;

.8 on tankers, volume at 98 per cent filling and the corresponding moment of inertia of the free surface;

.9 for dry cargo holds intended for the carriage of solid bulk cargoes, volume and coordinates of the centre of gravity depending on the level of filling;

.10 on container ships and ships equipped for the carriage of containers, container stowage plan (including deck containers) on the basis of which one can calculate the masses and the position of the centre of gravity of containers in the assumed loading condition. Maximum stack masses and maximum stack heights of containers shall be specified in the plan. A sketch shall be presented to confirm that the requirement for bridge visibility is fulfilled;

.11 on roll-on/roll-off ships, vehicle stowage plan;

.12 stowage plan for the deck cargo of timber with regard to the stowage factor and the requirements for bridge visibility.

4.4 Tank space information.

Information on each tank space, including cargo tanks, shall include:

.1 name and number of tank;

.2 location (frames);

.3 volume, volumetric centre coordinates and the moment of inertia of the free surface depending on the level of filling.

Intervals of 0,10 m shall, as a rule, be adopted for the level of liquid. In justified cases a greater interval may be adopted.

4.5 Hydrostatic particulars.

Hydrostatic particulars shall be calculated for the ship on even keel or design trim (without deflection) against displacement over a range from light ship to 115 per cent of the displacement to the load line. The draught intervals shall be 0,05 m. In justified cases, a greater interval may be adopted. The particulars shall be presented in the form of a table.

If the ship is intended for operation with a trim exceeding 1 per cent of the ship's length, additional tables of hydrostatic particulars shall be presented for a suitable range of trim.

Draught statements shall refer to bottom of keel.

4.6 Cross curve data.

Cross curve data shall be provided for heeling angles up to 20° at 5° intervals, and from 20° to 80° at 10° intervals. The displacement range shall correspond to that in 4.5; draught (displacement) intervals shall be 2 per cent of the draught (displacement) range. Cross curve values shall be presented in the form of a table. The table shall be supplemented by a sketch showing the ship's watertight spaces, which were taken into account for the calculation.

If the buoyancy of the deck cargo is taken into account when performing stability calculations, an additional separate cross curve table and a relevant sketch shall be drawn up.

Cross curve calculations shall be performed having regard to the accompanying trim.

4.7 Solid cargo information.

If solid cargo is stowed on board the ship, a sketch shall be presented showing the stowage of the ballast, with a specification containing information on the weight of each ballast group and the coordinates of the centre of gravity.

4.8 Information for stability control.

Information for stability control shall include permissible values of the height of the centre of gravity of the ship (or of permissible metacentric heights) depending on displacement (draught). The information shall be presented in the form of a table.

The information may include more than one table for different conditions of the ship's operation (for instance, for operation without deck cargo, with timber cargo on board the ship, with deck cargoes of timber having different permeabilities, under conditions of icing, when carrying one or two or three tiers of containers on deck, etc.). The permissible values of the height of the ship's centre of gravity shall be calculated with regard to subdivision requirements and damage stability and trim requirements where such requirements are compulsory for a ship.

Where necessary, a table shall be presented containing minimum values of the height of the ship's centre of gravity at which the requirements of the Rules for the acceleration criterion are fulfilled.

4.9 Information on angles of flooding.

Information on flooding angles in the form of a table (tables) proceeding from displacement or draught with a plan of openings assumed to be open. The names of the openings and their coordinates shall be indicated. Openings for ventilation of machinery spaces which ensure operation of machinery and its maintenance and which may not be closed in rough weather shall be assumed to be open.

4.10 Tables showing free surface correction values for liquid cargoes.

Free surface correction values to the initial metacentric height and righting levers for liquid cargoes, in tabular form.

4.11 A diagram of forward and aft draughts.

A diagram (or table) of forward and aft draughts (at perpendiculars) plotted on a graph of displacement versus the longitudinal static mass moment of the ship.

The diagram shall enable the master to speedily determine the draughts at forward and aft perpendiculars.

4.12 A diagram (or table) correlating the draughts at perpendiculars with the draughts at draught marks.

4.13 Data for direct calculation of weather criterion on the basis of the static or dynamic stability curves. If the weather criterion is not a limiting one, the data mentioned above shall be presented in the Section "Reference Information" of the Appendix.

5 REFERENCE INFORMATION

5.1 This Section shall contain information, which may be useful for the master, Port Administration and Flag Administration when resolving matters connected with the ship's stability.

The Section shall contain:

.1 a detailed diagram of permissible heights of the ship's centre of gravity, including curves for each of the stability criteria applicable to the ship in question. Resulting curves of permissible heights of the ship's centre of gravity shall be highlighted on the diagram;

.2 data for direct calculation of weather criterion on the basis of the static or dynamic stability curves (at the discretion of the developer);

.3 a copy of the inclining test report for the ship or its prototype;

.4 any other data included in the Information at the discretion of the shipowner.

5.2 Information for floating cranes.

5.2.1 For floating cranes, the Information shall contain data on their stability as regards the rated criteria for various boom radii and various loads on the hook (by mass and windage area) including loading conditions in which the stability becomes unsatisfactory by any criterion (criteria).

5.2.2 For floating cranes which stability in case of load drop is limited by the angle of flooding in the working condition, the Information shall contain requirements for reliable battening down of openings which are not to be permanently open during cargo-handling operations.

5.2.3 Because of the variety of their loading conditions, data on the stability of floating cranes shall be presented in a simple and obvious form (for instance, in tables and diagrams characterizing the loading and stability of the floating crane in each of the loading conditions).

5.2.4 In the case of floating cranes with luffing booms, the following rule shall be applied: in order to reduce the influence of external forces upon the floating crane the boom shall be lowered to the lowest position (secured for sea) on completion of cargo-handling operations.

5.2.5 In case of floating cranes with slewing cranes and a cargo platform on deck it is not recommended to perform cargo-handling operations when under way (e. g. carriage of loads hanging on the hook semi-submerged or raised above water: small ships, metal structures, etc.). Where this is performed by floating cranes of any type, restrictions on the area of navigation and weather shall be specified for such a voyage in each case, and arrangements shall be made for reliable securing to prevent the boom, hanger and the hanging load from swinging. The possibility of a voyage with a load on the hook shall be confirmed by calculation and approved by the Register in each case.

5.3 The Information on a tug shall include instructions to the Master for the case of the ship's operation in areas where current velocities above 1,3 m/s are observed.

APPENDIX 2

DETERMINATION OF CAPSIZING MOMENT

1.1 Determination of the Capsizing Moment for Transport and Fishing Vessels

1.1.1 The capsizing moment M_c taking into account the effect of rolling can be determined using either a curve of dynamical or of statical stability. When determining the capsizing moment, the following two cases may take place:

.1 a ship has normal curves of dynamical and statical stability, or the curve of statical stability is stepped and that of dynamical stability broken. In this case, the capsizing moment is determined as follows:

.1.1 when the curve of dynamical stability is used, auxiliary point A is to be found on it first. For this purpose the amplitude of roll is plotted along the abscissa to the right of the origin of the coordinates and its related point A' is fixed on the curve of dynamical stability (Fig. 1.1.1.1.1). Then a straight line parallel to the axis of abscissae is drawn through point A' and segment $A'A$ equal to the double amplitude of roll is laid off along it to the left of the auxiliary point $A'(A'A=2\theta_r)$.

Point A located symmetrically to point A' is referred to below as the initial one. From the initial point A tangent AC to the curve of dynamical stability is drawn

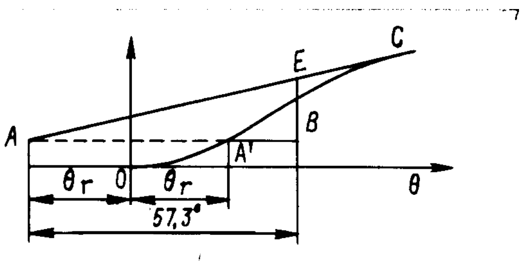


Fig. 1.1.1.1.1 Determination of capsizing moment using the curve of dynamical stability

and segment *AB* equal to one radian (57,3°) is laid off from *A* on the straight line parallel to the axis of abscissae. From point *B* perpendicular *BE* is erected up to its intersection with tangent *AC* at point *E*. Segment *BE* is equal to the capsizing moment, if the curve of dynamical stability is plotted to scale of work, and to the arm of the capsizing moment, if the curve of dynamical stability is plotted to scale of arms.

In the latter case, to determine the capsizing moment M_c, in kN·m, the value of the segment *BE*, in metres, shall be multiplied by corresponding displacement Δ, in kN

$$M_c=\Delta\overline{BE}; \qquad (1.1.1.1.1)$$

.1.2 when the curve of statical stability is used, the capsizing moment can be determined assuming the work of the capsizing and righting moments to be equal and taking into account the effect of rolling. For this purpose, the curve of statical stability is continued into the region of negative abscissae for a length equal to the amplitude of roll (Fig. 1.1.1.1.2), and such a straight line *MK* parallel to the axis of abscissae is chosen with which cross-hatched areas S_1 and S_2 are equal. Ordinate *OM* will correspond to the capsizing moment, if moments are plotted along the axis of ordinates, or to the arm of the capsizing moment, if arms of stability are plotted along this axis. In the latter case, to determine the capsizing moment M_c, in kN·m, ordinate *OM*, in metres, shall be multiplied by the ship's displacement, in kN

$$M_c=\Delta\overline{OM}; \qquad (1.1.1.1.2)$$

.2 the curves of statical and dynamical stability are cut short at the angle of flooding. The capsizing moment is then determined by one of the methods given below:

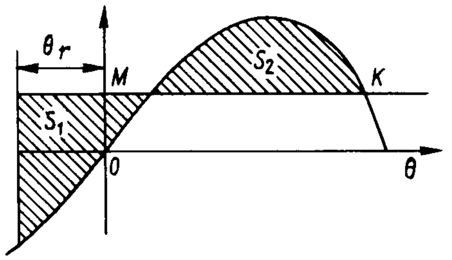


Fig. 1.1.1.1.2 Determination of capsizing moment using the curve of statical stability

.2.1 when the curve of dynamical stability is used, the capsizing moment is determined as follows. Making use of the method specified in 1.1.1.1.1, position of the initial point *A* is found (Fig. 1.1.1.2.1).

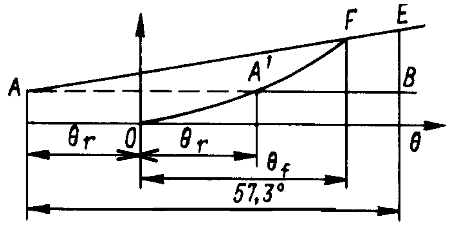


Fig 1.1.1.2.1 Determination of capsizing moment from the curve of dynamical stability taking account of the angle of flooding

A tangent to the curve of dynamical stability is drawn from the initial point *A*, which is possible only when the angle of heel corresponding to the point of tangency is less than the angle of flooding. The capsizing moment or its arm is determined by using the tangent and same method as in the first case described above.

If it is impossible to draw the tangent, a straight line passing through the top final point *F* of the curve of dynamical stability, corresponding to the angle of flooding, is drawn from the initial point *A*. A straight line parallel to the axis of abscissae is also drawn from the same initial point *A* and segment *AB* equal to 57,3° is laid off on this straight line. From point *B* perpendicular *BE* is erected up to its intersection with the inclined straight line *AF* at point *E*. Segment *BE* is equal to the capsizing moment sought, if work is plotted along the axis of ordinates on the curve of dynamical stability or is equal to the arm of the capsizing moment, if arms of dynamical stability are plotted along the axis of ordinates. In the latter case, the capsizing moment is determined from the Formula (1.1.1.1.1);

.2.2 when curve of statical stability is used, the capsizing moment for the angle of flooding θ_r is determined as follows:

The curve of statical stability is continued into the region of negative abscissae to a length equal to the amplitude of roll (Fig. 1.1.1.2.2) and such a straight line

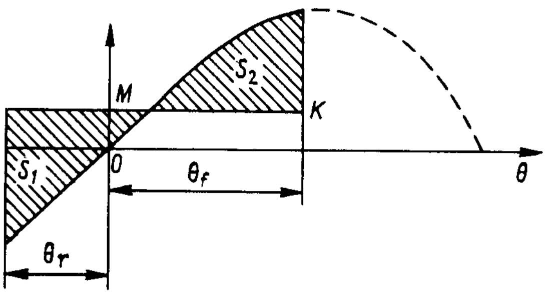


Fig. 1.1.1.2.2 Determination of capsizing moment from the curve of statical stability taking into account the angle of flooding

MK parallel to the axis of abscissae is chosen with which cross-hatched areas S_1 and S_2 are equal. Ordinate *OM* will correspond to capsizing moment M_c sought or its arm depending upon the method used for constructing the curve. In the latter case, the capsizing moment is determined from the Formula (1.1.1.1.2).

1.2 Determination of Capsizing Moment for Hopper Dredgers and Hopper Barges

1.2.1 To determine the capsizing moment, a curve of dynamical stability of the ship after spoil discharge is plotted in compliance with the Formula (3.8.4.7-2) of this Part of the Rules, continued partially into the region of negative angles of heeling. From point *A* corresponding to the minimum on the curve (heeling angle θ_{BC1}) a segment equal to the amplitude of roll θ_r is laid off to the left along the axis of abscissae (Fig. 1.2.1-1).

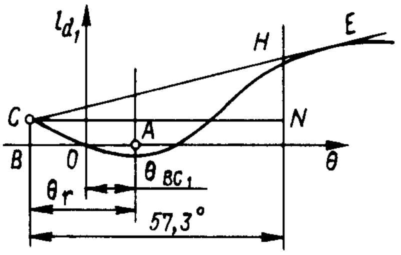


Fig. 1.2.1-1 Determination of capsizing moment for hopper dredgers and hopper barges

The amplitude of roll θ_r in this case is assumed to be 10° with regard only to statical character of spoil discharge (with density of spoil in the hopper under 1,3 t/m^3) and equal to 10° plus θ_{3r} (the greatest amplitude of ship's rolling in relation to statically inclined position immediately after spoil discharging) with regard to dynamic character of spoil discharge. The corresponding point *C* is fixed on the curve and tangent *CE* is drawn from this point to the right part of the curve. From point *C* segment *CN* equal to 57,3° is laid off parallel to the axis of abscissae and a perpendicular is erected from the point *N* up to its intersection with the tangent at point *H*. Segment *NH* equals the arm of the capsizing moment M_c, in kN·m, which is determined from the formula

$$M_c=\Delta\overline{NH}. \qquad (1.2.1)$$

If the angle of flooding θ_f proves to be less than the angle of heel corresponding to the point *E* of the curve (see Fig. 1.2.1-1), the secant *CF* shall be drawn from the point *C* to the right part of the curve as shown in Fig. 1.2.1-2.

In this case, the arm of the capsizing moment will be determined by segment $\overline{NK}$. If point *F* on the curve (see Fig. 1.2.1-2) corresponding to the angle of flooding is below point F_1, where the curve intersects straight line *CN*, the stability of the ship is regarded to be unsatisfactory.

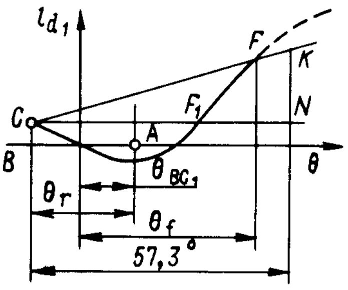


Fig 1.2.1-2 Determination of capsizing moment for hopper dredgers and hopper barges taking into account the angle of flooding

If no curve of dynamical stability is available, the minimum capsizing moment is determined from the curve of statical stability (see Fig. 1.1.1.1.2) as in 1.1.1.1, taking into account initial statical heel.

1.3 Determination of Capsizing Moment for a Floating Crane

1.3.1 Determination of capsizing moment and the angle of dynamical heel in working condition in case of load drop.

To determine the capsizing moment and the angle of dynamical heel after load drop, the curve of dynamical stability (to arm scale) is to be constructed for the loading condition under consideration, but without load on hook. In case the floating crane centre of gravity after the load drop does not coincide with the centre line, the curve is to be constructed with regard to angle of heel θ'_0 due to unsymmetrical loading (including also unsymmetrical arrangement of cargo on deck). A portion of the curve is to be constructed in the negative angle area. To be plotted to the left from the origin of the coordinates is the initial angle of heel θ'_{d2} of the floating crane with a load on the hook, equal to the sum of the amplitude of roll θ_r in the working condition and the angle of statical heel θ_0 when the load is lifted (Fig. 1.3.1).

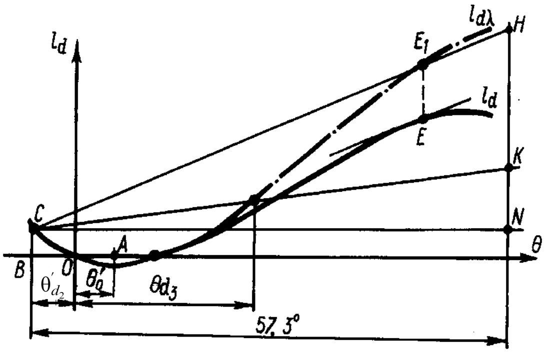


Fig. 1.3.1 Determination of the capsizing moment and the angle of dynamical heel at the inclination after load drop

The appropriate point *C* is fixed on the curve. The curve of the reduced arms is plotted to the right from the origin of the coordinates above the curve of statical stability, whose ordinates, in m, are calculated from the formula

$$l_{d\lambda}=l_d+\Delta l_\lambda \qquad (1.3.1\text{-}1)$$

where Δl_λ = correction taking into account damping forces to be obtained in compliance with 1.3.4 of the present Appendix.

The secant CE_1 is drawn from the point *C* so that the point of its intersection E_1 with the reduced arm curve lies on the same vertical line with point *E*, in which the straight line parallel to the secant touches the curve. From point *C* segment *CN* equal to 57,3° is laid off parallel to the axis of abscissae. From point *N* the perpendicular is erected up to its intersection with the secant at point *H*. Segment *NH* is equal to the arm of the capsizing moment, in kN·m, with due regard for damping to be obtained from the formula

$$M_{c\lambda}=\Delta\overline{NH}. \qquad (1.3.1\text{-}2)$$

From point N segment *NK* is laid off equal to the arm of the heeling moment, in m, to be determined from the formula

$$NK=M_v/\Delta \qquad (1.3.1\text{-}3)$$

where M_v = heeling moment due to wind pressure.

Points *C* and *K* are connected by the straight line, whose point of intersection with the curve of reduced arms determines the angle of dynamical heel θ_{d3} at the inclination after load drop.

Stability may be checked taking no account of damping. In this case, the curve of reduced arms is not constructed, but the tangent is drawn from point *C* to the curve of dynamical stability. The angle of dynamical heel θ_{d3} is determined by the point of intersection of straight line *CK* with the curve.

1.3.2 Determination of capsizing moment during voyage.

The capsizing moment M_c of the floating crane under the effect of rolling and steady wind may be determined both by the curve of dynamical stability and the curve of statical stability, some portions of which are constructed for negative angles.

1.3.2.1 When using the curve of dynamical stability the positions of initial point *A* and point A_1 (Fig. 1.3.2.1) are so selected that tangent *AC* is parallel to the tangent A_1K and the difference of angles of heel corresponding to points A_1 and *A* is equal to the amplitude of roll.

Angle θ_s obtained therefrom corresponds to the angle of statical heel due to limiting wind pressure, and segment *BE* is equal to the capsizing moment if the curve of dynamical stability is plotted to scale of moments, and to the arm of the capsizing moment, if the curve of dynamical stability is plotted to scale of arms.

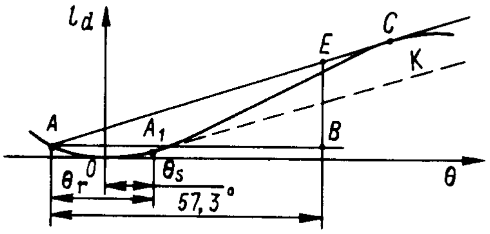


Fig. 1.3.2.1 Determination of capsizing moment of a floating crane secured for sea from the curve of dynamical stability

In the latter case, the capsizing moment, in kN·m, is determined from the formula

$$M_c=\Delta\overline{BE}. \qquad (1.3.2.1)$$

1.3.2.2 When the curve of statical stability is used, the capsizing moment can be determined assuming the work of the capsizing moment and that of the righting moment to be equal and taking account of the effect of rolling and statical heel due to limiting wind pressure (Fig. 1.3.2.2). For this purpose, the curve of statical stability is continued in the region of negative angles for such a portion that straight line *MK* parallel to the axis of abscissae cuts off the cross-hatched areas S_1 and S_2 equal to each other and the difference of angles corresponding to points A_1 and *A* is equal to the amplitude of roll.

Ordinate *OM* will correspond to the capsizing moment, if moments are plotted along the axis of ordinates or to the arm of the capsizing moment, if arms of stability are plotted along the axis of ordinates.

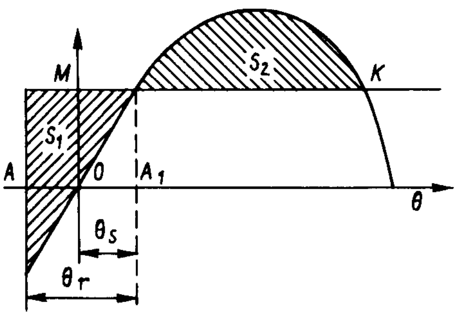


Fig. 1.3.2.2 Determination of the capsizing moment of a floating crane secured for sea from the curve of statical stability

1.3.2.3 If the curves of statical and dynamical stability are cut short at the angle of flooding, the capsizing moment shall be determined similarly to that stated in 1.1.1.2 with regard to statical heel and the amplitudes of roll as specified in 1.3.2.1 and 1.3.2.2.

1.3.3 Determination of capsizing moment in non-working condition.

The capsizing moment is determined from the curve of statical stability (Fig. 1.3.3) for non-working loading condition with due regard for the free surface effect as well as the initial angle of heel θ'_0 due to the boom turn in the plane of the frame for floating cranes and crane ships with slewing cranes.

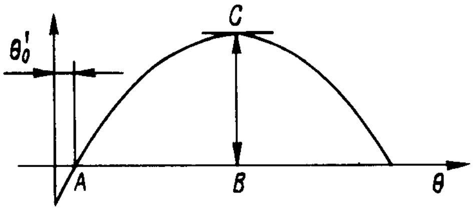


Fig. 1.3.3 Determination of capsizing moment in non-working condition

Segment *CB* is equal to the capsizing moment if the curve is plotted to scale of moments, and to the arm of the capsizing moment l_{max} if the curve is plotted to scale of arms. In the latter case, the capsizing moment, in kN·m, is to be obtained from the formula

$$M_c = \Delta l_{max}. \qquad (1.3.3)$$

1.3.4 Correction Δl_λ, in m, taking account of damping forces is to be calculated from the formula

$$\Delta l_\lambda = l_\lambda \sqrt{C_B B d}\,(\theta_{sw}/57,3)^2 F_5 \qquad (1.3.4\text{-}1)$$

where B = breadth of the ship, in m;
d = moulded draught of the ship, in m;
C_B = block coefficient of the ship;
θ_{sw} = double swing value counting from the angle equal to the initial heel at the moment of load drop, in deg.;
l_λ = factor found from the formula

$$l_\lambda = F_0\left(F_1 + \frac{z_g - d}{\sqrt{C_B B d}} F_2\right) + \frac{z_g - d}{\sqrt{C_B B d}} F_3 + F_4 \qquad (1.3.4\text{-}2)$$

z_g = centre of gravity height above the base line, in m;
F_0 is taken from Fig. 1.3.4 depending on characteristic F and P;
F is found from the Formula (4.1.5.1-2);
F_1, F_2, F_3, F_4 are taken from Table 1.3.4-1 depending on P;
F_5 = factor obtained from Table 1.3.4-2 depending on the ratio $(\theta_d+\theta'_{d2})/\theta_p$;
θ_d = angle of deck immersion.

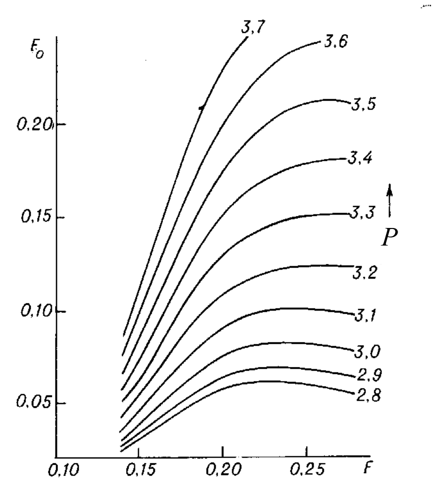


Fig. 1.3.4

Table 1.3.4-1

Factors F_1, F_2, F_3, F_4

P	F_1	F_2	F_3	F_4
2,8	1,987	— 3,435	0,0725	—0,021
2,9	2,087	—3,313	0,0856	—0,028
3,0	2,144	—3,097	0,1007	—0,037
3,1	2,157	—2,823	0,1150	—0,047
3,2	2,138	—2,525	0,1273	—0,057
3,3	2,097	—2,230	0,1357	—0,067
3,4	2,043	—1,955	0,1417	—0,076
3,5	1,982	—1,711	0,1454	—0,084
3,6	1,921	—1,497	0,1474	—0,091
3,7	1,861	—1,312	0,1475	—0,097

Table 1.3.4-2

Factor F_5

$\frac{\theta_d+\theta'_{d_2}}{\theta_p}$	F_5	$\frac{\theta_d+\theta'_{d_2}}{\theta_p}$	F_5
1,0	1,0	0,5	1,5
0,9	1,053	0,4	1,626
0,8	1,138	0,3	1,747
0,7	1,253	0,2	1,862
0,6	1,374		

см.Б1

APPENDIX 3

INSTRUCTIONS ON INCLINING TEST

1 APPLICATION

The present Instructions on Inclining Test shall be applied when determining the light-ship weight and its vertical centre of gravity in accordance with the requirements of the present Part of the Rules. When applying these Instructions, the requirements of 1.5 of the present Part of the Rules shall be complied with.

2 DEFINITIONS AND EXPLANATIONS

For the purposes of the present Instructions, use is made of the following terms are used.

The inclining test involves moving a series of test weights on a ship in the transverse direction in order to reach a number of inclines and then measuring the resulting angles of heel needed for determining the light-ship weight and its vertical centre of gravity by applying basic naval architecture principles.

Draught is the vertical distance from the moulded baseline to the waterline.

A light-weight survey involves taking an audit of all items which are to be added to the ship, removed from the ship or relocated on the ship. The weight and the coordinates of the centre of gravity of each item shall be accurately determined and recorded, since using this information, as well as the measurement and inclining test results, the values of the light-ship weight and the coordinates of its centre of gravity will be obtained.

Certification of the test weights is the verification of the weight marked on a test weight. The certification shall be performed immediately before to the inclining test.

Light ship is a ship the construction (modification, repair) of which is completed, but without cargo, stores, crew and their effects, and other deadweight components.

A pressed-up tank means a completely full tank with no voids caused by heel, trim or inadequate venting. Anything less than 100 per cent full, for example, the 98 per cent condition regarded as full for operational purposes, is not acceptable. After pressing the tanks, the ship shall be rolled from side to side to eliminate entrapped air. This procedure shall be performed prior to taking the final sounding. Special care shall be taken when pressing fuel oil tanks to prevent accidental pollution.

Empty tanks means tanks, which do not contain liquid. It is generally not sufficient to simply pump tanks until suction is lost. Enter the tank after pumping to determine if final stripping with portable pumps or by hand is necessary. The exceptions are very narrow tanks or tanks where there is a sharp deadrise, since the free surface would be negligible. All empty tanks shall be inspected, all manholes shall be open and the tanks well ventilated and certified as safe for entry. A safe testing device shall be on hand to test for sufficient oxygen and minimum toxic levels. A document issued by a competent body certifying that all the tanks and enclosed spaces are safe for entry shall be available on board the ship.

3 PREPARATION OF THE SHIP FOR INCLINING TEST

3.1 Ship Instructions on the Conduct of an Inclining Test shall be drawn up for the ship concerned in good time prior to the inclining test and submitted to the Register for consideration and approval. These Instructions shall to contain the following information:

.1 identification of the ship by name and shipyard hull number;

.2 date, time and location of the test;

.3 acceptable weather conditions;

.4 mooring arrangement plan;

.5 test weight data:

type;

total weight and composition (number of units and weight of each);

method of moving from side to side;

maximum anticipated angle of heel to each side;

.6 measuring devices:

pendulums – location and length;

U-tubes – location and distance between the tube's ends;

inclinometers – location and details of calibrations;

.7 anticipated parameters of trim and initial stability of the ship at the time of the inclining test;

.8 condition of tanks;

.9 estimated weights and coordinates of the centre of gravity of items which are to be added, removed and relocated;

.10 specific instructions on removing the surplus items from the ship and loading the missing items on board the ship, clearing of the ship of wastes, debris, etc.

.11 procedure for moving test weights;

.12 specific instructions on taking measurements;

.13 detailed description of any computer software to be used to aid in calculations during the inclining test;

3.2 Generally, preparations for the inclining test means the following.

3.2.1 The ship's construction (modification, repair) shall, as a general rule, be completed at the time of the inclining test.

3.2.2 Since the amount and type of work left to be completed (weights to be added) affect the accuracy of the light-ship characteristics, the full extent of such work shall be known. If the weight or centre of gravity of an item to be added cannot be determined precisely, the inclining test shall be conducted after the item is installed on the ship.

3.2.3 Temporary material, tool boxes, staging, sand, debris, etc., on board the ship shall be reduced to absolute minimum before the inclining test. Excess crew or personnel not directly involved in the inclining test shall be removed from the ship before the test.

3.2.4 Any rain, snow or ice accumulated on the ship shall be removed prior to the test.

3.2.5 The liquid cargo shall be removed, except for the liquids in the machinery, arrangements, systems and piping ensuring their working condition, and for the ballast needed for achieving a metacentric height of not less than 0,2 m (or for removing excessive trim), which shall be located in carefully pressed-up tanks.

As the width of the tank increases, the value of the free surface moment increases by the third power. The distance available for the liquid to shift is the predominant factor. This is why even the smallest amount of liquid in the bottom of a wide tank or bilge is normally unacceptable and shall be removed prior to the inclining experiment. Insignificant amounts of liquids in V-shaped tanks or voids (e.g. a chain locker in the bow) where the potential shift is negligible, may remain.

A Tank Content Report shall be drawn up. The liquid cargoes carried on board at the time of the inclining test shall be included in the Tank Content Report.

3.2.5.1 When particular tanks are left slack, on agreement with the Register, the density and the level of the liquid, and the shape of the tank, shall be such that the weight, the coordinates of the centre of gravity an the free surface moment of the liquid can be accurately determined.

Slack tanks shall be regular in shape (i.e. rectangular, trapezoidal, etc.) when viewed from above, so that the additional heeling moment from the free surface of liquids can be accurately determined.

3.2.5.2 The number of slack tanks shall be limited to one symmetrical pair or one centerline tank of the following:

fresh water tanks;
fuel oil storage tanks;
fuel oil day tanks;
lubricating oil tanks;
flushing sanitary tanks.

To avoid pocketing, such tanks shall be 20 per cent to 80 per cent full if they are deep tanks and 40 per cent to 60 per cent full if they are double-bottom tanks.

If the trim changes as the ship is inclined, then consideration shall also be given to longitudinal pocketing.

Slack tanks containing viscous liquids (such as heavy oil fuel at low temperature) shall be avoided since the correction for free surface of viscous liquid cannot be calculated accurately.

3.2.5.3 Communication between tanks shall never be allowed. Cross connections and sections of ship systems via which the liquid may flow from one tank to another, shall be closed. Valves and other closing devices shall be sealed. Equal liquid levels in slack tank pairs can be a warning sign of open cross connections. A bilge, ballast, and fuel oil piping plan is to be referred to, when checking for cross connection closures.

3.2.6 The ship shall be moored in a sheltered area free from extraneous forces such as propeller wash from passing vessels, swell, or sudden discharges from shore-side pumps. The current and the trim of the ship during the test shall be considered. Prior to the test, the depth of water shall be measured and recorded in as many locations as are necessary to ensure that the ship will not contact the bottom during the test. The water's specific gravity shall be accurately measured. The ship shall be moored in a manner to allow unrestricted heeling. The access ramps shall be removed. Power lines, hoses, etc., connected to shore shall be at a minimum, and capable of slackening.

3.2.7 The ship shall be upright and have sufficient draught so that any abrupt changes in the waterline area will be avoided as the ship is inclined from side to side. The trim is not to exceed 1 per cent of the ship's length when using hydrostsatic data in calculations; otherwise, direct calculations for the actual trim shall be made. In any case, significant change of waterplane area during heeling shall be avoided. With test weights in the initial position, the ship's list shall not exceed 0,5°.

3.2.8 The total test weight used shall be sufficient to provide an inclination of 2 to 4 degrees of heel to each side. A minimum inclination of 1° may be accepted for large ships, subject to agreement with the Register. The test weights shall be compact and such that their coordinates of the centre of gravity can be accurately determined. Each test weight shall be marked with an identification number and its weight. Certification of each test weight shall be carried out prior to each inclining.

It is recommended that the test weights be divided into 4 groups, two at each side.

Cranes of sufficient capacity and reach, or some other means, shall be available to shift test weights in an expeditious and safe manner.

Generally, the test weights shall be positioned as far outboard as possible on the upper deck. Precautions shall be taken to ensure that the decks are not overloaded during weight placement and movements. If deck strength is questionable then a structural analysis shall be performed to determine if existing framing can support the weight, and measures for its supporting shall be taken, if necessary.

Water ballast is not acceptable as test weight. However, in justified cases subject to special agreement with the Register, use of the water ballast as test weight may be permitted.

3.2.9 A minimum of 3 pendulums shall be used during the inclining test to allow identification of bad readings at any one pendulum station. The pendulums shall be located in an area protected from the wind. The pendulums shall be long enough to give a measured deflection, to each side of upright, of at least 15 cm. To ensure recordings from individual instruments are kept separate, the pendulums shall be physically located as far apart as practical.

The use of U-tubes, inclinometers and other devices approved by the Register is permitted. At least one pendulum shall be used for the control of the readings of these devices.

3.2.10 Efficient two-way communications shall be provided between the inclining test control station and the weight handlers and the persons taking readings. One person at the inclining test control station shall have control over the test.

4 DOCUMENTATION

The following documentation shall be available on board the ship at the time of the inclining test:

.1 lines plan;

.2 hydrostatic tables or curves;

.3 general arrangement plan;

.4 capacity plan showing capacities and volumetric centre of cargo spaces, tanks, etc.

.5 tank sounding tables;

.6 draught mark locations;

.7 docking drawing with keel profile (for ships designed with a rake of keel) with dimensions allowing to determine moulded draughts;

.8 stability calculations and preliminary Information on Stability.

5 TEST PROCEDURE

5.1 The inclining test shall be conducted in accordance with the Ship Instructions on the Conduct of an Inclining Test approved by the Register.

5.2 Survey of the ship shall be carried out prior to the inclining test to verify that the ship is prepared for the test.

5.3 Freeboard/draught readings shall be taken to establish the position of the waterline in order to determine the displacement of the ship. It is recommended that 5 freeboard readings be taken on each side of the ship. The readings shall be taken immediately before or immediately after the inclining test. The accuracy of the readings shall be checked by plotting the waterline on the lines drawing based on the readings.

5.4 Prior to any test weight movements the following shall be done:

.1 the mooring arrangement shall be checked to ensure that the ship is floating free (this shall also be done just prior to each reading of the pendulums);

.2 the pendulums shall be measured and their lengths recorded;

.3 the initial position of test weights is marked on the deck;

.4 the communications arrangement is adequate;

.5 all personnel are in place.

5.5 A control plot shall be run during the test in the coordinates of heeling moment versus the tangent of the angle of heel to ensure that acceptable data are being obtained.

Plotting of all the readings for each of the pendulums during the inclining test aids in the discovery of incorrect readings. The points on the plot are to be on a straight line or close to a straight line. Deviations from a straight line are an indication that there were other moments acting on the ship during the inclining test. These other moments shall be identified, the cause corrected, and test weight movements repeated until a straight line is achieved.

5.6 The standard test employs the following test weight shifts, which are given in Table 5.6.

If a straight line is achieved after the initial zero and the weight shifts on the plot referred to in 5.5, the readings may be used for further calculations. If a straight line plot is not achieved, those weight movements that did not yield acceptable plotted points shall be repeated.

Table 5.6

Nos of groups	Side	Shifts												
		0	1	2	3	4	5	6	7	8	9	10	11	12
2	PS	2		1	1, 2	2		1	1, 2	2				
	SB	1	1, 2	2		1	1, 2	2		1				
4	PS	2, 4	4		1	1, 3	1, 2, 3	1, 2, 3, 4	2, 3, 4	2, 4				
	SB	1, 3	1, 2, 3	1, 2, 3, 4	2, 3, 4	2, 4	4		1	1,3				
6	PS	2, 4, 6	4, 6	6		1	1, 3	1, 3, 5	1, 2, 3, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5, 6	2, 3, 4, 5, 6	2, 4, 5, 6	2, 4, 6
	SB	1, 3, 5	1, 2, 3, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5, 6	2, 3, 4, 5, 6	2, 4, 5, 6	2, 4, 6	4, 6	6		1	1, 3	1, 3, 5
Note: The numbers indicate test weight groups.														

Upon completion of inclining test with the use of inclinometers, the Surveyor to the Register shall sign the report on the availability of devices and the traces of the recorded heel pattern.

5.7 The accuracy of readings shall be ensured in preparation for and at the time of the inclining test, as follows:

length of pendulums, in mm	5
draught and freeboard, in mm	10
arms of test weight shifting and coordinates of the centre of gravity of cargoes, in mm	10
deviations of pendulums, in mm	1
measurement of traces of the recorded heel pattern, in mm	0,2
weight of test weights, in per cent	1
density, in per cent	0,1
time, in s	0,1

6 INCLINING TEST REPORT

6.1 A Report on the results of the inclining test shall be drawn up and submitted to the Register for consideration. If the results of consideration are satisfactory the Surveyor to the Register sign and seal the title page of the Report.

6.2 The Report shall contain the assessment of the inclining test carried out in accordance with 1.5.11 of the present Part of the Rules.

6.3 The recommended Report form is given in Appendix 11-1 to Section 2 "Hull", Part IV of Guidelines on Technical Supervision During Construction of Ships and Manufacture of Materials and Products. The Report shall have an identification number.

6.4 If computer programs are used to aid in calculations such programs shall be approved by the Register.

6.5 For ships engaged on international voyages, the Report shall be translated into English.

см.Б1

APPENDIX 4

INSTRUCTIONS ON LIGHT-WEIGHT CHECK

1 GENERAL

1.1 A light-weight check of a ship means determining the light-ship weight and its longitudinal centre of gravity on the basis of ship survey and draught measurements.

1.2 The shipowner shall engage a group of qualified specialists (board) for light-weight check and designate one of them in charge of the check.

1.3 The light-weight check shall be witnessed by the Surveyor to the Register.

1.4 The waters in the area where the light-weight check is conducted are to be free from floating objects and ice which might restrict draught measurements. The depth of water under the keel is to be not less than 0,5 m.

1.5 The light-weight check shall be carried out in calm weather, in a sheltered area. It is permitted to proceed with the light-weight check if insignificant current, swell or wind of up 3,5 m/s is present.

Conduct of a light-weight check under icing is not permitted.

2 PREPARATIONS FOR LIGHT-WEIGHT CHECK

2.1 The ship shall drift freely or be held by lines. Mooring lines, hoses and power lines connected to the ship shall be slack. The access ramps shall be removed.

2.2 The angle of heel shall not exceed 1°.

2.3 The ship's metacentric height at the time of the light-weight check shall be positive.

2.4 Cargo in the holds is not permitted. The number of missing items and surplus items whose weight and coordinates of the centre of gravity can be accurately determined, is unrestricted at the time of the light-weight check. Where this is impracticable, the surplus items shall be removed from the ship, and the missing items, loaded on board the ship.

2.5 The equipment, outfit, spares, etc., shall be in their regular positions.

2.6 The chance of the liquid cargoes carried on board the ship flowing (transferring) from tank to tank shall be excluded. Pipeline valves shall be closed and sealed.

2.7 Technical documentation to establish the weight and location of the surplus and missing items shall be in place prior to the light-weight check.

2.8 Any unwanted objects, debris, snow, ice, etc., shall be removed from the ship.

2.9 A light-weight check can be conducted with auxiliary machinery running, provided this does not impair the check results.

2.10 The persons involved in the light-weight check shall be briefed and efficient communications between those involved in the check provided.

2.11 Prior to the light-weight check, lists of surplus and missing items shall be drawn up, with indication of their name, location, weight and coordinates of the centre of gravity. The lists are to be approved by the person in charge of the check and submitted to the Surveyor to the Register. The inspection of the ship shall be carryed out by the board and the Surveyor to the Register prior to the check shall verify that the lists mentioned above are complete, and the ship properly prepared.

2.12 Instructions of the person in charge shall be followed for commencing and completing the light-weight check.

3 LIGHT-WEIGHT CHECK

3.1 Measurements of the ship's draughts shall be performed by draught marks and by freeboard readings to be taken in at least 5 locations over the length of the ship. A report on draught measurement results shall be drawn up.

3.2 In case of discrepancy between the ship's draughts obtained from draught marks and those obtained from freeboard readings, the freeboard readings shall be authoritative.

3.3 The specific gravity of the water shall be determined on the basis of a sample taken from a depth equal to half the mean draught of the ship at the time of the light-weight check.

3.4 The deflection of the ship may be taken into account when calculating the displacement using any method of adequate accuracy.

3.5 When a ship has a trim, the displacement and the abscissa of the centre of buoyancy shall be obtained by direct calculation by a computer program approved by the Register. The ship's vertical centre of gravity shall be obtained by calculation in accordance with the Information on Stability for a non-typical loading condition.

3.6 The displacement and the longitudinal centre of gravity of a light ship at light-weight check shall be determined according to Table 3.6.

Table 3.6

Load	Weight	Longitudinal centre of gravity, X_g	Moment, M_x
	T	M	TM
Ship during check Missing items Surplus items			
Light-ship during check			
+ distance forward of midships, in m. – – distance aft of midships, in m.			

3.7 Readings shall be accurate to:

draught . . . . 10 mm;

freeboard. . . . . 10 mm.

3.8 Upon completion of the light-weight check, the panel shall draw up the Light-Weight Check Report. The Report shall have an identification number. The coordinate system and the units shall correspond to those used in the Information on Stability.

The recommended form of the Report is given in the Annex to these Instructions.

3.9 The Light-Weight Check Report shall be referred for consideration to the Register. The Report will be signed by the Register provided the results of consideration are satisfactory.

3.10 If the ship is engaged on international voyages the Report shall be translated into English.

Annex to the Instructions on Light-Weight Check

LIGHT-WEIGHT CHECK REPORT

No.__________ « » 200 .

1 Ship particulars

1.1 Name.
1.2 Type.
1.3 Builder.
1.4 Hull number.
1.5 Year of build.
1.6 RS number.
1.7 IMO number.
1.8 Port of registry.
1.9 Principal dimensions.

2 Organization and conditions of light-weight check

2.1 Location of check (country, port).

2.2 Date and time of check.

2.3 Person in charge and check performers (names, positions).

2.4 The Surveyor to the Register witnessed the check (name, position).

2.5 Area and weather conditions:
.1 name of area;
.2 current speed;
.3 condition of water surface;
.4 ice conditions;
.5 temperature of water;
.6 specific gravity of water;
.7 minimum depth under keel;
.8 wind speed.

2.6 Preparation of the ship for light-weight check:
.1 brief description of the ship's condition;
.2 initial heel of ship;
.3 mooring lines (type, number, method of attachment).

3 Light-weight check

3.1 The ship's draughts by draught marks (Table 3.1).

Table 3.1

Name	Draughts by draught marks		Draughts at marks dmean *T*	Draughts at perpendiculars
	PS	SB	—	—
Draught forward, in m Draught aft, in m Draught amidships, in m				

3.2 Ship's draughts by freeboard readings (Table 3.2).

Table 3.2

Locations of freeboard readings, in fr.	Freeboard values, in m		Averaged freeboard values, in m	Moulded draughts at perpendiculars and amidships
	PS	SB		

The following values of draughts are assumed for the calculation:

$d_f =$

$d_a =$

$d_{mean} =$

3.3 Calculation of displacement and hydrostatic components (computer printout attached).

3.4 Missing items.

The following missing items are assumed for the calculation (Table 3.4).

Table 3.4

Identification of items	Weight	Longitudinal centre of gravity, X_g	Moment, M_x
	t	m	tm
1 2 3 *n*			
Total:	ΣP		ΣM_x

3.5 Surplus items.

The following surplus items are assumed for the calculation (Table 3.5).

Table 3.5

Identification of items	Weight	Longitudinal centre of gravity, X_g	Moment, M_x
	t	m	tm
1 2 3 *n*			
Total:	ΣP		ΣM_x

3.6 Permanent solid cargo having a weight of _________ t is carried on board the ship, stowed according to sketch________________.

3.7 The design metacentric height *h* was _______ m at the time of the light-weight check.

3.8 The following departures from the present Instructions were made during the light-weight check (Table 3.8):

Table 3.8

No.	Nature of departures	Explanation of departures

3.9 Determination of the light-ship displacement and the ship's longitudinal centre of gravity on the basis of light-weight check (Table 3.9).

Table 3.9

Load	Weight	Longitudinal centre of gravity, X_g	Moment, M_x
	t	m	tm
Ship during check Missing items Surplus items Light ship			

4 CONCLUSION

The light-weight check of the ship was conducted in accordance with the Register Instructions on Light-Weight Check.

The following experimental data were obtained for the lightship based on the results of the light-weight check:

displacement________;

longitudinal centre of gravity ________ m forward (aft) of the midship section (after perpendicular).

Signed:

Person in charge of light-weight check_____________
(signature; name)

Board members________________________________
(signature; name)

Surveyor to the Register__________________________
(signature; name)

TABLE
OF SYMBOLS FOR THE VALUES ADOPTED IN PART IV "STABILITY"

Register	IMO	Value
Δ	Δ	Displacement
$\Delta_{\min}$	—	Displacement corresponding to the minimum loading condition of the ship specified by the Rules
$\Delta_{\max}$	—	Full-load displacement
Δ_0	—	Light-ship displacement
Δ_1	—	Ship's displacement in the most unfavourable loading condition as regards values of h and $l_{\max}$
γ	γ	Density
A_v	A_v	Windage area
A_k	—	Area of keels
A_{vi}	—	Windage area component of a floating crane
a_{cal}	—	Calculated value of acceleration (in fractions of g)
B	B	Breadth of the ship
b_0	—	Shroud spacing
C_B	C_B	Block coefficient of the ship
C_b	C_b	Tank block coefficient
c_t, b_t, a_t	—	Tank overall length, breadth and height (by base planes)
c, b	—	Relative "dynamic" abscissa and ordinate of tow hook suspension point
D	D	Depth, moulded
d	d	Draught of the ship, moulded
$d_{\min}$	—	Draught, moulded, for minimum practicable ship's loading condition
$d_{\otimes}$	—	Draught amidships
g	g	Acceleration due to gravity
h	GM	Corrected metacentric height (with correction for free surfaces)
h_0	GM_0	Initial metacentric height (not corrected for free surfaces)
$h_{3\%}$	—	Calculated wave height with 3 per cent probability of exceeding level
H	—	Corrected longitudinal metacentric height of a floating dock, floating crane, crane ship (with correction for free surfaces)
K	—	Weather criterion
K^*	—	Acceleration criterion
K_1	—	Safety factor with respect to tow line jerk for general service and ship-handling tugs
K_2	—	Safety factor with respect to tow line jerk for sea-going tugs
ΔK	—	Component of K_2 allowing for effect of rolling on resultant angle of heel
ψ	—	Angle of trim of a floating dock
k	—	Factor allowing for effect of bilge keels
k_i	—	Aerodynamic flow coefficient for crane structures
L	L	Length of the ship
l	GZ	Arm of statical stability corrected for free surfaces
$l_{\max}$	GZ_m	Maximum arm of statical stability corrected for free surfaces
l_d	l	Arm of dynamical stability corrected for free surfaces
l'_d	—	Ditto, but not corrected for free surfaces
l_1; l_{d1}	—	Arms of statical and dynamical stability with permanent heeling moment due to load, as corrected for free surfaces
l'_{d1}	—	Ditto, but not corrected for free surfaces
l_F	—	Arm of form stability with respect to the centre of buoyancy
l_M	—	Arm of form stability with respect to metacentre
l_{P}	—	Arm of form stability with respect to arbitrary pole
l_K	—	Arm of form stability with respect to moulded base line
l_c	—	Capsizing lever corrected for free surfaces of liquids
l_v	—	Heeling lever
$l_{d\,caps}$	—	Arm of dynamical stability defined as ordinate of curve of dynamical stability for tug at the angle of heel equal to flooding or capsizing angle, whichever is less
$l_{d.\,h}$	—	Dynamic heeling lever characterizing assumed jerk of tow line
$l_{d\,\max}$; l_{d_f}	—	Ordinate of curve of dynamical stability at the angle of heel equal to angle of the maximum of statical stability curve or angle of flooding, whichever is less
$\overline{l}_{30}$	—	Non-dimensional coefficient for determination of free surface correction at heel of 30°
θ	θ	Angle of heel
θ_f	θ_f	Angle of flooding
θ_v	θ_v	Angle of vanishing stability
θ_d	_	Angle of deck immersion
θ_b	_	Angle of coming out of water of bilge middle
θ_m	θ_m	Angle of heel corresponding to the maximum of the statical stability curve
θ_{caps}	—	Capsizing angle
θ_{d_1}	—	Angle of dynamical heel of tug due to assumed jerk of tow line
θ'_{caps}	—	Angle of tug capsizing defined as abscissa of the tangency point of dynamical stability curve and tangent to it passing through origin of the coordinates
θ_{BC_1}	—	Statical heel after spoil discharge
θ_{1r}	θ_r	Amplitude of roll for round-bilged ship

Table of symbols — continued

Register	IMO	Value
θ_{2r}	θ_r	Amplitude of roll for ship with keels
θ_{3r}	θ_r	Maximum amplitude of dredger rolling with respect to statical inclination immediately after spoil is discharged from one side
θ_r	—	Amplitude of roll of a floating crane, crane ship
θ'_r	—	Amplitude of roll of a floating crane/crane ship taking into account bilge keels
$\delta\theta_r$	—	Correction (function) having regard to the effect of the crane centre of gravity elevation above waterline
θ_0	—	Initial statical heel of a floating crane due to load hook and unsymmetrical stowage of cargo on deck
θ_s	—	Angle of heel of a pontoon floating crane due to heeling moment M_v caused by the permanent wind
θ_{d_2}	—	Angle of heel of a floating crane due to combined effect of initial heeling moment, statical wind effect and rolling
θ'_{d_2}	—	Calculated angle of heel of a floating crane prior to load drop equal to the sum of angles θ_o and θ_r minus θ_s
M_c	M_c	Capsizing moment
M_v	M_v	Heeling moment due to wind pressure
M_{h1}	M_h	Heeling moment due to passenger crowding
M_{h2}	M_h	Heeling moment due to turning
M_{h3}	M_h	Heeling moment due to long chute or conveyor
M_ψ	—	Trimming moment due to crane mass with maximum load for the most unfavourable service case of crane arrangement on a floating dock
ΔM_{30}	M_h	Heeling moment due to liquid overflow at ship's heel of 30°
Δm_h	—	Correction of stability coefficient for liquid cargo effect
m	—	Regulated frequency of natural oscillations of the ship
N_e	—	Shaft power
n_i	—	Zone coefficient taking into account changes in wind velocity head depending on the height of windage area centre of gravity of a floating crane
P	P	Mass of spoil in the hopper
p_v	p_v	Rated wind pressure
q	—	Rated wind velocity head
v_t	—	Tank volume
$v_{0,8}$	—	Initial turning speed assumed to be 80 per cent of full speed
v_s	—	Speed of straightline movement of a ship
x_H	—	Longitudinal distance between tow hook suspension point and ship's centre of gravity as measured over horizontal
X, X_1, X_2, $X_{1,2}$, X_3, X_4, X_5	—	Factors for determination of amplitude of roll
y	—	Ship's centre of gravity ordinate from centre plane
y_g	—	Side shifting of ship's centre of gravity from centre plane
Y	—	Factor (function) for determination of amplitude of roll
z	—	Arm of windage area
z_g	KG	Centre of gravity elevation above moulded base plane
z_H	—	Elevation of tow hook suspension point above moulded base plane
z_0	—	Elevation of shroud mounting point
z_i	—	Height of geometrical centres of areas A_{vi} within a given zone above the actual waterline of a floating crane
z_v	—	Arm of windage area of a floating crane due to the permanent wind
C_{CL}	—	Lateral area coefficient of a floating crane, crane ship
C_{WL}	—	Water-plane coefficient of a floating crane, crane ship
θ''_r	—	Amplitude of roll of a floating crane during voyage/passage with regard to bilge coming out of water at midsection or deck immersion
θ'_s	—	Angle of heel of a crane ship which hull shape is similar to the ship lines, exposed to heeling moment M'_v caused by squall
X_C	X_B	Abscissa of the centre of buoyancy
X_g	X_G	Abscissa of the centre of ship gravity
Z_v	—	Arm of windage area of a floating crane due to squall

PART V. SUBDIVISION

1 GENERAL

1.1 APPLICATION

1.1.1 The requirements of the Part apply to ships of the following types:

.1 passenger ships;

.2 oil tankers;

.3 fishing vessels having the length $L_1 \geqslant 100$ m;

.4 type "A" ships and type "B" ships with reduced freeboard as mentioned under 4.1.2.1 and 4.1.3.3 of Load Line Rules for Sea-Going Ships;

.5 chemical tankers;

.6 gas carriers;

.7 special purpose ships;

.8 supply vessels;

.9 ships intended for the carriage of radioactive agents;

.10 cargo ships having the length $L_s \geqslant 80$ m not mentioned above;

.11 dry cargo ships having the length $L_s < 80$ m (see 1.4.9);

.12 icebreakers having the length $L_1 \geqslant 50$ m;

.13 tugs having the length $L_1 \geqslant 40$ m;

.14 dredgers having the length $L_1 \geqslant 40$ m, hopper dredgers having the length $L_1 \geqslant 60$ m;

.15 salvage ships;

.16 drilling ships;

.17 lightships;

.18 ships having the ice strengthening marks **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8** and **ЛУ9** in the class notation;

.19 berth-connected ships used as floating hotels and/or having over 100 persons on board;

.20 passenger ships and bulk carriers in service, which construction date is stated in Section 5.

1.1.2 For ships to which the present Part of the Rules is not applicable it is recommended that all measures allowed by the type and service conditions of the ship be taken to obtain the best subdivision characteristics possible.

However, if the shipowner wishes a subdivision mark to be introduced in the class notation, the ship shall satisfy all the requirements contained in the Part.

The applicability of the present Part of the Rules to novel craft shall be determined on agreement with the Register.

1.1.3 Section 4 is applicable to type "A" ships and type "B" ships with reduced freeboard provided compliance with 4.1 of the Load Line Rules as regards the subdivision of those ships is confirmed. When making calculations required by Section 4, calculations as required by Sections 2 and 3 may be considered.

1.2 DEFINITIONS AND EXPLANATIONS

1.2.1 Definitions and explanations relating to the general terminology of the Rules are given in Part I "Classification".

For the purpose of the present Part of the Rules the following definitions have been adopted:

A drilling ship is a ship intended for drilling operations.

The depth D is the least vertical distance measured from the top of the plate keel or from the line where the inner surface of shell plating abuts upon the bar keel, to the inner line of bulkhead deck abutting to the side. In ships having rounded gunwales, this distance is measured to the point of intersection of the continued inner surfaces of bulkhead deck steel plating and the side shell plating at side, as though the gunwale were of angular design. In non-metal ships the above-said shall be referred to the outer surfaces of the deck and plating.

Moulded depth is measured in the same way as the depth D, but up to the top of the freeboard beam.

A hopper barge is a cargo transport ship intended only for the transportation of spoil.

The subdivision length of ship L_s:

for passenger ships — the largest length of the ship portion located below the bulkhead deck;

for cargo ships — the largest moulded length of the ship's projection at or below the level of the deck or decks limiting the maximum vertical length of flooding $H_{\max}$ determined in accordance with 2.3.10.

The ship length L_{ice} is the ship length on the waterline corresponding to the draft d_{ice}.

The ship length L_1 is 96 per cent of the total length on a waterline at 85 per cent of the least moulded depth or the length from the fore side of stem to the axis of rudder stock on that waterline if that be greater.

A dredger is a ship extracting spoil by any appliances and having no spoil hopper.

Permeability of a space μ is the ratio of the volume within that space, which is assumed to be occupied by water to the total volume of that space.

An icebreaker is a ship intended for sailing in ice for the purpose of maintaining navigation in ice-obstructed waterways.

The ship draft d is a vertical distance measured at the midpoint of the appropriate ship length from the top of the flat keel or from the point of abutment of the inner surface of the shell (outer surface, for ships with non-metal shell) to the relevant waterline of the ship.

The ship draft d_{ice} is the smallest ship draft: a draft corresponding to the waterline serving as the upper boundary of the ice strengthening of the hull, or a draft at which the requirements for ice damage trim and stability are met, as contained in 2.4 and 3.4.11.

A compartment is an inner space limited by the ship bottom, sides, bulkhead deck and two adjacent transverse watertight bulkheads or a peak bulkhead and an extremity.

Bulkhead deck is the uppermost deck up to which transverse watertight bulkheads are carried over the entire breadth of the ship.

In case of flooding of a compartment or group of adjacent compartments, where there is a watertight deck above the bulkhead deck which, together with the shell plating and watertight bulkhead, restricts progressive flooding this deck may be adopted as relevant bulkhead deck in calculating the flooding case concerned.

A lightship is a vessel provided with powerful sources of light and other equipment to orient navigators and ensure the sea-faring safety of other ships.

Factory-and-mother ship is a cargo ship to collect the products from fishing and processing vessels directly at sea.

A salvage ship is a ship for rendering aid to vessels in distress at sea.

A hopper dredger is a ship extracting spoil by any appliances and having a hopper for its transportation.

The ship breadth B is the extreme moulded breadth of a ship at midlength at the level of or below the deepest subdivision load line.

For the purpose of this Part the following explanations have been adopted:

Damage waterline is the waterline of a damaged ship with one or more adjacent compartments flooded.

Subdivision load line is the load line of an undamaged ship, which is used in determining the subdivision of the ship.

A fishing vessel is a vessel for catching and processing or only for catching fish and other living resources of the sea.

The lightest service draft d_0 is the service draft corresponding to the lightest anticipated loading and associated tankage including such ballast as may be necessary for trim and/or stability.

The subdivision draft d_s is the draft up to the subdivision load line.

The deepest subdivision load line is the waterline, which corresponds to the deepest draft permitted by applicable subdivision requirements.

Midlength is the midpoint of the subdivision length of a ship.

Equalization of a ship is the process of eliminating or reducing heel and/or trim.

1.2.2 In all calculated cases of flooding only one hole in the hull is assumed and only one free surface of sea water which penetrated after the accident. In this case the hole is considered to have the shape of a rectangular parallelepiped.

1.2.3 All linear dimensions used in the present Part of the Rules are taken in meters.

1.3 SCOPE OF SURVEY

1.3.1 The provisions pertaining to the procedure of classification, survey of ships under construction and classification surveys, as well as the requirements for the technical documentation to be submitted for consideration by the Register are contained in General Regulations for the Classification and Other Activity and in Part I "Classification".

1.3.2 For every ship meeting the requirements of the present Part of the Rules, the Register shall carry out the following:

.1 check of compliance of the structural measures taken to ensure subdivision of the ship with the requirements specified in 1.1.6 and 2.7, Part II "Hull", Section 7, Part III "Equipment, Arrangements and Outfit", Sections 2, 4, 5 and 7.1 to 7.11, 9.7, 10.1, 10.2, 12.1, Part VIII "Systems and Piping";

см.Б1 **.2** consideration and approval of Information on Damage Trim and Stability, Damage Control Plan, as well as consideration of Information on the Effect of Flooding (to be duly noted), as stipulated in 1.4.9;

.3 checking of correct assignment and marking of additional load lines corresponding to subdivision load lines;

.4 examination and approval of the computer installed on board the ship and the relevant software where it is used for assessing damage trim and stability.

1.4 GENERAL TECHNICAL REQUIREMENTS

1.4.1 The ship subdivision shall be the most effective bearing in mind the service of the ship. The degree of subdivision shall vary proceeding from the area of navigation, ship length and number of persons on board so that the highest subdivision degree would be characteristic of ships of the greatest length engaged for the most part in the carriage of passengers and of those navigating in the Arctic and the Antarctic.

1.4.2 In no case shall any subdivision load line be assigned above the highest load line in seawater determined on the basis of the ship hull safety or in accordance with the Load Line Rules for Sea-Going Ships.

The subdivision load line assigned to the ship is marked on its sides and recorded in the documents of the Register as required by the Load Line Rules for Sea-Going Ships.

1.4.3 The volumes and areas shall, in all cases, be calculated to moulded lines. The volumes and free surfaces of water which penetrates the compartments of reinforced-concrete, plastic, wood and composite ships shall be calculated to inboard hull lines.

1.4.4 When determining the initial metacentric height of a ship in damaged condition, corrections for the effect of free surfaces of liquid cargoes, ship stores and ballast water shall be taken into account in the same manner as in the case of calculating the intact stability of a ship in compliance with 1.4.7, Part IV "Stability".

When plotting static stability curves for a damaged ship, the enclosed superstructures, trunks, deckhouses, angles of flooding through openings in ship's sides, decks, hull and superstructure bulkheads considered open as well as corrections for free surfaces of liquid cargoes shall be taken into account in the same manner as in the case of plotting curves for an intact ship in compliance with 1.4.9, Part IV "Stability".

Superstructures, trunks and deckhouses which sustain damage may only be taken into account with the permeability specified in 1.6, or ignored. The openings in such structures leading to spaces, which are not flooded, are considered open at appropriate angles of heel only when regular weathertight means of closing are not fitted.

1.4.5 When calculating damage trim and stability, account shall be taken of changes in the initial ship loading (intact ship) due to liquid cargoes being replaced by sea water in damaged tanks, taking into consideration that in the flooded tanks below the damage waterline the free surface of those cargoes disappears.

1.4.6 Ships to which the present Part of the Rules is applicable shall be provided with approved Information on Damage Trim and Stability with compartments flooded and with Damage Control Plan. These documents shall enable the master operating the ship, to consider the requirements concerning subdivision and to estimate the condition of the ship when compartments are flooded as well as to take measures for maintaining the damaged ship afloat.

1.4.6.1 Information on Damage Trim and Stability shall include the following:

.1 data on the ship, including its dimensions and permissible drafts on clear water and in ice conditions, its longitudinal section, deck and double-bottom plans, typical cross-sections with indication of all watertight bulkheads and enclosures with openings therein, means of their closure and drives, openings of air and ventilation pipes, as well as diagrammatic arrangement of systems necessary for the survival of the damaged ship;

.2 information necessary to maintain the stability of an intact ship sufficient to withstand, in accordance with the requirements of the present Part of the Rules, the most dangerous extent of damage; instructions on loading and ballasting the ship, including recommendations on distributing cargo in the holds, stores and ballast in a manner reasonable as regards the subdivision adopted and satisfying at the same time the requirements for the trim, stability and strength of the ship; brief list of requirements for damage trim and stability;

.3 diagram of the limiting gravity-centre heights of the ship (limiting moments or minimum metacentric heights) plotted taking into the account the requirements of this Part and Part IV "Stability";

.4 list of results of symmetrical and unsymmetrical flooding calculations with data on initial and damage draught, heel, trim and metacentric height both before and after taking measures for the equalization of the ship or for improving its stability as well as measures recommended for these procedures and the period of time required. Parameters of static stability curves anticipated under the worst flooding conditions are also to be included. Where necessary, for ships with **ЛУ4** to **ЛУ9** ice strengthening, the information on the characteristics of ice unsinkability, damage trim and stability shall be indicated when sustaining design ice damage;

.5 data on structural measures to ensure ship subdivision, instructions on the use of covers, cross flooding arrangements and emergency appliances as well as on possible consequences of flooding relating to the particular features of the ship and on advisable and prohibited actions of the crew under normal conditions of service and in case of damage involving flooding.

1.4.6.2 Damage Control Plan shall be made on the scale acceptable for operation, but not less the 1:200. On passenger ships, the Plan shall be permanently exhibited on the navigating bridge. On cargo ships the Plan shall be permanently exhibited or be readily available on the navigating bridge. The Plan containing the longitudinal section, plans of decks, double bottom and transverse sections shall include:

boundaries of watertight compartments and tanks;

ballast, bilge, overflow (discharge) systems and arrangements to correct heel caused by flooding;

location of openings in watertight compartments, their closing appliances and the location of their local and remote controls, position indicators and alarms;

location of doors in the shell of the ship, position indicators, leakage detection and surveillance devices;

location of weathertight closing appliances above the bulkhead deck and on the lowest exposed weather deck, together with location of controls and position indicators, if applicable;

location of all bilge flood and ballast pumps, their control stations and valves.

1.4.7 Information on Damage Trim and Stability shall be compiled on the basis of the Information on Stability. The procedure of extending the validity of the Information on Damage Trim and Stability from one ship to another is similar to that of extending the validity of Information on Stability as specified in 1.4.11.3, Part IV "Stability". Information on Damage Trim and Stability may be incorporated in Information on Intact Stability as a separate section.

1.4.8 For estimation of the ship damage trim and stability it is recommended to use the onboard computer. The associated software shall have Type Approval Certificate issued by the Register.

A computer is not equivalent to Information on Damage Trim and Stability.

1.4.9 Dry cargo ships less than 80 m in length shall be provided with Information on the Effect of Flooding. This Information shall contain data and documentation listed in 1.4.6.1 and results of damage stability calculations when machinery spaces and every cargo space are flooded. The calculations shall be made for two draughts one of which shall be the summer load line draught. The maximum permissible position of ship's centre of gravity shall be taken according to Information on Stability. Permeabilities of cargo spaces shall be taken with regard to the cargoes intended to be carried and shall be within 0,60 to 0,90. The information shall contain a summary table of calculation results with indication of critical factors, as well as details given in 1.4.6.1.5.

1.4.10 Every ship shall have draught scales prominently marked at bow and stern. Where the draught scales are so placed that they are not clearly visible or where service conditions impede reading the indications of the scale the ship shall be provided with a reliable draught measurement system whereby the forward and aft draughts can be easily determined.

1.5 SATISFACTORY SUBDIVISION

1.5.1 The subdivision of a ship can be considered satisfactory as regards the present Part of the Rules, if:

.1 the attained (actual) probability subdivision index A is not lower than the required probability subdivision index R. The indices A and R shall be determined on the basis of Section 2;

.2 the attained (actual) probability ice subdivision index A_{ice} is not lower than the required probability ice subdivision index R_{ice}. The indices A_{ice} and R_{ice} shall be determined on the basis of Section 2;

.3 damage stability is in accordance with Section 3.

The requirements under 1.5.1.1 are not applicable to ships for which in Section 2 there are no instructions for determining the indices A and/or R.

1.5.2 A subdivision distinguishing mark is introduced in the class notation of the ship in accordance with 2.2.4, Part I "Classification" provided under all design loading conditions corresponding to the type of ship concerned its subdivision is considered satisfactory according to 1.5.1 and the compliance of structural measures related to the subdivision of the ship with the requirements of 1.1.6 and 2.7, Part II "Hull" and in Section 7, Part III "Equipment, Arrangements and Outfit" is ensured.

When, in accordance with 3.4 of the present Part of the Rules the number of floodable compartments is changed throughout the ship length, the lowest value shall be stated in the subdivision distinguishing mark.

1.5.3 Additional conditions under which a subdivision distinguishing mark shall be introduced in the class notation can be found in 3.4.

1.6 PERMEABILITY

1.6.1 In the calculations of damage trim and stability the permeability of flooded space shall be assumed equal to:

.1 0,85 for spaces occupied by machinery, electric generating sets and processing equipment on fishing vessels and factory ships;

.2 0,95 for accommodation spaces and empty spaces including empty tanks;

.3 0,6 for the spaces intended for dry stores.

1.6.2 Permeability of flooded tanks with liquid cargo or liquid stores or water ballast is determined based on the assumption that all the cargo is discharged from the tank and sea water is ingressed taking into consideration the permeability index being equal to 0,95.

1.6.3 The permeability of the spaces intended for solid cargoes is given below in the appropriate paragraphs of Sections 2 to 5.

1.6.4 The permeability of spaces may be assumed lower than specified above only in case a special calculation is performed which is approved by the Register.

When performing such special calculations for cargo spaces including refrigerating ones, the permeability of net cargo shall be assumed equal to 0,6, and that of the cargo in containers, trailers, roll trailers and lorries shall be assumed equal to 0,71.

1.6.5 Where the arrangement of spaces or the service conditions of the ship are such that the expediency of the application of other permeabilities resulting in more severe requirements is evident, the Register is entitled to require the application of those permeabilities.

2 PROBABILITY ESTIMATION OF SUBDIVISION

2.1 GENERAL

2.1.1 The degree of ship unsinkability shall be determined by the obtained probability subdivision indices:

A — when the ship is side-holed due to collision or getting foul;

A_{ice} (ice) — when the ship is side-holed during the navigation in ice conditions.

2.1.2 The permissible degree of subdivision shall be determined by the required subdivision indices R and R_{ice}, i.e. the following conditions shall be met:

$$A \geqslant R \text{ and } A_{ice} \geqslant R_{ice}.$$

2.1.3 The attained probability indices (A and A_{ice}) are determined by the formulae:

$$A = \Sigma Ws \qquad (2.1.3\text{-}1)$$

and

$$A_{ice} = \Sigma W_{ice}s \qquad (2.1.3\text{-}2)$$

where W = the probability of flooding of the compartment or a group of adjacent compartments when a ship is side-holed;

W_{ice} = the probability of flooding of the compartment or a group of adjacent compartments when a ship is ice-holed;

s = the probability of the ship survival after damage to a compartment or a group of adjacent compartments.

Summarising in the Formulae (2.1.3-1) and (2.1.3-2) is carried out through the numbers of all the compartments and groups of adjacent compartments the results of flooding of which are estimated by the damage trim and stability calculations.

2.1.4 When determining the probabilities W and W_{ice} the length of the compartment or a group of adjacent compartments, bounded by one or two watertight transverse bulkheads with steps, is assumed equal to the distance between transverse planes passing through the nearest parts of these bulkheads.

It is allowed not to consider the steps formed by watertight floors in the double bottom.

2.1.5 For groups of adjacent compartments the values of W are determined by the following formulae:

for pairs of adjacent compartments

$$W = W_{ij} - W_i - W_j; \qquad (2.1.5\text{-}1)$$

for groups of three adjacent compartments

$$W = W_{ijk} - W_{ij} - W_{ik} + W_j; \qquad (2.1.5\text{-}2)$$

for groups of four adjacent compartments

$$W = W_{ijkm} - W_{ijk} - W_{jkm} + W_{jk}\,. \qquad (2.1.5\text{-}3)$$

In the above mentioned formulae the following shall be specified:

W_i ,W_j — for compartments of the lengths l_i and l_j;

W_{ij}, W_{jk} — for compartments of the lengths $l_{ij} = l_i + l_j$ and $l_{jk} = l_j + l_k$, accordingly;

W_{ijk}, W_{jkm} — for compartments of the lengths $l_{ijk}=l_i+l_j+l_k$ and $l_{jkm} = l_j + l_k + l_m$, accordingly;

W_{ijkm} — for a compartment of the length $l_{ijkm}=l_i+l_j+l_k+l_m$.

For stepped bulkheads the compartment lengths for calculation purposes shall be determined in accordance with Fig. 2.1.5.

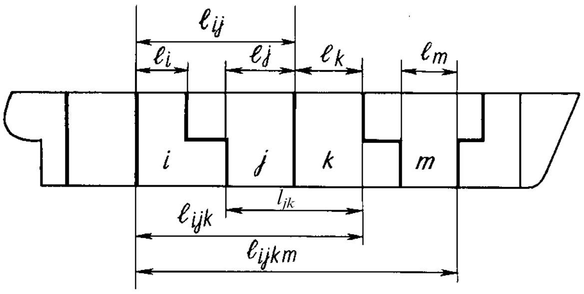


Fig. 2.1.5 Sketch for determining lengths of compartments for calculation purposes

2.1.6 In case of longitudinal subdivision the following shall be considered separately:

holes which do not damage the longitudinal bulkhead with the probability r;

holes which damage the longitudinal bulkhead with the probability $1-r$.

2.1.7 The values of the probabilities W, W_{ice}, s and r shall be determined by the formulae given in 2.2 to 2.4.

2.1.8 When calculating the probabilities s it is assumed that:

the ship has no trim before the damage;

gravity-centre height for each calculated draught is not lower than the maximum permissible value obtained in compliance with the requirements of Part IV "Stability" and the requirements of the present Part;

permeabilities of non-cargo spaces are equal to those stated in 1.6, and for cargo spaces they are assumed according to the requirements of 2.2 to 2.4.

When considering the progressive flooding due to submergence of the openings, as mentioned in 3.3.4, which lead to undamaged spaces, for the purpose of determination of the probability s, the components of ship's damage trim and stability at additional flooding of the appropriate undamaged spaces shall be taken into account.

2.2 PROBABILISTIC ESTIMATION OF SUBDIVISION IN PASSENGER SHIPS

2.2.1 The requirements of this Chapter apply to the ship types listed below:

passenger ships;

special purpose ships having special personnel on board exceeding 200 persons;

roll-on/roll-off ships where transportation of vehicles with accompanying personnel in excess of 12 persons, including passengers, is intended.

When checking compliance with the requirements of the present Chapter, the instructions of 2.1 shall be taken into account.

2.2.2 The required subdivision index R shall be determined by the formula

$$R = 1 - \frac{250}{L_s + (N/4) + 375} \qquad (2.2.2)$$

where $N = N_1 + 2N_2$;

N_1 = the number of persons for whom lifeboats are provided as compared to the total number of persons that shall be on board during the voyage;

N_2 = the number of persons (including officers and crew) that the ship is permitted to carry in excess of N_1.

2.2.3 The probability W of a compartment, restricted by transverse bulkheads, being flooded is equal to ap.

The value of a determines the conditional effect upon the above probability of the position of a compartment as part of the ship length with regard to the law of abscissae distribution of the middle of the longitudinal extent of damage, the value of p accounts for the effect of compartment length with regard to the law of distribution of the longitudinal extent of damage.

2.2.4 The value of a is determined for each compartment or a group of adjacent compartments by the formula

$$a = 0{,}4[1 + \xi_1 + \xi_2 + \xi_{12}] \qquad (2.2.4)$$

where $\xi_1 = x_1/L_s$, if $x_1 \leqslant 0{,}5L_s$;

$\xi_2 = x_2/L_s$, if $x_2 \geqslant 0{,}5L_s$;

$\xi_1 = 0{,}5$, if $x_1 > 0{,}5L_s$;

$\xi_2 = 0{,}5$, if $x_2 > 0{,}5L_s$;

$\xi_{12} = (x_1 + x_2)/L_s$, if $x_1 + x_2 \leqslant L_s$;

$\xi_{12} = 1{,}0$, if $x_1 + x_2 > L_s$;

x_1 = the distance from the aft terminal of ship's hull at or below the bulkhead deck to the aft end of the considered compartment or group of adjacent compartments;

x_2 = the distance from the aft terminal of ship's hull to the forward end of the considered compartment or group of adjacent compartments.

2.2.5 The value of p is determined by the formulae below:

for $L_s \leqslant 200$ m

$$p = 4{,}46(l/L_s)^2 - 6{,}20\ (l/L_s)^3,\ \text{if}\ l/L_s \leqslant 0{,}24; \qquad (2.2.5\text{-}1)$$

$$p = 1{,}072l/L_s - 0{,}086,\ \text{if}\ l/L_s > 0{,}24; \qquad (2.2.5\text{-}2)$$

for $L_s > 200$ m

$$p = 184[4{,}46(l/L_s)^2 - 6{,}20(l/L_s)^3]/(L_s - 16),\ \text{if}\ l/200 \leqslant 0{,}24; \qquad (2.2.5\text{-}3)$$

$$p = 184[1{,}072l/L_s - 0{,}086]/(L_s - 16),\ \text{if}\ l/200 > 0{,}24 \qquad (2.2.5\text{-}4)$$

where l = the length of a compartment or a group of adjacent compartments being determined with regard to 2.1.4.

2.2.6 In case of longitudinal subdivision:

.1 the probability W of side compartment flooding

$$W = rap; \qquad (2.2.6\text{-}1)$$

and that of the side compartment flooding together with the central one

$$W = (1 - r)ap; \qquad (2.2.6\text{-}2)$$

.2 the value of a is determined according to 2.2.4, the value of p — according to 2.2.5;

.3 the probability of r is determined by the formulae:

for $l/L_s \geqslant 0{,}2b/B$

$$r = b/B[2{,}8 + 0{,}08/(l/L_s + 0{,}02)],\ \text{if}\ b/B \leqslant 0{,}2; \qquad (2.2.6.3\text{-}1)$$

$$r = b/B + 0{,}36 + 0{,}016/(l/L_s + 0{,}02),\ \text{if}\ b/B > 0{,}2; \qquad (2.2.6.3\text{-}2)$$

where $l/L_s < 0{,}2b/B$, the value of r shall be determined by linear interpolation assuming $l/L_s = 0$ with $r = 1{,}0$, and with $l/L_s = 0{,}2b/B$, the value of r shall be determined by the Formulae (2.2.6.3-1), (2.2.6.3-2).

In the Formulae (2.2.6.3-1), (2.2.6.3-2), b is the transverse distance measured at right angle to the centreline between the shell plating (at subdivision loadline) and the section of longitudinal watertight bulkhead nearest to the shell plating (see Fig. 2.2.6.3).

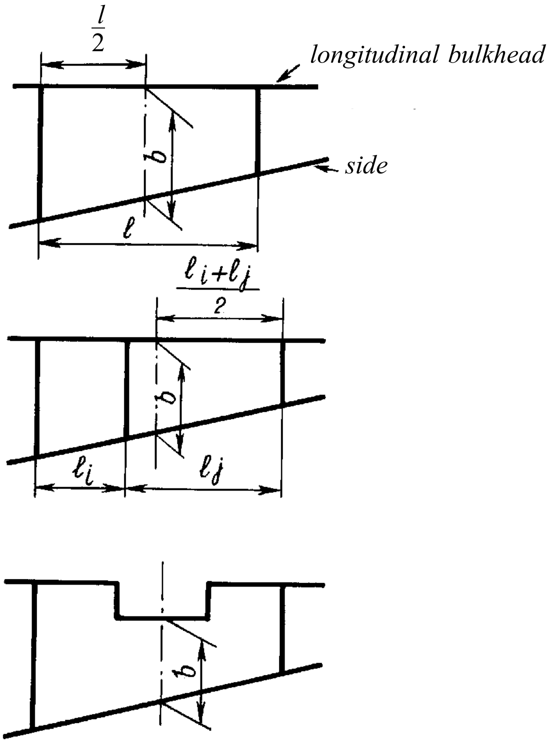


Fig. 2.2.6.3
Determining of the desigh value of b

2.2.7 The value of s shall be determined by the formula

$$s = 0,45s_1 + 0,33s_2 + 0,22s_3 \qquad (2.2.7)$$

where s_1 shall be determined at the draught d_1;
s_2 shall be determined at the draught d_2;
s_3 shall be determined at the draught d_3.

2.2.8 Draughts d_j shall be determined by the formulae:

$$d_1 = d_s - 2/3(d_s - d_0); \qquad (2.2.8\text{-}1)$$

$$d_2 = d_s - 1/3(d_s - d_0); \qquad (2.2.8\text{-}2)$$

$$d_3 = d_s - 1/6(d_s - d_0). \qquad (2.2.8\text{-}3)$$

2.2.9 In calculations for determining of the probabilities s_j:

.1 permeability μ_j of cargo spaces is assumed equal to

$$\mu_j = 1 - 1,2(d_j - d_0)/d_s - 0,05(d_s - d_j)/(d_s - d_0),$$

but it shall not be taken greater than 0,95 or less than 0,60;

.2 for spaces intended for cargo loaded by roll-on method (on passenger roll-on/roll-off ships) the permeability μ_j is assumed equal to 0,9. Permeability of cargo spaces intended for cargo vehicles and containers shall be specified based on the worst operation conditions by means of calculations where it is assumed that cargo vehicles and containers are not watertight and their permeability is assumed equal to 0,65. For ships engaged in specialised carriage, the actual permeability value of containers and cargo vehicles may be accepted. However, the permeability of cargo spaces where vehicles and containers are carried shall in no case be assumed lower than 0,60.

2.2.10 The probability s_j (s_1, s_2 and s_3) shall be determined by the formula:

$$s_j = 2,58c\sqrt[4]{GZ_{max}\psi\Omega} \qquad (2.2.10)$$

where GZ_{max} = the maximum positive righting lever of the static stability diagram for a damaged ship within 15° of the equilibrium, but not greater than 0,1 m;
ψ = the range of positive righting levers of the static stability diagram, but not exceeding 15°;
Ω = the area, m.rad, of the static stability diagram, being determined in accordance with 3.4.10, but not exceeding 0,015 m·rad;
c = a coefficient equal to:
c = 1, when the angle of heel in the final stage of flooding θ_e does not exceed 7°;
$c = [(20° - \theta_e)/13°]^{1/2}$, if $7° < \theta_e \leqslant 20°$,
c = 0, if the angle θ_e exceeds 20°;
θ_e = the angle of heel in the final stage of flooding (prior to equalisation), in degrees.

2.2.11 When damage trim and stability, in case of compartment flooding at the draught d_j, are in full compliance with the requirements of 3.3 and 3.4.1, the probability s_j for the particular compartment is assumed equal to 1.

However, the value of s_j is taken equal to zero for any case of flooding:

the heeling angle exceeds 20° or an angle when any openings are immersed through which spreading of water on the ship may take place during the intermediate stage of flooding or prior to equalisation; or

in the final stage of flooding, the bulkhead deck is immersed excluding the area where the flooded compartment or compartments are located; or

in the final stage of flooding the heeling angle exceeds 12°; or

in the final stage of flooding the initial metacentric height is less than 0,05 m.

2.2.12 As the calculated value of s_j, the lowest of the s_j values shall be assumed being determined for the worst cases of flooding of a compartment or a group of adjacent compartments at the draught d_j.

2.2.13 Special requirements for subdivision of passenger ships and similar ships (see 2.2.1).

2.2.13.1 In ships with $L_s \geqslant 100$ m the probability s shall be not less than 1 in case of fore damage of the following length:

$0,08L_s + 3$ m if $L_s \leqslant 200$ m;
$0,03L_s + 13$ m if $200 < L_s \leqslant 267$ m;
21 m if $L_s > 267$ m.

2.2.13.2 The main transverse bulkhead may be recessed provided that all parts of the recess lie between inner vertical surfaces situated at a distance from the shell plating equal to 1/5 of the breadth of the ship B and measured at a right angle to the centreline at the level of the subdivision loadline.

Any part of the recess, which lies outside these limits shall be considered.

2.2.13.3 The scheme of calculating subdivision index A given in 2.2 is predicated upon the condition that transverse bulkheads extend from side to side. However, a combination of transverse and longitudinal watertight bulkheads may be accepted, wherein some of the transverse watertight bulkheads extend inboard only to longitudinal watertight bulkheads, provided that:

the subdivision index A calculated with regard to 2.2.6 is not less than the required subdivision index R;

watertight floors in the double bottom are in line with watertight transverse bulkheads in the wings or the double bottom is subdivided by other equivalent means;

in passenger ships the inner bottom plating between the longitudinal bulkheads is located not less than $0,1B$ above the base line.

2.3 PROBABILISTIC ESTIMATION OF SUBDIVISION IN CARGO SHIPS

2.3.1 The requirements of the present Chapter are applicable to cargo ships having the length $L_s \geqslant 80$ m, other than the ships referred to in 1.1.1.2 to 1.1.1.9, 1.1.1.19, 1.1.1.20, roll-on/roll-off ships similar to passenger ships (see 2.2.1) and nuclear ships.

The ships having the length $L_s \geqslant 80$ m intended for the carriage of timber cargoes in holds and on the upper deck shall meet the requirements of this Chapter both at the draught corresponding to the summer load line with regard to 2.3.8 and at the draught corresponding to the summer timber load line and in case the specified summer draught is equal to the specified timber summer draught in accordance with 2.3.14.

Requirements of the Explanatory Note to the SOLAS Convention on subdivision and damage stability of cargo ships, which length is 80 m and over, shall be taken into consideration for verification of probability requirements for such ships (see Collection of Regulating Documents of the Register. Book 10. 2001.).

2.3.2 The required subdivision index R, except for the ships carrying radioactive substances, shall be determined by the formulae:

$$R = R_{100} = (0{,}002+0{,}0009L_s)^{1/3} \text{ at } L_s \geqslant 100 \text{ m}; \qquad (2.3.2\text{-}1)$$

$$R = R_{80} = 1 - \{1/[1+(L_s/100)(R_{100}/(1-R_{100})]\} \text{ at } 80 \text{ m} \leqslant L_s < 100 \text{ m}. \qquad (2.3.2\text{-}2)$$

2.3.3 For ships carrying radioactive substances the required subdivision index R shall be specified by the Register. In any case, for ships carrying substances with the total radioactivity above 2×10^6 TBq (Terabecquerel) or plutonium with the total radioactivity over 2×10^5 TBq the required subdivision index is equal to $R + 0{,}2(1-R)$, but not less than 0, 6, where R is obtained by the Formulae (2.3.2-1), (2.3.2-2).

2.3.4 In case of no longitudinal subdivision, the probabilities W_i are assumed equal to the value of p_i which is determined as follows for every single compartment:

.1 where the calculated length of the compartment considered extends over the entire ship length L_s the factor $p_i = 1$;

.2 where the aft limit of the compartment considered coincides with the forward terminal

$$p_i = F + 0{,}5ap + q; \qquad (2.3.4.2)$$

.3 where the forward limit of the compartment considered coincides with the forward terminal

$$p_i = 1 - F + 0{,}5ap; \qquad (2.3.4.3)$$

.4 when both ends of the compartment considered are inside the aft and forward terminals of the ship length L_s

$$p_i = ap. \qquad (2.3.4.4)$$

2.3.5 The values in 2.3.4.1 to 2.3.4.4 shall be determined from the formulae:

$$a = 1{,}2 + 0{,}8E, \text{ but not greater than } 1{,}2; \qquad (2.3.5\text{-}1)$$

$$F = 0{,}4 + 0{,}25E(1{,}2 + a); \qquad (2.3.5\text{-}2)$$

$$p = J_{\max}F_1; \qquad (2.3.5.\text{-}3)$$

$$q = 0{,}4(J_{\max})^2F_2 \qquad (2.3.5.\text{-}4)$$

where $E = E_1 + E_2 - 1$;
$E_1 = x_1/L_s$;
$E_2 = x_2/L_s$;
x_1 and x_2 shall be adopted in accordance with 2.2.4;
$J_{\max} = 48/L_s$, but not greater than 0,24;
$F_1 = y^2 - y^3/3$, if $y < 1$;
$F_1 = y - 1/3$, if $y \geqslant 1$;
$F_2 = y^3/3 - y^4/12$, if $y < 1$;
$F_2 = y^2/2 - y/3 + 1/12$, if $y \geqslant 1$;
$y = J/J_{\max}$;
$J = E_2 - E_1$.

2.3.6 The values of p_i obtained from the Formulae (2.3.4.2), (2.3.4.3) and (2.3.4.4) where the compartment considered extends over the mid-length L_s shall be reduced by an amount determined from the Formula (2.3.5-4) in which case F_2 is calculated taking

$$y = J'/J_{\max} \qquad (2.3.6)$$

where $J' = J - E$, if $E \geqslant 0$;
$J' = J + E$, if $E < 0$.

2.3.7 For the purpose of ship subdivision by longitudinal watertight bulkheads, for a wing compartment, the probability W is equal to the value of rp. The probability r of non-damage to the longitudinal bulkhead is obtained as per the following formulae:

.1 for $J \geqslant 0{,}2b/B$

$$r = b/B[2{,}3+0{,}08/(J+0{,}02)]+0{,}1, \text{ if } b/B \leqslant 0{,}2; \qquad (2.3.7.1\text{-}1)$$

$$r = [b/B + 0{,}36+0{,}016/(J+0{,}02)], \text{ if } b/B > 0{,}2; \qquad (2.3.7.1\text{-}2)$$

.2 for $J < 0{,}2b/B$ the reduction factor r shall be determined by linear interpolation between $r = 1$ for $J = 0$ and the value of r obtained from the Formulae (2.3.7.1-1), (2.3.7.1-2) for $J = 0{,}2b/B$.

The value of b shall be determined in conformity with Appendix.

2.3.8 For a single i compartment or a group of adjacent compartments, the probability s_i shall be determined by the formula

$$s_i = 0{,}5s_l + 0{,}5s_p \qquad (2.3.8)$$

where s_l = the s-factor calculated for the deepest subdivision load line corresponding to the summer load line draught;
s_p = the s-factor calculated for the intermediate draught of the ship, corresponding to the lightship draught plus 60 per cent of the difference between the summer load line draught and light ship draught.

2.3.9 Unless otherwise specified, the factor s for any condition of flooding from any initial loading condition permissible in operation shall be:

$$s = C\sqrt{0{,}5GZ_{\max}\psi}, \qquad (2.3.9)$$

where $C = 1$, if $\theta_e \leqslant 25°$;
$C = 0$, if $\theta_e > 30°$;
$C = [(30 - \theta_e)/5]^{1/2}$, if $25° < \theta_e \leqslant 30°$;

GZ_{max} = the maximum positive righting lever within the range θ_+, but not more than 0,1 m;

ψ = the range of positive righting levers for a damaged ship, angle of flooding considered, which shall not exceed 20°;

θ_e = final equilibrium angle of heel, in deg.

$s = 0$ where, in the final stage of flooding (equalization disregarded), the lower edge of openings through which progressive flooding may take place is immersed. Such openings shall include the openings specified in 3.3.4.

The least of s values determined at the worst conditions of flooding of the compartment under consideration or the group of adjacent compartments shall be taken as the s design value.

2.3.10 When taking into account the horizontal subdivision fitted above the waterline of the ship being not damaged (waterline positions are defined under 2.3.8) s shall be determined as follows:

.1 the value of s for the compartment or group of adjacent compartments located below the horizontal watertight subdivision located just above the warerline or higher shall be obtained by multiplying the value as determined in 2.3.9 by the reduction factor v representing the probability that the horizontal watertight subdivision will not be flooded, and determined as follows:

$$\nu_j = (\mathrm{H} - d_j)/(H_{max} - d_j), \qquad (2.3.10.1\text{-}1)$$

where H = the height of watertight horizontal subdivision above the base line, in m, which is assumed to limit the vertical extent of damage;

H_{max} = the maximum possible vertical extent of damage above the base line, in m, equal to

$$H_{max} = d_j + 0{,}056L_s(1 - L_s/500), \text{ if } L_s \leqslant 250 \text{ m}; \qquad (2.3.10.1\text{-}2)$$

$$H_{max} = d_j + 7, \text{ if } L_s > 250 \text{ m}, \qquad (2.3.10.1\text{-}3)$$

but not more than 1;

.2 v_j = 1 if the uppermost watertight horizontal subdivision in way of the assumed damaged region is at a height above the base line which is less than H_{max}.

2.3.11 In cases of positive contribution to index A due to simultaneous flooding of the spaces under the watertight horizontal subdivision and above it, the resulting s_j value for such a compartment or a group of compartments shall be obtained by the formula:

$$s_j = \nu_j s'_j + (1 - \nu_j) s''_j \qquad (2.3.11)$$

where s'_j is determined for the case of flooding of compartments located below the horizontal subdivision,

s''_j is determined for the case of simultaneous flooding of compartments located below and above the horizontal subdivision.

2.3.12 In damage stability calculations, for the purpose of determining the probability subdivision index, the permeability of dry cargo holds shall be adopted equal to 0,7.

2.3.13 With all compartments forward of the collision bulkhead flooded simultaneously, the s value calculated assuming the ship to be at its deepest subdivision load line and with assumed unlimited vertical extent of damage shall be not less than 1.

2.3.14 Probabilistic estimation of subdivision in ships intended for the carriage of timber in holds and on the upper deck[1].

2.3.14.1 The required subdivision index R as applied to the summer timber load line draught is equal to the index R for summer load line draught obtained according to 2.3.2.

2.3.14.2 In calculating the attained subdivision index A_{tim} for the carriage of timber in the holds and on the upper deck:

.1 in the Formula (2.3.8), the probabilities s_i shall be determined at the summer timber load line draught assigned to the ship;

.2 permeability of cargo holds shall be assumed equal to 0,35;

.3 the buoyancy of timber deck cargo with a height equal to one standard height of superstructure shall be taken into account with the permeability of 0,25;

.4 the probabilities s_p are adopted the same as those calculated in accordance with 2.3.8 and 2.3.9;

.5 the buoyancy of timber deck cargo in the area of assumed damage shall not be taken into consideration.

2.3.14.3 According to the conditions of unsinkability for timber carriers two curves of permissible heights of ship centre of gravity shall be determined:

.1 the first curve shall be determined based on the requirements of 2.1.2 and 2.3.2 to 2.3.13. This curve is applied when transporting timber cargo either in the holds only or on the upper deck only;

.2 the second curve shall be determined based upon condition of $A_{tim} \geqslant R$. This curve is applied in operation of the ship carrying timber cargo in the holds and on the upper deck simultaneously.

2.3.14.4 Accordingly, the Information on Stability and Information on Damage Trim and Stability shall indicate that the use of permissible height of ship gravity centre determined based on $A_{tim} \geqslant R$ is only possible when carrying timber cargoes both in the holds and on the upper deck.

2.4 PROBABILITY ESTIMATION OF SUBDIVISION IN CASE OF ICE DAMAGE

2.4.1 The requirements of the present Chapter apply to ships with the **ЛУ9**, **ЛУ8**, **ЛУ7**, **ЛУ6**, **ЛУ5** and **ЛУ4** ice marks in class notation.

2.4.2 The Subdivision will be considered satisfactory from the point of view of this Chapter, if the following is observed within the range of drafts up to the waterline corresponding to the draft d_{ice}:

---

[1] When estimating probabilistic requirements for these ships, the appropriate direction given in 2.3.1 shall be taken into consideration.

.1 the actual subdivision index A_{ice} determined in accordance with 2.4.5 to 2.4.10 is not lower than the required ice subdivision index R_{ice} determined in accordance with 2.4.4.;

.2 damage stability is in accordance with the requirements of Section 3 in case of ice damage mentioned under 3.4.11.4 and 3.4.11.5.

Observance of the requirements of this Chapter does not substitute the compliance with the other requirements of the present Part.

2.4.3 For ships satisfactory from the point of view of Section 3, provided the ice damage is located anywhere in the area mentioned under 3.4.11.4, it is not necessary to check whether the condition $A_{ice} \geqslant R_{ice}$ is observed.

2.4.4 The required ice subdivision index R_{ice} shall be obtained by the formula:

$$R_{ice} = \sqrt[5]{R} \tag{2.4.4}$$

where R = the required subdivision index to be determined in accordance with 2.2.2 for passenger ships and ships similar to them and in accordance with 2.3.2, for non-passenger ships,

but not less than 0,87.

For ships not covered by the requirements of 2.2 and 2.3, the value of R_{ice} = 0,87.

2.4.5 The probability ice subdivision index A_{ice} shall be obtained from the formulae:

.1 where horizontal watertight subdivision are not present or may be disregarded

$$A_{ice} = \Sigma W_{ice} s; \tag{2.4.5.1}$$

.2 where horizontal watertight subdivision shall be taken into account

$$A_{ice} = \Sigma W_{ice} r_{ice} s. \tag{2.4.5.2}$$

Summing-up shall be effected on the basis of the numbers of all the compartments and groups of adjacent compartments.

The values W_{ice}, r_{ice} and s shall be determined in accordance with 2.4.6 to 2.4.10.

2.4.6 In case of ice damage the probability of a compartment being flooded, which is bounded by transverse bulkheads, shall be obtained from the following formulae:

$$W_{ice} = 0{,}57[F(x_f/L_{ice}) - F(x_a/L_{ice})] + 0{,}43 a_{ice} p_{ice} \tag{2.4.6}$$

where $F(x/L_{\text{ice}}) = 0{,}196(x/L_{ice}+0{,}5)$, if $x/L_{ice} \leqslant 0{,}092$;
$F(x/L_{ice}) = 6{,}35(x/L_{ice})^2 - 0{,}97x/L_{ice} + 0{,}1515$, if $0{,}092 < x/L_{ice} < 0{,}3$;
$F(x/L_{ice}) = 2{,}84x/L_{ice} - 0{,}42$, if $x/L_{ice} \geqslant 0{,}3$;
$a_{ice} = [F(x_f/L_{ice}) - F(x_a/L_{ice})]L_{ice}/(x_f - x_a)$;
$p_{ice} = 5(l/L_{ice})^2 + 0{,}255l/L_{ice}$, if $l/L_{ice} < 0{,}08$,
$p_{ice} = 1{,}03(l/L_{ice}) - 0{,}03$, if $l/L_{ice} \geqslant 0{,}08$

x_a = the distance from the midlength of L_{ice} to the aft bulkhead of the compartment or group of adjacent compartments in question, in m;
x_f = the distance from the midlength of L_{ice} to the fore bulkhead of the compartment or group of adjacent compartments in question, in m;
l = the compartment length, in m.

Values of x are positive where the bulkhead is located forward of the midlength and negative where it is located aft of the midlength of L_{ice}.

The extreme points by which the length of peak compartments is determined, when calculating W_{ice}, shall be chosen on perpendiculars plotted through the extreme points of the length L_{ice}.

2.4.7 When using the calculations according to 2.4.6 the provisions of 2.1.4 and 2.1.5 shall be taken into account as regards considering the bulkhead steps where these are by less than 1,2 of the draft d_{ice} above the base plane.

2.4.8 With watertight double sides, an inner bulkhead is considered damaged in case of ice damage, if, by any of its points, it is less than 0,76 m away from the shell as measured along the normal.

2.4.9 With horizontal watertight platforms the probabilities r_{ice} shall be determined from the formulae below proceeding from the location of the space being flooded:

.1 above the platform

$$r_{ice1} = 1 - F_b(z/d_{ice}); \tag{2.4.9.1}$$

.2 below the platform

$$r_{ice2} = 1 - F_a(z/d_{ice}); \tag{2.4.9.2}$$

.3 both above and below the platform

$$r_{ice3} = F_b(z/d_{ice}) - F_a(z/d_{ice}) \tag{2.4.9.3}$$

where $F_b(z/d_{ice}) = 2z/d_{ice}$, if $z/d_{ice} \leqslant 0{,}3$;
$F_b(z/d_{ice}) = (0{,}6z/d_{ice}) + 0{,}42$, if $0{,}3 < z/d_{ice} < 0{,}97$;
$F_b(z/d_{ice}) = 1$, if $z/d_{ice} \geqslant 0{,}97$;
$F_a(z/d_{ice}) = 4(z/d_{ice})^2$, if $z/d_{ice} \leqslant 0{,}3$;
$F_a(z/d_{ice}) = 1{,}74z/d_{ice} - 0{,}69(z/d_{ice})^2 - 0{,}1$, if $0{,}3 < z/d_{ice} < 1{,}25$;
$F_a(z/d_{ice}) = 1{,}0$, if $z/d_{ice} \geqslant 1{,}25$

where z = the height of the horizontal watertight subdivision above the base plane.

2.4.10 The values of the probabilities s shall be obtained by the formulae given in 2.2 and 2.3. Hereby, where the draft d_{ice} is not equal to the draft d_s, the probabilities s_l for non-passenger ships and s_j for passenger ships shall be determined for the case of the draft d_{ice}.

3 DAMAGE TRIM AND STABILITY

3.1 GENERAL

3.1.1 Under all loading conditions to be encountered in service and which are in agreement with the purpose of the ship (icing disregarded), the trim and stability of an intact ship shall be sufficient for satisfying damage trim and stability requirements.

3.1.2 Requirements for the ship trim and stability shall be considered satisfied if, in case of damage mentioned in 3.2 and 3.4, with the number of compartments flooded as mentioned in 3.4, and the permeability determined in accordance with 1.6, calculations made in conformity with 3.1.3 to 3.1.7 indicate that the requirements of 3.3 and 3.4 are satisfied.

3.1.3 Calculations to confirm compliance with the requirements of 3.3 and 3.4 as regards damage trim and stability shall be performed for such a number of loading conditions to be encountered in service and being the most unfavourable from the point of view of trim and stability (within the range of drafts up to the deepest subdivision waterline and cargo distribution stipulated by the design), such distribution and extent of damage, to be determined in accordance with 3.2 and 3.4, that, proceeding from those calculations, one could assure that in all other cases the damaged ship would be in a better condition as regards damage stability, the residual freeboard, distance from the damage water line to openings through which the ship may be flooded and heeling angles. Besides, the following shall be considered: the actual configuration of damaged compartments, their permeabilities, type of covers, whether intermediate decks, platforms, double sides, longitudinal and transverse bulkheads are provided sufficiently watertight as to render the flow of water through the ship completely or temporarily impossible.

3.1.4 Where the distance between two consecutive main transverse bulkheads is less than the longitudinal extent of design damage, the relevant compartment shall, at the discretion of the designer, be added to any of the adjacent compartments when checking damage stability. For non-passenger ships relaxation from this provision may be granted where the arrangement of the bulkhead is in agreement with the condition $A \geqslant R$.

Forepeak and afterpeak are considered to be separate compartment regardless of the length.

3.1.5 Where two adjacent compartments are separated from each other by a stepped bulkhead, the bulkhead shall be held for damaged when the flooding of any of the two compartments is considered.

Where the length of the step does not exceed one frame or 0,8 m, whichever is less, or where the step is formed by floors of the double bottom, this requirement may be dispensed with in case of non-passenger ships.

3.1.6 If any damage of a lesser extent than stated in 3.2 and 3.4 might result in a more severe condition as regards damage trim and stability, such a damage shall be considered when making check calculations for damage trim and stability.

3.1.7 Where there are pipes, ducts or tunnels in the area of assumed damage, these shall be so designed that no water enters compartments which are considered not flooded.

3.1.8 For passenger ships, the equalization time will be established on agreement with the Register proceeding from the ship type.

3.1.9 The arrangements for righting the ship after damage shall be approved by the Register and shall be self-acting as far as practicable.

Where controllable cross-flooding arrangements are available, side-valve control stations shall be located above the bulkhead deck.

3.2 EXTENT OF DESIGN DAMAGE

3.2.1 Except cases specially provided for, including those stated in 3.1.6, the following extent of side damage shall be assumed when making damage trim and stability calculations to confirm compliance with 3.3 and 3.4:

.1 longitudinal extent: $1/3L_1^{2/3}$ or 14,5 m (whichever is less);

.2 transverse extent measured inboard of ship side at right angles to the centre line at the level of the deepest subdivision load line: 1/5 of the ship breadth B;

.3 vertical extent: from the base line upwards without limit.

3.2.2 The requirements of 3.3 shall be complied with in case of simultaneous flooding of all compartments located forward of collision bulkhead.

3.3 REQUIREMENTS FOR DAMAGE TRIM AND STABILITY CHARACTERISTICS

3.3.1 In the final stage of flooding, the initial metacentric height of a ship in the upright condition determined by the constant displacement method, shall not be less than 0,05 m before appropriate measures to increase the metacentric height are taken.

For non-passenger ships, a positive metacentric height below 0,05 m may be permitted for the upright condition in the final stage of flooding on the Register approval.

3.3.2 For unsymmetric flooding the angle of heel shall not exceed:

20° before equalization measures and cross-flooding fittings being used;

12° after equalization measures and cross-flooding fittings being used.

3.3.3 The static stability curve of a damaged ship shall have a sufficient positive lever arm section. In the final stage of flooding, cross-flooding fittings disregarded, and after the equalization of the ship, a length of positive lever arm curve, flooding angle considered, shall be ensured not less than 20°. The angle of submersion of the openings which are not equipped with watertight or weathertight covers through which water may spread to undamaged compartments may be taken as flooding angle.

The maximum lever arm shall be at least 0,1 m within this length, i.e. within the heel angle equal to the static one plus 20°.

The positive lever arm section within the said extent shall not be less than 0,0175 m·rad.

In the intermediate stages of flooding, the maximum lever arm of the static stability curve shall be at least 0,05 m, and the length of its positive section shall not be less than 7°.

3.3.4 Before, during and after equalization, the damage waterline shall be at least 0,3 m or $0{,}1+(L_1-10)/150$ m (whichever is less) below the openings in the bulkheads, decks and sides through which progressive flooding could take place. Such openings include the outlets of air and vent pipes and those which are closed by means of weathertight doors and covers.

These do not necessarily include:

.1 non-opening side and deck scuttles;

.2 manholes having covers with closely spaced bolts;

.3 cargo tank hatchways in tankers;

.4 remotely controlled sliding doors, as well as watertight doors with indication systems and access hatch covers usually closed when at sea;

.5 openings in subdivision bulkheads intended for the passage of vehicles during cargo handling operations which are permanently closed with strong watertight covers while at sea. Such openings are only permitted for ro-ro ships including those mentioned under 3.4.2.2.

The position and arrangement of closures of openings shall meet the requirements of Section 7, Part III "Equipment, Arrangement and Outfit".

The location of spaces for emergency sources of electric power shall comply with the requirements of 9.2.1, Part XI "Electrical Equipment".

3.3.5 For cargo ships, immersion of the bulkhead deck and, moreover, of the weather deck is permitted.

3.3.6 The requirements of 3.3.1 to 3.3.5 apply to all ship types except those for which special provision is made in 3.4.

3.4 ADDITIONAL REQUIREMENTS FOR DAMAGE TRIM AND STABILITY

3.4.1 Passenger ships.

3.4.1.1 For passenger ships, damage trim and stability shall be checked on the assumption that all the passengers are crowding on the uppermost accessible decks.

In particular deck areas, the distribution of passengers shall be determined proceeding from 3.1.7 and 3.1.8, Part IV "Stability" except when calculating the heeling moments included in the Formula (3.4.1.11.2) in which case the distribution of passengers shall be assumed in accordance with 3.4.1.12.

3.4.1.2 For the purpose of damage trim and stability calculations, the following extent of damage shall be adopted:

longitudinal extent 3 m plus 3 per cent of the ship length L_s or 11 m (whichever is less);

transverse and vertical extent shall be adopted on the basis of 3.2.1.2 and 3.2.1.3.

3.4.1.3 With N less than or equal to 600, damage stability requirements shall be satisfied when any single ship compartment is flooded, and with N (see 2.2.2) equal to or greater than 1200, those requirements shall be satisfied in the case of any two adjacent compartments being flooded.

3.4.1.4 In case of passenger ships having N between 600 and 1200, damage stability requirements shall be satisfied when any pair of adjacent compartments is flooded within that section of ship length where a transverse bulkhead dividing two compartments is fitted closer to the foremost point of L_s than $(N/600-1)L_s$ and when any single compartment is flooded within that section of ship length where the bulkheads bounding the compartments are spaced farther than $(N/600-1)L_s$ from each other. For such ships, $\boxed{1}$ shall be introduced in the subdivision distinguishing mark.

Notwithstanding the requirements of 3.4.1.3 and the requirements of this paragraph, passenger ships certified to carry 400 persons or more, which keels were laid on or after 1 July 2002, sustained shall comply with the requirements of this Chapter, assuming the damage applied anywhere within the ship length.

3.4.1.5 For passenger ships having the length L_s 100 m and more the requirements for damage trim and stability shall be complied with in the case of fore hole of the extent given in 2.2.13.

3.4.1.6 For unsymmetrical flooding, the angle of heel shall not exceed:

15° before equalization measures and cross-flooding fittings being used;

7° after equalization measures and cross-flooding fittings being used with one compartment flooded and 12° with two or more adjacent compartments flooded.

3.4.1.7 The equalization time necessary for the above requirements to be fulfilled shall not exceed 10 min.

3.4.1.8 During the intermediate stages of flooding or equalization, the heel shall not exceed 20°, and the maximum lever arm of the static stability curve shall not be less than 0,05 m with the length of positive section not less than 7°.

3.4.1.9 After the equalization of the ship and where no equalization shall be effected, after flooding, the damage waterline shall be below the bulkhead deck outside the area flooded.

3.4.1.10 In case of unsymmetrical flooding, static stability curve of a damaged ship shall have a positive lever arm section not less than 20° as measured from the equilibrium position both before and after equalization and/or cross flooding fittings being used.

The positive lever arm section shall be at least 0,015 m·rad. This area shall be determined for the curve section between the heeling angle corresponding to the equilibrium position of the ship and flooding angle or an angle of 22°, if one compartment is flooded, and an angle of 27°, if two or more adjacent compartments are flooded simultaneously, whichever is less.

3.4.1.11 Within the length stated under 3.4.1.10, the lever arm of static stability curve shall not be less than the greater of the values:

.1 0,1 m;

.2 value determined from the formula

$$l = M_{heel}/\Delta + 0{,}04 \text{ m} \qquad (3.4.1.11.2)$$

where M_{heel} = the heeling moment.

In the Formula (3.4.1.11.2) the greater heeling moment shall be used out of those due to:

all passengers crowding to one side (with regard to 3.4.1.12.1 to 3.4.1.12.3);

launching of all life-saving appliances with their full complement of persons on one side (with regard to 3.4.1.12.4 to 3.4.1.12.6);

wind pressure (3.4.1.12.7 to 3.4.1.12.9).

The requirements of this paragraph apply both to symmetrical and unsymemtrical flooding.

3.4.1.12 The heeling moments as mentioned under 3.4.1.11 shall be determined on the basis of the following assumptions:

.1 the density of the passenger distribution is assumed to be 4 persons per square metre of deck area accessible to them;

.2 the mass of each passenger is assumed to be 75 kg;

.3 passengers are crowding to one side on areas accessible to them of the decks where muster stations are located. Out of all possible variants of the crowding of passengers the one shall be chosen providing for the greatest heeling moment;

.4 all the lifeboats and rescue boats of the side to which the ship has got a heel are assumed fully loaded, swung out and ready for launching. Where the launching of fully loaded lifeboats shall be effected from their stowage position, the maximum heeling moment likely to occur during launching shall be adopted for calculation.

The above assumptions are applicable to liferafts as well for which launching devices are provided;

.5 when determining the heeling moment due to life-saving appliances being launched, persons who are not in lifeboats or liferafts being swung out shall not be considered a source of additional heeling or righting moments;

.6 life-saving appliances on the opposite side are assumed to be stowed for sea;

.7 wind pressure is assumed equal to 120 Pa;

.8 the above-water lateral plane area is determined for the initial draught of an intact ship;

.9 the lever arm of wind-pressure heeling moment is determined as the distance between the centre of effort and the point corresponding to half the mean draught of an intact ship.

3.4.1.13 When passenger ships of limited navigation areas **I** and **II** are equipped with life-saving appliances in conformity with 3.1.1.2, Part II "Life-Saving Appliances" of Rules for the Equipment of Sea-Going Ships, the requirements for damage trim and stability shall be satisfied in the case of any pair of adjacent compartments being flooded.

3.4.2 Roll-on/roll-off ships similar to passenger ships.

3.4.2.1 Where vehicles accompanied by personnel of more than 12 persons including passengers (if any) shall be carried by roll-on/roll-off ships, such ships, irrespective of their length, shall be considered equal to passenger ships in respect of all relevant requirements to subdivision bearing in mind the provision of 3.3.4.5, if applicable according to 7.12.1.1, Part III "Equipment, Arrangements and Outfit".

3.4.2.2 The requirements for the damage trim and stability of a roll-on/roll-off ship carrying 400 or more persons shall be met when the damage is located anywhere along the ship length.

3.4.3 Ice-breakers and fishing vessels.

3.4.3.1 In Table 3.4.3.1 the number of compartments is indicated after the flooding of which the requirements of 3.3 for damage stability shall be satisfied.

Table 3.4.3.1

Type of ship	Length L_1, in m	Number of floodable compartments
Icebreakers Fishing vessels	50 and upwards 100 and upwards	2 1

3.4.3.2 In areas where double sides are provided, ice breakers having the length L_1 of 50 to 75 m may satisfy the requirements of 3.3 where a single compartment is flooded. The subdivision distinguishing mark of such ships shall include $\boxed{1}$.

3.4.4 Special purpose ships.

3.4.4.1 Special purpose ships having special personnel on board in excess of 200 persons shall satisfy the requirements of the present Part of the Rules pertaining to passenger ships carrying an equal number of passengers.

3.4.4.2 Special purpose ships having special personnel on board in excess of 50 persons but not over 200 persons shall satisfy the requirements of 3.3 when a single compartment is flooded. Moreover, such ships having the length $L_1 \geqslant 100$ m shall meet the requirements of 3.3 in the case of forward damage with the extent stated in 2.2.13.1. In case of unsymmetrical flooding due to the forward damage the heeling angle of 12° is permitted.

3.4.4.3 Special purpose ships having special personnel on board of 50 persons or less shall satisfy the requirements of 3.3 when one of the compartments is flooded, except the engine room.

3.4.4.4 The requirements for the subdivision of special purpose ships having special personnel on board of 50 persons or less with the length $L_1 \leqslant 50$ m and special purpose ships, which gross tonnage is below 500 shall be specially considered by the Register in each case.

3.4.4.5 In the case of usymmetrical flooding of a single compartment in special purpose ships, the heel angle after equalization shall notexceed 7°.

3.4.5 Tugs, dredgers, salvage ships and lightships.

3.4.5.1 If a single compartment is flooded, the requirements of 3.3 for damage trim and stability shall be satisfied for the following types of ships:

tugs having the length $L_1 \geqslant 40$ m;

dredgers having the length $L_1 \geqslant 40$ m;

rescue ships and lightships irrespective of length;

hopper dredgers having the length $L_1 \geqslant 60$ m.

3.4.5.2 Bucket dredgers shall comply with the requirements of 3.3 if a single compartment is flooded in way of the bucket opening. The depth of the damage is assumed equal to 0,76 m.

3.4.5.3 Where hopper dredgers and hopper barges are concerned, damage conditions may not be considered corresponding to ship condition after spoil discharge from one side.

3.4.6 Oil tankers and chemical tankers.

3.4.6.1 The damage trim and stability of oil tankers and chemical tankers shall satisfy the requirements of 3.3 both for the case of side and bottom damage.

3.4.6.2 Extent of bottom damage:

.1 the longitudinal extent shall be $1/3L_1^{2/3}$ or 14,5 m (whichever is less) within $0{,}3L_1$ from the forward perpendicular and $1/3L_1^{2/3}$ or 5 m (whichever is less) through the rest of the ship length;

.2 the transverse extent shall be $B/6$ or 10 m (whichever is less) within $0{,}3L_1$ from the forward perpendicular and $B/6$ or 5 m (whichever is less) through the rest of the ship length;

.3 the vertical extent, measured from the moulded line of the shell at centre line, shall be $B/15$ or 6 m (whichever is less).

3.4.6.3 In addition to 3.4.6.2, bottom shell damage shall be considered for oil tankers with a deadweight of 20 000 t and upwards, having touched the ground, the extent of damage being as follows:

.1 length of 0,6 L_1 from the forward perpendicular for ships having a deadweight of 75000 t and upwards, and 0,4 L_1 from the forward perpendicular for ships having a deadweigth below 75 000 t;

.2 breadth $B/3$ anywhere in the bottom.

3.4.6.4 Damage trim and stability requirements shall be satisfied for the following locations of side and bottom damage:

.1 oil tankers:

where the length $L_1 > 225$ m — anywhere along the ship length;

where the length $L_1 = 150$ to 225 m — anywhere in the ship length except for the machinery space when this is located aft. In this case, the machinery space shall be considered a separate floodable compartment;

where the length $L_1 \leqslant 150$ m — anywhere in the ship length between consecutive transverse bulkheads except for the machinery space;

where the substances of the Category *C* are carried under the provisions of Appendix II to MARPOL-73/78, as for chemical tankers 3;

.2 chemical tankers:

chemical tanker 1 — anywhere along the ship length;

chemical tanker 2 having the length L_1 over 150 m — anywhere along the ship length;

chemical tanker 2 having the length L_1=150 m and below — anywhere in the ship length except for the machinery space where this is located aft. In this case, the machinery space shall be considered a separate floodable compartment;

chemical tanker 3 having the length $L_1 > 225$ m — anywhere along the ship length;

chemical tanker 3 having the length $L_1 = 125$ to 225 m — anywhere in the ship length except for the machinery space where this is located aft. In this case, the machinery space shall be considered a separate floodable compartment;

chemical tanker 3 having the length $L_1 < 125$ m — anywhere along the ship length except for the machinery space where this is located aft. Nevertheless, damage trim and stability calculations for the conditions of the machinery space flooded shall be submitted for the consideration of the Register.

3.4.6.5 Ships which do not comply with the requirements for damage trim and stability when their machinery space is flooded, as stipulated by 3.4.6.4.1 and 3.4.6.4.2, are not assigned a subdivision mark in their class notation.

3.4.6.6 In the final stage of unsymmetric flooding before equalization measures and cross-flooding fittings being used, the angle of heel shall not exceed 25° or 30° where the bulkhead deck is not immersed). After equalization measures, the heeling angle shall not exceed 17°.

3.4.7 Gas carriers.

For gas carriers, the requirements of 3.4.6 apply except for the following details:

.1 damage trim and stability requirements shall be satisfied when side and bottom damage is sustained as stated below:

gas carriers 1G — anywhere along the ship length;

gas carriers 2G having the length $L_1 > 150$ m — anywhere along the ship length;

gas carriers 2G having the length $L_1 \leqslant 150$ m or below — anywhere along the ship length except the machinery space where this is located aft. In this case the machinery space shall be considered a separate floodable compartment;

gas carriers 2PG — anywhere in the ship length between subdivision bulkheads;

gas carriers 3G having the length $L_1 \geqslant 125$ m — anywhere in the ship length between subdivision bulkheads;

gas carriers 3G having the length $L_1 < 125$ m — anywhere in the ship length between subdivision bulkheads except the machinery space where this is located aft. However, damage trim and stability calculations for the case of the machinery spaces being flooded shall be submitted for the consideration of the Register. No subdivision distinguishing mark shall be introduced in the class notation if damage trim and stability requirements are not met;

.2 the vertical extent of a bottom damage shall be assumed equal to $B/15$ or 2 m, whichever is less.

3.4.8 Drilling ships.

With any single compartment flooded, drilling ships shall satisfy the requirements of 3.3, unless more stringent requirements are put forward by the shipowner.

Drilling ships shall have sufficient reserve of damage stability to withstand the wind heeling moment produced by wind with a speed of 25,8 m/sec (50 knots) acting from any direction. Under these conditions the final waterline after flooding shall be located below the lower edge of any opening through which the undamaged compartments may be flooded by the sea.

3.4.9 Ships intended for the carriage of radioactive agents.

Damage trim and stability of ships intended for the carriage of packaged irradiated nuclear fuel, plutonium and high-level radioactive wastes with the total radioactivity below 4000 TBq shall in each case be specially considered by the Register.

The requirements for the damage trim and stability of ships carrying packaged irradiated nuclear fuel or high-level radioactive wastes with the total radioactivity below 2×10^6 TBq or plutonium with the total radioactivity below 2×10^5 TBq shall be satisfied for the case of specified damage anywhere along the ship length between the consecutive transverse bulkheads.

The requirements for damage trim and stability of the ships carrying packaged irradiated nuclear fuel or high-level radioactive wastes with the total radioactivity above 2×10^6 TBq or plutonium with the total radioactivity 2×10^5 TBq and above shall be satisfied in the case of the calculated damage anywhere along the ship length.

On the Register approval the possible probability estimation of the ship subdivision may be considered being an alternative to the requirements indicated.

3.4.10 Supply vessels.

3.4.10.1 The requirements of the present Part of the Rules apply to all supply vessels having the length $L_1 \leqslant 100$ m.

The subdivision and damage stability of supply vessels having a length over 100 m shall in each case be specially considered by the Register.

3.4.10.2 Extent of damage.

For damage trim and stability calculations, the depth of damage shall be assumed equal to 0,76 m and measured from the inner side at right angle to the centre line on the level of the deepest waterline permitted by the loadline. The requirements of 3.2.1.2 are not applicable.

3.4.10.3 Number of floodable compartments.

The damage stability requirements of 3.3 shall be satisfied in the case of single compartment flooding proceeding from the extent of damage stated under 3.2.1.1, 3.2.1.3 and 3.4.10.2.

3.4.10.4 Ships complying with the requirements of 3.4.10.2 only will receive no subdivision distinguishing mark in the class notation.

3.4.10.5 If preferred by the shipowner, a supply vessel may receive a subdivision distinguishing mark with the number of floodable compartments indicated in the class notation. In this case, the transverse extent of damage shall be assumed in accordance with 3.2.1.2. The number of compartments at the flooding of which the damage trim and stability requirements shall be satisfied shall be determined by the shipowner.

3.4.11 Ships with the ice marks ЛУ4, ЛУ5, ЛУ6, ЛУ7, ЛУ8 and ЛУ9 in the class notation.

3.4.11.1 The requirements of this paragraph apply to all ice strengthened ships of categories **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8** and **ЛУ9**. The damage trim and stability requirements shall be satisfied as far as the draught d_{ice} is concerned except for the requirement of 3.4.11.2.

3.4.11.2 Where the extent of damage is in accordance with 3.2, the damage trim and stability requirements of 3.3 shall be satisfied within range of the summer draught assigned to the ship shall be satisfied if a single compartment is flooded in ships having the following marks in the class notation:

ice marks **ЛУ7**, **ЛУ8** and **ЛУ9** irrespective of ship length;

ice marks **ЛУ5** and **ЛУ6** with the ship length $L_1 \geqslant 120$ m.

The subdivision distinguishing mark of such ships shall include $\boxed{1}$.

3.4.11.3 Ships with the ice strengthening marks for categories **ЛУ4**, **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8** and **ЛУ9** (irrespective of their length) shall comply with the requirements of 3.3 with relevant ice damage stated in 3.4.11.4 and the number of floodable compartments given in 3.4.11.5.

Where compliance with the requirements of other chapters of this Section also testifies to 3.4.11 being complied with, no additional damage trim and stability calculations need be made for damage conditions mentioned under 3.4.11.4 and 3.4.11.5.

3.4.11.4 For the purpose of damage trim and stability calculations, the following extent of ice damage shall be assumed:

.1 longitudinal extent $0{,}045L_{ice}$, if the centre of damage lies within $0{,}4L_{ice}$ from the forward perpendicular, and $0{,}015L_{ice}$ in other areas;

.2 damage depth 0,76 m as measured along the normal to the shell at any point in the area of assumed damage;

.3 vertical extent $0{,}2d_{ice}$;

.4 location of damage from the base line to the level of $1{,}2d_{ice}$ within L_{ice}.

3.4.11.5 When performing damage trim and stability calculations, the number of floodable compartments shall be determined proceeding from the location of the assumed ice damage listed in Table 3.4.11.5.

3.4.11.6 In all cases, irrespective of the requirements stated in items 11 and 12 of Table 3.4.11.5, the calculations of damage trim and stability for the case of the machinery spaces being flooded shall be submitted for the consideration of the Register.

3.4.11.7 For oil tankers, chemical tankers 2 and 3, gas carriers 2G and 3G below or equal to 150 m in length, the necessity of considering a simultaneous flooding of the machinery space and an adjacent compartment will be specially considered by the Register.

3.4.11.8 Ships conforming with the requirements of 3.4.11.3 to 3.4.11.7 only will receive no subdivision mark in the class notation.

см.Б1 **3.4.12 Bulk carriers.**

см.Б1 **3.4.12.1** Bulk carriers having the length L_1 of 150 m and upwards, which carry solid bulk cargoes with density of 1000 kg/m^3 and above, shall meet the requirements of 4.4 at flooding of any cargo hold bounded by the side shell only or being double side skin construction with the width less than 1000 mm in all cases of draught up to the summer loadline.

3.4.12.2 When calculating damage stability the following permeabilities shall be taken:

0,90 for loaded holds;

0,95 for empty holds.

см.Б1-добавлено 3.14.12.3-3.4.12.5

Table 3.4.11.5

Nos	Type of ship and/or ice strengthening category	Location of ice damage mentioned under 3.4.11.4
1	Ice-strengthened ships of **ЛУ7**, **ЛУ8** and **ЛУ9** categories except fishing vessels and fish carriers	Anywhere in the ice damage area
2	Passenger ships allowed to carry over 400 passengers including the crew	Ditto
3	Special purpose ships allowed to carry over 400 passengers including the crew	—"—
4	Ships intended for the carriage of radioactive agents	—"—
5	Chemical tankers	—"—
6	Oil tankers	—"—
7	Gas carriers	—"—
8	Drilling ships	—"—
9	Ice-strengthened salvage ships with ice categories **ЛУ5**, **ЛУ6**, **ЛУ7**, **ЛУ8** and **ЛУ9**	—"—
10	Ice-strengthened fishing vessels and refrigerated fish carriers with ice categories **ЛУ7**, **ЛУ8** and **ЛУ9**	Between watertight bulkheads, platforms, decks and plating[1]
11	Ice-strengthened ships with ice categories **ЛУ5** and **ЛУ6** not mentioned in 2 to 9	Between watertight bulk-heads, platforms, decks and plating[1]. With the hull length L_1<100 m it is permitted not to comply with the requirements for damage trim and stability where machinery space located aft is flooded in case of ice damage The same refers to the flooding of engine rooms of tugs less than 40 meters in length irrespective of the engine room location
12	Ice-strengthened ships with ice category **ЛУ4** not mentioned in 2 to 9	Between watertight bulkheads, platforms, decks and plating[1]. With the hull length L_1<125 m it is permitted not to comply with the requirements for damage trim and stability where machinery space located aft is flooded in case of ice damage. The same refers to the flooding of engine rooms of tugs less than 40 meters in length irrespective of the engine room location

[1] Where the distance between two consecutive watertight structures is less than the extent of damage, relative adjacent compartments shall be considered a single floodable compartment when checking damage trim and stability.

Ships assigned with the reduced freeboard in accordance with Section 4 are regarded of satisfying the requirements of 3.4.12.

Information on compliance with these requirements shall be included in the Information on Stability and Strength for the Ship Loaded with Solid Bulk Cargoes other than Grain as required by 1.4.9.7, Part II "Hull".

3.4.13 Berth-connected ships.

3.4.13.1 Damage stability requirements stated in 3.3 shall be complied with in the case of any single flooded compartment lying along the ship periphery and having the length not less than the length of damage given in 3.4.13.2.2.

3.4.13.2 For the purpose of damage trim and stability calculations, the following extent of damage shall be assumed:

.1 transverse extent measured from the inner skin at right angles to the centre line on the level of the deepest waterline permitted by the load line — 0,76 m;

.2 longitudinal extent — $1/6L_1^{2/3}$ or 7,2 m (whichever is less);

.3 vertical extent in accordance with 3.2.1.3.

3.4.13.3 No subdivision mark will be inserted in the class notation of berth-connected ships which comply solely with the requirements of this Chapter and for which regard to 3.4.13.2 shall be taken.

3.4.13.4 If the depth of waters on which the berth-connected ship floats is such that the lowermost deck accessible to passengers cannot be immersed not to mention capsizing of the ship, the requirements of this Part of the Rules may be waived.

4 SPECIAL REQUIREMENTS FOR TYPE "B" SHIPS WITH REDUCED FREEBOARD AND FOR TYPE "A" SHIPS

4.1 GENERAL

4.1.1 This Section applies to type "A" and type "B" ships specified in 1.1.3.

The requirements of the Section shall be fulfilled irrespective of meeting the requirements of other sections by these ships.

4.1.2 The requirements are considered fulfilled where it is demonstrated by calculations that a ship being in assumed loading condition specified in 4.2 after the flooding of the number of compartments required by 4.1.3 to 4.1.5 caused by damages stipulated in 4.3 remains afloat and in a condition of equilibrium it meets the requirements of 4.4.

4.1.3 For type "A" ships above 150 m in length (L_1), when they are assigned a freeboard less than that of the appropriate ships of the type "B" the requirements of this Section are to be complied with in the case of any single compartment being flooded.

4.1.4 For type "B" ships above 100 m in length (L_1) for which the permitted reduction of tabular freeboard does not exceed 60 per cent of the difference between its values as per Tables 4.1.2.3 and 4.1.3.2 of Load Line Rules for Sea-Going Ships, the following cases of flooding shall be considered:

.1 any single compartment with the exception of the machinery space;

.2 any single compartment including the machinery space where the ship length exceeds 150 m.

4.1.5 Type "B" ships, having the length L_1 over 100 m, for which the permitted reduction in the tabular freeboard exceeds 60 per cent of the difference between its values as per Tables 4.1.2.3 and 4.1.3.2 of Load Line Rules for Sea-Going Ships shall be considered for the following cases of flooding:

.1 any two adjacent compartments, except for the machinery space;

.2 any two adjacent compartments and the machinery space considered separately in ships over 150 m in length.

4.1.6 The following permeabilities shall be assumed in calculations required by 4.1.2:

0,95 for any floodable compartments and spaces, except for the machinery space;

0,85 for floodable machinery space.

The permeability value of 0,95 is applicable to cargo spaces and tanks as well which are to be considered full when determining the height of the ship centre of gravity in conformity with 4.2.3.

4.1.7 In addition to the requirements of 4.1.4 and 4.1.5, ships intended for carriage of deck cargoes shall comply with the requirements of 2.3. Height of the centre of gravity used for demonstration of compliance with the requirements of 4.4 during the deterministic analysis of damage stability shall be equal to the height of the centre of gravity used for calculation of damage stability at probabilistic assessment at assumption of the highest loadline. The diagram of ultimate elevation of the centre of gravity with deck cargo drawn taking into consideration the fulfilment of the requirements of 2.3 shall be included into the Information on Stability and Information on Damage Trim and Stability.

4.2 TRIM AND LOADING CONDITION OF THE SHIP PRIOR TO DAMAGE

4.2.1 All cases of flooding shall be analyzed under one assumed initial loading condition of the ship, as specified in 4.2.2 to 4.2.4.

4.2.2 The ship is considered to be loaded by homogeneous cargo to its draught up to the summer load line in salt water on an even keel.

4.2.3 The height of the centre of gravity of the ship shall be calculated for the following assumed loading condition:

.1 all cargo spaces, except for those under 4.2.3.2, including the anticipated in service, partly filled spaces are considered to be fully loaded with dry cargo and to be 98 per cent loaded with liquid cargo;

.2 where the ship when loaded to the summer load line is to operate with some spaces not loaded or filled with dry or liquid cargo, such spaces shall be assumed empty provided that the height of the centre of gravity of the ship, calculated with regard to empty compartments is not less than that calculated on the assumption that all the spaces are occupied with cargoes;

.3 the amount of every type of the ship's stores and consumable liquids is taken to be equal to 50 per cent of the full capacity. Tanks, except for those under 4.2.4.2, are assumed to be empty or completely filled, the distribution of the stores in the tanks resulting in the highest position of the centre of gravity of the ship. The centres of gravity of the contents of the tanks mentioned in 4.2.4.2 are taken to be in the centres of gravity of their volumes;

.4 loading of the ship as regards consumable liquids and ballast water shall be estimated on the basis of the following values of their density, in t/m^3:

Salt water	1,025
Fresh water	1,000
Fuel oil	0,950
Diesel oil	0,900
Lubricating oil	0,900

4.2.4 In estimating the height of the centre of gravity of the ship account shall be taken of the effect of free surfaces of liquids:

.1 for liquid cargo, proceeding from loading specified in 4.2.3.1;

.2 for consumable liquids, proceeding from the assumption that for every type of liquid at least one centreline tank or one transverse pair of tanks have free surfaces. To be taken into consideration are the tanks or the combination of tanks where the effect of free surfaces is the greatest.

It is recommended that the correction for free surfaces effect be taken into account in accordance with the Register's Instructions of Estimating Liquid Cargo Free Surface Effect on Ship's Stability.

4.3 EXTENT OF DAMAGE

4.3.1 The vertical extent of damage shall be assumed from the base line upwards without limit.

4.3.2 The transverse extent of damage measured inboard from the ship's side, at a right angle to the centre line at the level of the summer load waterline shall be assumed equal to one-fifth of the breadth of the ship, or 11,5 m, whichever is the less.

4.3.3 If any damage of lesser extent than indicated in 4.3.1 and 4.3.2 would result in a more severe condition, such damage shall be assumed in the calculations.

4.3.4 Transverse bulkheads are considered effective if the distance between them or between the transverse planes passing through the nearest portions of the stepped bulkheads is at least $1{,}3L_1^{2/3}$, or 14,5 m, whichever is the less. In case of lesser distance, one or more of these bulkheads shall be assumed as non-existent.

4.3.5 When one compartment is flooded, with due regard for provisions of 4.3.4, main transverse bulkheads are considered not to be damaged if they have no steps more than 3 m in length.

In case these bulkheads are provided with steps more than 3 m in length, the two compartments adjacent to such bulkheads are to be considered as flooded.

The extent of damage may be limited by transverse bulkheads of a side tank in case its longitudinal bulkheads are beyond the transverse extent of damage.

Where a side tank or a double bottom tank is divided by a transverse bulkhead located more than 3 m from a main transverse bulkhead, both tanks divided by such bulkhead shall be considered as flooded.

The following compartments are to be considered as flooded:

A+D, B+E, C+E+F (Fig. 4.3.5-1);
A+D+E, B+E (Fig. 4.3.5-2);
A+D, B+D+E (Fig. 4.3.5-3);
A+B+D, B+D+E (Fig. 4.3.5-4);

4.3.6 Where a side tank has openings into a hold, it is to be considered as communicating with the hold even where such openings are fitted with closing appliances. This provision is applicable to ships carrying liquid cargoes, except in case of sluice valves fitted in bulkheads between tanks and where the valves are controlled from above the bulkhead deck.

4.3.7 Where pipes, ducts or tunnels are located within the assumed extent of damage, satisfactory arrangements shall be provided to preclude the possibility of progressive flooding through them to other spaces beyond the limits assumed for the calculations of the damage stability of the ship.

4.3.8 In case of two-compartment flooding the requirements of 4.3.1 to 4.3.4, 4.3.6 and 4.3.7 shall be met.

4.4 TRIM AND STABILITY OF A SHIP IN DAMAGED CONDITION

4.4.1 The metacentric height of the ship in the damaged condition prior to taking measures for the increase thereof shall be positive.

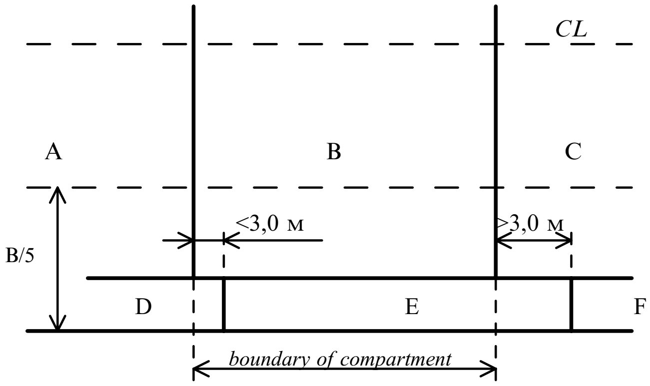


Fig. 4.3.5-1

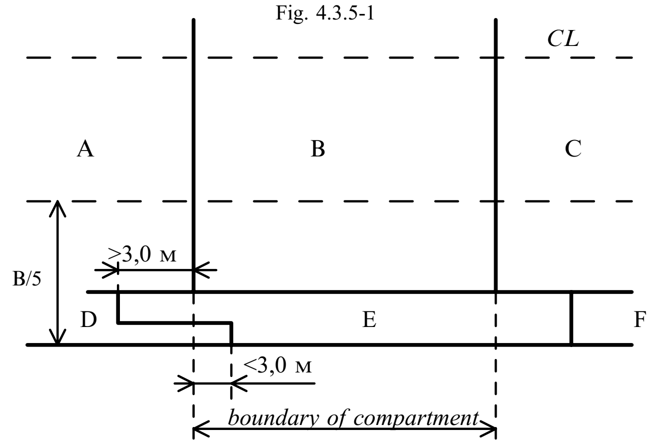


Fig. 4.3.5-2

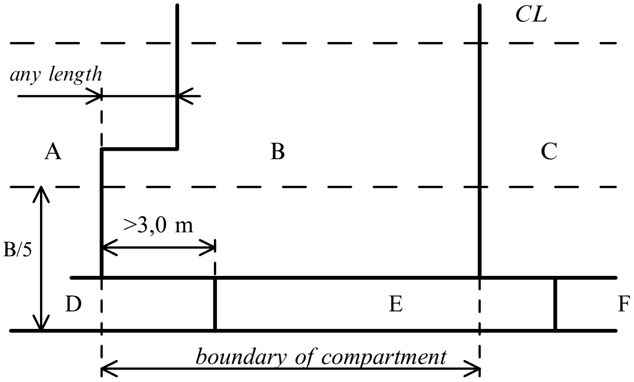


Fig. 4.3.5-3

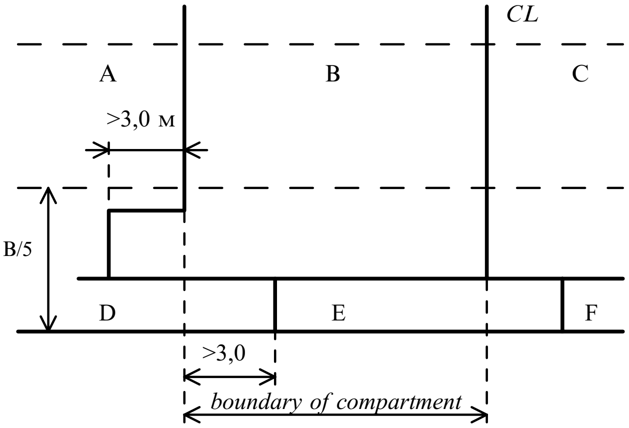


Fig. 4.3.5-4

4.4.2 The angle of heel due to unsymmetrical flooding prior to the beginning of the equalization of the ship shall not exceed 15°. If no part of the deck immerses, the increase of heel up to 17° may be allowed.

4.4.3 The final damage waterline having regard to heel and trim prior to the beginning of the equalization of the ship shall not be above the lower edge of openings indicated in 3.4.4, through which progressive flooding may take place.

4.4.4 When any part of the bulkhead deck beyond the limits of the flooded compartments immerses, or the margin of damage stability is doubtful, damage stability at large angles of heel is to be investigated. It shall be shown that the value of a maximum arm of the righting lever curve of a damaged ship is not less than 0,1 m within the rated extent (20°) in association with a range of the curve with positive arms of at least 20°, the area of the positive portion of the curve being not less than 0,0175 m·rad.

5 REQUIREMENTS FOR SHIPS IN SERVICE

5.1 REQUIREMENTS FOR ROLL-ON/ROLL-OFF PASSENGER SHIPS (RO-RO PASSENGER SHIPS)

5.1.1 Ro-ro passenger ships constructed before 1 July 1997 shall comply with the requirements of 5.1.3 not later than the date of the first periodical survey after the date of compliance prescribed below, according to the value of $A/A_{\max}$ (ratio of the probability index A as defined in 5.1.4 to the maximum probability index $A_{\max}$ as defined in 5.1.5):

less than 85 per cent — not later than 1 October 1998;

85 per cent or more but less than 90 per cent — not later than 1 October 2000;

90 per cent or more but less than 95 per cent — not later than 1 October 2002;

95 per cent or more but less than 97,5 per cent — not later than 1 October 2004;

97,5 per cent or more — not later than 1 October 2005.

Number of floodable compartments shall be adopted in accordance with the requirements of 3.4.1.3 and 3.4.1.4.

5.1.2 In addition to the requirements of 5.1.1 ro-ro passenger ships certified to carry 400 persons or more shall comply with the requirements of 5.1.3.2 and 5.1.3.3, assuming the damage applied anywhere within the ship' length, not later than the date of the first periodical survey after the date of compliance prescribed in 5.1.2.1, 5.1.2.2 and 5.1.2.3 which occurs the latest:

.1 depending on the value of $A/A_{\max}$:

less than 85 per cent — not later than 1 October 1998;

85 per cent or more but less than 90 per cent — not later than 1 October 2000;

90 per cent or more but less than 95 per cent — not later than 1 October 2002;

95 per cent or more but less than 97,5 per cent — not later than 1 October 2004;

97,5 per cent or more — not later than 1 October 2010;

.2 depending on the number of persons permitted to be carried:

1500 or more — not later than 1 October 2002;

1000 or more but less than 1500 — not later than 1 October 2006;

600 or more but less than 1000 — not later than 1 October 2008;

400 or more but less than 600 — not later than 1 October 2010;

.3 age of the ship equal or greater than 20 years (where the age of the ship means the time counted from the date on which the keel was laid or the date on which it was at a similar stage of construction or from the date on which the ship was converted to a ro-ro passenger ship).

5.1.3 Requirements for damage trim and stability.

5.1.3.1 When performing damage trim and stability calculations account must be taken of the requirements of 3.1.1, 3.1.2, 3.1.4 to 3.1.7, 3.1.9. References to 3.2, 3.3 and 3.4 in the above paragraphs have been replaced by reference to 5.1.3.6.

5.1.3.2 In the final stage of symmetric flooding before appropriate measures to increase metacentric height are taken the initial metacentric height of a ship in the upright condition determined by the constant displacement method shall not be less than 0,05 m.

5.1.3.3 The statical stability curve for the final stage of flooding (after equalization, if effected) shall have a positive range not less than 15°.

Within the range stated above the area under the lever curve and the maximum lever arm of statical stability curve shall comply with the requirements of 3.4.1.10 and 3.4.1.11.

5.1.3.4 During the intermediate stages of flooding, stability shall comply with the requirements of 3.4.1.8.

5.1.3.5 For the purposes of damage stability calculations, the permeabilities of spaces and surfaces shall be generally assumed equal to the values to be determined from Table 5.1.3.5.

Table 5.1.3.5

Spaces	Permeability
Spaces intended for carriage of coal or stores	0,60
Accommodation spaces	0,95
Spaces occupied by machinery	0,85
Spaces intended for liquid cargoes	0 or 0,95 [1]
Ro-ro cargo spaces	0,90

[1] That value shall be taken, which results in more severe requirements.

Higher surface permeabilities shall be assumed for those spaces which are not occupied by substantional numbers of accommodation rooms or machinery in the vicinity of the damage waterline as well as for spaces which are not generally occupied by any substantional quantities of cargo or stores.

5.1.3.6 For the purpose of compliance with the requirements for damage trim and stability laid down in 5.1.3 the extent of damage is adopted on the basis of 3.4.1.2.

5.1.3.7 The trim of a damaged ship shall comply with the requirements of 3.4.1.6; the equalization time necessary for the above requirements to be fulfilled is not to exceed 15 min.

5.1.3.8 The damage waterline after the equalization of the ship and where no equalization is to be effected shall be 76 mm below the bulkhead deck.

5.1.4 The probability index A is determined from the formula:

$$A = \Sigma aps. \tag{5.1.4}$$

To be summed up are the single compartments and groups of two adjacent compartments.

5.1.4.1 For the purpose of determining the index A the ship is considered to be loaded to the deepest subdivision waterline, with null or designed (if any) trim and with maximum height of centre of gravity which may occur in the ship's service.

The permeabilities are assumed in compliance with 1.6.1.1, 1.6.1.3, 1.6.2 and 1.6.5.

For spaces of ro-ro ships the permeability shall be assumed to be equal to 0,90.

5.1.4.2 The factors a and p are determined in conformity with 2.2.4 and 2.2.5. The value of the factor k_v is assumed to be equal to 1.

5.1.4.3 The factor s is determined from the formula

$$s = 2{,}58c\sqrt[4]{GZ_{\max}\psi\,\Omega} \tag{5.1.4.3}$$

where $GZ_{\max}$ = the maximum positive righting lever for a damaged ship within the range of 15° from the position of equilibrium but not more than 0,1 m;

ψ = the range of positive righting lever in degrees but not more than 15°;

Ω = the positive lever arm section (m·rad) of thestatical stability curve for a damaged ship, determined in conformity with 3.4.1.10, but not more than 0,015 m·rad;

c = the factor equal to:

c =1 if the heeling angle in the final stage of flooding θ_e does not exceed 7°;

$$c = \sqrt{\frac{20° - \theta_e}{13°}}\text{, if } 7° < \theta_e \leqslant 20°;$$

c = 0, if the heeling angle θ_e exceeds 20°;

θ_e = the heeling angle in the final stage of flooding (before equalization), in deg.

5.1.4.4 Where the damage trim and stability satisfy fully the requirements of 3.4.1 the factor s shall be taken as 1.

s shall be taken as zero for any case of flooding which results:

during intermediate flooding or prior to equalization, in the angle of heel in excess of 20° or which immerses any openings through which down-flooding might take place; or

for the final stage of flooding, except in way of the flooded compartment or compartments, in immersion of the bulkhead deck; or

in the final stage of flooding heel in excess of 12°; or

h_d less than 0,05 m.

5.1.4.5 If subdivision of the ship by longitudinal watertight bulkheads is taken into account the value p is multiplied by the reduction factor r obtained in compliance with 2.2.6.3 at k_v=1.

5.1.5 Where the value s<1 in case of flooding of any single compartment in a ship which requires the one-compartment subdivision standard (number of persons on board is less than 400) or in case of any two adjacent compartments being flooded in a ship, for which the two-compartment subdivision standard is required (number of persons on board is equal or greater than 400), provision is to be made for calculating the maximum probability index $A_{\max1}$ or $A_{\max2}$ in the same way as A_1 or A_2 but the value of s is assumed to be equal to 1 in case of:

flooding of every compartment in a ship which requires the one-compartment subdivision standard,

flooding of every two adjacent compartments in a ship which requires the two-compartment subdivision standard.

5.1.6 The value $A/A_{\max}$ is calculated from the following formulae:

for the one-compartment subdivision standard

$$\frac{A}{A_{\max}} = \frac{A_1}{A_{\max1}} \quad\text{or}\quad \frac{A}{A_{\max}} = \frac{A_1 + A_2}{A_{\max1} + A_2}\ ; \tag{5.1.6-1}$$

for the two-compartment subdivision standard

$$\frac{A}{A_{\max}} = \frac{A_1 + A_2}{A_{\max1} + A_{\max2}} \tag{5.1.6-2}$$

where A_1 = a part of the value A determined in accordance with 5.1.4 for the cases where one compartment is flooded;

A_2 = a part of the value A determined in accordance with 5.1.4 for the cases where two adjacent compartments are flooded;

$A_{\max1}$ = a part of the value A determined in accordance with 5.1.5 for the cases where one compartment is flooded;

$A_{\max2}$ = a part of the value A determined in accordance with 5.1.5 for the cases where two adjacent compartments are flooded.

см.Б1 5.2 BULK CARRIERS

5.2.1 The bulk carrier, which forward cargo hold is confined by the outer plating or double side skin construction with a width less than 760 mm with an length L_1 of 150 m and more built before 1 July 1999 carrying hard bulk cargoes with density of 1780 kg/m^3 and more, is to comply with the requirements of 4.4 while flooding the fore cargo hold in all cases up to the summer load line not later than the date of survey assigned in relation to the ship age:

.1 for ships which age at 1 July 1998 is 20 years and more, the date of the first intermediate (the second or the third annual survey) or the first special survey, which is to be carried out after 1 July 1998 is accepted, whichever is earlier;

.2 for ships which age at 1 July 1998 is 15 years and more but less then 20 years, the date of the first special survey which is to be carried out after 1 July 1998 but not later than 1 July 2002 is accepted;

.3 for ships which age at 1 July 1998 is less than 15 years, the date of the third special survey or the date when the ship's age becomes equal to 15 years is accepted, whichever is later.

5.2.2 The following values of permeabilities are to be taken for the damage stability calculations:

0,90 for loaded holds;

0,95 for empty holds.

5.2.3 The ships which don't comply with the requirements of 5.2.1 may be acquitted from this requirement provided the following conditions are met:

.1 the programme of the fore hold annual survey is replaced by the programme approved at the full scale intermediate survey in accordance with the Section 2, Part III "Additional Surveys of Ships in Relation to Their Purpose and Hull Material" of Rules for the Classifications Surveys of Ships.

.2 The visual and audible alarm shall be fitted in the wheelhouse for signalling in case of:

flooding over two metres above the double bottom in the stern part of each cargo hold;

filling of bilge well of each hold up to the upper level.

Such signalling system shall meet the requirements of Part XI "Electrical equipment";

.3 the ship is to be supplied with detailed information on the effect of the phased flooding of cargo hold and detailed instructions in accordance with Section 8 of International Safety Management Code (ISM Code).

Information shall include the data and documentation stated in 1.4.6.1 and the results of damage trim and stability calculations at stage-by-stage compartment flooding under all conditions of loading to the summer load line on an even keel. When the ship meets the requirements of 4.4 at a lesser draught, the document shall contain a diagram of maximum heights of the centre of gravity of the ship (minimum metacentric heights) plotted with due regard to the trim and ship load. The strength of the bulkhead shall be taken into consideration. The information shall contain a summary table of calculation results with indication of critical factors and the data given in 1.4.6.1.5.

5.2.4 The ships which are assigned with the reduced freeboard in accordance with Section 4 are considered compliant with the requirements of this Chapter.

см.Б1 **5.2.5** Information on compliance with the requirements of this Chapter are to be contained in the Booklet required by 1.4.9.7, Part II "Hull".

см.Б1

APPENDIX

FORMULAE FOR DETERMINING THE VALUES OF *p* FOR DIFFERENT COMPARTMENT ARRANGEMENTS (see 2.2.6)

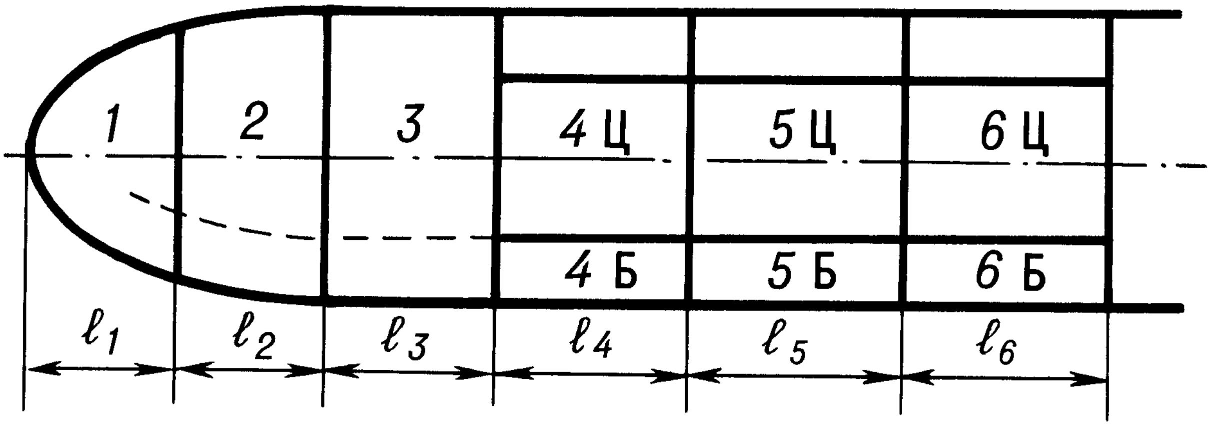


Fig. 1

Arrangement of compartments	Formula for determining the value of *p*	Distances for determining the value of *a*	
		x_1	x_2
4Б	$p_4 r_4$	l_{1-3}	l_{1-4}
4Б+4Ц	$p_4(1 - r_4)$	l_{1-3}	l_{1-4}
3+4Б	$p_{34}\overset{*}{r}_{34} - p_3\overset{*}{r}_3 - p_4 r_4$	l_{1-2}	l_{1-4}
3+4Б+4Ц	$p_{34}(1 - \overset{*}{r}_{34}) - p_3(1 - \overset{*}{r}_3) - p_4(1 - r_4)$	l_{1-2}	l_{1-4}
4Б+5Б	$p_{45}r_{45} - p_4 r_4 - p_5 r_5$	l_{1-3}	l_{1-5}
4Б+4Ц+5Б+5Ц	$p_{45}(1 - r_{45}) - p_4(1 - r_4) - p_5(1 - r_5)$	l_{1-3}	l_{1-5}
2+3+4Б	$p_{234}\overset{*}{r}_{234} - p_{23}\overset{*}{r}_{23} - p_{34}\overset{*}{r}_{34} + p_3\overset{*}{r}_3$	l_1	l_{1-4}
2+3+4Б+4Ц	$p_{234}(1 - \overset{*}{r}_{234}) - p_{23}(1 - \overset{*}{r}_{23}) - p_{34}(1 - \overset{*}{r}_{34}) + p_3(1 - \overset{*}{r}_3)$	l_1	l_{1-4}
3+4Б+5Б	$p_{345}\overset{*}{r}_{345} - p_{34}\overset{*}{r}_{34} - p_{45}r_{45} + p_4 r_4$	l_{1-2}	l_{1-5}
3+4Б+4Ц+5Б+5Ц	$p_{345}(1 - \overset{*}{r}_{345}) - p_{34}(1 - \overset{*}{r}_{34}) - p_{45}(1 - r_{45}) + p_4(1 - r_4)$	l_{1-2}	l_{1-5}
4Б+5Б+6Б	$p_{456}r_{456} - p_{45}r_{45} - p_{56}r_{56} + p_5 r_5$	l_{1-3}	l_{1-6}
4Б+4Ц+5Б+5Ц+6Б+6Ц	$p_{456}(1 - r_{456}) - p_{45}(1 - r_{45}) - p_{56}(1 - r_{56}) + p_5(1 - r_5)$	l_{1-3}	l_{1-6}

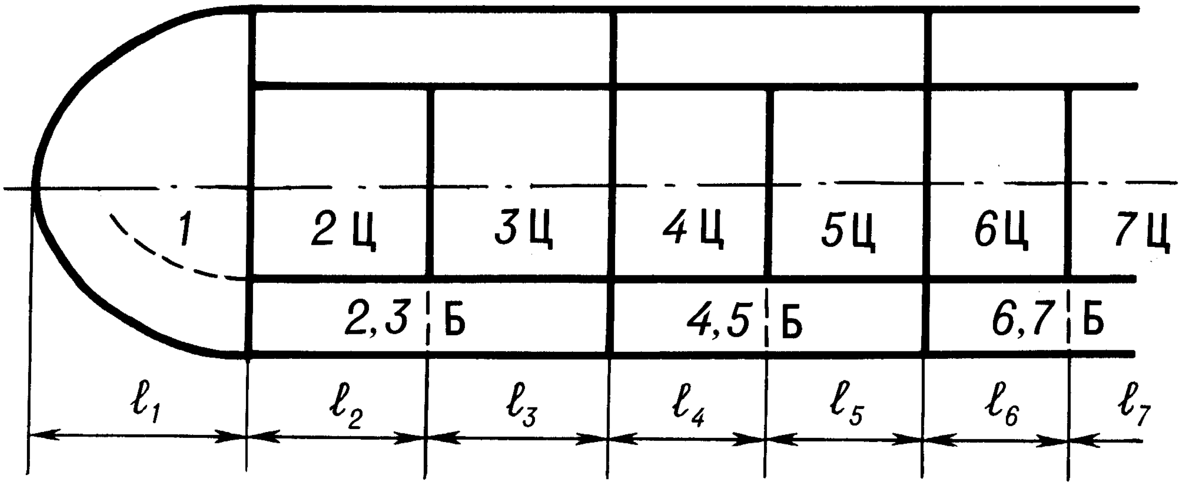


Fig. 2

1	p_1	0	l_1
2,3Б	$p_{23}r_{23}$	l_1	l_{1-3}
4,5Б	$p_{45}r_{45}$	l_{1-3}	l_{1-5}
1+2,3Б	$p_{123}r^*_{123} - p_1r^*_1 - p_{23}r_{23}$	0	l_{1-3}
2,3Б+4,5Б	$p_{2-5}r_{2-5} - p_{23}r_{23} - p_{45}r_{45}$	l_1	l_{1-5}
1+2,3Б+4,5Б	$p_{1-5}r^*_{1-5} - p_{123}r^*_{123} - p_{2-5}r_{2-5} + p_{23}r_{23}$	0	l_{1-5}
2,3Б+4,5Б+6,7Б	$p_{2-7}r_{2-7} - p_{2-5}r_{2-5} - p_{4-7}r_{4-7}+p_{45}r_{45}$	l_1	l_{1-7}
2Ц+2,3Б	$p_2(1 - r_2)$	l_1	l_{1-2}
3Ц+2,3Б	$p_3(1 - r_3)$	l_{1-2}	l_{1-3}
1+2Ц+2,3Б	$p_{12}(1 - r^*_{12}) - p_1(1 - r^*_1) - p_2(1 - r_2)$	0	l_{1-2}
2Ц+3Ц+2,3Б	$p_{23}(1 - r_{23}) - p_2(1 - r_2) - p_3(1 - r_3)$	l_1	l_{1-3}
3Ц+4Ц+2,3Б+4,5Б	$p_{34}(1 - r_{34}) - p_3(1 - r_3) - p_4(1 - r_4)$	l_{1-2}	l_{1-4}
1+2Ц+3Ц+2,3Б	$p_{123}(1 - r^*_{123}) - p_{12}(1 - r^*_{12}) - p_{23}(1 - r_{23}) + p_2(1 - r_2)$	0	l_{1-3}
2Ц+3Ц+4Ц+2,3Б+4,5Б	$p_{234}(1 - r_{234}) - p_{23}(1 - r_{23}) - p_{34}(1 - r_{34}) + p_3(1 - r_3)$	l_1	l_{1-4}

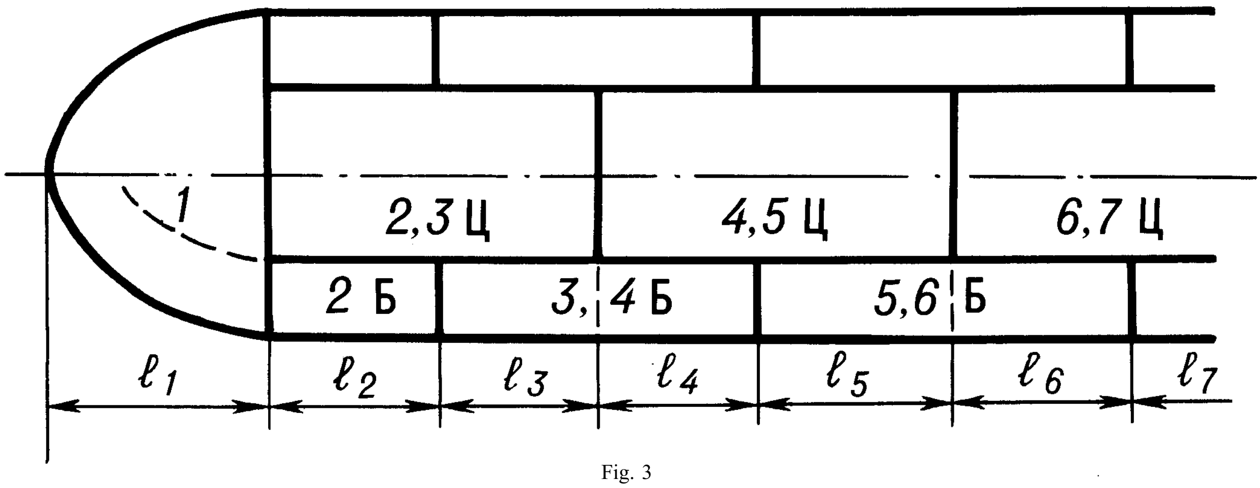


Fig. 3

1	p_1	0	l_1
2Б	p_2r_2	l_1	l_{1-2}
3,4Б	$p_{34}r_{34}$	l_{1-2}	l_{1-4}
1+2Б	$p_{12}r^*_{12} - p_1r^*_1 - p_2r_2$	0	l_{1-2}
2Б+3,4Б	$p_{234}r_{234} - p_2r_2 - p_{34}r_{34}$	l_1	l_{1-4}
1+2Б+3,4Б	$p_{1-4}r^*_{1-4} - p_{12}r^*_{12} - p_{234}r_{234}+p_2r_2$	0	l_{1-4}
2Б+3,4Б+5,6Б	$p_{2-6}r_{2-6} - p_{234}r_{234} - p_{3-6}r_{3-6}+p_{34}r_{34}$	l_1	l_{1-6}
2,3Ц+2Б	$p_2(1 - r_2)$	l_1	l_{12}
2,3Ц+3,4Б	$p_3(1 - r_3)$	l_{1-2}	l_{1-3}
4,5Ц+3,4Б	$p_4(1 - r_4)$	l_{1-3}	l_{1-4}
1+2,3Ц+2Б	$p_{12}(1 - r^*_{12}) - p_1(1 - r^*_1) - p_2(1 - r_2)$	0	l_{12}
1+2,3Ц+2Б+3,4Б	$p_{123}(1 - r^*_{123}) - p_{12}(1 - r^*_{12}) - p_{23}(1 - r_{23})+p_2(1 - r_2)$	0	l_{1-3}
2,3Ц+4,5Ц+3,4Б	$p_{34}(1 - r_{34}) - p_3(1 - r_3) - p_4(1 - r_4)$	l_{1-2}	l_{1-4}
2,3Ц+4,5Ц+2Б+3,4Б	$p_{24}(1 - r_{24}) - p_2(1 - r_2) - p_{34}(1 - r_{34})$	l_1	l_{1-4}
2,3Ц+4,5Ц+3,4Б+5,6Б	$p_{35}(1 - r_{35}) - p_{34}(1 - r_{34}) - p_{45}(1 - r_{45})+p_4(1 - r_4)$	l_{1-2}	l_{1-5}
2,3Ц+4,5Ц+2Б+3,4Б+5,6Б	$p_{2-5}(1 - r_{2-5}) - p_{234}(1 - r_{234}) - p_{345}(1 - r_{345})+ +p_{34}(1 - r_{34})$	l_1	l_{1-5}

Notes: 1. When determining the probablility values of r^*, it is to be assumed than in compartments 1 (Figs 2 and 3), 2 and 3 (Fig. 1) an inner side is available being a continuation of the existing one.

2. The compartment arrangements to be found in the Table shall be considered flooded when determining the values of s.

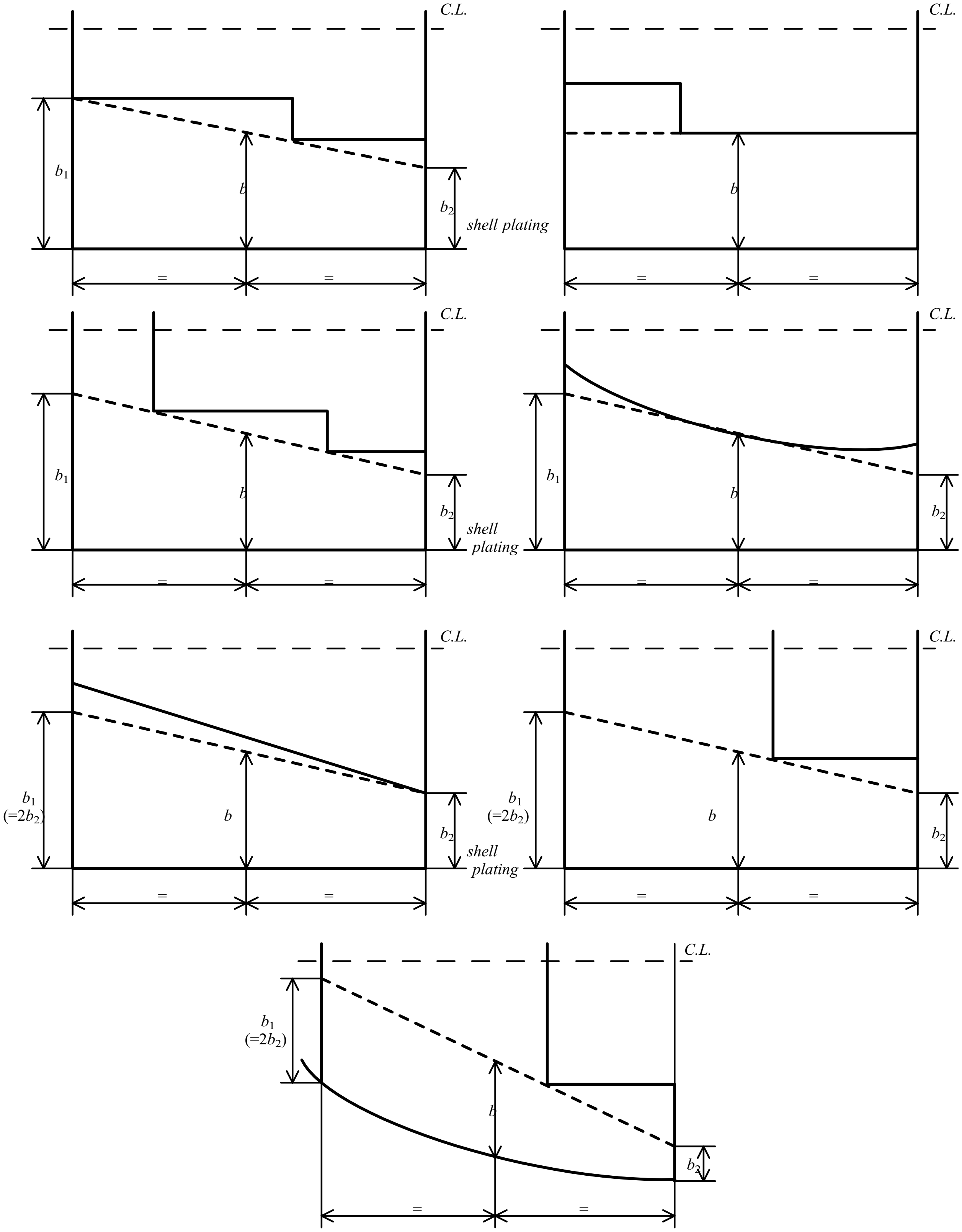
3. In the tables: $l_{1-2}=l_1+l_2$

$l_{1-3}=l_1+l_2+l_3$

. . . .

$l_{1-7}=l_1+l_2+l_3+l_4+l_5+l_6+l_7$

DETERMINATION OF THE DEPTH OF PENETRATION *b*



If r is calculated for a group of two or more compartments, the value of b is the same for all compartments of this group, and it is equal to the least b value in this group:

$$b = \min(b_1, b_2, ... b_n)$$

where n = the number of side compartments comprisind this group;
$b_1, b_2, ... b_n$ = is the mean value of b for individual side compartments forming this group.

PART VI. FIRE PROTECTION

1 GENERAL

1.1 APPLICATION

1.1.1 This Part of the Rules applies to ship's structural fire protection, fire extinguishing systems and fire detection and alarm systems, as well as fire fighting equipment and outfit.

1.1.2 The fire protection requirements relating to the structural items of the ship hull, machinery and parts thereof, electrical equipment, pumping and piping, ship's arrangements, fuel and lubricating oil tanks, construction and location of boilers, refrigerating plants, ship's spaces, etc. are set out in the relevant parts of the Rules.

1.2 DEFINITIONS AND EXPLANATIONS

The definitions and explanations relating to the general terminology of the Rules are given in Part I "Classification".

The following definitions have been adopted in this Part of the Rules.

Cargo area is that part of the ship that contains cargo tanks, slop tanks and pump rooms, cofferdams, ballast and void spaces adjacent to cargo tanks and also deck areas throughout the entire length and breadth of the parts of the ship over the above-mentioned spaces.

Dangerous goods. For the purpose of the Rules and in accordance with International Maritime Dangerous Goods Code (IMDG Code) the following is considered as dangerous goods:

Class 1 — Explosives.
Class 2 — Gases: compressed, liquefied or dissolved under pressure.
Class 3 — Flammable liquids.
Class 4 — Flammable solids (Class 4.1); substances liable to spontaneous combustion (Class 4.2); substances, which in contact with water emit flammable gases (Class 4.3).
Class 5 — Oxidizing substances (Class 5.1) and organic peroxides (Class 5.2).
Class 6 — Poisonous and infectious substances. Poisonous substances (Class 6.1).
Class 7 — Radioactive substances.
Class 8 — Corrosives.
Class 9 — Miscellaneous dangerous substances.

Explosives of Class 1.4, compatibility group *S* are substances and articles which present only a small hazard and are so packaged or designed that any hazardous effects are confined within the package.

Flammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (e.g. paints, varnishes, lacquers, etc.) which give off flammable vapours at or below 60°C closed cup test.

Main vertical fire zones are those sections into which the hull, superstructure and deckhouses are divided by "A" class divisions, the mean length and width of which on any deck does not in general exceed 40 m. The length or width of a main vertical zone is the maximum distance between the furthermost points of the bulkheads bounding it.

Fire Safety Systems Code means International Code for Fire Safety Systems, as adopted by the IMO Maritime Safety Committee by Resolution MSC.98(73).

Fire Test Procedures Code means International Code for Application of Fire Test Procedures, as adopted by the IMO Maritime Safety Committee by Resolution MSC.61(67).

A standard fire test is a test in which the specimens of the relevant bulkheads and decks are exposed in a test furnace to temperatures corresponding approximately to the time-temperature curve. The test methods are to be in correspondence with Fire Test Procedures Code.

"A" class or fire-resisting divisions are those divisions which comply with the requirements set out in 2.1.2.1 to 2.1.2.4, 2.1.2.6, 2.1.3.9.

"B" class or fire-retarding divisions are those divisions which comply with the requirements of 2.1.2.3, 2.1.2.5 to 2.1.2.8.

"C" class divisions are those divisions which are constructed of approved non-combustible materials. They need meet no requirements relative to the passage of smoke and flame nor the limiting of temperature rise.

Materials equivalent to steel means any non-combustible material which, by itself or due to insulation provided, has structural and integrity properties equivalent to steel at the end of the applicable fire exposure during a standard fire test (e.g., aluminium alloy with suitable insulation).

Continuous "B" class ceilings or linings are those "B" class ceilings or linings which terminate at an "A" or "B" class division or at outer surfaces of the ship.

Lower flammable limit (LFL) is minimum concentration of oil gases and vapours in air capable of igniting from a source of ignition and propagating combustion in the mixture.

A standard fire test specimen is a specimen of the bulkhead or deck, having a heat-exposed surface of not less than 4,65 m^2 and a height (or length, in the case of decks) of 2,44 m resembling as closely as possible the intended construction and including, where appropriate, at least one insulation joint (butt).

Adjacent compartments or spaces are those compartments or spaces which are separated from one another by a bulkhead, deck, platform, or any other fixed division without openings or with openings provided with means of closure.

Compartments or spaces continuous to one another at the corners only are not considered as adjacent.

Compartments and spaces separated from one another by removable divisions (i.e. those removable under normal service conditions) or having openings not fitted with means of closing, in the bulkhead or deck that separates them, are considered as one single space.

Protected space is a space equipped with one of the fire extinguishing systems or with an automatic fire detection system.

Rooms containing furniture and furnishings of restricted fire risk for the purpose of application on ships carrying more than 36 persons are the rooms (whether cabins, public spaces, offices or other types of accommodation referred to in 1.5.2) in which:

all furniture, such as desks, wardrobes, dressing tables, bureaux, dressers, is constructed entirely of approved non-combustible materials, except that a combustible veneer not exceeding 2 mm in thickness may be used on the working surface of such articles;

for the purpose of this Part of the Rules the following explanation have been adopted: all free-standing furniture, such as chairs, sofas, tables, is constructed with frames of non-combustible materials;

all draperies, curtains and other suspended textile materials have qualities of resistance to the flame propagation not inferior to those of wool of mass 0,8 kg/m^2, this being determined in accordance with Fire Test Procedures Code;

all floor coverings have low flame spread characteristics;

all exposed surfaces of bulkheads, linings and ceilings have low flame spread characteristics;

all upholstered furniture has qualities of resistance to the flame ignition and propagation, this being determined in accordance with Fire Test Procedures Code;

all bedding components have qualities of resistance to the flame ignition and propagation, this being determined in accordance with Fire Test Procedures Code.

Fire control station is a room where items of the fire fighting outfit, fire fighting control systems and/or fire detection and alarm systems are kept.

Main fire control station is a room or part thereof, where the following control and indicator functions are centralized:

fixed fire detection and alarm systems;

automatic sprinklers, fire detection and alarm systems, as well as remote starting controls of other fire fighting systems;

fire door indicator panels;

fire door closures;

watertight door indicator panels;

watertight door closures;

ventilation fans;

general/fire alarms;

communication systems including telephones; and

microphones for public address systems.

A system equivalent to a deck foam system for cargo tanks is a system which shall be capable of extinguishing spill fires, precluding ignition of spilled oil not yet ignited and combating fires in ruptured tanks.

A system equivalent to a fixed inert gas system is a system which shall be capable of preventing dangerous accumulations of explosive mixtures in intact cargo tanks during normal service throughout the ballast voyage and necessary in tank operations and so designed as to minimize the risk of ignition from the generation of static electricity by the system itself.

Combustible medium is flammable liquids; flammable gases, compressed, liquefied or dissolved under pressure; solid combustible materials and substances, including cargoes, fuel, fishing materials, equipment, insulation, furniture.

Primary deck coating is a deck coating located between steel plating and finishing covering (if any) except for thin layers of painting.

Crude oil means any oil occurring naturally in the earth whether or not treated to render it suitable for transportation and includes crude oil from which certain distillate fractions may have been removed and crude oil to which certain distillate fractions may have been added.

Flash point is the lowest temperature at which the vapours of a flammable liquid form with the ambient air a mixture capable of igniting at an open flame.

The flash point of flammable liquids shall be determined in closed cup by means of an approved flash point apparatus.

Structural fire protection is a complex of the passive means of structural fire protection intended for:

prevention of fire;

containment of flame and smoke spreading throughout the ship;

creation of conditions for safe evacuation of people from the ship's spaces and from the ship, as well as for effective extinguishment of the fire.

Foam expansion ratio is the ratio of the volume of foam produced to the volume of the mix-ture of water and foam-making concentrate required.

Fire fighting equipment and systems are those active fire fighting measures which are intended for extinguishing and containment of fire spreading throughout the ship.

Rated volume of a protected space is the gross volume of a space bounded by watertight or gastight bulkheads and decks with the deduction for the volume occupied by main machinery reduction gear, auxiliaries, boilers, condensers, evaporators, tanks, ventilation and exhaust gas piping.

Fire fighting outfit is portable fire fighting equipment (apparatus, appliances, consumable materials) intended for:

extinguishing a fire;

ensuring effective fire fighting actions of the crew;

ensuring operation of fire fighting system.

Water-screen systems are systems which create a water barrier in the form of sufficiently thick curtain of water fed through spray nozzles. Such systems are fitted where the use of fire-resisting divisions is impracticable.

Water drenching systems are those systems which supply water onto vertical or horizontal ship's structures.

Fire detection and fire alarm systems are subdivided into:

fire detection systems designed for sending signal (automatically and/or manually) from the place where a fire has broken out to the main fire control station and fire warning alarms designed to inform the crew and special personnel in the protected space that a fire extinguishing medium is on the point of being discharged.

Fixed fire extinguishing systems are those systems which are intended to supply fire extinguishing medium to the protected spaces or di-rectly therein and structurally fixed to the ship's hull.

Smothering is filling of a protected space with a medium not supporting combustion.

Surface extinction is cooling, wetting or restriction of oxygen access to burning surfaces.

Slop tank is a tank intended for accumulation of slops after washing of cargo tanks and contaminated ballast water.

Helideck is a purpose-built helicopter landing area located on a ship including all structures, fire-fighting appliances and other equipment necessary for the safe operation of helicopters.

Helicopter facility is a helideck including any refuelling and hanger facilities.

INF Code means International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships, adopted by the IMO Maritime Safety Committee by resolution MSC.88(71), as amended.

INF Cargo means packaged irradiated nuclear fuel, plutonium and high-level radioactive wastes carried as cargo in accordance with Class 7 of International Maritime Dangerous Goods Code (IMDG Code), schedule 10, 11, 12 or 13.

Irradiated nuclear fuel means material containing uranium, thorium and/or plutonium isotopes which has been used to maintain a self-sustaining nuclear chain reaction.

Plutonium means the resultant mixture of isotopes of that material extracted from irradiated nuclear fuel from reprocessing.

High-level radioactive wastes mean liquid wastes resulting from the operation of the first stage extraction system or the concentrated wastes from subsequent extraction stages, in a facility for reprocessing irradiated nuclear fuel, or solids into which liquid wastes have been converted.

Sauna is a hot room with temperatures normally varying between (usually 80 to 120°C) where the heat is provided by a hot surface (e.g by electrically-heated oven). The hot room may also include the space where the oven is located and adjacent bathrooms.

1.3 SCOPE OF SURVEY

1.3.1 General regulations for the classification, survey of ships under construction and classification surveys, as well as the requirements for the documentation to be submitted to the Register for consideration are set out in General Regulations for the Classification and Other Activity and in Part I "Classification".

1.3.2 Subject to the Register survey during construction of a ship are: structural fire protection, materials used for the interior finishing of ship's spaces, as regards fire hazardous properties thereof, fire extinguishing, fire detection and alarm systems subject to the provisions of this Part of the Rules, except for fire fighting outfit which is only to be checked for complete availability in accordance with the rates specified in this part of the Rules and for correct location.

1.3.3 The following shall be submitted to the Register for approval of newly applied active fire fighting means and passive measures of structural fire protection:

.1 documents on fire tests run by competent bodies, confirming the efficiency of a fire extinguishing medium with the recommended standards on composition and application rates, as well as information on storage life and conditions;

.2 documents on the fire tests of "A" and "B" class fire-proof divisions and closures of openings in such divisions ("A" and "B" class doors included);

.3 drawings of fire-proof divisions together with the data which certify their compliance with "A" and "B" class divisions according to the requirements of this Part of the Rules;

.4 data on the combustibility of the materials with reference to the documents certifying the performance of appropriate tests of the materials concerned;

.5 drawings and calculations for individual standard assemblies (equipment) of the fire extinguishing, fire detection and alarm systems;

.6 drawings of standard components of the ventilation system of accommodation, service, cargo, machinery and working spaces, indispensable for ensuring fire safety of the ship.

1.4 FIRE PLANS

1.4.1 At the main fire control station, wheelhouse or in conspicuous positions in corridors and lobbies of any ship, there shall be exhibited general arrangement plans clearly showing the following for each deck:

.1 location of control stations;

.2 arrangement of fire-resisting and fire-retarding divisions;

.3 spaces protected by the fire detection and alarm system;

.4 spaces protected by fixed fire extinguishing systems with indication of the location of instruments and fittings for their control and also the disposition of fire hydrants;

.5 means of access to different compartments, decks, etc., with indication of escape routes, corridors and doors;

.6 ventilation system including the controls of fans and showing the disposition of dampers and the identification numbers of the fans;

.7 arrangement of fire fighting outfit;

.8 location of the documents referred to in 1.4.6;

.9 location of emergency escape breathing devices specified in 6.3 and 6.4.

1.4.2 In lieu of the plans, information specified in 1.4.1 may be set out in a booklet, a copy of which shall be supplied to each officer, and one copy at all times shall be available on board in an accessible position.

1.4.3 A duplicate set of the plans or the booklet protected against marine environment shall be permanently stowed outside the deckhouse in a weathertight enclosure painted red and marked as indicated in Fig. 1.4.3-1.

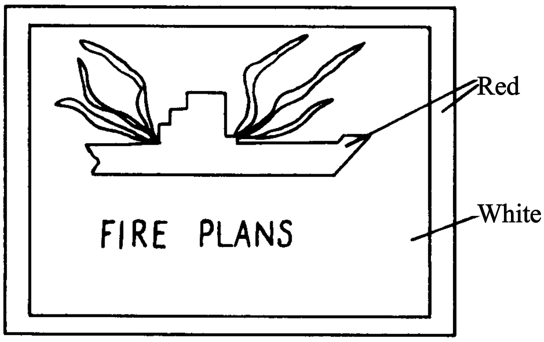


Fig. 1.4.3-1

The enclosure shall be capable of being easily opened, be readily available to the shoreside firefighting personnel, be located in a well-illuminated position, if possible including illumination from an emergency source.

In oil tankers, chemical tankers and gas carriers the enclosure of fire control plans shall not be located on exterior bulkheads of superstructures which face cargo area and the surfaces within 3 m from them along the side.

If the enclosure is not adjacent to the gangway, there shall be guide signs as indicated in Fig. 1.4.3-2 showing the way thereto. The dimensions of the signs are to be not less than 300 × 400 mm.

In cargo ships of less than 150 gross tonnage the duplicate set or the booklet may be omitted.

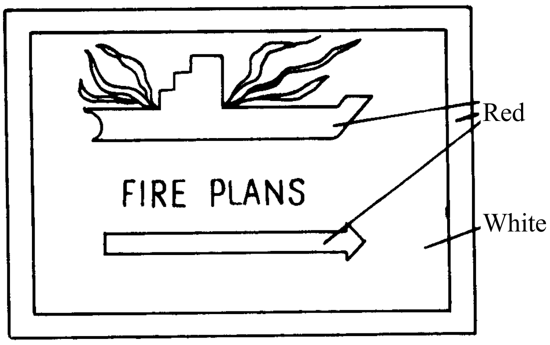


Fig. 1.4.3-2

1.4.4 Description in such plans and booklets shall be in the state language and in the English/French language. The symbols for items listed in 1.4.1 are to be in agreement with IMO Resolution A.654(16) "Graphical Symbols for Fire Control Plans".

For ships not engaged on international voyages, translation into English is not required.

The graphical symbols are to be coloured.

1.4.5 All alterations in the fire protection of a ship shall be entered in the ship's documents stated in 1.4.1 and 1.4.2.

1.4.6 To be kept in a separate file in an accessible position are technical instructions for maintenance and use of all ship's installations for extinguishing and containment of fire.

1.5 CATEGORIES OF SHIP'S SPACES

1.5.1 Control stations:

.1 spaces containing the navigational instruments and ship's control equipment, radio equipment, public address system stations, main fire control stations, fire extinction stations, spaces containing storage batteries and generators for radio stations;

main control station (see 1.2, Part VII "Machinery Installations") provided it is located beyond the machinery space;

fire and rescue operations control station;

.2 spaces containing emergency sources of power;

.3 spaces containing equipment for the control of submersion, emersion and heeling.

1.5.2 Accommodation spaces:

.1 crew's quarters, cabins for passengers and special personnel, including medical service rooms and offices;

.2 public spaces, such as lounges, messrooms, dining rooms, smoking rooms, cinema halls, libraries, reading rooms, gymnasiums, hairdresser's and barber's saloons, sheltered verandahs, nurseries, games and hobbies rooms, shops, information counters, offices, pantries containing no cooking appliances;

.3 sanitary spaces: toilets, lavatories, wash-rooms, shower-rooms, bathrooms, saunas (see 2.1.9.2.7), changing rooms, indoor swimming pools, operating rooms, etc.

1.5.3 Service spaces.

1.5.3.1 Domestic service spaces:

.1 galleys, water heater rooms, bakeries, confectioneries, etc., containing solid-fuel-fired, oil-fired or gas-fired equipment;

.2 same as under 1.5.3.1.1, but containing electrically heated equipment, as also ironing rooms, shoe-repair and tailor's shops, pantries, post offices;

.3 provision rooms, sculleries, food preparation shops.

1.5.3.2 Storerooms and garages:

.1 storerooms for explosives;

.2 storerooms for readily flammable materials and substances: paint lockers, spaces for flammable liquids, flammable liquefied and compressed gases, sheltered garages, fuel distribution systems;

.3 storerooms for combustible materials: boatswain's and carpenter's stores, ship's document files rooms, baggage rooms, rooms of articles for recreation, customs rooms, mail rooms, overall lockers, linen lockers, drying rooms, manufactured goods sale shops, bookstalls, laundries;

.4 storerooms for non-combustible materials: stores of spare parts, storerooms for mechanical and electrical shops other than those forming part of machinery spaces and similar spaces as well as trunks leading to such spaces.

1.5.3.3 Cargo control stations containing arrangements for control, monitoring and alarm of the cargo oil system (see 1.2, Part VII "Machinery Installations").

1.5.4 Cargo spaces:

.1 cargo tanks intended for the carriage of liquids in bulk, slop tanks included;

.2 spaces for dry cargoes other than ship stores: dry cargo and refrigerated cargo holds and 'tween-decks, including those intended also for carriage of containers and portable tanks, dangerous goods in packaged form or in bulk, motor vehicles without fuel in their tanks; storage spaces for ready produce, utilizable refuse, fishing equipment, packages, etc., as well as produce discharge trunks, cargo lifts and access trunks leading to such spaces;

.3 ro-ro cargo spaces not normally subdivided in any way and extending to either a substantial length or the entire length of the ship. Goods packaged or in bulk, on rail or road cars, vehicles (including road or rail tanks), trailers, containers, pallets, demountable tanks can be loaded and unloaded normally in a horizontal direction into the following spaces:

.3.1 closed ro-ro cargo spaces which are not spaces specified in 1.5.4.3.2 and 1.5.4.5;

.3.2 open ro-ro cargo spaces either open at both ends, or open at one and provided with adequate natural ventilation effective over their entire length through permanent openings in the side plating or deckhead or from above while the total square of openings shall be at least 10 per cent of the square of side plating of spaces;

.4 vehicle spaces intended for carriage of motor vehicles with fuel in their tanks for their own propulsion, which divide into:

.4.1 enclosed spaces for vehicles which are not open spaces for vehicles neither upper decks;

.4.2 open vehicle spaces (see 1.5.4.3.2);

.5 weather deck is a deck fully open for environmental exposure from above and at least from two sides.

1.5.5 Machinery spaces — see definition of 1.2, Part VII "Machinery Installations".

1.5.6 Oil fuel and lubricating oil tanks are main storage tanks, service tanks, drainage tanks, overflow tanks, settling and other tanks.

1.5.7 Pump rooms on tankers and combination carriers:

.1 cargo pump rooms where cargo pumps are located as well as exits and trunks leading to such spaces; pump rooms adjacent to cargo tanks and bilge tanks (see 2.4.7);

.2 pump rooms where pumps transporting water and liquid fuel are located.

1.5.8 Working spaces are shops and workshops (other than those forming part of machinery spaces), laboratories and other spaces where:

.1 oil fuel or flammable liquids are used or combustible materials are processed;

.2 neither flammable liquids are used, nor combustible materials are processed.

1.5.9 Special category space is that enclosed space in a passenger ship intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion, into and from which such vehicles can be driven and to which passengers have access.

1.5.10 Special electrical spaces — see 1.2, Part XI "Electrical Equipment".

1.6 SUBDIVISION OF MATERIALS ACCORDING TO FIRE TEST PROCEDURES CODE

1.6.1 Non-metal materials are tested for combustibility and subdivided into non-combustible and combustible what is determined in accordance with Fire Test Procedures Code.

Non-combustible material is a material which neither burns nor gives off flammable vapours in the amount sufficient for self-ignition when heated to 750°C approximately. Any other material is a combustible material.

1.6.2 Materials used as finish materials of bulkheads, ceilings and decks are tested for surface flammability and, if the test results are satisfactory, low surface flame spread characteristics are assigned thereto.

Low flame spread means that the surface thus described in accordance with Fire Test Procedures Code will adequately restrict the flame spread.

1.6.3 Primary deck coverings are subdivided into not readily ignitible and readily ignitible.

Not readily ignitable deck coverings are coverings, which in process of combustibility testing show low flame spread characteristics and form no burning drops.

Other deck coverings are deemed readily ignitable.

1.6.4 Textiles and films used for manufacture of curtains, blinds and other hanging articles are tested for the flame resistance. The materials which have passed the test are considered suitable for the above purposes.

1.6.5 Materials (material combinations) for furniture upholstery are tested for ignition resistance and flame spread.

Materials (material combinations) are considered to have passed the test if during an hour from the beginning of the test no flaming or progressive smouldering is observed.

1.6.6 The bedding components (blankets, bedspreads, pillows and mattresses including thin light mattresses placed above other mattresses) are tested for ignitability and assigned not readily ignitable characteristics if no flaming or progressive smouldering is observed.

1.6.7 Materials (material combinations) are to be tested in accordance with Fire Test Procedures Code where required by the Rules.

2 STRUCTURAL FIRE PROTECTION

2.1 GENERAL REQUIREMENTS

2.1.1 Requirements for materials.

2.1.1.1 Except in cargo spaces, mail and baggage compartments and refrigerated provision storerooms of service spaces, insulating materials shall be non-combustible.

Vapour barriers and adhesives used in conjunction with insulation, as well as the insulation of pipe fittings of the cooling systems, need not be of non-combustible materials, but they shall be kept to the minimum quantity practicable and their exposed surfaces shall have low flame spread characteristics.

In spaces where petroleum products are likely to be present, the surface of insulation shall be impervious for them and their vapours.

2.1.1.2 Casings and crowns of machinery spaces of category A shall be of steel. Openings in such crowns and casings shall be arranged and protected so that to prevent the spread of fire.

The floor plating of normal passageways in machinery spaces of category A shall be made of steel.

Spaces for oil fuel purifiers and similar spaces specified in 4.2.7, Part VII "Machinery Installations" shall be restricted by steel bulkheads extending from deck to deck.

2.1.1.3 Where superstructures and deckhouses, as well as ships under 300 gross tonnage are constructed of aluminium alloys, the following requirements shall be complied with:

.1 the metallic core of load-bearing "A" or "B" class divisions made of aluminium alloy is to be so covered with an insulating material of sufficient thickness that the temperature of the structural core of the specimen does not rise more than 200°C above the initial temperature at any time during the applicable fire exposure to the standard fire test.

For ships of less than 300 gross tonnage the period of fire test of "A" class divisions may be 30 min instead of 1 hour;

.2 adequate measures are to be taken to ensure that for aluminium alloy components of columns, stanchions and other structural members required to support lifeboat and liferaft stowage, launching and embarkation areas and "A" class divisions, the temperature rise limitation shall apply at the end of one hour and for such members required to support "B" class divisions, the temperature rise limitation shall apply at the end of half an hour;

.3 the use of combustible materials for the construction of structural details, grounds, supports, linings of bulkheads, furniture, etc. in superstructures and deckhouses constructed of aluminium alloy shall be limited.

Ceilings in corridors and spaces shall be constructed of non-combustible materials.

2.1.1.4 The mass of combustible materials used for the construction of partition bulkheads, grounds, supports, linings, finishes, furniture and other equipment of control stations, accommodation and domestic service spaces (other than saunas and refrigerated storerooms) where the use of such materials is not prohibited by this Part of the Rules, shall be not in excess of 45 kg per 1 m^2 of deck area in each space.

The Register may revise the standard indicated on the basis of the type and purpose of the ship.

2.1.1.5 The hull, superstructures, deckhouses, structural bulkheads and decks shall be constructed of steel or other equivalent material.

If aluminium alloys or glass-reinforced plastics are utilized, the requirements of 2.1.1.3 or 2.9 shall be met, respectively.

The Register may allow the use of other materials according to the purpose and the size of a ship.

2.1.1.6 Primary deck coverings, if applied within accommodation and service spaces and control stations, shall be of an approved material which will not readily ignite, or give rise to toxic or explosive hazards at elevated temperatures, this being determined in accordance with Fire Test Procedures Code.

2.1.1.7 Paints, varnishes and other finishes used on exposed interior surfaces shall not cause generation of excessive quantity of smoke and toxic vapours, this being determined in accordance with Fire Test Procedures Code.

In oil tankers and oil recovery vessels the use of aluminium paints in cargo oil tanks, cofferdams, pump rooms, in way of cargo tank decks and in other places where explosion-dangerous vapours can accumulate, is not permitted.

2.1.1.8 In accordance with Fire Test Procedures Code the following surface shall have low flame spread characteristics:

.1 on passenger ships:

.1.1 exposed surfaces in corridors and stairway enclosures and plating of bulkheads, ceiling linings in accommodation and service spaces (except saunas) and control stations;

.1.2 surfaces and grounds in concealed and inaccessible spaces in accommodation and service spaces and control stations;

.2 on cargo ships with gross tonnage more than 500:

.2.1 exposed surfaces in corridors and stairway enclosures and of ceilings in accommodation and service spaces (except saunas) and control stations;

.2.2 surfaces and grounds in concealed and inaccessible spaces in accommodation and service spaces and control stations.

2.1.1.9 Not readily ignitable bedding is recommended.

2.1.1.10 On passenger ships, A, B and C class divisions in accommodation and service spaces, which are faced with combustible materials, facings, mouldings, decorations and veneers shall comply with the requirements of the present paragraph and 2.1.1.6 to 2.1.1.8. Such materials may not be taken into calculation required by the paragraph.

On cargo ships, non-combustible bulkheads, ceilings and linings fitted in accommodation and service spaces may be faced with combustible materials, facings, mouldings, decorations and veneers provided such spaces are bounded by non-combustible bulkheads, ceilings and linings in accordance with the requirements of the present paragraph and 2.1.1.6 to 2.1.1.8.

Combustible materials used on the surfaces and linings shall have calorific value not exceeding 45 MJ/m^2 taking into consideration their thickness. Requirements of this article are not applicable to the surfaces of furniture fixed to linings or bulkheads.

Calorific value Q, in MJ/m^2, taking into consideration the thickness of covering material, is determined by the formula

$$Q = Q_g p s \qquad (2.1.1.10)$$

where Q_g = the maximum specific heat of combustion determined in accordance with ISO 1716 "Construction Materials. Determination of the Calorific Potential", in MJ/kg;
p = the density of material, in kg/m^3;
s = the thickness of material, in m.

Where combustible materials are used in accordance with the present paragraph, they shall comply with the following requirements:

.1 the total volume of combustible facings, mouldings, decorations and veneers in any accommodation or service spaces shall not exceed a volume equivalent to 2,5 mm veneer of the combined area of the walls and ceiling linings. The furniture fixed to linings, bulkheads or decks may be not included into the calculation of the total volume of combustible materials;

.2 in case of ships fitted with an automatic sprinkler system complying with the provisions of Fire Safety Systems Code, the above volume may include some combustible materials used for erection of C class divisions.

On cargo ships of 500 gross tonnage and more and on non-self-propelled ships without regard of their gross tonnage, it is permissible to fit non-combustible bulkheads, ceilings and linings with a combustible covering at most 2 mm thick instead of compliance with the above requirements, except corridors, stairway enclosures as well as control stations where thickness of combustible covering shall not exceed 1,5 mm.

2.1.1.11 All waste-paper receptacles shall be constructed of non-combustible materials with no openings in the sides and bottom.

2.1.2 Fire-resisting and fire-retarding divisions.

2.1.2.1 Fire-resisting or "A" class divisions are those divisions which are formed by bulkheads or decks complying with the following requirements:

.1 they shall be constructed of steel or other equivalent material;

.2 they shall be suitably stiffened;

.3 they shall be so constructed as to be capable of preventing the passage of smoke and flame up to the end of the 60-min standard fire test;

.4 they shall be so insulated with non-combustible material that the average temperature of the unexposed side will not rise more than 140°C above the original temperature, nor will the temperature, at any one point, including any joint, rise more than 180°C above the original temperature.

Depending on the time during which the above-indicated temperature rise is ensured in the course of the standard fire test, the following symbols are conferred to divisions: "A-60" — during 60 min.; "A-30" — during 30 min.; "A" — during 15 min.; "A-0" — during 0 min.

2.1.2.2 When approving the structural fire protection the danger of heat transfer through joints and ends of insulation shall be taken into account. Insulation of steel and aluminium decks and bulkheads shall extend for at least 450 mm beyond boundaries of structures forming the given space. If a space is divided by the "A" type deck or bulkhead with an insulation of different size, then an insulation of greater size shall extend over the deck and bulkhead for at least 450 mm from the less insulated structure.

2.1.2.3 "A" and "B" class bulkheads with an aluminum-alloy core shall have insulation on both sides of the core if they are load-bearing or if they separate adjacent spaces each containing combustible medium. Non-load-bearing bulkheads may not be provided with insulation on the core on the side of the space containing no combustible medium. "A" class decks having an aluminum-alloy core are to be insulated from below.

2.1.2.4 Where in ships of less than 500 gross tonnage an "A" class division separates two adjacent spaces, one of which does not contain any combustible medium or it is an outer surface of a superstructure or a deckhouse, except for those referred to in 2.4.3, such a division may be "A-0" class division, if it is made of steel.

2.1.2.5 Fire-retarding or "B" class divisions are those divisions which are formed by bulkheads, decks, ceilings or linings which comply with the following requirements:

.1 they are fully made of non-combustible materials. Use of combustible veneer is permitted (see 2.1.1.8 and 2.1.1.10 and for passenger ships, 2.2.2.8);

.2 divisions shall be so constructed as to remain capable of preventing the passage of flame up to the end of the 30-minute standard fire test;

.3 divisions shall have an insulation value such that the average temperature on the unexposed side during the fire test will not rise more than 140°C above the original temperature, nor will the temperature at any one point, including any joint, rise more than 225°C above the original temperature when either side is exposed to the fire test.

According to the time during which the above-mentioned temperature rise is ensured in the course of the standard fire test, the following symbols are conferred to divisions: "B-15" — during 15 min.; "B-0" — during 0 min.

2.1.2.6 Fire-resisting and fire-retarding divisions are tested according to the IMO Resolution A.517(13) "Recommendation for Fire Test Procedures for "A" and "B" Class Divisions".

2.1.2.7 Continuous "B" class ceilings and linings in association with the relevant decks or bulkheads, may be accepted as contributing wholly or in part, to the required insulation and integrity specified in the appropriate fire integrity tables.

2.1.2.8 All "B" class bulkheads shall extend from deck to deck and to the shell or other boundaries, unless continuous "B" class ceilings and/or linings are fitted on both sides of the bulkhead, in which case the bulkhead may terminate at the continuous ceiling or lining.

2.1.3 Closures of openings in fire-resisting and fire-retarding divisions.

2.1.3.1 Design of all doors and door frames in "A" class divisions with arrangements keeping them closed shall ensure the same fire resistance and proof from smoke and fire like the divisions where they are installed in accordance with Fire Test Procedures Code. Such doors and door frames shall be made of steel or other equivalent material. Doors and door frames in "B" class divisions and fixing arrangements shall ensure the same fire resistance like the divisions where they are installed in accordance with Fire Test Procedures Code. Doors shall be incombustible.

All windows and scuttles in bulkheads within accommodation and service spaces shall be fitted so as to ensure that fire resistance of the bulkhead is not impaired.

This requirement is not applied to glass partitions, window and side scuttles in the outer boundaries of the ship and to exterior doors in superstructures and deckhouses except for passenger ships (see 2.2.4.4 and 2.2.4.5).

All windows and side scuttles in the outer bulkheads of accommodation spaces, service spaces and control stations shall meet the requirements of 7.2.2.4, Part III "Equipment, Arrangements and Outfit".

2.1.3.2 The doors designed in compliance with the requirements of 7.5.2 and 7.12, Part III "Equipment, Arrangements and Outfit"and fitted according to 7.12 of the above mentioned Part, and, in certain cases (e.g., for providing gastightness), if specially agreed with the Register, may be fitted in "A" class bulkheads. Watertight doors may be not insulated and they do not require fire tests if fitted below the bulkhead deck.

2.1.3.3 Doors in all fire-resisting bulkheads (self-closing and automatically closing doors included) shall be so arranged as to be capable of being opened manually from either side of the bulkhead by one person only (see also 4.1.8).

2.1.3.4 Doors to machinery spaces of category A and stairway enclosures, other than power-operated watertight doors and those which are normally locked, shall be of the self-closing type and should have no hold-back hooks. However, fail-safe hook-back facilities are permitted which are provided with a remotely operated release device.

2.1.3.5 Ventilation openings and louvers in "A" class doors shall not be permitted.

2.1.3.6 Ventilation openings may be permitted in the lower portion or under "B" class doors, except for the doors in stairway enclosures.

The total next area of any such opening or openings shall not exceed 0,05 m^2. Alternatively, pressure equalizing duct is allowed. When such openings is cut in a door, it shall be fitted with a grill made of non-combustible material.

2.1.3.7 The upper portion of "B" class doors may be glazed for which purpose either specially manufactured fire-resistant or wire-reinforced glass shall be used. The glass panels shall be mounted in frames of steel or other non-combustible material. At all times only those glazed doors of "B" class shall be permitted the specimens of which comply with the requirements for "B" class divisions when exposed to the standard fire test.

Where doors fitted in large public spaces fail to comply with the requirements for "B" class divisions, owing to the excessively large area glazed, such doors may be permitted on agreement with the Register, on condition that water screens meeting the applicable requirements of 3.5 are provided.

2.1.3.8 The hinges of "A" and "B" class doors and parts of dogs and locks of "A" class doors are to be manufactured of materials with a melting point not below 950°C, and parts of dogs and locks of "B" class doors are to be made of materials having a melting point not below 845°C except where it has been proved by the tests that materials with a melting point below 845°C do not impair fire integrity of the doors.

2.1.3.9 Where "A" or "B" class divisions are penetrated by framing members, electric cables, pipes, trunks, ducts, etc. or are pierced for fitting of ventilation terminals, lighting fixtures and similar devices, arrangements shall be made to ensure that the fire resistance is not impaired.

2.1.3.10 Hatches shall be provided by the construction of the ceilings and bulkheads (in order to detect any smoke originated in concealed and inaccessible places) except for the places where there is no risk of fire originating.

2.1.4 Closure of doorways, access trunks and other openings.

2.1.4.1 Provision shall be made to control the opening and closing of skilights, closing of exhaust ventilation openings in funnels, closing of ventilation flaps smoke release, closing of power-operated doors or actuating the release mechanism of doors that are not watertight and are power-operated, closing of other openings in spaces protected by fire smothering systems. The controls are to be located outside the spaces in question or where they would not be isolated in case of fire.

On passenger ships, such controls are to be located in one place or in as few places as possible to which safe access from the weather deck is ensured.

2.1.4.2 Skylights in machinery and pump rooms (see 1.5.7.1) shall be made of steel, they shall have no glass panels and the means of control, specified in 2.1.4.1, shall be provided.

Windows are not to be fitted in machinery room boundaries. This does not preclude the use of glass in control stations within the machinery rooms.

2.1.4.3 In accommodation and service spaces, as well as in control stations stairways and lift trunks shall be protected in the following way:

.1 stairways which penetrate only a single deck shall be protected at least at one level by at least "B-0" class divisions and self-closing doors. Lifts which penetrate only a single deck shall be surrounded by "A-0" class divisions with steel doors at both levels. Stairways and lift trunks which penetrate more than a single deck shall be surrounded by at least "A-0" class divisions and protected by self-closing doors at all levels. Stairway enclosures may be arranged so as to allow to go from one stair to a superimposed stair within such enclosure (Fig. 2.1.4.3.1-1), or to enclose the stairs only with doors at each end of the stair (Fig. 2.1.4.3.1-3), or to enclose the stairs only in combination with fully closed steel stairs and doors fitted at the end of each stair (Fig. 2.1.4.3.1-2);

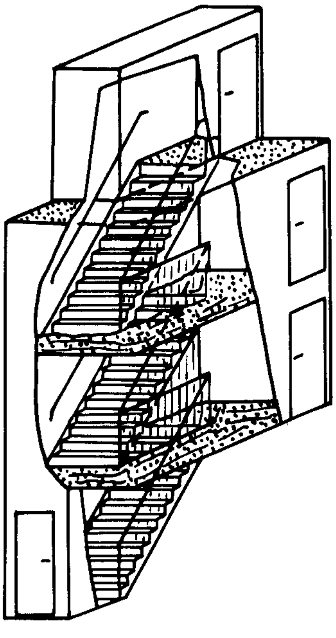


Fig. 2.1.4.3.1-1

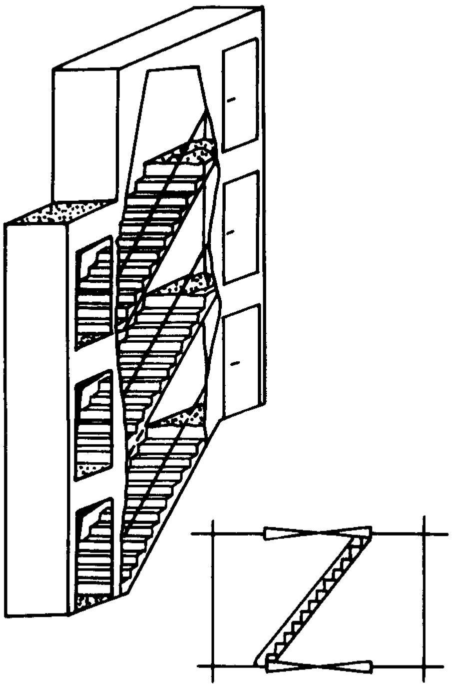


Fig. 2.1.4.3.1-2

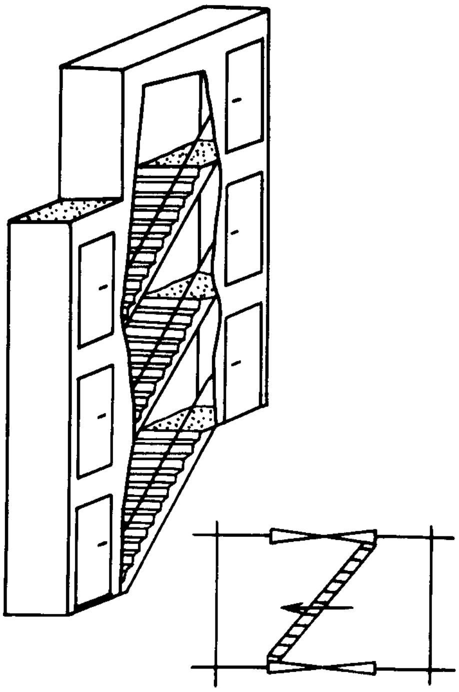


Fig. 2.1.4.3.1-3

.2 on ships having accommodation for 12 persons or less, where stairways penetrate more than a single deck and where there are at least two escapes direct to the open deck at every accommodation level, stairways and lift trunks may be protected by "B-0" class divisions;

.3 lift trunks shall be so fitted as to prevent the passage of smoke and flame from one tween-deck to another and they shall be provided with means of closing so as to permit control of draught and smoke. Machinery for lifts located within stairway enclosures shall be arranged in a separate room, surrounded by steel boundaries, except that small passages for ropes and lift cables are permitted. Lifts which open into spaces other than corridors, public spaces, special category spaces, stairways and external areas shall not open into stairways included in the means of escape;

.4 insulation of passenger lift trunks within stairway enclosures is not compulsory. In this case, the doors in lift trunks need not be of fire-resisting type;

.5 where a hold-back hook is fitted it is to comply with 2.1.3.4;

.6 the construction of stairways shall comply with the requirements of 8.5.4, Part III "Equipment, Arrangements and Outfit";

.7 on passenger ships stairways and lift trunks are to be protected as under 2.1.4.3.3 to 2.1.4.3.6 and 2.2.2.4.

2.1.4.4 Air spaces enclosed behind ceilings, panellings, or linings shall be divided by close-fitting draught stops spaced not more than 14 m apart.

In the vertical direction, such air spaces, including those behind linings or stairways, trunks, etc. are to be closed at each deck.

2.1.4.5 In machinery spaces from which two stairways are provided in accordance with 4.5, Part VII "Machinery Installations" one of them shall be protected by enclosure along its whole length meeting requirement 2.2.1.3 category (*2*) or requirements 2.2.1.5, 2.3.3 or 2.4.2 category (*4*) as appropriate. Self-closing fire doors of the same type of fire protection shall be fitted in the enclosure.

2.1.4.6 In addition to watertight door separating the machinery space of category A from the shaft tunnel, from the side of the latter a light steel fire-screen door shall be fitted to be operated from each side.

2.1.4.7 Permanent openings in the side plating, the ends or deckhead of open and closed cargo spaces of ro-ro ships, as well as special category spaces shall be so situated that a fire in these spaces does not endanger stowage areas and embarkation stations for lifeboats and liferafts, accommodation spaces, service spaces and control stations in superstructures and deckhouses above the mentioned spaces.

2.1.5 Storerooms for readily flammable materials and substances, except hangars and garages.

2.1.5.1 Storerooms for readily flammable materials shall not be generally situated in common with accommodation spaces in superstructure or deckhouse. Access to the storerooms is to be provided from the open deck directly or through a corridor and/or a stairway leading only to these storerooms.

In ships of less than 300 gross tonnage storerooms may be arranged in way of the accommodation spaces, but not adjacent thereto.

2.1.5.2 Flammable liquids with a flash point below 43°C shall be kept in ventilated storerooms in metal tanks, each of which is to be provided with:

fittings for sampling with self-closing valve;

a measuring device of a closed type;

a device for filling the tank from outside the storeroom;

an air pipe led beyond the storeroom and complying with the requirements of 10.1.4, 10.1.6, 10.1.8, 10.1.9 and 10.1.11, Part VIII "Systems and Piping";

a tray.

Where the amount of some flammable liquid does not exceed 35 *l*, it is permitted to store it in metal cans with tight-closing lids.

Where the total capacity of the tanks exceeds 250 *l* (but is not more than 2500 *l*), the storeroom shall be equipped with independent power exhaust ventilation to remove the air from the lower part of the space ensuring at least 20 air changes per hour. The supply ventilation may be natural. The operation of fans may be interlocked with opening of doors to the storeroom. Electrical equipment in the storeroom shall be flameproof as required in 2.9, Part XI "Electrical Equipment".

Where the quantity of flammable liquids exceeds 2500 *l* the tanks for their storage shall be arranged in compliance with 2.1.11.

2.1.5.3 In ships of less than 300 gross tonnage where provision of a separate storeroom for flammable liquids specified in 2.1.5.2 is impeded, it is permissible to keep such liquids in steel ventilated lockers or cases. The lockers or cases shall not be continuous to accommodation spaces. The doors of such lockers or cases shall open outside. The liquids shall be kept in metal cans with tight-closing lids of total capacity not more than 50 *l*.

2.1.6 Other storerooms.

2.1.6.1 It is recommended that means of escape from storerooms for combustible materials lead to the open deck or a corridor directly communicating with the open deck.

2.1.6.2 Spaces for storing cylinders referred to in 6.4.5.4, Part X "Boilers, Heat Exchangers and Pressure Vessels"are to have entrance from the open deck and are to be separated from adjacent spaces by "A-60" class divisions.

2.1.7 Storerooms for explosives (magazines).

2.1.7.1 In special purpose ships the arrangement of storerooms for explosives (magazines) may be permitted on condition that the requirements set forth in 2.1.7.2 to 2.1.7.22 are fulfilled. The magazines may be of the following categories:

.1 integral magazines forming an integral part of the ship;

.2 independent magazines that are non-integral, portable magazines with a capacity of 3 m^3 or greater;

.3 magazine boxes that are non-integral, portable magazines with a capacity of less than 3 m^3.

2.1.7.2 Integral magazines are to be located in the forward or after portion of the ship and be well removed from the propeller shaft, propeller and rudder (in any case as far off as one watertight space). They are not to be located below accommodation spaces, control stations, fuel tanks and be adjacent to them.

2.1.7.3 Integral magazines are not to be located adjacent to machinery spaces of category A, galleys or other spaces presenting a fire hazard. If it is necessary to construct the magazines in proximity to these areas, a cofferdam of at least 0,6 m is to be provided separating the two spaces. Such a cofferdam is not to be used for stowage and is to be provided with ventilation. One of the bulkheads forming the cofferdam is to be of "A-15" class unless there is adjacent machinery space of category A in which case "A-30" is appropriate.

2.1.7.4 Access to integral magazines is preferably to be from the open deck through a water-or gastight door, but in no case through spaces mentioned in 2.1.7.2 and 2.1.7.3.

2.1.7.5 Independent magazines and magazine boxes are to be located on an open deck in a location protected from direct impact of the sea. The location is to provide sufficient protection against warm air hazardous vapours being emitted from galleys, pump rooms, etc. Due regard is to be paid to the possible risk of subjecting certain explosives to radio emissions.

2.1.7.6 Magazine boxes are to be located on a weather deck at least 0,1 m from the deck and any deckhouse and in a position suitable for jettisoning the contents.

2.1.7.7 Bulkheads and decks bounding integral magazines are to be of steel watertight construction and of "A-15" class (see 2.1.2.4). Insulation is to be provided to prevent the condensation of moisture.

2.1.7.8 Piping of fresh or salt water and drainage systems and piping of systems installed in the magazines themselves may be routed through magazines. Piping of other systems are to be permitted only if they are enclosed in a watertight trunk.

2.1.7.9 Doors and lids of magazines are to be provided with locks.

2.1.7.10 Racks are to be installed, the construction and capacity of which are to provide safe stowage of explosives in their approved shipping containers and to prevent them from shifting and falling when the ship is rolling.

The upper rack is not to be located higher than 1,8 m above the deck. The racks are to have holes for water flowing from the upper to the lower racks during operation of the drenching system.

2.1.7.11 Decks of magazines are to be covered with a permanent nonslip, nonspark covering (for example, with mats or two layers of linoleum).

2.1.7.12 A free volume of the magazine, when loaded, is to be at least 70 per cent of the entire magazine volume. The volume of the space is to be not less than 1 m^3 for each 100 kg of explosives or 1000 detonators.

2.1.7.13 Integral magazines are to be provided with natural or mechanical ventilation fitted with flame screen sufficient to maintain the magazine temperature not higher than 38°C.

2.1.7.14 Independent magazines are to be provided with efficient natural ventilation fitted with flame screen.

2.1.7.15 Magazines are to be fitted with automatic heat detectors operating at temperatures rising above 40°C. An appropriate indicating unit is to be provided in the wheelhouse and in the chief mate's cabin.

2.1.7.16 Integral and portable magazines are to be fitted with drenching systems for racks in compliance with 3.6. The controls are to be clearly marked as to their function.

2.1.7.17 Scuppers are to be fitted in the magazine deck. The scupper pipes are to be provided with valves which are to be kept permanently closed under normal service conditions. The valves are to be controlled from outside the magazines.

2.1.7.18 A portable magazine is to bear a label indicating mass in light condition and maximum permissible mass of explosives.

2.1.7.19 Magazine boxes are to be of watertight metal construction having a body and lid thickness of not less than 3 mm. Where the box may be exposed to direct sun, sun shields are to be provided.

2.1.7.20 Integral and independent magazines are to be clearly labelled:

.1 "The space is a magazine";

.2 "Open lights and flame are to be kept away";

.3 "The magazine door is to be locked";

.4 "Matches and lighters are to be removed prior to entering";

.5 "Not to lift with contents" (in the case of independent magazines).

2.1.7.21 Magazine boxes are to be clearly labelled:

.1 "The container is a magazine box";

.2 "Open lights and flame are to be kept away";

.3 "The box is to be locked".

2.1.7.22 Electrical equipment in magazines is to comply with the provisions of 19.4.3 and other requirements of Part XI "Electrical Equipment" as appropriate.

2.1.7.23 Detonators are to be stowed separately from other explosives.

2.1.7.24 Charging of cartridges and other preparatory operations for using explosives are to be made in charging rooms which are to be specially provided for that purpose. Charging rooms are to be arranged in steel enclosures and located on the weather deck, well removed from control stations, accommodation and service spaces. Bulkheads, decks and equipment of the charging rooms are to be faced with nonspark materials.

2.1.8 Spaces for electric and gas welding operations and for storage of cylinders.

2.1.8.1 Spaces for the storage of oxygen and acetylene cylinders shall be arranged, having regard to the following:

.1 oxygen and acetylene cylinders shall be stored in vertical position in special naturally ventilated closed spaces on the open deck;

.2 locations where cylinders are stored shall be fitted with stands having sockets, straps or other arrangements to ensure efficient securing and quick releasing of the cylinders. Fastening of cylinders to bulkheads of accommodation spaces is not permitted;

.3 locations of the storage of cylinders shall be chosen so as to preclude mechanical damage to the cylinders. The cylinders shall be properly protected from the access of the unauthorized persons thereto. Sun shades painted in white shall be fitted in order to protect the cylinders from direct sunbeams. On the barrier around the cylinder storage there shall be provided warning plates: "Danger of explosion!" and "No smoking!";

.4 locations for the storage of cylinders shall be located at a distance not less than 2 m from the accommodation spaces and control stations and not less than 4 m from the spaces where readily flammable substances or fuel oil are stored or where essential ship equipment is installed.

The storage space for acetylene cylinders shall be independent of the oxygen cylinder storage space. Such spaces shall have direct entrances from the open deck. The doors opening outside shall be fitted with locks. Danger warning inscriptions shall be provided on the doors of the spaces. These spaces shall be separated from adjacent spaces by "A-60" class divisions (see 2.1.2.4).

2.1.8.2 Spaces for electric and gas welding operations in ships shall be arranged, having regard to the following:

.1 the space shall have an exit to the open deck and be separated from adjacent spaces by "A-60" class divisions (2.1.2.4);

.2 the door shall be fitted with a lock.

2.1.8.3 In addition to fulfilment of the requirements of 2.1.8.2 the space for electric and gas welding operations in oil tankers shall meet the below-listed requirements:

.1 the space shall be located aft of cargo oil tanks, slop tanks and their cofferdams;

.2 the space shall not be located in machinery spaces of category A or less than 5 m to the spaces intended for storage and carriage of explosion- and fire-hazardous substances;

.3 the distance from the space to vents of cargo oil tanks and slop tanks shall be not less than 9 m;

.4 the space shall be provided with power ventilation ensuring not less than 20 air changes per hour;

.5 power source for welding operations shall be interlocked to prevent the possibility of its switching on with the entrance door open and the artificial ventilation disconnected;

.6 an illuminated board with inscription "Do not enter! Welding!" shall be provided near the entrance door.

2.1.9 Galleys. Saunas.

2.1.9.1 Galleys shall comply with the following requirements:

.1 bulkheads and decks of galleys are to be made of steel;

.2 galleys using sources of energy, other than electricity shall not be adjacent to storerooms for readily flammable and combustible materials or to fuel oil and lubricating oil storage spaces;

.3 decks of galleys shall be covered with ceramic tiles or other equivalent covering of non-combustible material;

.4 any galley serving 50 persons and more shall have at least two means of escape, except for electric galleys which may have only one;

.5 the equipment of oil- and gas fired galleys shall be constructed of non-combustible materials. If necessary, wood (preferably hardwood) may be permitted for the equipment of galleys;

.6 the smoke stacks of galleys within the ship spaces shall be insulated with non-combustible materials;

.7 if exhaust ventilation ducts from galley ranges pass through accommodation spaces or spaces containing combustible materials, such ducts shall be made of "A-0" class divisions (see also 12.2.4 and 12.2.7, Part VIII "Systems and Piping");

.8 in the case of oil-fired equipment it is permitted to use oil fuel with a flash point not less than 60°C.

The capacity of fuel oil service tanks located in galleys shall not exceed the daily consumption requirement.

A shut-off valve on the supply pipe shall be remotely controlled from readily accessible place outside the galley.

It is recommended to use quick-closing type valves.

Tanks, fuel oil pumps and heaters shall be placed at least 2 m from the nearest point on the heating equipment, and at a 0,5 m distance from the same in the plan view of the place.

If the galley space is sufficiently large, it is recommended to place fuel oil tanks, pumps and other appliances of the fuel oil system in special enclosures.

All oil-fired equipment, burners included, shall be fitted with trays underneath (or an equivalent protection provided directly on the steel deck), with beads not less than 75 mm in height, extending not less than 100 mm outside the equipment perimeter;

.9 if a deep fat cooking equipment is used in galleys, places of their location shall be fitted with the local fire extinguishing systems. Such systems may have automatic or manual start-up, clearly identified and accessible for the crew. Galley room shall be fitted with an audible fire extinguishing alarm. Galley deep fat cooking equipment shall be fitted with:

main and back-up thermostat with an audible alarm warning about its breakdown;

automatic de-energizing device when the fire extinguishing system is starting.

2.1.9.2 Saunas shall comply with the following requirements:

.1 the perimeter of the sauna shall be of "A" class boundaries and may include changing rooms, showers and toilets. The sauna shall be insulated to "A-60" standard against other spaces except those inside of the perimeter and spaces of categories (*5*), (*9*) and (*10*) as specified in 2.2.1.3;

.2 bathrooms with direct access to saunas may be considered as part of them. In such cases, the doors between sauna and the bathroom may not comply with fire safety requirements;

.3 the traditional wooden lining on the bulkheads and ceiling is permitted in the sauna. The ceiling above the oven shall be lined with a non-combustible plate with an air gap of at least 30 mm. The distance from the hot surfaces to combustible materials shall be at least 500 mm or the combustible materials shall be protected (e.g. by a non-combustible plate with an air gap of at least 30 mm);

.4 the traditional wooden benches are permitted in saunas;

.5 the sauna door shall have no locks and open outwards by pushing;

.6 electrically heated ovens shall be provided with a timer and shall comply with the requirements of Section 15, Part XI "Electrical equipment", cables and wires shall comply with the requirements of 16.8 of the same Part of the Rules;

.7 on ships carrying more than 36 passengers saunas are referred to as accommodation spaces of greater fire risk, on other types of ships saunas are referred to services spaces of high fire risk.

2.1.10 Helicopter facility onboard.

2.1.10.1 Helidecks are to be of steel or other equivalent material. If the helideck forms the deckhead of a deckhouse or superstructure it is to be insulated to "A-60" class standard.

The Register may permit aluminium or other low-melting metal construction that may be considered equivalent to steel, provided the following provisions are satisfied:

.1 if the platform is cantilevered over the side of the ship, after each fire on the ship or on the platform, the platform is to undergo a structural analysis to determine its suitability for further use;

.2 if the platform is located above the ship deckhouse or similar structure, the following conditions are to be satisfied:

the deckhouse top and bulkheads under the platform are to have no openings;

all windows under the platform are to be provided with steel shutters;

after each fire on the platform or in close proximity, the platform is to undergo a structural analysis to determine its suitability for further use.

2.1.10.2 A helideck is to be provided with both a main and emergency means of escape. They are to be located as far apart from each other as practicable and preferably on opposite sides of the helideck.

2.1.10.3 Helidecks and areas for helicopter refuelling are to be clearly marked and provided with coamings to prevent oil fuel spillage from spreading beyond the areas. The drainage system of the helideck is to comply with the requirements of 7.14, Part VIII "Systems and Piping".

2.1.10.4 As regards structural fire protection, fixed fire fighting systems and fire alarm systems for hangers and spaces where refuelling and hanger facilities are located, the requirements relating to category "A" machinery spaces are to be met.

2.1.10.5 The bulkheads and decks that enclose the helicopter hangar are to be constructed of steel.

2.1.10.6 The ventilation system of hangers and spaces where refuelling facilities are located is to meet the requirements of 12.11, Part VIII " Systems and Piping". Electrical equipment and electric wiring of hangers and spaces where refuelling facilities are located shall comply with the requirements of 2.9, Part XI "Electrical Equipment".

2.1.10.7 All the equipment used in refuelling operations is to be electrically bonded. All the equipment, arrangements, machinery and deck coatings are be made and installed so as to prevent spark formation.

2.1.10.8 A designated area is to be provided for storage of oil fuel tanks which is to be:

.1 as remote as is practicable from accommodation spaces, escape routes and embarkation stations;

.2 isolated from areas containing sources of vapour ignition.

2.1.10.9 Fuelling systems for helicopters are to meet the requirements of 13.13, Part VIII "Systems and Piping".

2.1.10.10 "NO SMOKING" signs are to be in hangers and spaces where refuelling facilities are located.

2.1.10.11 In close proximity to the helideck the following fire fighting appliances are to be provided:

.1 at least two dry powder extinguishers having a total capacity of not less than 45 kg;

.2 carbon dioxide extinguishers of a total capacity of not less than 18 kg or equivalent fire extinguishers containing an approved gaseous fire extinguishing compound;

.3 at least two nozzles of an approved dual-purpose type and hose sufficient to reach any part of the helideck;

.4 two sets of fireman's outfits in addition to those required by item 10 of Table 5.1.2;

.5 emergency equipment, stored so as to provide for immediate use and protection including the following elements: adjustable wrench, fire blanket, cutters, hook, hacksaw, complete with 6 spare blades, ladder, lifeline of 5 mm diameter x 15 m in length, side-cutting pliers, set of assorted screwdrivers, knife with sheath.

2.1.10.12 The requirements of items 10 and 20 of Tables 3.1.2.1 and 3.7.2.12 of this Part of the Rules as well as general aviation requirements for helicopter facilities on board are to be taken into account.

2.1.11 Storage of fuel with a flash point below 43°C. Fuel distribution stations.[1]

2.1.11.1 Storage tanks for the fuel with a flash point below 43°C shall comply with the following requirements:

.1 the tanks shall be placed within the hull as close as possible to the ship's ends;

.2 on all sides and corners, except for the ship side, below the light-ship waterline the tanks shall be surrounded by cofferdams meeting the requirements of 2.7.5.2, Part II "Hull" filled up with inert gas (see 3.9.11) under service conditions. The cross-section area of the air (ventilation) pipes shall comply with the requirements of 10.1.10 and 10.1.11, Part VIII "Systems and Piping". The cofferdams shall be fitted with a sounding pipe led to the upper open deck;

.3 each fuel tank shall be provided with a filling, service, sounding and air pipe. The open end of the filling pipe shall not be placed higher than 300 mm above the tank bottom. The sounding pipe shall terminate at a distance of 30 to 50 mm from the tank bottom and shall be led out to the upper open deck.

It is recommended that a closed-type level indicators should be fitted instead of sounding pipes;

.4 fuel tank air pipes shall terminate not less than 2,4 m above the open deck. The open ends of the pipes shall be located at a distance of at least 9 m from openings in deckhouses and superstructures and shall be fitted with flame-arresting wire gauzes or some other equivalent devices approved by the Register;

.5 fuel, air and sounding pipes leading from fuel tanks to a distribution station shall be laid in a separate gastight steel trunk, sufficiently large to provide access

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[1] The present requirements cover the storage facilities for fuel not intended for the onboard machinery of ships other than oil tankers.

for a man throughout the length of the trunk. The trunk walls shall be of "A-60" class divisions. Where provision is made for filling the trunk with water or inert gas, the trunk may be made of "A-0" class divisions. In any case, the trunk shall be provided with supply and exhaust ventilation. The open ends of the ventilation pipes shall be fitted with flame-restricting gauzes or other flame-restricting devices.

No other pipes or electric cables shall be laid through the trunks.

2.1.11.2 Distribution stations of fuel with a flash point below 43°C to ships and helicopters shall comply with the following requirements:

.1 the stations shall be situated on the open decks and shall be as remote as practicable from accommodation spaces and areas containing a source of vapour ignition;

.2 the spaces of the stations shall be enclosed by "A-60" class bulkheads and decks (see 2.1.2.4), the doors may be of steel and have no insulation. All the boundary surfaces of such spaces shall be gastight;

.3 deck coverings shall preclude spark formation;

.4 the means of closing the doors leading into the station shall exclude the possibility of spark formation;

.5 a fuel distribution arrangement shall consist of a metering device to record the quantity of supplied fuel, a flexible hose with a nozzle provided with a self-closing valve;

.6 tanks for the fuel shall be made of a material excluding the possibility of spark formation;

.7 all outgoint pipes shall be so fitted as to secure the gastightness of the bulkheads;

.8 provision shall be made for the arrangement whereby a fuel spillage may be collected and drained to a slop tank;

.9 warning notices forbidding smoking and use of a naked light shall be made on the door of the station.

2.1.11.3 Storage tanks for helicopter fuel (see also 2.1.10.8 and 2.1.11.1) are to comply with the following requirements:

.1 fixed tanks may be installed on weather decks. In so doing, the tanks shall be protected against physical damage and from direct influence of the sunbeams. The tanks shall be installed in compliance with the requirements of 2.1.11.2.1.

Where such tanks are equipped with arrangements for their emergency jettisoning, measures shall be taken to prevent a jettisoned tank from striking the ship structures;

.2 storage tanks shall be provided with remotely controlled fuel shut-off devices;

.3 fuel storage in transported tanks is permitted at specially provided locations. Such tanks shall be efficiently secured, closed and bonded. The tanks shall be readily accessible for inspection;

.4 the tanks mentioned above shall be fitted up with devices for collecting of spillage and its discharge into the off-grade fuel tank;

.5 the fuel pump shall be connected to one tank at a time only. An oil fuel pumping unit is to incorporate a device that will prevent over-pressurization of the filling hose. The pipe connecting the tank to the pump is to be made of steel or equivalent material and shall, as far as practicable, be short and protected from damage;

.6 warning notices forbidding smoking and use of a naked light shall be provided in places where the tanks are located.

2.1.11.4 Storage of fuel and distribution stations of fuel including tanks, fuel pipes and other devices intended for storage and transportation of fuel shall comply with the requirements on electrostatic and galvanic spark safety.

2.1.12 Arrangement of fuel oil and lubricating oil tanks.

Arrangement of fuel oil and lubricating oil tanks is permitted in way of accommodation, service and refrigerated spaces provided they are isolated from those spaces with cofferdams. For cofferdam scantlings and design, see 2.7.5.2, Part II "Hull".

On arrangement with the Register and on condition special measures are taken, the above compartments and spaces may be isolated from the tanks without the use of cofferdams.

Cofferdam scuttles are not permitted in way of accommodation and service spaces.

2.1.13 Heating.

2.1.13.1 Electric heating shall be in compliance with the requirements of Section 15, Part XI "Electrical Equipment".

2.1.13.2 All radiators shall be so constructed and located as to preclude the danger of setting fire to the equipment and also to the clothes and baggage of the persons accommodated in the space concerned.

2.1.13.3 Steam and electric radiators shall be located at a distance of at least 50 mm from the ship's sides or bulkheads. If the ship's sides or bulkheads are lined with a combustible material, the portions located against the heating elements shall be protected with heat insulation of non-combustible material. In the absence of such heat insulation the heating elements shall be located at a distance of not less than 150 mm from the combustible lining.

2.1.14 Liquefied gas system for domestic needs.

2.1.14.1 The use of gas meeting the requirements of current national standards is permitted.

2.1.14.2 Liquefied gas may be used for galley ranges, as also for straight-through liquid heaters (including provision refrigerators) consuming not more than 1 kg of liquefied gas per hour.

The use of liquefied gas system in passenger ships and oil tankers is subject to special consideration by the Register in each case.

2.1.14.3 Only standard gas containers and gas-consuming appliances of type approved by competent technical supervision bodies may be installed on board the ship.

2.1.14.4 An automatic safety gas cut-off device shall be fitted on gas-consuming appliances, which operates in the event of flame failure.

For straight-through heaters this device shall have check flame.

2.1.14.5 Gas containers shall be stowed in a special compartment on the open deck, complying with the requirements of 2.1.5.1 with direct access to the open deck.

Where provision is made for stowage of not more than two gas containers, they may be arranged in an enclosed recess in the superstructure or deckhouse, or in a steel locker.

Furthermore, the stowage compartment for gas containers shall meet the following requirements:

.1 efficient natural ventilation shall be provided, account being taken of the provisions of 12.1.4 and 12.4.6, Part VIII "Systems and Piping".

In addition to natural ventilation, mechanical ventilation may be used, the requirements of 12.1.4, Part VIII "Systems and Piping" being taken into consideration;

.2 where necessary, structural arrangements shall be made to prevent the temperature in the compartment from exceeding +50°C;

.3 electric illumination and electrical equipment at a distance of 2 m from openings to the compartment shall comply with the requirements of 2.9, Part XI "Electrical Equipment";

.4 a warning notice recalling of the risk of explosion and prohibiting the use of naked flame and smoking shall be displayed on the door.

2.1.14.6 The installation of gas containers in the compartment shall comply with the following requirements:

.1 cylinders shall be installed with stop valves upwards and be secured with quick-detachable arrangements.

Other measures shall be taken to quickly release containers;

.2 a reducing valve shall generally be fitted on the container head; in this case, flexible hose of approved type may be used for connection of the reducing valve to the liquefied gas pipeline;

.3 if a group of containers is connected to the manifold, only one reducing valve shall be fitted between each container and the manifold; in this case, containers shall be connected to manifold by copper pipes;

.4 where more than one container is connected to the manifold, shut-off valve or cock shall be fitted between each container and the manifold. A notice prohibiting the simultaneous use of more than one container shall be displayed in the compartment.

2.1.14.7 Compartments containing gas-consuming appliances shall be equipped in compliance with 2.1.9 and meet the following requirements:

.1 they shall not be arranged below the upper deck and be provided with efficient natural ventilation for extraction of combustion products and air taking from the lower part of the compartment;

.2 where the compartment is partially below the open deck, it shall be provided with mechanical ventilation;

.3 straight-through gas-consuming appliances shall be provided with separate lines for removal of combustion products.

2.1.14.8 Pipes shall be of seamless steel or copper. Steel pipes shall be protected against corrosion.

2.1.14.9 The thickness of pipe walls shall meet the requirements of column 2 or 8, Table 2.3.8, Part VIII "Systems and Piping".

2.1.14.10 Pipes from gas containers to gas-consuming appliances shall be laid over the open deck and be protected against mechanical damages.

2.1.14.11 Pipe joints shall be welded. Threaded or flange joints are permitted only in places of connection of instrumentation lines, gas-consuming appliances and fittings.

2.1.14.12 A shut-off valve or cock shall be fitted on the pipe where it pierces the bulkhead of the container compartment, this valve or cock being operated from outside the compartment. The valve or cock shall be provided with a turning limiter and a plug position indicator.

2.1.14.13 Where more than one gas-consuming appliance is installed, a shut-off valve or cock provided with a turning limiter and a plug position indicator shall be fitted on branches from a common pipe line to each gas-consuming appliance.

Where these valves or cocks are fitted in the container compartment, provision shall be made for their operation from outside the compartment; in this case, the installation of a cock or valve on the common pipe line may be omitted (see 2.1.14.12).

2.1.14.14 The reducing valve shall provide the pressure of not more than 5 kPa in the system.

2.1.14.15 The reducing valve or the pipe line after it shall be provided with a safety valve with a setting pressure less than 7 kPa with gas outlets piped to a safe place of the upper deck.

Where the reducing valve is so designed that gas outlet to a low pressure pipe line is closed in case of failure or break of the diaphragm, the safety valve need not be provided.

2.1.14.16 Fittings may be of bronze, brass or other corrosion-resistant material.

2.1.14.17 Liquefied gas pipe lines from containers to reducin valves shall be tested:

in ship, by hydraulic pressure of 2,5 MPa;

in ship, by air pressure of 1,7 MPa.

Pipe lines from reducing valves to gas-consuming appliances shall be tested by air pressure of 0,02 MPa after installation on board.

2.2 PASSENGER SHIPS

2.2.1 General requirements.

2.2.1.1 The requirements of this Chapter are additional to those set out in 2.1.1 to 2.1.6, 2.1.8 to 2.1.12 and 2.1.14.

2.2.1.2 For ships carrying more than 36 passengers, the hull, superstructure and deckhouses shall be divided into main vertical zones by "A-60" class divisions. Steps and recesses shall be kept to a minimum, but where they are necessary they are also to be "A-60" class divisions. Where a category 2.2.1.3 (*5*), 2.2.1.3 (*9*) or 2.2.1.3 (*10*) space is on one side of the division the standard may be reduced to "A-0".

For ships carrying not more than 36 passengers, the hull, superstructure and deckhouses in way of accommodation and service spaces shall be divided into main vertical zones by "A" class divisions. These divisions shall have insulation values in accordance with Tables 2.2.1.5-1 and 2.2.1.5-2.

As far as practicable, the bulkheads forming the boundaries of the main vertical zones above the bulkhead deck should be in line with watertight subdivision bulkheads situated immediately below the bulkhead deck. The length and width of main vertical zones may be extended to a maximum of 48 m in order to bring the ends of main vertical zones to coincide with subdivision watertight bulkheads or in order to accommodate a large public space extending for the whole length of the main vertical zone provided that the total area of the main vertical zone is not greater than 1600 m^2 on any deck.

Bulkheads forming the boundaries of main vertical zones shall extend from deck to deck and to the shell or other boundaries.

Where the main vertical zone of ships carrying not more than 36 passengers is divided by horizontal "A" class divisions into horizontal zones for the purpose of providing an appropriate barrier between sprinklered and non-sprinklered zones of the ship, the divisions shall extend between adjacent main vertical zone bulkheads and to the shell or exterior boundaries of the ship and shall be insulated in accordance with the fire insulation classes given in Table 2.2.1.5-2.

On ships designed for special purposes, such as automobile or railroad car ferries, where the provision of main vertical zone bulkheads would defeat the purpose for which the ship is intended, equivalent means for controlling and limiting a fire, such as water screens, shall be provided. Service spaces shall not be located on decks of ships specified in 1.5.4.3.

In ships with special category spaces, the provisions of 2.2.3 shall be complied with.

2.2.1.3 The minimum fire integrity of all bulkheads and decks separating adjacent spaces in ships carrying 36 passengers and more is to be as prescribed in Tables 2.2.1.3-1 and 2.2.1.3-2.

For the purpose of determining the class of structures between adjacent spaces, such spaces are classified according to their fire risk as follows.

(1) Control stations — in compliance with 1.5.1.

(2) Stairways: interior stairways beyond the machinery spaces with enclosures thereto and trunks of lifts for passengers and crew.

A stairway which is enclosed at only one level shall be regarded as part of the space from which it is not separated by a fire door.

(3) Corridors:

corridors and lobbies for passengers and crew.

(4) Evacuation stations and external escape routes; survival craft stowage area; open deck spaces and enclosed promenades forming lifeboat and liferaft embarkation and lowering stations; muster stations, internal and external; external stairs and open decks used for escape routes; the ship's side to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferaft's and evacuation slide's embarkation areas.

(5) Open deck spaces:

open deck spaces and enclosed promenades clear of lifeboat and liferaft embarkation and lowering stations. To be considered in this category, enclosed promenades shall have no fire risk. This means that furnishings shall be restricted to deck furniture. In addition, such places shall be naturally ventilated by permanent openings;

air spaces (spaces outside superstructures and deckhouses).

(6) Accommodation spaces of minor fire risk: cabins, offices, dispensaries and public spaces containing furniture and furnishings of restricted fire risk and having a deck area of less than 50 m^2 (see 1.2).

(7) Accommodation spaces of moderate fire risk:

public spaces as in category (*6*) but containing furniture and furnishings of restricted fire risk and having a deck area of 50 m^2 and greater;

isolated lockers and small storerooms in accommodation spaces having areas less than 4 m^2 (in which flammable liquids are not stowed), sales shops, motion picture projection and film rooms;

cleaning gear lockers;

laboratories (in which flammable liquids are not stowed);

small drying rooms (having a deck area of 4 m^2 or less);

diet kitchens (containing no open flame);

specie rooms;

Table 2.2.1.3-1

Bulkheads not bounding either main vertical zones or horizontal zones

Spaces		(*1*)	(*2*)	(*3*)	(*4*)	(*5*)	(*6*)	(*7*)	(*8*)	(*9*)	(*10*)	(*11*)	(*12*)	(*13*)	(*14*)
Control stations	(*1*)	B-0[1]	A-0	A-0	A-0	A-0	A-60	A-60	A-60	A-0	A-0	A-60	A-60	A-60	A-60
Stairways	(*2*)		A-0[1]	A-0	A-0	A-0	A-0	A-15	A-15	A-0[3]	A-0	A-15	A-30	A-15	A-30
Corridors	(*3*)			B-15	A-60	A-0	B-15	B-15	B-15	B-15	A-0	A-15	A-30	A-0	A-30
Evacuation stations and external escape routes	(*4*)					A-0	A-60[2]	A-60[2]	A-60[2]	A-0	A-0	A-60[2]	A-60[2]	A-60[2]	A-60[2]
Open deck spaces	(*5*)					—	A-0[4]	A-0[4]	A-0[4]	A-0[4]	A-0	A-0	A-0	A-0	A-0
Accommodation spaces of minor fire risk	(*6*)						B-0	B-0	B-0	C	A-0	A-0	A-30	A-0	A-30
Accommodation spaces of moderate fire risk	(*7*)							B-0	B-0	C	A-0	A-15	A-60	A-15	A-60
Accommodation spaces of greater fire risk	(*8*)								B-0	C	A-0	A-30	A-60	A-15	A-60
Sanitary and similar spaces	(*9*)									C	A-0	A-0	A-0	A-0	A-0
Tanks, voids and auxiliary machinery spaces having little or no fire risk	(*10*)										A-0[1]	A-0	A-0	A-0	A-0
Auxiliary machinery spaces, cargo spaces, special category spaces,[5] cargo and other oil tanks and other similar spaces of moderate fire risk	(*11*)											A-0[1]	A-0	A-0	A-15
Machinery spaces and main galleys	(*12*)												A-0[1]	A-0	A-60
Storerooms, workshops, pantries, etc.	(*13*)													A-0[1]	A-0
Other spaces in which flammable liquids are stored	(*14*)														A-30

[1] If adjacent spaces marked with footnote 1 have the same fire integrity, it is not nessary to divide such spaces with a bulkhead or deck. For instance for spaces of category (*12*) it is not necessary to divide a galley and buffets which are part thereof with bulkheads provided the bulkheads and buffet decks have the same fire resistance equal to that of structures bordering the galley. However, it is necessary to erect a bulkhead between the galley and engine room although both spaces have the same category (*12*).

[2] The ship's side, to the waterline in the lightest seagoing condition, superstructure and deckhouse sides situated below and adjacent to the liferafts and evacuation slides may be reduced to "A-30".

[3] Where public toilets are installed completely within the stairway enclosure, the public toilet bulkhead within the stairway enclosure can be of "B" class integrity.

[4] Where spaces of categories (*6*), (*7*), (*8*) and (*9*) are located completely within the outer perimeter of the muster station, the bulkheads of these spaces are allowed to be of "B-0" class integrity. Control positions for audio, video and light installations may be considered as part of the muster station.

[5] Where oil fuel tanks are located under a special category space, the integrity of the separating deck may be reduced to "A-0" class.

Notes: 1. In respect of category (*5*) spaces, it is subject to the special consideration of the Register whether the insulation values in Table 2.2.1.3-1 shall apply to ends of deckhouses and superstructures, and whether the insulation values in Table 2.2.1.3-2 shall apply to weather decks. In no case shall the requirements of category (*5*) of Table 2.2.1.3-1 to 2.2.1.3-2 necessitate enclosure of spaces which in the opinion of the Register need not be enclosed.

2. Where, due to any particular structural arrangements in the ship, difficulty is experienced in determining from the tables the minimum fire integrity value of any divisions, such values are subject to the special consideration of the Register.

3. Where the contents and use of a space are such that there is a doubt as to its classification, it shall be treated as a space within the relevant category having the most stringent boundary requirements.

4. Notwithstanding the provisions of 2.2.1.2 there are no special requirements for material or integrity of boundaries where only a dash appears in the tables.

5. Small enclosed spaces inside the room are treated as separate spaces if square of doorways to adjacent spaces is less than 30 per cent of openings (doorways). Fire integrity of bulkheads and decks surrounding such spaces shall comply with the requirements set forth in tables of the paragraph of the Rules.

motion picture projection rooms and film rooms;
drug-stores;
operating rooms.

(8) Accommodation spaces of greater fire risk:

public spaces containing furniture and furnishings of other than restricted fire risk and having a deck area of 50 m^2 and greater;

barber shops, beauty parlours and saunas.

Table 2.2.1.3-2

Decks not forming steps in main vertical zones nor bounding horizontal zones

Spaces below		Spaces above													
		(*1*)	(*2*)	(*3*)	(*4*)	(*5*)	(*6*)	(*7*)	(*8*)	(*9*)	(*10*)	(*11*)	(*12*)	(*13*)	(*14*)
Control stations	(*1*)	A-30	A-30	A-15	A-0	A-0	A-0	A-15	A-30	A-0	A-0	A-0	A-60	A-0	A-60
Stairways	(*2*)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-30	A-0	A-30
Corridors	(*3*)	A-15	A-0	A-0[1]	A-60	A-0	B-0	A-15	A-15	A-0	A-0	A-15	A-30	A-0	A-30
Evacuation stations and external escape routes	(*4*)	A-0	A-0	A-0	A-0	—	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Open deck spaces	(*5*)	A-0	A-0	A-0	A-0	—	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Accommodation spaces of minor fire risk	(*6*)	A-60	A-15	A-0	A-60	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Accommodation spaces of moderate fire risk	(*7*)	A-60	A-15	A-15	A-60	A-0	A-15	A-15	A-15	A-0	A-0	A-0	A-0	A-0	A-0
Accommodation spaces of greater fire risk	(*8*)	A-60	A-15	A-15	A-60	A-0	A-0	A-15	A-30	A-0	A-0	A-0	A-0	A-0	A-0
Sanitary and similar spaces	(*9*)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0
Tanks, voids and auxiliary machinery spaces having little or no fire risk	(*10*)	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0	A-0[1]	A-0	A-0	A-0	A-0
Auxiliary machinery spaces, cargo spaces, special category spaces, cargo and other oil tanks and other similar spaces of moderate fire risk	(*11*)	A-60	A-60	A-60	A-60	A-0	A-0	A-15	A-30	A-0	A-0	A-0[1]	A-0	A-0	A-30
Machinery spaces and main galleys	(*12*)	A-60	A-60	A-60	A-60	A-0	A-60	A-60	A-60	A-0	A-0	A-30	A-30[1]	A-0	A-60
Storerooms, workshops, pantries, etc.	(*13*)	A-60	A-30	A-15	A-60	A-0	A-15	A-30	A-30	A-0	A-0	A-0	A-0	A-0	A-0
Other spaces in which flammable liquids are stored	(*14*)	A-60	A-60	A-60	A-60	A-0	A-30	A-60	A-60	A-0	A-0	A-0	A-0	A-0	A-0

[1] See footnote [1] to Table 2.2.1.3-1.

Note. See notes to Table 2.2.1.3-1.

(9) Sanitary and similar spaces:

communal sanitary facilities, showers, baths, water closets, etc.;

small laundry rooms;

indoor swimming pool area;

isolated serving pantries containing no cooking appliances in accommodation spaces.

Enclosed private sanitary facilities shall be considered a portion of the spaces in which they are located.

(10) Tanks, voids and auxiliary machinery spaces having little or no fire risk:

water tanks forming part of the ship's structure;

voids and cofferdams;

auxiliary machinery spaces which do not contain machinery having a pressure lubrication system and where storage of combustibles is prohibited, such as: ventilation and air-conditioning rooms; windlass room; steering gear room; stabilizer equipment room; electrical propulsion motor room; rooms containing section switchboards and purely electrical equipment, shaft alleys and pipe tunnels; spaces for pumps and refrigeration machinery (not handling or using flammable liquids);

closed trunks serving the spaces listed above;

other closed trunks such as pipe and cable trunks.

(11) Auxiliary machinery spaces, cargo spaces, cargo and other oil tanks and other similar spaces of moderaie fire risk:

cargo oil tanks;

cargo holds, trunkways and hatchways;

refrigerated chambers;

oil fuel tanks (where installed in a separate space with no machinery);

shaft alleys and pipe tunnels allowing storage of combustibles;

auxiliary machinery spaces as in category (*10*) which contain machinery having a pressure lubrication system or where storage of combustibles is permitted;

oil fuel filling stations;

spaces containing turbine and reciprocating steam engine driven auxiliary generators and small internal combustion engines up to 110 kW driving generators, sprinkler, drencher or fire pumps, bilge pumps, etc.;

closed trunks serving the spaces listed above.

(12) Machinery spaces and main galleys:

main propelling machinery rooms (other than electric propulsion motor rooms) and boiler rooms;

auxiliary machinery spaces other than those in categories (*10*) and (*11*) which contain internal combustion machinery or other oil-burning heating or pumping units;

main galleys and annexes;

trunks and casings to the spaces listed above.

(13) Storerooms, workshops, pantries, etc.:

main pantries, not annexed to galleys;

main laundry;

large drying rooms (having a deck area of more than 4 m^2);

miscellaneous stores;

mail and baggage rooms;

garbage rooms;

workshops (not part of machinery spaces, galleys, etc.);

lockers and storerooms having areas of more than 4 m^2 and not having provisions for the storage of flammable liquids.

(14) Other spaces in which flammable liquids are stowed:

paint rooms;

storerooms containing flammable liquids (including dyes, medicines, etc.);

laboratories (in which flammable liquids are stowed).

2.2.1.4 On ships carrying not more than 36 passengers, where a space is protected by an automatic sprinkler system or fitted with a continuous "B" class ceiling, openings in decks not forming steps in main vertical zones nor bounding horizontal zones shall be closed reasonably tight and such decks shall meet the "A" requirements.

2.2.1.5 The minimum fire integrity of all bulkheads and decks separating adjacent spaces in ships carrying not more than 36 passengers is to be as prescribed in Tables 2.2.1.5-1 and 2.2.1.5-2 with regard to the following:

.1 for determining the appropriate fire integrity standards to be applied to divisions between adjacent spaces, such spaces are classified according to their fire risk as shown in categories (*1*) to (*11*) below:

(*1*) control stations as defined in 1.5.1;

(*2*) corridors and lobbies;

(*3*) accommodation spaces as defined in 1.5.2;

(*4*) stairways:

interior stairways, lifts, totally enclosed emergency escape exits trunks and escalators (other than those wholly contained within machinery spaces) and enclosures thereto.

In this connexion, a stairway which is enclosed only at one level is to be regarded as part of the space from which it is not separated by a fire door;

(*5*) service spaces (low risk):

storerooms for combustible materials not having provisions for the storage of flammable liquids and having areas less than 4 m^2, storerooms for non-combustible materials, drying rooms and laundries;

(*6*) machinery spaces of category A:

spaces as defined in 1.2, Part VII "Machinery Installations";

(*7*) other machinery spaces:

machinery spaces excluding spaces referred to in (*6*) and special electrical spaces in compliance with 1.5.10;

(*8*) cargo spaces as defined in 1.5.4;

(*9*) service spaces (high risk) as defined in 1.5.3, excluding spaces referred to in (*5*);

(*10*) open decks:

open deck spaces and enclosed promenades having no fire risk. To be considered in this category, enclosed promenades shall have no fire risk. This means that furnishings shall be restricted to deck furniture. In addition, such spaces shall be naturally ventilated by means of permanent openings;

air spaces (spaces outside superstructures and deckhouses).

(*11*) special category spaces as defined in 1.5.9.

.2 the doors from the cabins to individual sanitary spaces may be of combustible materials.

2.2.1.6 In public spaces (including trade centres, restaurants, agencies, etc.) which contain free volumes extending to three or more decks and comprising combustible matter (such as furniture), provision shall be made for an automatic sprinkler system and a smoke detection system with smoke detectors along the whole length of the main vertical fire zone.

The exits from the above spaces shall be in compliance with the requirements of 8.5.2, Part III "Equipment, Arrangements and Outfit"and of 12.3, Part VIII "Systems and Piping". см.Б1

2.2.2 Accommodation and service spaces within a main vertical zones.

2.2.2.1 For ships carrying more than 36 passengers all bulkheads which are not required to be "A" class divisions shall be "B" class or "C" class divisions as prescribed in Table 2.2.1.3-1.

For ships carrying not more than 36 passengers all bulkheads within accommodation and service spaces which are not required to be "A" class divisions shall be "B" class or "C" class divisions as prescribed in Table 2.2.1.5-1.

All such divisions may be faced with combustible materials in accordance with the provisions of 2.1.1.10.

2.2.2.2 For ships carrying not more than 36 passengers all corridor bulkheads where not required to be "A" class divisions should be "B" class divisions which should extend from deck to deck except:

.1 when continuous "B" class ceilings or linings are fitted on both sides of the bulkhead, the portion of the

Table 2.2.1.5-1

Fire integrity of bulkheads separating adjacent spaces

Spaces		(*1*)	(*2*)	(*3*)	(*4*)	(*5*)	(*6*)	(*7*)	(*8*)	(*9*)	(*10*)	(*11*)
Control stations	(*1*)	A-0[1]	A-0	A-60	A-0	A-15	A-60	A-15	A-60	A-60	*	A-60
Corridors and lobbies	(*2*)		C[2]	B-0[2]	A-0	B-0[2]	A-60	A-0	A-0	A-15 A-0[3]	*	A-15
Accommodation spaces	(*3*)			C[2]	A-0	B-0[2]	A-60	A-0	A-0	A-15 A-0[3]	*	A-30 A-0[3]
Stairways	(*4*)				A-0	A-0	A-60	A-0	A-0	A-15 A-0[3]	*	A-15
Service spaces (low risk)	(*5*)					C[2]	A-60	A-0	A-0	A-0	*	A-0
Machinery spaces of category A	(*6*)						*	A-0	A-0	A-60	*	A-60
Other machinery spaces	(*7*)							A-0[4]	A-0	A-0	*	A-0
Cargo spaces	(*8*)								*	A-0	*	A-0
Service spaces (high risk)	(*9*)									A-0[4]	*	A-30
Open decks	(*10*)										—	A-0
Special category spaces	(*11*)											A-0

[1] Bulkheads separating the wheelhouse and chartroom from each other may be "B-0" rating.

[2] "B-0" or "C" class bulkheads, where appearing in the table as main fire-proof divisions required by 2.2.1.2 shall be read as "A-0".

[3] Where each of the adjacent spaces is protected by an automatic sprinkler system, the lower of the two values given in the tables may be used.

[4] Where the spaces are used for the same purpose, no divisions may be fitted between them.

Notes: 1. Where an asterisk appears in the tables the division is required to be of steel or equivalent material, but is not required to be of "A" class standard.
2. See Note 5 to Table 2.2.1.3-1.

Table 2.2.1.5-2

Fire integrity of decks separating adjacent spaces

Spaces below		Spaces above										
		(*1*)	(*2*)	(*3*)	(*4*)	(*5*)	(*6*)	(*7*)	(*8*)	(*9*)	(*10*)	(*11*)
Control stations	(*1*)	A-0	A-0	A-0	A-0	A-0	A-60	A-0	A-0	A-0	*	A-30
Corridors and lobbies	(*2*)	A-0	*	*	A-0	*	A-60	A-0	A-0	A-0	*	A-0
Accommodation spaces	(*3*)	A-60	A-0	*	A-0	*	A-60	A-0	A-0	A-0	*	A-30 A-0[3]
Stairways	(*4*)	A-0	A-0	A-0	*	A-0	A-60	A-0	A-0	A-0	*	A-0
Service spaces (low risk)	(*5*)	A-15	A-0	A-0	A-0	*	A-60	A-0	A-0	A-0	*	A-0
Machinery spaces of category A	(*6*)	A-60	A-60	A-60	A-60	A-60	*	A-60[5]	A-30	A-60	*	A-60
Other machinery spaces	(*7*)	A-15	A-0	A-0	A-0	A-0	A-0	*	A-0	A-0	*	A-0
Cargo spaces	(*8*)	A-60	A-0	A-0	A-0	A-0	A-0	A-0	*	A-0	*	A-0
Service spaces (high risk)	(*9*)	A-60	A-30 A-0[3]	A-30 A-0[3]	A-30 A-0[3]	A-0	A-60	A-0	A-0	A-0	*	A-30
Open decks	(*10*)	*	*	*	*	*	*	*	*	*	—	A-0
Special category spaces	(*11*)	A-60	A-15	A-30 A-0[3]	A-15	A-0	A-30	A-0	A-0	A-30	A-0	A-0

[1] See footnote 3 to Table 2.2.1.5-1.

[2] Where other machinery spaces of category (*7*) are the spaces of little fire risk, i.e. they do not contain machinery operating in fuel oil or having a pressure lubrication systems, "A-0" class divisions are permitted.

Notes: 1. For the application of 2.2.1.2 an asterisk, where appearing in Table 2.2.1.5-2, except for categories (*8*) and (*10*) is to be read as "A-0".

2. See Note 5 to Table 2.2.1.3-1.

bulkhead behind the continuous ceiling or lining shall be of material which, in thickness and composition, is acceptable in the construction of "B" class divisions but which shall be required to meet "B" class integrity standards only in so far as is reasonable and practicable in the opinion of the Register;

.2 on ships equipped with an automatic sprinkler fire detection complying with the provisions of Fire Safety Systems Code, corridor bulkheads may end by the corridor ceilings provided that such bulkheads and ceilings are of B class in accordance with 2.2.1.5. All doors and door frames in such bulkheads shall be made of non-combustible materials and they shall have the same fire integrity as the bulkhead in which they are fitted.

2.2.2.3 All bulkheads required to be "B" class divisions, except corridor bulkheads required by 2.2.2.2, shall extend from deck to deck and to the shell or other boundaries unless the continuous "B" class ceilings or linings, having at least the same fire integrity as the bulkhead, are fitted on both sides of it, in which case the bulkhead may terminate at the continuous ceiling or lining.

2.2.2.4 Stairways in accommodation and service spaces shall be protected as follows:

.1 stairways shall be enclosed in trunks formed by divisions specified in Tables 2.2.1.3-1 and 2.2.1.3-2 or 2.2.1.5-1 and 2.2.1.5-2;

.2 a stairway connecting only two decks need not be enclosed, provided the integrity of the deck is maintained by proper bulkheads or doors in one 'tweendeck space. Where a stairway is closed in one 'tweendeck space, the stairway enclosure shall be protected in accordance with the requirements of Tables 2.2.1.3-2 and 2.2.1.5-2;

.3 stairways may be fitted in the open in a public space, provided they lie wholly within such public space;

.4 stairway enclosures shall have direct communications with the corridors and be of sufficient area to comply with 8.5.4.2, Part III "Equipment, Arrangements and Outfit". Within the perimeter of such stairway, enclosures, only public toilets, lockers of non-combustible material providing storage for safety equipment and open information counters are permitted. Only public spaces, corridors, public toilets, special category spaces, other escape stairways required by Part III "Equipment, Arrangements and Outfit" and external areas are permitted to have direct access to these stairway enclosures;

.5 one of the means of escape from a watertight compartment or a main fire vertical zone as required in 8.5.2.1, Part III "Equipment, Arrangements and Outfit" is to consist of enclosed stairways which provide a continuous shelter according to the requirements of 2.2.1.3 or 2.2.1.5.

.6 if the stairway serves for the two main vertical zones then it shall be limited by the bulkheads and doors on the side of each zone as required for these zones.

2.2.2.5 In all spaces, except for refrigerating provision storerooms, cargo spaces, mail baggage cabins and saunas, the ceilings, bulkheads, linings, draught stops and grounds shall be made of non-combustible materials.

Partial bulkheads or decks used for the division of the space for practical or decorative reasons shall also be made of non-combustible materials.

2.2.2.6 In the case of ships fitted with an automatic sprinkler system, combustible materials used for erection of "C" class divisions may be added to the total volume of combustible materials mentioned in 2.1.1.10.

2.2.2.7 The construction of ceiling and bulkheading shall be such that it will be possible, without impairing the efficiency of the fire protection, for the fire patrols to detect any smoke originating in concealed and inaccessible places, except where there is no risk of fire originating in such places.

2.2.2.8 The furniture in stairway enclosures consists of seats only. It shall be fixed to six seats on each deck in each stairway enclosure, be of restricted fire risk determined in accordance with Fire Test Procedures Code and shall not restrict the passenger escape route. The Register may permit additional seating in the main reception area within the stairway enclosure if it is fixed, non-combustible and does not restrict the passenger escape route. The furniture shall not be permitted in passenger and crew corridors forming escape routes in cabin areas. In addition to the above lockers of non-combustible material, providing storage for non-hazardous safety equipment and life-saving appliances required by the present Rules may be permitted. Drinking water dispensers and ice cube machines may be permitted in corridors provided they are properly fixed and do not restrict the width of the escape routes. This applies as well to decorative flower or plant arrangements, statues or other objects of art such as painting and tapestries in corridors and stairways.

2.2.3 Special category spaces.

2.2.3.1 When the above spaces cannot be protected by main vertical fire zones, their protection shall be ensured by subdivision into horizontal zones. These zones may cover more than one deck, but their overall height calculated as a sum of distances between adjacent decks without regard of framing height shall not exceed 10 m.

2.2.3.2 In ships carrying more than 36 passengers the boundary bulkheads and decks of special category spaces shall be insulated to "A-60" class standard. However, where a category 2.2.1.3 (*5*), 2.2.1.3 (*9*) or 2.2.1.3 (*10*) space is on one side of the division the standard may be reduced to "A-0". If fuel oil tanks are located under special category spaces, the fire integrity of decks between such spaces may be of A-0 class.

In ships carrying not more than 36 passengers the boundary bulkheads of special category spaces shall be insulated as required for category (*11*) spaces in 2.2.1.5-1 and the horizontal boundaries as required for category (11) spaces in Table 2.2.1.5-2.

2.2.3.3 Indicators shall be provided on the navigating bridge which shall indicate when any fire door leading to or from the special category spaces is closed.

2.2.3.4 Special category spaces shall have means of escape leading to the lifeboat and liferaft embarkation places complying with the requirements of 8.5.1, 8.5.2.3, Part III "Equipment, Arrangements and Outfit" as well as the requirements of 2.1.4.7 and 2.2.2.4.1 of this Part.

Escape routes from the machinery spaces where the crew is normally employed shall avoid direct access to any special category space.

2.2.4 Doors, windows and sidescuttles.

2.2.4.1 Doors to machinery spaces of category A shall satisfy the requirements of 2.1.3.4 with regard to 2.2.4.1.1. Doors/hatchways for the emergency escape may not to be equipped with locking devices and remotely controlled release mechanisms.

Fire doors in main vertical bulkheads, galley boundaries and stairway enclosures other than power-operated watertight doors and those which are normally locked, shall satisfy the following requirements:

.1 the doors shall be self-closing and be capable of closing with an angle of inclination of up to 3,5° opposing closure;

.2 the approximate time of closure for hinged fire doors shall be no more than 40 s and no less than 10 s from the beginning of their movement with the ship in the upright position. The approximate uniform rate of closure for sliding fire doors shall be no more than 0,2 m/s and no less than 0,1 m/s from the beginning of their movement with the ship in the upright position;

.3 the doors shall be capable of remote release from the continuously manned central control station, either simultaneously or in groups and shall be capable of release also individually from a position at both sides of the door. Release switches shall have an on-off function to prevent automatic resetting of the system;

.4 hold-back hooks not subject to central control station release are prohibited;

.5 a door closed remotely from the central control station shall be capable of being re-opened at both sides of the door by local control. After such local opening, the door shall automatically close again;

.6 indication shall be provided at the fire door indicator panel in the continuously manned central control station whether each of the remote-released doors is closed;

.7 the release mechanism shall be so designed that the door will automatically close in case of disruption of the control system or main power source;

.8 local power accumulators for power-operated doors shall be provided in the immediate vicinity of the doors to enable the doors to be operated after disruption of the control system or main source of electrical power at least ten times (fully opened and closed) using the local controls;

.9 disruption of the control system or main source of electrical power of one door shall not impair the safe functioning of other doors;

.10 remote-released sliding or power-operated doors shall be equipped with an alarm that sounds for at least 5 s but no more than 10 s after the door is released from the central control station and before the door begins to move and continues sounding until the door is completely closed;

.11 a door designed to re-open upon contacting an object in its path shall re-open not more than 1 m far from the point of contact;

.12 double-leaf doors equipped with a latch necessary to their fire integrity shall have a latch that is automatically activated by the operation of the doors when released by the control system;

.13 doors giving direct access to special category spaces which are power-operated and automatically closed need not be equipped with the alarms and remote-release mechanisms required in 2.4.4.1.3 and 2.4.4.1.10 above;

.14 the components of the local control system shall be accessible for maintenance and adjusting; and

.15 power-operated doors shall be provided with a control system of an approved type which shall be able to operate in case of fire, this being determined in accordance with Fire Test Procedures Code. This system shall satisfy the following requirements:

the control system shall be able to operate the door at the temperature of at least 200°C for at least 60 min, served by the power supply;

the power supply for all other doors not subject to fire shall not be impaired;

at temperatures exceeding 200°C the control system shall be automatically isolated from the power supply and shall be capable of keeping the door closed up to at least 945°C.

2.2.4.2 All "A" class doors located in stairways, public spaces and main vertical zone bulkheads in escape routes shall be equipped with a self-closing hose port of material, construction and fire resistance which is equivalent to the door into which it is fitted, and shall be a 150 cm square clear opening with the door closed and shall be inset into the lower edge of the door, opposite the door hinges, or in the case of sliding doors, nearest the opening.

2.2.4.3 Cabin doors in "B" class divisions shall be of a self-closing type. Hold-backs are not permitted.

2.2.4.4 Windows facing life-saving appliances, embarkation and muster areas, external stairs and open decks used for escape routes, and windows situated below liferaft and escape slide embarkation areas shall have the fire integrity as required in Tables 2.2.1.3-1 and 2.2.3.1-2. Where automatic dedicated sprinkler heads are provided for windows, "A-0" windows may be accepted as equivalent. Sprinklers shall be located above windows in addition to sprinklers of ceilings; alternatively this may be sprinklers of ceilings fitted in such manner that a window is protected by water flow with a feed of at least 5 l/m^2, the square of a window shall be included into calculation of the area covered by the sprinkler. Windows located in the ship's side below the lifeboat embarkation areas shall have the fire integrity at least equal to "A-0" class.

2.2.4.5 The requirements for "A" class integrity of the outer boundaries of a ship shall not apply to exterior doors, except for those in superstructures and deckhouses facing life-saving appliances, embarkation and external muster station areas, external stairs and open decks used for escape routes. Stairway enclosure doors need not meet this requirement.

2.2.4.6 In passenger ships carrying not more than 36 passengers, it is allowed to use combustible materials for manufacture of doors separating cabins from internal individual sanitary spaces such as showers.

2.2.5 Closed and open ro-ro cargo spaces other than special category spaces.

2.2.5.1 These requirements are additional to those set forth in 2.1.4.7, 2.2.1.4, 2.2.3.1 and 2.2.4.1.

2.2.5.2 In passenger ships carrying more than 36 passengers, the boundary bulkheads and decks of closed and open ro-ro cargo spaces shall be insulated to "A-60" class standard. However, where a category (*5*), (*9*) or (*10*) space in accordance with the requirements of Tables 2.2.1.3-1 and 2.2.1.3-2 is on one side of the division, the standard may be reduced to "A-0". Where fuel oil tanks are below a ro-ro cargo space, the integrity of the deck between such spaces may be reduced to "A-0" standard.

2.2.5.3 In passenger ships carrying not more than 36 passengers, the boundary bulkheads and decks of closed and open ro-ro cargo spaces shall have a fire integrity as required for category (*8*) spaces in Table 2.2.1.5-1 and the horizontal boundaries as required for category (*8*) spaces in Table 2.2.1.5-2.

2.2.5.4 Closed ro-ro cargo spaces.

Closed ro-ro cargo spaces shall comply with the requirements for cargo spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion.

2.2.5.5 Open ro-ro cargo spaces.

Open ro-ro cargo spaces shall be fitted with a pressure water-spraying system for manual operation (see 3.4) and shall comply with the requirements of 4.2.1.2 (except that a sample extraction smoke detection system is not permitted) and 4.14 of Table 5.1.2.

2.3 CARGO SHIPS

2.3.1 The requirements of this Chapter are additional to those set out in 2.1 and apply to cargo ships of 500 gross tonnage and upwards.

см.Б1 **2.3.2** In accommodation and service spaces one of the following methods of protection shall be adopted:

Method IC: the construction of all internal divisional bulkheading of non-combustible "B" or "C" class divisions; or

Method IIC: the fitting of an automatic sprinkler and fire alarm system for the detection and extinction of fire in all spaces in which fire might be expected to originate, generally with no restriction on the type of internal divisional bulkheading; or

Method IIIC: the fitting of a fixed fire detection and fire alarm system of approved type complying with requirements of 4.1 and 4.2 in all spaces referred to in 1.5.2 except spaces which have no significant fire risk (such as sanitary, empty spaces etc.), generally with no restriction on divisional bulkheads, except that in no case shall the area of any accommodation space bounded by A or B class division exceeds 50 m^2. Consideration may be given by the Register to increasing this area for public spaces.

2.3.3 The minimum fire integrity of the bulkheads and decks separating adjacent spaces is to be as prescribed in Tables 2.3.3-1 and 2.3.3-2.

For determining the appropriate fire integrity standards to be applied to divisions between adjacent spaces, the spaces are classified according to their fire risk as follows:

(*1*) control stations in accordance with 1.5.1;

(*2*) corridors and lobbies;

(*3*) accommodation spaces in accordance with 1.5.2;

(*4*) stairways:

interior stairways, lifts, totally enclosed emergency escape trunks and escalators (other than those wholly contained within the machinery spaces) and enclosures thereto.

A stairway which is enclosed only at one level shall be regarded as part of the space from which it is not separated by a fire door;

(*5*) service spaces (low risk):

combustible material storerooms having areas less than 4 m^2, non-combustible material storerooms, drying rooms, laundries, and working spaces in compliance with 1.5.8.2;

(*6*) machinery spaces of category A:

spaces as defined in 1.2, Part VII "Machinery Installations";

(*7*) other machinery spaces:

machinery spaces excluding those specified in (*6*) and special electrical spaces in compliance with 1.5.10;

(*8*) cargo spaces:

all spaces used for carriage of cargoes specified in 1.5.4 as well as trunkways and hatchways to such spaces;

(*9*) service spaces (high risk) in compliance with 1.5.3, excluding those specified in (*5*), as well as working spaces in compliance with 1.5.8.1;

Table 2.3.3-1

Fire integrity of bulkheads separating adjacent spaces

Spaces		(*1*)	(*2*)	(*3*)	(*4*)	(*5*)	(*6*)	(*7*)	(*8*)	(*9*)	(*10*)	(*11*)
Control stations	(*1*)	A-0[1]	A-0	A-60	A-0	A-15	A-60	A-15	A-60	A-60	*	A-60
Corridors and lobbies	(*2*)		C	B-0	A-0[2] B-0	B-0	A-60	A-0	A-0	A-0	*	A-30
Accommodation spaces	(*3*)			C[3,4]	A-0[2] B-0	B-0	A-60	A-0	A-0	A-0	*	A-30
Stairways	(*4*)				A-0[2] B-0	A-0[2] B-0	A-60	A-0	A-0	A-0	*	A-30
Service spaces (low risk)	(*5*)					C	A-60	A-0	A-0	A-0	*	A-0
Machinery spaces of category A	(*6*)						*	A-0	A-0[5]	A-60	*	A-60[6]
Other machinery spaces	(*7*)							A-0[7]	A-0	A-0	*	A-0
Cargo spaces	(*8*)								*	A-0	*	A-0
Service spaces (high risk)	(*9*)									A-0[7]	*	A-30
Open decks	(*10*)										—	A-0
Ro-ro cargo spaces and spaces for motor vehicles	(*11*)											*[8]

[1] Bulkheads separating the wheelhouse, chartroom and radio room from each other may be "B-0" rating.

[2] For clarification as to which applies, see 2.1.4.3.

[3] Doors separating cabins from individual sanitary accommodation may be constructed of combustible materials in method IC fire protection. No special requirements are imposed upon bulkheads in methods IIC and IIIC.

[4] In case of method IIIC bulkheads of "B-0" rating shall be provided between spaces or groups of spaces of 50 m^2 and over in area.

[5] For cargo spaces intended for carriage of dangerous goods see 2.8.10.

[6] "A-0" rating may be used if no dangerous goods are intended to be carried.

[7] Where spaces are used for the same purpose, divisions between them need not be fitted.

[8] Openings in bulkheads and decks shall be closed reasonably gastight.

Notes: 1. Where an asterisk appears in the tables the division is required to be of steel or equivalent but is not required to be of "A" class standard.
2. See Note 5 to Table 2.2.1.3-1.

Table 2.3.3-2

Fire integrity of decks separating adjacent spaces

Spaces below		Spaces above										
		(*1*)	(*2*)	(*3*)	(*4*)	(*5*)	(*6*)	(*7*)	(*8*)	(*9*)	(*10*)	(*11*)
Control stations	(*1*)	A-0	A-0	A-0	A-0	A-0	A-60	A-0	A-0	A-0	*	A-60
Corridors and lobbies	(*2*)	A-0	*	*	A-0	*	A-60	A-0	A-0	A-0	*	A-30
Accommodation spaces	(*3*)	A-60	A-0	*	A-0	*	A-60	A-0	A-0	A-0	*	A-30
Stairways	(*4*)	A-0	A-0	A-0	*	A-0	A-60	A-0	A-0	A-0	*	A-30
Service spaces (low risk)	(*5*)	A-15	A-0	A-0	A-0	*	A-60	A-0	A-0	A-0	*	A-0
Machinery spaces of category A	(*6*)	A-60	A-60	A-60	A-60	A-60	*	A-60[1]	A-30	A-60	*	A-60
Other machinery spaces	(*7*)	A-15	A-0	A-0	A-0	A-0	A-0	*	A-0	A-0	*	A-0
Cargo spaces	(*8*)	A-60	A-0	A-0	A-0	A-0	A-0	A-0	*	A-0	*	A-0
Service spaces (high risk)	(*9*)	A-60	A-0	A-0	A-0	A-0	A-60	A-0	A-0	A-0[2]	*	A-30
Open decks	(*10*)	*	*	*	*	*	*	*	*	*	—	*
Ro-ro cargo spaces and vehicle spaces	(*11*)	A-60	A-30	A-30	A-30	A-0	A-60	A-0	A-0	A-30	*	*[8]

[1] Where other machinery spaces of category (*7*) are the spaces of little fire risk, i.e. they do not contain machinery operating on fuel oil or having a pressure lubrication systems, "A-0" class divisions are permitted.

[2] See footnote 7 to Table 2.3.3-1.

[3] See footnote 8 to Table 2.3.3-1.

Notes: 1. Where an asterisk appears in the tables the division is required to be of steel or equivalent but is not required to be of "A" class standard.
2. See Note 5 to Table 2.2.1.3-1.

(*10*) open decks:

open deck spaces and enclosed promenades having no fire risk. This means that their furnishings shall be restricted to deck furniture. In addition, such spaces shall be naturally ventilated by permanent openings:

air spaces (spaces outside superstructures and deckhouses);

(*11*) ro-ro cargo spaces as defined in 1.5.4.3 and 1.5.4.4.

2.3.4 Linings, ceilings, draught stops and their associated grounds shall be made of non-combustible materials: in accomodation and service spaces, and in control stations, if protection method IC is used; in corridors and stairway enclosures serving accomodation and service spaces, and control stations, if protection methods IIC and IIIC are used.

2.3.5 In accommodation and service spaces bulkheads not required to be "A" or "B" class divisions shall be:

.1 at least "C" class division in method IC fire protection;

.2 not subject to any restrictions, except in cases where class "C" bulkheads are required in accordance with Table 2.3.3-1 in method IIC fire protection;

.3 not subject to any restrictions except that in no case must the area of any accommodation space or spaces bounded by "A" or "B" class divisions exceed 50 m^2 (except in cases where "C" bulkheads are required in accordance with Table 2.3.3-1).

Consideration may be given by the Register to increasing this area for public spaces.

If the IC method of protection has been used while ship construction, application of combustible materials may be allowed for doors separating cabins from internal sanitary spaces such as showers.

2.4 OIL TANKERS

2.4.1 The requirements of this Chapter are additional to those set out in 2.1 and 2.3 (except for 2.3.3) when only method IC fire protection is adopted and apply to oil tankers and combination carriers of 500 gross tonnage and upwards.

2.4.2 The minimum fire integrity of bulkheads and decks separating adjacent spaces is to be as prescribed in Tables 2.4.2-1 and 2.4.2-2 with regard to the following.

For determining the appropriate fire integrity standards to be applied to divisions between adjacent spaces, the spaces are classified according to their fire risk as follows:

(*1*) control stations as defined in 1.5.1;

(*2*) corridors and lobbies;

(*3*) accommodation spaces as defined in 1.5.2;

(*4*) stairways:

interior stairways, lifts, totally enclosed emergency escape trunks and escalators (other than those wholly contained within the machinery spaces) and enclosures thereto.

A stairway which is enclosed only at one level is to be regarded as part of the space from which it is separated by a fire door;

(*5*) service spaces (low risk):

combustible material storerooms having areas less than 4 m^2 and not having provisions for the storage of flammable liquids, non-combustible material storerooms, drying rooms and laundries;

(*6*) machinery spaces of category A:

spaces as defined in 1.2, Part VII "Machinery Installations";

(*7*) other machinery spaces:

machinery spaces excluding spaces referred to in (*6*) and special electrical spaces in compliance with 1.5.10;

(*8*) cargo pump rooms as defined in 1.5.7.1;

(*9*) service spaces (high risk) as defined in 1.5.3 excluding those specified in (*5*), as well as cargo control stations;

(*10*) open decks:

open deck spaces and enclosed promenades having no fire risk. This means that their furnishings shall be restricted to deck furniture. In addition, such spaces shall be naturally ventilated by permanent openings.

air spaces (spaces outside superstructures and deckhouses);

см.Б1 **2.4.3** Exterior boundaries of superstructures and deckhouses enclosing accommodation and including any overhanging decks which support such accommodation, shall be constructed of steel and insulated to "A-60" standard for the whole of the portions which face the cargo area and on the outward sides for a distance of 3 m from the end boundary facing the cargo area.

The distance of 3 m shall be measured horizontally and parallel to the middle line of the ship from the boundary facing the cargo area at the each deck level. Such insulation of sides of superstructures and deckhouses shall be carried up to the underside of navigating bridge deck.

2.4.4 Fitting of doors shall comply with the following requirements:

2.4.4.1 Except as permitted in 2.4.4.2, access doors, air inletskes and openings to accommodation spaces, service spaces, control stations and machinery spaces shall not face the cargo area. They shall be located on the transverse bulkhead not facing the cargo area or on the outboard side of the superstructure or deckhouse at the distance of at least 4 per cent of the ship length but not less than 3 meters from the end of the superstructure or deckhouse facing the cargo area. However, this distance need not exceed 5 meters.

2.4.4.2 The Register may permit access doors in superstructures or deckhouses on transverse bulkheads

Table 2.4.2-1

Fire integrity of bulkheads separating adjacent spaces

Spaces		(*1*)	(*2*)	(*3*)	(*4*)	(*5*)	(*6*)	(*7*)	(*8*)	(*9*)	(*10*)
Control stations	(*1*)	A-0[1]	A-0	A-60	A-0	A-15	A-60	A-15	A-60	A-60	*
Corridors and lobbies	(*2*)		C	B-0	A-0 B-0[2]	B-0	A-60	A-0	A-60	A-0	*
Accommodation spaces	(*3*)			C	A-0 B-0[2]	B-0	A-60	A-0	A-60	A-0	*
Stairways and lifts	(*4*)				A-0 B-0[2]	A-0 B-0[2]	A-60	A-0	A-60	A-0	*
Service spaces (low risk)	(*5*)					C	A-60	A-0	A-60	A-0	*
Machinery spaces of category A	(*6*)						*	A-0	A-0[3]	A-60	*
Other machinery spaces	(*7*)							A-0[4]	A-0	A-0	*
Cargo pump rooms	(*8*)								*	A-60	*
Service spaces (high risk)	(*9*)									A-0[4]	*
Open decks	(*10*)										—

[1] Bulkheads separating the wheelhouse, chartroom and radio room from each other may be "B-0" rating.

[2] For clarification as to which applies, see 2.1.4.3.

[3] Where bulkheads and decks are penetrated by cargo pump shafts, electric cables, etc. see 2.4.8.

[4] Where spaces are used for the same purpose, divisions between them need not be fitted.

Notes: 1. Where an asterisk appears in the tables the division is required to be of steel or other equivalent material but is not required to be of "A" class standard.
2. See Note 5 to Table 2.2.1.3-1.

Table 2.4.2-2

Fire integrity of decks separating adjacent spaces

Spaces below		Spaces above									
		(*1*)	(*2*)	(*3*)	(*4*)	(*5*)	(*6*)	(*7*)	(*8*)	(*9*)	(*10*)
Control stations	(*1*)	A-0	A-0	A-0	A-0	A-0	A-60	A-0	—	A-0	*
Corridors and lobbies	(*2*)	A-0	*	*	A-0	*	A-60	A-0	—	A-0	*
Accommodation spaces	(*3*)	A-60	A-0	*	A-0	*	A-60	A-0	—	A-0	*
Stairways and lifts	(*4*)	A-0	A-0	A-0	*	A-0	A-60	A-0	—	A-0	*
Service spaces (low risk)	(*5*)	A-15	A-0	A-0	A-0	*	A-60	A-0	—	A-0	*
Machinery spaces of category A	(*6*)	A-60	A-60	A-60	A-60	A-60	*	A-60[1]	A-0	A-60	*
Other machinery spaces	(*7*)	A-15	A-0	A-0	A-0	A-0	A-0	*	A-0	A-0	*
Cargo pump rooms	(*8*)	—	—	—	—	—	A-0[2]	A-0	*	—	*
Service spaces (high risk)	(*9*)	A-60	A-0	A-0	A-0	A-0	A-60	A-0	—	A-0[3]	*
Open decks	(*10*)	*	*	*	*	*	*	*	*	*	*

[1] Where other machinery spaces of category (*7*) are the spaces of little fire risk, i.e. they do not contain machinery operating on fuel oil or having a pressure lubrication systems, "A-0" class divisions are permitted.

[2] See footnote 3 to Table 2.4.2-1.

[3] See footnote 4 to Table 2.4.2-1.

Notes: 1. Where an asterisk appears in the tables the division is required to be of steel or other equivalent material but is not required to be of "A" class standard.
2. See Note 5 to Table 2.2.1.3-1.

facing the cargo area or on side bulkheads within 5 m (distance specified in 2.4.4.1), to main cargo control stations and to such service spaces as provision rooms, storerooms and lockers, provided they do not give direct or indirect access to any another space containing or providing for accommodation, control station or service spaces such as galleys, pantries or workshops or similar spaces containing sources of vapour ignition. Boundaries of such space shall be insulated to A-60 standard except for boundary facing the cargo area. Within the limits specified in 2.4.4.1 it is allowed to fit bolted plates for the removal of machinery. Wheelhouse doors and windows may be located within the limits specified in 2.4.4.1, so long as they are designed to ensure that the wheelhouse can be made rapidly and efficiently gas and vapour tight.

2.4.5 Windows and sidescuttles facing the cargo area and located on the sides of superstructures and deckhouses within the limits specified in 2.4.4.1 shall be of the fixed (non-opening) lights. Such windows and sidescuttles, except wheelhouse window, shall comply with the A-60 standard.

2.4.6 The Register may permit a navigation position to be fitted above the cargo area where this is for navigation purposes only, and it shall be separated from the cargo tank deck by means of an open space with a height of at least 2 m. The fire protection of such a navigation position shall be as required for control stations in 2.4.2 and other provisions, as applicable, of this Part.

Where the main control station is on the forecastle deck or in the forward part of the ship equipped with a fore cargo gear, an emergency exit shall be provided to ensure safe escape in case of fire.

2.4.7 Machinery spaces are to be positioned aft of cargo tanks and slop tanks; they shall also be situated aft of pump rooms and cofferdams, but not necessarily aft of the oil fuel tanks. Any machinery space shall be isolated from cargo tanks and slop tanks by cofferdams, pump rooms, oil fuel tanks, or ballast tanks.

Pump rooms containing pumps and their accessories for ballasting those spaces situated adjacent to cargo tanks and slop tanks, and pumps for oil fuel transfer may be used for isolation of machinery spaces from cargo tanks and slop tanks provided that such pump rooms have the same safety standard as that required for cargo pump rooms.

The lower portion of the pump room bulkhead may be recessed into machinery spaces of category A to accommodate pumps. The deck head of the recess is not more than one third of the moulded depth above the keel. In ships of not more than 25000 tons deadweight, for reasons of access and satisfactory piping arrangements and on agreement with the Register, the deck head of the recess may be at a level of up to one half of the moulded depth above the keel.

A cargo tank or a slop tank adjoining machinery spaces by a corner shall be isolated therefrom by a corner cofferdam.

The design and dimensions of cofferdams shall comply with the requirements of 2.7.5.2, Part II "Hull".

Corner cofferdams inaccessible for inspection shall be fitted with suitable media.

2.4.8 Pump rooms shall be closed in by gastight bulkheads.

Permanent approved gastight lighting enclosures may be installed in bulkheads and decks separating pump rooms from other spaces. These enclosures are intended for lighting of pump rooms provided that they are sufficiently durable and that fire resistance and fire-tightness of the bulkhead or deck is preserved.

The divisions separating pump rooms from machinery spaces of category A may be pierced for penetration of cargo pump shafts, electric cables, etc., provided suitable glands of approved type are fitted in places of penetration thereof.

The pump rooms shall be provided with arrangements for continuous monitoring hydrocarbon vapour concentration. Sampling or measuring points shall be located at places where oil leakage is likely to occur, in the exhaust air ducts, in the lower part of pump room above the flooring.

When the hydrocarbon gas concentration reaches a pre-set level which shall not be higher than 10 per cent of the lower flammable limit, a continuous audible and visual signal shall be automatically effected in the pump room, engine control room, cargo control room and on the navigating bridge.

2.4.9 Control stations, cargo control stations, accommodation and service spaces (except for isolated cargo handling gear lockers) are to be positioned aft of all cargo tanks, slop tanks and spaces isolating cargo or slop tanks from machinery spaces, but not necessarily aft of the oil fuel tanks and ballast tanks, and are to be arranged in such a way that a single failure to a deck or bulkhead shall not permit the entry of gas or fumes from the cargo tanks into such spaces. The recess provided in accordance with 2.4.7 may be disregarded when determining the location of the said spaces.

Enclosed smoking rooms shall be provided within the accommodation area. These spaces shall be formed by "B-15" class divisions, and facings shall be made of materials having low flame spread characteristics.

2.4.10 Where deemed necessary and on agreement with the Register, control stations, cargo control stations, accommodation and service spaces may be positioned forward of the cargo tanks, slop tanks and spaces which isolate cargo tanks and slop tanks from machinery spaces but not necessarily forward of oil fuel tanks or ballast tanks. Machinery spaces other than category A may be permitted forward of the cargo tanks and slop tanks provided they are isolated from the cargo tanks and slop tanks by cofferdams, pump rooms, oil fuel tanks or ballast tanks.

All of the above-mentioned spaces shall be subject to an equivalent standard of safety and appropriate availability of fire-extinguishing arrangements. Control stations, cargo control stations, accommodation and service spaces shall be arranged in such a way that a single failure of a deck or a bulkhead shall not permit the entry of gas or fumes from the cargo tanks into such spaces. In addition, where deemed necessary for the safety of navigation of the ship, machinery spaces containing internal combustion engines not being main propulsion machinery having output greater than 375 kW may be located forward of the cargo area.

2.4.11 No access holes to oil fuel tanks located in the double bottom below cargo tanks are permitted in cargo tanks and in the machinery space.

2.4.12 Means shall be provided to keep deck spills away from the accommodation and service spaces. This may be accomplished by provision of a permanent continuous coaming of a height at least 300 mm from side to side. Similar measures and arrangements shall be provided for stern loading.

2.4.13 Manholes, openings for cleaning cargo tanks and other openings shall not be arranged in completely enclosed or in semienclosed spaces.

2.4.14 Deck openings for the ropes supporting the repair suspension sites shall comply with the following requirements:

.1 the number and arrangement of the openings are subject to special consideration by the Register. These openings shall be easily accessible for inspection and maintenance.

Deck holes shall be so tapped as to achieve a smooth transition on the upper and lower surfaces of the deck plate;

.2 closures for openings shall be metal thread plugs. Metal plugs shall have the fine thread with the sufficient number of threads in the joint;

.3 plugs and threaded joints shall be manufactured of material resistant to sea atmosphere and any cargoes carried in the ship;

.4 spare plugs shall be provided in any ship in the number not less than 10 per cent of the total number of openings;

.5 special tool shall be used to make the torque moment necessary for tightening the plugs and to set the efficient tightness;

.6 as for the tightness to cargo, the closures shall comply with the requirements of 7.11.3, Part III "Equipment, Arrangements and Outfit".

2.4.15 The following requirements are to be also met in combination carriers:

.1 the slop tanks are to be surrounded by cofferdams, except where the boundaries of the slop tanks are the hull, main cargo deck, cargo pump room bulkhead or oil fuel bunker tank. These cofferdams are not to be open to a double bottom, pipe tunnel, pump room or other enclosed space, as well as they shall not be used for carriage of cargo or ballast and they need not be connected with cargo or ballast systems.

Means are to be provided for filling the cofferdams with water and draining them.

Where the boundary of the slop tank is the cargo pump room bulkhead, the pump room is not to be open to the double bottom, pipe tunnel or other enclosed space. However, openings provided with gastight bolted covers may be permitted;

.2 hatches and tank cleaning openings to slop tanks are to be only permitted on the open deck; they are to be fitted with closing arrangements, except where they consist of bolted plates with bolts at watertight spacing. Closing arrangements shall be fitted with securing devices controlled by responsible person out of ship officers;

.3 an approved fixed gas warning system capable of monitoring flammable vapours is to be provided in cargo pump rooms, pipe ducts and cofferdams adjacent to slop tanks, referred to in 2.4.7.

Suitable arrangements are to be made to facilitate measurement of flammable vapours in all other spaces within the cargo tank area. Such measurements are to be made possible from open deck or easily accessible positions;

.4 arrangement of openings for cargo handling operations in decks and bulkheads separating the spaces for the carriage of oil and oil products from the spaces not intended or fitted for their carriage is permitted only provided equivalent tightness for oil products and their vapours is ensured;

.5 detailed instructions are to be exhibited on board, covering safety measures to be taken during loading or unloading of the ship and when dry cargoes are carried with oil product residues in the slop tanks.

2.4.16 Where the electrochemical protection is fitted on the ship it shall comply with the following requirements:

.1 where the electrochemical protection of structures or their elements is fitted, anodes can be made of zinc, magnesium or aluminium alloys as well as of steel in accordance with the RS-approved standards;

.2 where dissolving anodes are secured the resistance shall be not more than 0,02 ohm provided their fastening does not provide for variable resistance or if resistance is required to reduce protection potential;

.3 magnesium alloy anodes used for protection of unpainted elements of structures made of light metals shall be shielded by blinds which do not conduct electricity.

Additional painting shall be applied where magnesium alloy anodes are used on the suspended steel and aluminium structures;

.4 magnesium alloy anodes and electrochemical protection systems with superimposed current are not permitted in oil cargo tanks and tanks adjacent to them of ships carrying oil products.

Use of magnesium alloy anodes in other places of possible concentration of combustible compounds is allowed upon the Register approval;

.5 aluminium alloy anodes are only permitted in cargo tanks and tanks adjacent to cargo tanks of ships carrying oil products in locations where the potential energy does not exceed 275 J. The height of the anode shall be measured from the bottom of the tank to the centre of the anode, and its weight shall be taken as the weight of the anode as fitted, including the fitting devices and inserts.

However, where aluminium alloy anodes are located on horizontal surfaces such as bulkhead girders and stringers not less than 1 m wide and fitted with an upstanding flange or face flat projecting not less than 75 mm above the horizontal surface, the height of the anode may be measured from the surface.

Aluminium alloy anodes shall not be located under tank hatches or openings (in order to avoid any metal parts falling on the fitted anodes), unless protected by adjacent structure;

.6 the anodes shall have steel covers and these shall be sufficiently rigid to avoid resonance in the anode support and be designed so that they retain the anode even when it is wasted. Anodes shall be fitted with delimiters from sides and bottom made of the material which does not spark while contact with the anode. The steel inserts shall be attached to the structure by means of a continuous weld of adequate section. Alternatively they may be attached to separate supports by bolting, provided a minimum of two bolts with locknuts are used.

However, the ways of attachment are subject to special consideration by the Register.

The supports at each end of an anode shall not be attached to separate items which are likely to move independently.

2.5 SHIPS SERVING OIL TANKERS

2.5.1 The requirements of this Chapter are additional to those set forth in 2.1 and apply to oil lighters and harbour vessels serving oil tankers carrying flammable liquids.

2.5.2 Rubbing strakes shall be made of, or faced with, materials precluding spark formation.

Rubbing strakes shall not be fastened to the shell plating by means of through bolts.

2.5.3 The use of strake fenders with the outside surface formed by steel ropes is not permitted.

2.6 SPECIAL PURPOSE SHIPS

2.6.1 The requirements of this Chapter are additional to those set forth in 2.1.

2.6.2 For ships carrying not more than 50 persons of special personnel the fire protection requirements for cargo ships more than 500 gross tonnage are to be applied.

2.6.3 For ships carrying more than 50, but not more than 200 persons of special personnel the fire protection requirements for passenger ships carrying not more than 36 passengers are to be applied.

2.6.4 For ships carrying more than 200 persons of special personnel the fire protection requirements for passenger ships carrying more than 36 passengers are to be applied.

2.6.5 The minimal fire integrity of bulkheads and decks dividing the working spaces (see 1.5.8) of ships mentioned in 2.6.2 and 2.6.3 is to be in conformity with the requirements of 2.3.3 where service spaces of categories (*5*) and (*9*) respectively are concerned, and for ships mentioned in 2.6.4 it is to be in conformity with the requirements of 2.2.1.3 for spaces of categories (*10*) and (*14*) respectively.

2.7 OIL TANKERS (>60°C)

2.7.1 The requirements of this Chapter are additional to the requirements of 2.1 and 2.3 and apply to ships of 500 gross tonnage and upwards.

2.7.2 Cargo tanks shall not be adjacent to accommodation spaces.

2.7.3 No doors leading to accommodation spaces shall be permitted in the front bulkhead of superstructures and deckhouses.

2.7.4 A continuous coaming not less than 150 mm high extending from side to side shall be fitted on the upper deck at a distance of about 2 m from a superstructure where accommodation and service spaces are arranged.

2.7.5 Machinery spaces of category A shall be arranged aft beyond cargo and slop tank area.

2.7.6 Where cargo heating arrangements are fitted, provision is to be made to prevent cargo from heating up to the temperature by 15°C less than the flash temperature.

2.8 SHIPS CARRYING DANGEROUS GOODS

2.8.1 The requirements of this Chapter are additional to those set forth in 2.1, 2.2, 2.3, 2.6, 3.1.2.1 and apply to the following types of ships and cargo spaces:

.1 ships and cargo spaces not specially designed for the carriage of freight containers but intended for the carriage of dangerous goods in packed form including goods in freight containers and portable tanks;

.2 purpose-built container ships and cargo spaces intended for the carriage of dangerous goods in freight containers and portable tanks;

.3 ro-ro ships and ro-ro cargo spaces intended for the carriage of dangerous goods;

.4 ships and cargo spaces intended for the carriage of solid dangerous goods in bulk;

.5 ships and cargo spaces intended for the carriage of dangerous goods other than liquids and gases in bulk in shipborne barges.

Cargo ships of less than 500 gross tonnage shall comply with these requirements; however, these requirements may be reduced, and such reduced requirements shall be recorded in the ship documents referring to carriage of dangerous goods.

In addition to the requirements of the present Chapter the requirements of the IMDG Code for the packaged cargoes and of Code of Safe Practice for Solid Bulk Cargoes (BC Code) for solid bulk cargoes.

2.8.2 Depending on the modes of carriage of dangerous goods the requirements of Table 2.8.2-1 shall apply; depending on the class of dangerous goods the requirements of Table 2.8.2-2 shall apply; depending on the class of dangerous goods other than those carried in bulk the requirements of Table 2.8.2-3 shall apply.

2.8.3 The water fire main system is to comply with the following additional requirements:

.1 to ensure immediate availability of water supply at the required pressure either by permanent pressurization in the fire main or by suitably placed remote arrangements for the fire pumps from the locations referred to in 3.2.3.9;

.2 to ensure the supply of the quantity of water to four nozzles with applicators provided on board under the pressure as specified in 3.2.1.1 to any part of the cargo spaces;

.3 to effectively cool a cargo space by a pressure water-spraying system with a rate of water supply specified in 3.4.2.1 or by flooding the cargo space with water (see 3.6.4).

Hoses capable to ensure the delivery of the required quantity of water may be used for this purpose in small cargo spaces.

In any event the drainage and pumping arrangements shall be such as to prevent the build-up of free surfaces. If this is not provided, a calculation is to be made to prove that the ship with the cargo space flooded with water complies with the requirements of Sections 2 and 3, Part V "Subdivision";

.4 in lieu of the compliance with the requirements of 2.8.3.3 cargo space may be flooded with high expansion foam as specified in 3.7.3, using a supply rate and time

Table 2.8.2-1

Ships and cargo spaces Requirements of paragraphs	Weather deck of ships and cargo spaces listed in 2.8.1.1 to 2.8.1.5	Ships not specifically designed (see 2.8.1.1)	Container cargo spaces (see 2.8.1.2)	Closed cargo spaces as given in 1.5.4.3.1[1] (see 2.8.1.3)	Open cargo spaces as given in 1.5.4.3.2 (see 2.8.1.3)	Ships for the carriage of solid dangerous goods in bulk (see 2.8.1.4)	Shipborne barges (see 2.8.1.5)
2.8.3.1	+	+	+	+	+	For application of the requirements of 2.8 to different classes of dangerous goods, see Table 2.8.2-2	+
2.8.3.2	+	+	+	+	+		—
2.8.3.3	—	+	+	+	+		+
2.8.3.4	—	+	+	+	+		+
2.8.4	—	+	+	+	+		+[3]
2.8.5	—	+	+	+	—		+[3]
2.8.6.1	—	+	+[2]	+	—		+[3]
2.8.6.2	—	+	+[2]	+	—		+[3]
2.8.7	—	+	+	+	—		—
2.8.8.1	+	+	+	+	+		—
2.8.8.2	+	+	+	+	+		—
2.8.9	+	+	—	—	+		—
2.8.10	+	+	+[4]	+	+		—
2.8.11	—	—	—	+[5]	+		—
2.8.12	—	—	—	+	—		—
2.8.13	—	—	—	+	—		—

[1] Special category spaces shall be treated as closed ro-ro cargo spaces when dangerous goods are carried.

[2] This requirement is not applicable to carriage of dangerous goods of classes 4 and 5.1 in closed freight containers. For classes 2, 3, 6.1 and 8 when carried in closed freight containers the ventilation rate may be reduced to not less than two air changes. For the purpose of this requirement a portable tank is a closed freight container.

[3] In special cases where the barges are capable of containing flammable vapours or alternatively if they are capable of discharging flammable vapours to a safe space outside the barge carrier compartment by means of ventilation ducts connected to the barges, these requirements may be reduced or waived, which is subject to special consideration by the Register.

[4] Applicable to decks only.

[5] Applies only to closed cargo spaces as given in 1.5.4.3.1, not capable of being sealed.

Note: Wherever + appears in the table, it means that this requirement is applicable to all classes of dangerous goods as given in the appropriate line of Table 2.8.2-3, except as indicated in the footnotes.

Table 2.8.2-2

Class of dangerous goods / Requirements of paragraphs	4.1	4.2	4.3 [1]	5.1	6.1	8	9
2.8.3.1	+	+	—	+	—	—	+
2.8.3.2	+	+	—	+	—	—	+
2.8.4	+	+[2]	+	+[3]	—	—	+[3]
2.8.6.1	—	+[2]	+	—	—	—	—
2.8.6.2	+[4]	+[2]	+	+[2, 4]	—	—	+[2, 4]
2.8.6.3	+	+	+	+	+	+	+
2.8.8	+	+	+	+	+	+	+
2.8.10	+	+	+	+[2]	—	—	+[5]

[1] The hazards of substances in this class which may be carried in bulk are such that special consideration shall be given to the construction and equipment of the ship involved in addition to meeting the requirements of this table.

[2] Only applicable to oilcake containing solvent extractions, ammonium nitrate and ammonium nitrate fertilizers.

[3] Only applicable to ammonium nitrate and ammonium nitrate fertilizers. However, the degree of protection in accordance with the standards contained in the International Electrotechnical Commission, publication 79 — Electrical Apparatus for Explosive Gas Atmospheres, is sufficient.

[4] Only suitable wire mesh guards are required.

[5] The requirements of BC Code are sufficient.

of continuous supply according to Table 3.7.1.3 for machinery and other spaces except for spaces intended for the carriage of dangerous cargoes reacting with water.

2.8.4 Electrical equipment shall comply with the requirements of 2.9.3, 2.9.9, 2.9.10, 2.9.12, 16.8.1.6, 16.8.4.5 and 16.8.6.1, Part XI "Electrical Equipment".

Any other equipment which may constitute a source of ignition of flammable vapours shall not be permitted.

2.8.5 Ro-ro cargo spaces shall be fitted with a fixed fire detection and fire alarm system complying with the requirements of 4.2.1. All other types of cargo spaces shall be fitted with either a fixed fire detection and fire alarm system complying with the requirements of 4.2.1 or a sample extraction smoke detection system complying with the requirements of 4.2.1.6. If a sample extraction smoke detection system is fitted, measures are to be taken to prevent penetration of the contaminated air in case of the gas leakage into the spaces where the equipment is installed. A notice plate indicating that the samples are discharged into the atmosphere shall be installed in such spaces.

2.8.6 Ventilation of cargo spaces shall comply with the following requirements of Part VIII "Systems and Piping":

.1 arrangement of the ventilation system, with the requirements of 12.17, 12.1.8, 12.7.1, 12.7.3 and 12.7.5;

.2 construction of ventilation fans, with the requirements of 12.7.4;

.3 at least natural ventilation system in compliance with the requirements of 12.7.2 shall be provided in enclosed ro-ro spaces intended for the carriage of solid dangerous goods in bulk.

2.8.7 The bilge system shall comply with the requirements of 7.14.1, Part VIII "Systems and Piping".

2.8.8 Ships shall be provided with the following personnel protection outfit (in addition to the fireman's outfits required by item 10, Table 5.1.2):

.1 four sets of full protective clothing resistant to chemical exposure and intended for use in emergency situations. Subject to cargo characteristics the protective clothing shall meet International Marine Dangerous Goods Code (volume "SUPPLEMENT", section "EMERGENCY PROCEDURES") or Code of Safe Practice for Solid Bulk Cargoes (Appendix E);

.2 at least two self-contained breathing apparatuses and spare cylinders for them (see 5.1.15.2).

2.8.9 Portable fire extinguishers with a total capacity of at least 12 kg of dry powder or equivalent shall be provided for the cargo spaces. These extinguishers shall be in addition to any portable fire extinguishers required elsewhere in this Part of the Rules.

2.8.10 Bulkheads forming boundaries between cargo spaces and machinery spaces of category A shall be insulated to "A-60" standard, unless dangerous goods are stowed at least 3 m horizontally away from such bulkheads. Other boundaries between such spaces shall be insulated to "A-60" standard.

When a cargo room is partially located above the engine room of category A and bounding structures don't have required insulation, such cargo room is unfit for carriage of dangerous cargoes. The same refers to areas of bare open deck located above the engine room of category A.

2.8.11 Each open ro-ro cargo space having a deck above it and each space deemed to be a closed ro-ro space not capable of being sealed shall be fitted with an approved fixed pressure water-spraying system for manual operation which shall protect all parts of any deck and vehicle platform in such space. However, the см.Б1 Table 2.8.2-3

Class of dangerous goods / Requirements of paragraphs	1.1 to 1.6	1.4S	2.1	2.2	2.3	3.1, 3.2	3.3	4.1	4.2	4.3	5.1	5.2	6.1				8				9
													liquids	liquids (⩽23°C)	liquids (>23 ⩽61°C)	solids	liquids	liquids (⩽23°C)	liquids (>23 ⩽61°C)	solids	
2.8.3.1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2.8.3.2	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	—
2.8.3.3	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2.8.3.4	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2.8.4	+	—	+	—	—	+	—	—	—	—	—	—	—	+	—	—	—	+	—	—	—
2.8.5	+	+	+	+	+	+	+	+	+	+	+	—	+	+	+	+	+	+	+	+	—
2.8.6.1	—	—	+	—	+	+	—	+[1]	+[1]	+	+[1]	—	—	+	+	+[1]	—	+	+	—	+[1]
2.8.6.2	—	—	+	—	—	+	—	—	—	—	—	—	—	+	+	—	—	+	+	—	—
2.8.7	—	—	—	—	—	+	—	—	—	—	—	—	+	+	+	—	—	+	—	—	—
2.8.8	—	—	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+[2]
2.8.9	—	—	—	—	—	+	+	+	+	+	+	—	—	+	+	—	—	+	+	—	—
2.8.10	+[3]	—	+	+	+	+	+	+	+	+	+[4]	—	—	+	+	—	—	+	+	—	—
2.8.11	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2.8.12	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
2.8.13	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

[1] When "mechanically-ventilated" spaces are required by IMDG Code (Resolution A.716(17), as amended).

[2] As appropriate to the goods being carried.

[3] Stow 3 m horizontally away from the machinery space boundaries in all cases.

[4] Refer to IMDG Code.

Register may permit the use of any other fixed fire-extinguishing system that has been shown by full-scale test to be not less effective (see 1.3.3). In any case the drainage and pumping arrangements shall be such as to prevent the build-up of free surfaces. If this is not possible the adverse effect upon stability of the added weight and free surface of water shall be taken into account to the extent deemed necessary by the Register in its approval of the stability information.[1]

2.8.12 In ships having ro-ro cargo spaces, separation shall be provided between a closed ro-ro cargo space and an adjacent open ro-ro cargo space. The separation shall be such as to minimize the passage of dangerous vapours and liquids between such spaces. Alternatively, such separation need not be provided if the ro-ro cargo space is considered to be a closed cargo space over its entire length and shall fully comply with the relevant special requirements of this Chapter.

2.8.13 In ships having ro-ro cargo spaces, separation shall be provided between a closed ro-ro cargo space and the adjacent weather deck. The separation shall be such as to minimize the passage of dangerous vapours and liquids between such spaces. Alternatively, such separation need not be provided if the arrangements of the closed ro-ro spaces are in accordance with those required for the dangerous goods carried on the adjacent weather deck.

2.8.14 Cargo spaces in ships other than ro-ro ships shall not be adjacent to accommodation and service spaces, except service spaces with low fire risk referred to in 1.5.3.2.4.

2.8.15 Hatch covers of dry-cargo holds shall comply with the requirements of 7.10.8.6, Part III "Equipment, Arrangements and Outfit".

2.9 SHIPS OF GLASS-REINFORCED PLASTIC

2.9.1 The requirements of the present Chapter apply to the ships whose hull and superstructures have been manufactured of structural glass-reinforced plastic having low flame spread characteristics. The requirements set forth in 2.1.1 to 2.1.6, 2.1.9 (except for 2.1.9.1), 2.1.12 and 2.1.13 shall be fulfilled to the extent which is reasonable for the glass-reinforced plastic ships.

2.9.2 In passenger ships the following decks and bulkheads shall be constructed as "A-30" class division with the difference that their core is made of glass-reinforced plastic and the standard fire test may last 30 min instead of 1 hour:

.1 bulkheads and decks separating machinery spaces of category A from adjacent spaces;

.2 bulkheads and decks separating control stations from adjacent spaces containing a combustible medium;

.3 crowns of machinery spaces;

.4 side shell plating in way of machinery spaces from the level 200 mm below the waterline to the crown of the machinery spaces;

.5 bulkheads and decks separating spaces referred to in 1.5.3.1.1, 1.5.3.2.2 and 1.5.3.2.3 from adjacent spaces containing a combustible medium;

.6 bulkheads and decks in way of stowage of lifeboats and liferafts.

2.9.3 In other ships divisions referred to in 2.9.2 shall be constructed as "A-15" class divisions with the difference that their core is to be made of glass reinforced plastic and the standard fire test may last 30 min instead of 1 hour.

2.9.4 Insulation of divisions referred to in 2.9.2 and 2.9.3 shall be such that the temperature of the glass-reinforced plastic core by the end of a half an hour (see 2.9.2) and 15 min (see 2.9.3) standard fire test, respectively, does not exceed the level at which the glass-reinforced plastic strength is reduced to 50 per cent of the original value.

2.9.5 Insulating materials, grounds, supports, linings of bulkheads and ceilings shall be made of non-combustible materials.

Bulkheads, linings of sides and ceilings may be faced with combustible materials having low flame spread characteristics and being not more than 1,5 mm in thickness.

2.9.6 Desks, wardrobes and similar furniture, as also frames of other furniture shall be made of non-combustible materials.

Such furniture may be faced with combustible materials of not more than 1,5 mm in thickness.

2.9.7 Bulkheads of corridors in accommodation and service spaces shall be of "B-15" class.

2.9.8 The requirements set forth in 12.2.4 and 13.7.4, Part VIII "Systems and Piping" and the requirements of Part XVI "Hull Structure and Strength of Glass-Reinforced Plastic Ship and Boats" shall also be taken into account.

2.10 SHIPS FOR CARRIAGE OF MOTOR VEHICLES WITH FUEL IN THEIR TANKS FOR THEIR OWN PROPULSION

2.10.1 The requirements of this Chapter are additional to those set forth in 2.1 and 2.3 and apply to cargo spaces in which motor vehicles with fuel in their tanks are carried.

The requirements are framed on the understanding that motor vehicles are efficiently secured to preclude their displacement during the voyage, the quantity of fuel in tanks does not exceed the value established by competent bodies and no dangerous cargoes are carried in the same space where motor vehicles are transported.

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[1] Refer to Recommendation on fixed fire-extinguishing systems for special category spaces adopted by IMO Resolution A.123(V).

Where motor vehicles are to be carried together with dangerous goods, the requirements of 2.8 are to be met.

2.10.2 Entrances to cargo spaces from accommodation machinery and special electrical spaces are to be fitted with permanently closed self-closing doors. The height of door sills shall be not less than 450 mm.

2.10.3 There shall be provided notices at the entrances to cargo spaces, prohibiting smoking.

2.10.4 Cargo spaces shall meet the requirements of 4.2.1, 4.2.2.2, 4.14, Tables 5.1.2 and 5.1.14.3 of this Part, as well as of 12.6, Part VIII "Systems and Piping", 19.3, Part XI "Electrical Equipment".

2.11 OIL RECOVERY SHIPS AND BILGE WATER REMOVING SHIPS

2.11.1 The requirements of this Chapter are additional to those stated in 2.1 and apply to oil recovery ships.

For an oil recovery ship (>60°C), the requirements stated in 2.3, as well as in 2.7.2, 2.7.3, 2.7.5, 2.11.2, 2.11.20 are applicable.

The fire fighting outfit of such ships shall include additionally two portable foam sets to protect the cargo tank deck.

2.11.2 The hull, superstructures, deckhouses and decks shall be manufactured of steel.

The use of aluminium alloys for this purpose is not permitted.

2.11.3 In all ship's spaces the insulating materials shall be of a non-combustible type.

2.11.4 The mass of combustible materials used for the purposes specified in 2.1.1.4 shall not exceed 30 kg per 1 m^2 deck area of control stations, accommodations and service spaces.

2.11.5 To apply structural fire protection, suitable requirements specified in 2.4.2 to 2.4.5, 2.4.7 to 2.4.10 shall be complied with.

2.11.6 Fire integrity decks and bulkheads of the enclosed spaces intended for removable equipment used for oil products recovery shall comply with the requirements of 2.4.2 (Tables 2.4.2-1 and 2.4.2-2 as applicable to category (*9*) spaces).

2.11.7 The spaces intended for electrical and gas welding works shall be safe for operation (see 4.2.9, Part VII "Machinery Installations").

2.11.8 In addition to the requirements of 2.4.7, the spaces intended for removable equipment which is applicable for oil recovery shall be used as cofferdams.

On agreement with the Register, for ships of restricted area of navigation the cofferdams need not be provided between the machinery spaces of Category A and cargo tankers on condition that the bulkhead is constructed from the solid plate, access for inspection is ensured and hydraulic tests are carried out during each special survey.

2.11.9 The ship shall be provided with the water drenching system for drenching of superstructure outside walls according to 3.6 with the rate of water discharge 10 1/min/m and with the foam fire extinguishing system of cargo tanks having regard for the requirements of 3.1.3 and 3.7.

2.11.10 The water fire main system shall comply with the following additional requirements:

.1 it shall be applicable to the oil tankers in compliance with the requirements of 3.2.5.4;

.2 to supply water by fire pumps only from the bottom sea valve;

.3 to provide remote control of fire pumps and water drenching system of superstructure outside walls from the navigating bridge.

2.11.11 The remote control of supply of an extinguishing medium into machinery spaces shall be provided from the navigating bridge; in this case, fire fighting station need not be provided with direct access to the open deck.

2.11.12 The control of supply of an extinguishing medium need not be provided with time delay arrangement mentioned in 4.3.3.

2.11.13 The high expansion foam system shall not be used for protection of machinery spaces.

2.11.14 If steam smothering system is used in ships of less than 2000 gross tonnage the amount of carbon dioxide for machinery spaces shall be calculated according to 3.8.1.1 where factor shall be equal to 0,35 and 0,4 respectively.

2.11.15 The enclosed spaces for removable equipment used for oil products recovery shall be protected by means of fire extinguishing system according to item 6 of Table 3.1.2.1.

2.11.16 For small multi-purpose ships (up to 1000 tons deadweight) periodically engaged in recovery of oil products at the sea surface, the fixed automatic system for atmosphere monitoring may be replaced, on agreement with the Register, by a periodic duty monitoring system with portable analyzers specified in 15.1 of Table 5.1.2.

Atmosphere monitoring shall be applied during the whole period of stay of the ship within the oil spot in locations specified in 2.11.17.

2.11.17 Sampling arrangements or detectors of the atmosphere monitoring system shall be located as follows:

.1 near the forced ventilation openings;

.2 at least at two locations at a height not more than 1 m above the open deck;

.3 in machinery space of category A;

.4 in air locks;

.5 in cofferdams adjacent to cargo tanks.

2.11.18 Fire fighting outfit, spares and tools shall be prescribed in the quantities provided for oil tankers; in this case, only a self-contained breathing apparatus may be included in the fireman's outfit.

2.11.19 For protection of working area of the deck two dry power fire extinguishers shall be installed with the mass of dry power being 45 kg each.

2.11.20 Fixed or portable instruments for determining the ignition temperature of oil products shall be provided in the ship.

2.11.21 The requirements of 9.4, 11.1.9 and 12.13, Part VIII "Systems and Piping"and those of 19.2, Part XI "Electrical Equipment" shall be taken into account.

2.12 BERTH-CONNECTED SHIPS

2.12.1 The requirements of the Chapter supplement those of 2.1 to 2.3.

2.12.2 Floating hostels accommodating more than 200 persons and floating hotels.

2.12.2.1 The fire protection of floating hostels accommodating more than 200 persons and of floating hotels is to be similar to that of passenger ships carrying not more than 36 passengers.

2.12.2.2 When applying Tables 2.2.1.5-1 and 2.2.1.5-2, the following shall be considered:

.1 instead of the term "special category spaces" the term "sanitary spaces" shall be used. Sanitary spaces shall be separated from adjacent spaces by "A-0" class bulkheads except for adjacent spaces of categories (*2*) and (*5*) where "B-0" class bulkheads may be fitted and of categories (*3*) and (*11*) where "C" class bulkheads may be fitted. The decks separating sanitary spaces from adjacent spaces are to be "A-0" class except for spaces of categories (*3*), (*10*), (*11*) lying below and spaces of categories (*3*), (*5*), (*10*), (*11*) lying above where decks of steel or another equivalent material are permitted which may not be "A" class decks;

.2 the space in which the emergency power source or parts thereof are contained shall be separated from an adjacent space containing the generating plant or part thereof by "A-60" class divisions.

2.12.2.3 The water fire main system shall comply with the requirements for the water fire main system of passenger ships irrespective of gross tonnage and considering the following:

.1 at least two permanent fire pumps shall be provided, independently driven and each having a separate sea valve, which are to be so arranged that a fire in any one space will not put both pumps out of action. No emergency fire pump may be provided.

With great suction lift, water may be taken by the pumps from tanks in which sea water is stored and which are filled by other pumps;

.2 one of the pumps shall be intended for fire fighting purposes only;

.3 total output of the pumps need not exceed 180 m^3/h.

2.12.3 Floating hostels accommodating 200 persons or less.

2.12.3.1 The fire protection of floating hostels accommodating 200 persons or less as well as of floating workshops, floating power plants and floating warehouses is to be similar to that of cargo ships of more than 500 gross tonnage.

2.12.3.2 When applying Tables 2.3.3-1 and 2.3.3-2, the following shall be considered:

.1 instead of the term "ro-ro cargo spaces"the term "sanitary spaces" shall be used. Sanitary spaces shall be separated from adjacent spaces by "A-0" class bulkheads except for adjacent spaces of categories (*2*) and (*5*) where "B-0" class bulkheads may be fitted and of categories (*3*) and (*11*) where "C" class bulkheads may be fitted.

The decks separating sanitary spaces from adjacent spaces are to be "A-0" class except for spaces of categories (*3*), (*10*), (*11*) lying below and spaces of categories (*3*), (*5*), (*10*), (*11*) lying above where decks of steel or another equivalent material are permitted which may not be "A" class decks;

.2 the space in which the emergency power source or parts thereof are contained shall be separated from adjacent spaces in conformity with 2.12.2.2.2.

2.12.3.3 The water fire main system shall comply with the requirements of 2.12.2.3. On agreement with the Register, a water fire main system with one of the pumps started remotely may be permitted in accordance with 3.2.3.9.

2.12.4 Floating docks, electric power plants, workshops and warehouses.

2.12.4.1 The fire protection of the above ships is to be similar to that of cargo ships of more than 500 gross tonnage taking into consideration 2.12.3.2.

2.12.4.2 The water fire main system of floating electric power plans, work-shops and warehouses is to comply with the requirements of 2.12.3.3, and in case of floating docks — with the requirements of 3.1.2.8.

2.13 SHIPS HAVING A DISTINGUISHING MARK OF PROVISION WITH MEANS FOR FIRE FIGHTING ABOARD OTHER SHIPS

2.13.1 The requirements of this Chapter are additional to those contained in 2.1 and 2.3.

2.13.2 Hull, superstructures, deckhouses and decks shall be made of steel.

2.13.3 Whatever method of fire protection of accommodation and service spaces is used, the requirements of 2.3.4 apply to these ships.

2.13.4 Ships shall be provided with a fire and rescue operations control station. The control station shall be placed so that the ship structures do not impair, as far as practicable, the vision of the water area around the ship.

2.13.5 The ships shall have:

special systems and equipment, the minimum number of which is indicated in Tables 2.13.5-1 and 2.13.5-2;

Table 2.13.5-1

Special systems	Distinguishing mark in the class notation				
	П1	**П1В**	**П2**	**П2В**	**П3В**
Water-screen system[1]	—	+	—	+	+
Drenching system[1]	—	+	—	+	+
Water fire main system	+	+	+	+	+[2]
Foam fire fighting system	+	+	+	+	—[2]
Dry powder fire fighting system	+[3]	+[3]	+[3]	+[3]	+[3]
Bilge system[4]	+	+	+	+	—

[1] See 2.13.8.6.

[2] See 2.13.10.2.

[3] See 2.13.12.1.

[4] See 7.1.10, Part VIII "Systems and Piping".

Table 2.13.5-2

Special equipment	Distinguishing mark in the class notation		
	П1, П1В	**П2, П2В**	**П3В**
Pumps, in pcs	2 — 4	2 — 3	1
Monitors:			
water monitors, in pcs	4	3	2
with supply rate of each monitor, in m^3/hour	2500	1200	100[1]/500/1000
jet range, in m	150	120	80[1]/100/420
foam monitors, in pcs	2	—[2]	—[2]
Dry powder monitors[3], in pcs	1	1	1
Distribution valve manifolds, in pcs	4	4	2

[1] The smaller value is for ships referred to in 2.13.10.2.

[2] A necessity in installation and characteristics to be indicated by the customer in accordance with the requirements of 2.13.11.2.

[3] For ships referred to in 2.13.12.1.

items of fire fighting outfit in compliance with 2.13.13.1;

additional bilge arrangements (systems) in accordance with 7.1.10 and 13.7.7, Part VIII "Systems and Piping";

additional internal service communications in compliance with 7.2.2, Part XI "Electrical Equipment".

2.13.6 Special systems installed on board ships for fire fighting on other objects and for their own protection (water-screen, drenching, water fire main, foam fire-extinguishing, dry powder systems) shall also comply with the requirements of Section 3 of this Part and Sections 2, 4, 5, Part VIII "Systems and Piping".

Where special systems other than specified in this Section of the Rules are installed for fire fighting on other objects, they shall comply with the requirements of the Rules to the extent agreed upon with the Register in each particular case.

2.13.7 The equipment of special systems (pumps, fittings, monitors) may be remote-controlled from the fire and rescue operations control station.

Air-operated and hydraulic control systems shall be supplied from two independent sources of power.

Electrically driven items shall comply with the requirements of 5.1 to 5.3, Part XI "Electrical Equipment".

2.13.8 Water-screen system.

2.13.8.1 In ships having distinguishing marks **П1В**, **П2В** or **П3В** in the class notation vertical hull surfaces, including superstructures and deckhouses, shall be protected with the water-screen system.

The water-screen system shall totally cover the ship and not impede visibility from the wheelhouse, fire and rescue operations control stations and hand monitor platforms.

2.13.8.2 Doors and side scuttles of ships having distinguishing marks **П1**, **П2** in the class notation, which are not fitted with the above system, shall comply with the requirements of 7.2.1.10, Part III "Equipment, Arrangements and Outfit".

2.13.8.3 The capacity of the pumps serving the system shall be sufficient to supply water at a rate indicated in 3.5.

2.13.8.4 Where the system is subdivided into sections by shut-off valves manual operation shall be provided from the place of their installation in spite of the provision of the remote control.

2.13.8.5 The water-screen system shall protect the hand monitor platforms; the system is to be put into operation directly at each monitor.

2.13.8.6 The ship may be fitted with the water-screen system in combination with the drenching or pressure water-spraying system or one of these two systems provided they are capable to ensure adequate protection of the ship. In any case the letter "B" shall be retained in the class notation.

2.13.9 Drenching and pressure water-spraying systems.

2.13.9.1 The drenching and pressure water-spraying systems in ships having distinguishing marks **П1В**, **П2В** or **П3В** in the class notation shall protect vertical surfaces of the hull, superstructures and deckhouses as well as horizontal surfaces where it is appropriate with regard to 2.13.8.6.

2.13.9.2 The rate of water discharge to the protected surface shall be at least 10 litres/min for 1 m of the tier length where the drenching system is applied and 10 litres/min per 1 m^2 of the protected surface where the pressure water-spraying system is applied.

Intensity of the water discharge to the protected surfaces may be reduced to 5 litres/min for 1 m of the tier length where the drenching system is applied and 5 litres/min per 1 m^2 of the protected surface where the pressure water-spraying system is applied provided the protected surfaces are insulated to "A-60" type.

2.13.9.3 For protection of superstructures and deckhouses the sections of the system shall be arranged on each tier; the arrangement of spray nozzles shall ensure uniform discharge of water onto the protected outer surface.

Where the system is subdivided into the sections, the requirement of 2.13.8.4 shall be met.

2.13.10 Special water fire-extinguishing system.

2.13.10.1 The system is generally intended for water supply to water monitors, distribution valve manifolds, as well as for supply of water-screen and pressure water-spraying systems. The system may be used for pumping out the water from compartments of the ship in distress (see 7.1.10, Part VIII "Systems and Piping").

The requirements for installation of pumps, laying of pipes, water intake arrangements, fittings and tests shall comply with the provisions of this Part and of Part VIII "Systems and Piping" as far as reasonable and practicable with regard to the requirements given below.

2.13.10.2 The special water fire-extinguishing system in ships having distinguishing marks **П1**, **П1В**, **П2** or **П2В** in the class notation shall be independent.

In ships having distinguishing mark **П3В** in the class notation the ship water fire main system may be used as part of the special water fire-extinguishing system.

2.13.10.3 Availability of remote starting and control of the system shall not prevent starting of the pumps, control of monitors and fittings from the place of their installation (see Section 5, Part XI "Electrical Equipment").

Remote-controlled fittings shall have devices for their opening/closing during the time which allows to prevent water hammers.

2.13.10.4 Provision is to be made for operation of the pumps without overheating in case of no or small supply of water to consumers.

2.13.10.5 The number of monitors shall be not less than that indicated in Table 2.13.5-2 and their arrangement is to:

provide supply of water from each monitor to both sides of the ship;

prevent water from being discharged to the ship's own deck and its equipment;

provide the water jet range in accordance with Table 2.13.5-2.

2.13.10.6 Each monitor shall have an independent connection to the main of the system.

2.13.10.7 Distribution valve manifolds shall be arranged on the upper deck. The number of the valves on the manifold is to be specified by the designer upon agreement with the customer.

2.13.10.8 The capacity of the pumps is to be calculated so that water can be simultaneously delivered to monitors, the number of which is to comply with Table 2.13.5-2 depending on the distinguishing mark in the class notation.

2.13.11 Special foam fire-extinguishing system.

2.13.11.1 The special foam fire-extinguishing system shall be provided on ships which have distinguishing marks of provision with means for fire fighting aboard other ships.

The system may use totally or partly the equipment of the special water system (pumps, pipes, monitors). The number and type of the equipment of the foam fire-extinguishing system shall be specified by the designer on agreement with the customer.

2.13.11.2 Ships with distinguishing marks **П2**, **П2В** or **П3В** in the class notation may have the system fitted with air-foam monitors, foam generators or combination foam units; foam monitors may be omitted.

2.13.11.3 Ships with distinguishing marks **П1** or **П1В** in the class notation shall be fitted with foam monitors or foam nozzles for monitors of the special water fire system. The number of foam monitors is to be not less than that indicated in Table 2.13.5-2; the requirements for their installation shall be in line with those for monitors of the special water fire-extinguishing system.

2.13.11.4 The reserve of foam concentrate is to be calculated on the basis of the operating time of a specified number of foam generators or one monitor during at least 30 minutes.

2.13.11.5 The type of the foam concentrate shall be chosen with regard to:

water salinity in the ship service area prescribed;

class of liquids, materials or goods the concentrate is intended to extinguish (oil and petroleum products, alcohols, ketones, aldehydes, etc.).

2.13.12 Special dry powder system.

2.13.12.1 The system shall be generally installed on ships servicing the operation area of gas carriers and chemical tankers.

2.13.12.2 Applicable requirements of 3.10 also cover the special dry powder system.

2.13.12.3 The system shall be provided with at least one hand monitor with a capacity not less than 40 kg/s.

The monitor shall be placed on a special platform fitted with devices for remote starting of the system (see 2.13.8.5).

2.13.12.4 The quantity of the extinguishing powder shall be specified by the designer on agreement with the customer.

2.13.13 Fire outfit.

2.13.13.1 In addition to the fire fighting outfit indicated in Table 5.1.2, the following outfit shall be provided on board ships:

fireman's outfits;

fire hoses;

dual-purpose fire nozzles;

portable air-foam nozzles, foam generators or combination foam units;

international shore connections;

complete sets of fire fighting tools;

gas analyzers for flammable liquids and gases;

induced-draught fans.

The number and composition of the additional fire fighting outfit and spare parts thereto shall be specified by the designer on agreement with the customer.

2.13.13.2 Additional fire fighting outfit shall be kept in special storerooms. Part of the fire fighting outfit (hoses, hand nozzles, foam generators, air-foam nozzles, hose wrenches) may be placed at fire stations near each distribution valve manifold.

2.13.13.3 For charging cylinders of self-contained compressed air-operated breathing apparatus ships shall be provided with special compressors allowed for use by competent authorities.

The capacity and the number of simultaneously charged cylinders shall be specified by the customers. There must be at least four charged cylinders on board the ship.

In addition to the self-contained breathing apparatus of the above type, the customer may require provision of the ship with breathing apparatus using other principles for protection of respiratory tract.

2.14 SHIPS CARRYING PACKAGED IRRADIATED NUCLEAR FUEL, PLUTONIUM AND HIGH-LEVEL RADIOACTIVE WASTES (INF CARGO)

2.14.1 For the purpose of this Part, ships carrying INF cargo are assigned to the following three classes, depending on the total activity of INF cargo which is carried on board:

Class INF 1 ship is a ship, which is certified to carry INF cargo with an aggregate activity less than 4000 TBq.

Class INF 2 ship is a ship, which is certified to carry irradiated nuclear fuel or high-level radioactive wastes with an aggregate activity less than 2×10^6 TBq and ship, which is certified to carry plutonium with an aggregate activity less than 2×10^5 TBq.

Class INF 3 ship is a ship, which is certified to carry irradiated nuclear fuel or high-level radioactive wastes and ship, which is certified to carry plutonium with no restriction of the maximum aggregate activity of the materials. INF cargo that would be required to be carried on Class INF 3 ships shall not be allowed on passenger ships.

2.14.2 The damage trim and stability shall comply with the requirements of 3.4.9, Part V "Subdivision".

2.14.3 The ships, regardless of their size, shall be fitted with following systems and equipment:

.1 a water fire main system complying with the requirements of 3.2;

.2 fixed fire-extinguishing arrangements in machinery spaces of category A, complying with the requirements of Table 3.1.2.1;

.3 fixed cargo space cooling arrangements, complying with the requirements of 2.8.3.3. In Class INF 1 ships, instead of compliance with the requirements of 2.8.3.3, compliance with the requirements of 2.8.3.1 and 2.8.3.2 may be accepted as sufficient;

.4 a fixed fire-detection and fire alarm system, protecting the machinery spaces, accommodation and service spaces, complying with the requirements of 4.2.

2.14.4 In Class INF 3 ships, accommodation spaces, service spaces, control stations and machinery spaces of Category A shall be fitted forward or aft of the cargo spaces, due regard being paid to the overall safety of the ship.

2.14.5 Ships shall be provided with systems and equipment to ensure temperature control of cargo spaces, complying with the requirements of 12.7.8, Part VIII "Systems and Piping".

2.14.6 The ship hull structure shall comply with the requirements of Part II "Hull".

2.14.7 The INF cargo shall be secured on board ships in accordance with the requirements of the Guidelines for the Preparation of the Cargo Securing Manual.

2.14.8 The electrical equipment of the systems and arrangements referred to in 2.14.3.3 and 2.14.5 shall comply with the requirements of Part XI "Electrical Equipment".

The requirements for the emergency source of electrical power supply are set out in Section 9, Part XI "Electrical Equipment".

2.14.9 Depending upon the characteristics of the INF cargo to be carried and upon the design of the ship, additional arrangements or equipment for radiological protection are, if necessary, to be provided.

2.14.10 Every ship shall carry on board an approved shipboard emergency plan based on the Guidelines for developing shipboard emergency plans for ships carrying materials subject to the INF Code, adopted by IMO Resolution A.854(20).

2.14.11 Every ship shall carry on board equipment (individual personnel protection outfit, apparatus, etc) for use in an emergency. The type and amount of such equipment depends upon the INF cargo to be carried and to be specified by the shipboard emergency plan.

3 FIRE FIGHTING EQUIPMENT AND SYSTEMS

3.1 GENERAL REQUIREMENTS

3.1.1 General provisions.

3.1.1.1 The requirements of this Section are applicable to all fire fighting equipment and systems fitted in sea-going ships for the purpose of fire protection of the ship concerned.

Where provision is made in a ship for extra fire fighting systems in addition to those prescribed by this Section, such systems shall also comply with the requirements set out below, to an extent approved by the Register.

During design and manufacture of fire fighting systems requirements of Fire Safety Systems Code and

Sections 2, 4, 5, Part VIII "Systems and Piping" shall be complied with

3.1.1.2 Fire fighting equipment and systems shall be so constructed that they will be efficient and readily available for operation under all conditions of service (see 2.3.1, Part VII "Machinery Installations").

3.1.1.3 Cylinders for storage of fire extinguishing medium, except for tanks for storage of foam-making compound, which are not under pressure, pressure tanks, carbon dioxide cylinders, compressed air bottles, nitrogen and halon containers used in fire fighting systems shall meet the requirements for pressure vessels and air bottles set forth in 6.4, Part X "Boilers, Heat Exchangers and Pressure Vessels".

3.1.1.4 The use of a fire extinguishing medium which either by itself or under expected conditions of use gives off toxic gases in such quantities as to endanger the persons shall not be permitted.

3.1.2 Fire extinguishing systems.

3.1.2.1 In addition to the water fire main system and in accordance with the purpose for which they are intended, all ship's spaces shall be protected by one of the fixed fire extinguishing systems according to Table 3.1.2.1, unless expressly provided otherwise.

The Register may consider the use of other equivalent systems.

Fitting of the equivalent fire fighting system complying with the requirements of IMO MSC/Circ.848 is allowed in category "A" machinery spaces and pump rooms specified in 1.5.7.1 instead of the carbon dioxide smothering system.

3.1.2.2 Calculation of the required amount of the extinguishing medium is to be made for each protected space. The maximum calculation values shall be taken for the amount of stored extinguishing medium.

Where two or more adjacent spaces presenting different degrees of fire hazard are not separated by gastight or watertight bulkheads or decks, or where oil fuel can flow from one space into another and the possibility of such flowing is not eliminated structurally, the choice of extinguishing medium and, consequently, of a fire extinguishing system shall be made to comply with the requirements for the fire protection of the space which affords the greatest fire hazard, and the calculation of the required amount of extinguishing medium and the rate of application shall be made on the basis of the total area or volume, respectively, of all spaces thus communicating.

3.1.2.3 Watertight and gastight doors in the bulkhead separating adjacent machinery spaces may be considered as closures of openings in such bulkhead only where they are of a self-closing type or operated remotely and the fire extinction stations, from which the extinguishing medium may be discharged, are provided with the signalling of the fully closed doors. In the absence of such signalling, the calculation of the required amount and the rate of discharge of extinguishing medium shall be based on the requirement of providing for the total volume (area) of the adjacent spaces.

3.1.2.4 In multi-deck ships, one 'tweendeck is considered as separated from another 'tweendeck or hold by a gastight deck, provided the cargo hatchways, other hatchways and openings in this deck are closed with watertight or gastight steel hatch closures and covers, while watertight stops are fitted where the deck is pierced in way of the framing. In the absence of such closures and stops, the spaces shall be considered as communicating, and the extinguishing medium calculation shall be made on the basis of the total volume of the spaces.

3.1.2.5 Where a space protected by means of carbon dioxide and aerosol fire extinguishing system contains air reservoirs whose free air equivalent capacity is more than 30 per cent of the volume of the space (more than 10 per cent for Halon systems), the required quantity of extinguishing medium shall be calculated on the basis of the designed volume of the protected space plus the excess of the free volume of the compressed air. If arrangements are made for discharging the compressed air outside the protected space, by means of relief valves and fuses provided on the air reservoirs then an increase of the quantity of carbon dioxide in the carbon dioxide fire extinguishing systems need not be provided and the volume of the air in the air receivers in the aerosol fire extinguishing systems while assessment of the quantity of the aerosol generating compound may be not considered (see 3.11.1.3).

3.1.2.6 In order to prevent excessive pressure in spaces protected by fire smothering systems, due to discharge of extinguishing medium, such spaces shall be fitted with breather valves, where necessary, or other available means (e.g. air pipes or ventilation ducts) shall be used.

3.1.2.7 Spaces for oil fuel units (see item 18 of Table 3.1.2.1) enclosed inside machinery spaces may have either an independent fire extinguishing system or they may be protected by the fire extinguishing system of the machinery space.

3.1.2.8 Whatever a fixed fire extinguishing system is specified in Table 3.1.2.1 for boiler spaces of oil tankers in which crude oil or clops are used for boilers, provision is to be made for 136 l capacity foam extinguisher in compliance with 5.1.10 or an equivalent foam unit both equipped with fixed foam generators capable of delivering foam to the boiler fronts and to trap under burners, valves and connections. This fire extinguisher (unit) shall be remote operated from outside the boiler room.

3.1.2.9 The systems are to be so arranged as to provide the delivery of extinguishing medium to the entire space protected, including the enclosed portions thereof (e.g. control stations, workshops, etc. in machinery spaces).

Table 3.1.2.1

Nos	Description of spaces	Fixed fire extinguishing systems								
		Sprinkler system	Pressure water spraying	Water screens	Drenching	Foam fire extinguishing	Carbon dioxide smothering	Inert gas smothering	Dry powder fire extinguishing	Aerosol
1	Control stations listed in 1.5.1.1	+[1]								
2	Control stations listed in 1.5.1.2[2]		+			+	+		+	+
3	Accommodation spaces listed in 1.5.2.1 and 1.5.2.2	+[1]								
4	Service spaces listed in 1.5.3.1, 1.5.3.2.3 and 1.5.3.2.4	+[1]								
5	Storerooms listed in 1.5.3.2.1				+					
6	Storerooms listed in 1.5.3.2.2[3]		+			+[4]	+		+	+[5]
7	Cargo spaces listed in 1.5.4.3		+	+[6]		+[7,8]	+			
8	Tanks for petroleum products, see 1.5.4.1					+		+[9]		
9	Cargo spaces, see 1.5.4.2[7,10]		+[11,12]			+[4]	+	+		
10	Machinery spaces of category A[2,13,14], hangers and spaces where refuelling and hanger facilities are located		+			+[8]	+			+
11	Silencers of internal combustion engines, exhaust gas boilers and in smoke uptakes of steam boilers, regenerators of gas turbine installations[15] and exhaust ventilation ducts indicated in 2.1.10.7		+				+			
12	Unattended machinery spaces containing propulsion electric motors, steam engines or steam turbines having power output not less than 375 kW					+[8]	+			
13	Pump rooms listed in 1.5.7.1		+			+[8]	+[16]			
14	Working spaces listed in 1.5.8.1		+			+[8]	+			+
15	Fire zones of category A machinery spaces				+[17]					
16	Special category spaces listed in 1.5.9		+							
17	Cargo tank deck in gas carriers and cargo piping and cargo manifolds								+	
18	Rooms for separators, etc. and other spaces specified in 4.2.7, Part VII "Machinery Installations"		+			+[8]	+			+
19	Scavenge spaces of the crosshead type internal combustion engines (see 2.2.4, Part IX "Machinery")						+			
20	Area of forward and aft loading/unloading arrangements in oil tankers, helidecks					+				
21	Chain stoppers and cargo hose connections on oil tankers accommodated to mooring at point berths carried out to sea and fitted up with a forward cargo gear		+							
22	Corridors and stairways	+[18]								

[1] A sprinkler system is compulsory for passenger ships (see 4.2.1.2) and cargo ships only where method IIC fire protection is applied. At the control stations — on the agreement with the Register.

[2] For glass-reinforced plastic ships specified in 2.9 a carbon dioxide smothering system shall be used.

[3] Paint lockers and storerooms for flammable liquids, liquefied and compressed gases need not be fitted with a fixed fire extinguishing system, if the volume of each storage space is not more than 4 m^3.

[4] A system using medium expansion foam with expansion ratio of about 100:1 shall be used, except for the hangars for helicopters and enclosed garages where a system with foam expansion ratio about 1000:1 is to be employed.

[5] See 3.11.4.

[6] Water screens are used in addition to the systems specified in cols 4, 7 and 10 in cases indicated in 2.1.2.8.

Table 3.1.2.1 — continued

[7] A foam smothering system shall not be used for the protection of cargo spaces of container ships.

[8] A system using foam with expansion ratio of about 1000:1 shall be used.

[9] In oil tankers and combination carriers of 20000 tons deadweight and upwards, as well as in ships on which tanks are cleaned by crude oil washing system.

[10] Dry cargo spaces, subject to agreement with the Register need not be fitted with fire fighting systems (with issuance, therewith, of an Exemption Certificate in accordance with the regulation II-2/10.7.1.4 of the Convention SOLAS-74 with Amendments-2000 for ships covered by this Convention) in the following cases:

on passenger ships engaged in short voyages it shall be inexpedient to apply requirements of the 9th line of the Table;

on passenger ships of less than 1000 gross tonnage, which are fitted with steel hatch covers and effective closing arrangements of all fans and other openings in cargo spaces;

in cargo ships of less than 2000 gross tonnage not having any ro-ro cargo spaces and not fitted for the carriage of dangerous goods;

where the holds are intended only for the carriage of ore, coal, grain, green timber, non-combustible cargoes and cargoes of low fire risk. In this case, holds are to be fitted with steel hatch covers and effective means for closing ventilation terminals and other openings leading into the holds.

[11] Only in fish meal spaces. Other systems are not permitted for these purposes.

[12] Holds and 'tween decks fitted for carriage of explosives, in addition to fire smothering systems shall be provided with water-spraying system (except goods of subclass 1.4 and compatibility group S (see also Table 2.8.2, item 7.3, note 1). In the area of these holds the system shall be arranged by the ring circuit. Provision shall be made for free drainage of water from 'tween decks to holds.

[13] Where the machinery space along with other steam driven machinery contains only one diesel-generator and one diesel-driven compressor, such space need not be fitted with a fixed fire extinction system on condition that the place where this machinery is located is enclosed by efficient arrangement preventing the oil fuel from spreading all over the space and provision is made for portable foam set to be available near these sets for fire extinguishing purposes.

[14] Where an auxiliary oil-fired boiler or boilers as well as incinerators operating on fuel oil situated inside the machinery space is (are) not isolated from the rest of the space by gastight enclosure bulkheads and platforms, the machinery space shall be fitted with one of the above fire extinguishing systems, this system being capable of protecting the entire space, even where this machinery space does not contain any other oil-fired equipment or machinery, besides the above boilers.

[15] Installation of one of the above systems is compulsory for all ships carrying flammable liquids and ships that serve them, all ships carrying readily flammable dry cargoes, irrespective of their gross tonnage, and for all other ships with a total power of main and auxiliary machinery more than 740 kW.

[16] A warning notice shall be provided at the carbon dioxide smothering system controls stating that because of ignition hazard caused by electrostatic discharges the system must be used only for fire extinguishing but not for inerting purposes.

[17] See 3.1.6.

[18] The sprinkler system is compulsory only on passenger ships carrying more than 36 passengers.

3.1.2.10 The use of steam may be permitted by the Register depending on the particular case as an addition to the required fire-extinguishing medium; the boiler or boilers available for supplying steam shall have an evaporation of at least 1,0 kg of steam per hour for each 0,75 m^3 of the gross volume of the largest space so protected.

3.1.2.11 Where a gas other than carbon dioxide is used as a fire-extinguishing medium, it is to be a gaseous product of fuel combustion in which the content of oxygen, carbon monoxide corrosive elements and any solid combustible elements has been reduced to a permissible minimum.

Where such gas is used as the fire-extinguishing medium in a fixed fire-extinguishing system for the protection of machinery spaces, the system shall ensure protection equivalent to that provided by a fixed system using carbon dioxide as the medium (see also 3.9.1.1.1).

3.1.2.12 Liquid cargoes with the flash point above 60°C other than oil products or liquid cargoes liable to the requirements of IMO Code on Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk are treated as those with low fire risk and requiring no fixed foam fire extinguishing system.

3.1.2.13 For cargo ships which holds are fitted with non-weathertight hatch covers (see 3.2.14 of Load Lines Rules for Sea-Going Ships) the capacity of a fixed fire fighting system is to be increased by 10 per cent as compared to ships having weathertight hatch covers, provided clearances between hatch covers parts do not exceed 50 mm. Otherwise, a fixed pressure water spraying system is to be provided.

3.1.3 Arrangement and equipment of fire extinction stations.

3.1.3.1 Mechanical equipment, such as foam mixers, reservoirs, cylinders or vessels containing extinguishing medium or compressed air, inert gas generators, or high expansion foam generators, refrigerating plants, etc., as well as the starting controls of all fire extinguishing systems, except for the water fire main system, shall be arranged as a rule in fire extinction stations outside the protected spaces. см.Б1

Where the operation of any fire extinguishing system, other than the water fire main system, involves the operation of the water fire pump or pumps, such pump or pumps shall be located outside the space or spaces protected; the operation of such pump or pumps shall be independent of the operation of equipment located in the space concerned.

3.1.3.2 Fire extinction stations shall comply with the following requirements:

см.Б1 **.1** all fire extinction stations, other than those for machinery spaces, shall be positioned on the open decks or directly below them and shall have an independent means of access from the open deck. Fire extinction stations for machinery spaces may have no direct exit to the open deck only in case where provision is made for remote control of discharge of the extinguishing medium from the wheelhouse or another space provided with a direct exit to the open deck;

The means of controlling the fixed fire extinguishing system are to be readily accessible and are to be grouped in as few locations as possible at positions not likely to be cut off by a fire in the protected space;

.2 stations shall not be arranged forward of the collision bulkhead;

см.Б1 **.3** fire extinction stations shall be bounded by steel tight bulkheads, decks or enclosures;

.4 the spaces housing stations shall be protected by heat insulation and shall be fitted with heating, if it is essential for normal operation of the station that positive temperature is maintained therein. The temperature in the spaces housing carbon dioxide extinction stations shall not exceed +45°C;

.5 air temperature in the station shall be controlled by means of thermometer so fitted therein that its readings are visible both from inside the station and, through a scuttle, from outside the station; in case of remote control of temperature limit the scuttle need not be required;

.6 fire extinction stations for cargo spaces shall be provided with telephone or other means of communication with the main control fire station and with the machinery space, if operation of the fire extinction station is dependent on the equipment located in the machinery space;

.7 entrance doors shall be opened outwards and kept permanently locked doors leading to a station located in a space specially provided for the purpose must be permanently locked, and one set of keys for the locks must be kept in a closed case with a glazed door located near the lock;

.8 all valves and other arrangements of the station shall be provided with nameplates identifying them with the spaces whose protection is controlled by the individual valves or arrangements. In addition, a schematic plan of the fire extinguishing system showing the controls and the spaces protected, as well as brief instructions for starting and operating the system shall be displayed in a conspicuous position within the station.

3.1.3.3 In ships of less than 150 gross tonnage where arranging a fire extinction station outside the protected space is hardly feasible, as well as in special cases in ships under 500 gross tonnage where the volume of individual protected spaces does not exceed 100 m^3, reservoirs with fire extinguishing medium and pressure vessels may be fitted within a protected space on condition that such stations are provided with efficient remote control for immediately putting the system from outside the protected space; the remote starting control position shall be distinctly indicated and provided with lighting both from the general lighting and from the emergency lighting circuit.

3.1.3.4 For lockers of a deck area of less than 4 m^2, which do not give access to accommodation spaces carbon dioxide portable fire extinguisher providing a minimum volume of free gas to 40 per cent of the gross space volume, may be accepted in lieu of fixed fire fighting systems. The inlet port shall be arranged in a locker bulkhead to allow discharge of extinguishing medium without entry into the protected space. This portable fire extinguisher shall be stowed adjacent to the port. Alternatively, a port or hose connection may be provided to facilitate the use of fire main water.

3.1.4 Pipes and fittings.

3.1.4.1 Pipes shall be so laid as to comply with the following requirements:

.1 extinguishing medium shall be supplied to each protected space through a separate pipe line, with shut-off fittings provided thereon in the fire extinction station.

This requirement does not apply to the foam extinguishing systems intended to deliver foam from outside the cargo tanks by means of monitors and portable air-foam nozzles or foam generators producing average expansion foam;

.2 where a cargo space provided with the pipes of a fire smothering system is periodically used for accommodation of passengers or special personnel, an additional closing arrangement is to be fitted to the pipes which is to be located in the fire control station behind the fire extinguishing medium discharge valve for the space in question;

.3 laying the pipes of fire extinguishing systems through spaces containing oil fuel and lubricating oil shall not be permitted.

Pipes of fire extinguishing systems, except for gas smothering systems, shall not be laid through refrigerated spaces.

Where gas smothering pipes are laid through refrigerated spaces, they shall be fitted with efficient insulation and shall be provided with arrangements for condensate drainage;

.4 laying pipes of gas smothering systems through accommodation and service spaces, except for corridors, may be permitted only where such pipes have no detachable joints within said spaces and have been tested by a pressure required in the case of hydraulic tests of manifolds fitted in fire extinction stations.

Where such pipes are laid in the corridors, of accommodation and service spaces, detachable joints are permitted, but the number of such joints shall be minimized;

.5 all fire extinguishing systems shall be so designed as to permit of periodical checks for operation.

In the case of carbon dioxide smothering systems and halogenated hydrocarbon and dry powder systems, it is sufficient that compressed air is used, in lieu of an extinguishing medium, when testing the system for operation.

A non-return shut-off valve shall be fitted on the pipe line supplying compressed air to the manifold of the fire smothering station;

.6 gaskets used in the pipe joints of fire extinguishing systems shall be made of non-combustible materials resistant to the effect of the extinguishing medium, and marine environment.

3.1.4.2 Pipes shall be made of steel.

Copper, copper-and-nickel or other bimetallic pipes (one of the layers being steel or copper) may be used as equivalent to steel pipes.

Steel pipes shall have anti-corrosive coating both inside and outside.

The fittings of fire extinguishing systems, including sprinklers and sprayers, are to be made of materials resistant to the fire extinguishing medium and to marine environment.

3.1.5 Starting of systems.

3.1.5.1 A system shall be put into operation without any supplementary change-over at the station and shall operate quickly and efficiently under all service conditions, including those when the temperature is below zero and during a fire.

3.1.5.2 The possibility of spontaneous starting of a fire extinguishing system shall be excluded under any service conditions, including the effect of such factors as pitching and rolling, shaking and vibration.

3.1.5.3 Where necessary, the starting appliances shall be protected against mechanical damage.

3.1.5.4 Arrangements shall be provided for the attachment of seals to the starting devices of the system.

3.1.5.5 Irrespective of the provision of remote starting control, the system shall be capable of being started directly at the fire extinction station, and the pump from the place of its installation.

3.1.5.6 Remote control system (by air, nitrogen, carbon dioxide, etc.) shall be provided with two cylinders, each being sufficient for one full operation of a fire extinguishing system.

3.1.5.7 Where provision is made for mechanical devices in the remote starting system, their valves shall be controlled with the help of hand wheel or levers to be positively connected to the valve stems or spindles.

3.1.5.8 Automatic discharge of fire extinguishing medium is not permitted except for cases stipulated by 3.3, 3.6.3 and 3.11.2.7.

3.1.6 Fixed local application fire fighting systems.

3.1.6.1 Fixed local application fire fighting systems shall be fitted on passenger ships of 500 and above gross tonnage and on cargo ships of 2000 and above gross tonnage.

см.Б1 **3.1.6.2** Category A machinery spaces above 500 m^3 in volume in addition to the fixed fire extinguishing system required in table 3.1.2.1 shall be protected by an approved type of fixed water-based or equivalent local application fire fighting systems complying with the requirements of IMO Guidelines (see MSC/Circ.913)[1]. In the case of periodically unattended machinery spaces, the fire fighting system shall have both automatic and

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[1] See IMO Resolutions Pertainig to the RS Activity. No. 3. 2000.

manual release capabilities. In the case of continuously manned machinery spaces, the fire-fighting system is only required to have a manual release capability.

см.Б1 **3.1.6.3** Fixed local application fire fighting systems are intended for protection of fire risk areas of the following machinery and equipment (without the necessity of the engine shutdown, personnel evacuation or sealing of the spaces):

.1 main internal combustion engines and diesel generators;

.2 incinerators;

.3 purifiers for heated fuel oil;

.4 boiler fronts.

см.Б1 **3.1.6.4** Activation of any local application fire fighting system shall give a visual and distinct audible alarm in the protected space and at the continuously manned fire control stations. The alarm shall indicate the specific system activated. Requirements to fire alarm systems set out in this paragraph shall be in addition to and not a substitute for the fire detection system required elsewhere in the Chapter.

3.2 WATER FIRE MAIN SYSTEM

3.2.1 Number and capacity of fire pumps.

3.2.1.1 In ships other than those referred to in 3.2.1.6, provision is to be made for pumps, fire mains, hydrants and hoses complying as applicable with the requirements of this Chapter.

The number of fixed fire pumps and the minimum pressure at any hydrant when discharging water through hydrants at the rate of discharge determined by the Formula (3.2.1.5) shall be not less than those specified in Table 3.2.1.1, the length of hoses complying with the requirements of 5.1.4, and the nozzle outlet diameters complying with 5.1.5.

For ships of restricted navigation areas, which are not engaged on international voyages (except for passenger ships) and have a gross tonnage under 2000, the requirement of Table 3.2.1.1 concerning the number of pumps may be waived subject to a special agreement with the Register.

Table 3.2.1.1

Gross tonnage	Passenger ships		Other ships	
	Number of pumps	Minimum pressure at hydrants, in MPa	Number of pumps	Minimum pressure at hydrants, in MPa
Under 500	2	0,31	1	0,20
500 to 1000	2	0,31	2	0,26
1000 to 4000	2	0,31	2	0,26
4000 to 6000	3	0,41	2	0,26
6000 and upwards	3	0,41	2	0,28
Note. The number of pumps indicated above does not include the emergency fire pump, if fitted.				

On floating cranes with a gross tonnage under 2000, one fire pump may be installed.

The pressure developed by the fire pumps shall be sufficent to ensure the operation of other fire extinguishing systems using water (e.g., for pressure water spraying, froth extinguishing, etc.) and supplied from the same fire pumps.

3.2.1.2 Passenger ships of less than 1000 gross tonnage and cargo ships of 2000 gross tonnage and over shall be provided with an emergency fire pump of a capacity not less than 25m^3/h and cargo ships of less than 2000 gross tonnage shall be provided with an emergency fire pump of a capacity not less than 15m^3/h with an independent source of power. Source of power and sea connection shall be located outside the machinery space in which the main fire pumps are installed (see also 3.2.4.2 and 3.2.5.8).

For self-propelled ships of less than 500 gross tonnage, except passenger ships, the provision of an emergency fire pump is subject to special consideration by the Register. A diesel motor pump complying with the requirements of 5.1.17 may be used as such a pump.

3.2.1.3 In cargo ships of 2000 gross tonnage and upwards if a fire in any one compartment could put all the fire pumps out of action there shall be a fixed independently driven emergency fire pump complying with the requirements of 3.2.4.

3.2.1.4 An emergency fire pump need not be fitted, if the fire pumps and the associated sources of power are located in different compartments having not more than one adjacent steel deck or "A-0" class bulkhead so that in the event of fire in one compartment the pumps located in another compartment (other compartments) will ensure the supply of water to the fire main.

3.2.1.5 The total capacity of fixed fire pumps, except for an emergency pump, if any, with the pressure at any hydrant not less than that specified in Table 3.2.1.1, shall ensure discharge of water through hose nozzles in a quantity, in m^3/h, not less than

$$Q = km^2 \qquad (3.2.1.5)$$

where m = 1,68$\sqrt{L(B+D)}$;
L = length of the ship (see 1.1.3, Part IV "Stability"), in m, excluding the length of the spoil hopper, if no tanks and other storages for combustible materials are installed therein, in hopper dredgers and hopper barges;
B = moulded breadth, in m;
D = depth to the bulkhead deck amidships, in m;
k = coefficient equal to:
0,016 for passenger ships having subdivision index R equal to, or more than, 0,5;
0,012 for passenger ships having subdivision index R less than 0,5;
0,008 for all other ships;
R = subdivision index determined in accordance with 2.3, Part V "Subdivision".

For catamarans and similar ships, the total capacity of fire pumps shall be determined as twice the capacity value for one hull.

3.2.1.6 The fixed water fire main system need not be installed in ships with the crew of less than 3 members.

3.2.1.7 In all ships other than passenger ships the total capacity of fire pumps need not exceed 180 m^3/h, unless a larger capacity is required in order to ensure the simultaneous operation of other systems using water.

3.2.1.8 The capacity, pressure head and number of fire pumps for floating docks shall be chosen in accordance with the quantity of water required by the largest cargo ship which the dock can carry, for the operation of the water fire main system.

On non-self-contained floating docks receiving water for the water fire main system from the shore the emergency fire pump need not be installed.

3.2.1.9 When determining the total capacity of fire pumps, the capacity of fixed pumps fitted in the forward part of oil tankers, as well as the capacity of an emergency pump, shall not be taken into account.

3.2.1.10 Each fixed fire pump shall be capable of supplying at least two jets of water, with the largest nozzle size adopted in the given ship (see 5.1.5).

3.2.1.11 The capacity of each fixed pump, other than an emergency pump, shall not be less than 80 per cent of the total required capacity divided by the required number of fire pumps, but in any case not less than 25 m^3/h.

If the number of fire pumps exceeds the required number, the feed of the additional pumps shall be at least 24 m^3/h and it shall be sufficient to support at least two nozzles in accordance with 3.2.6.2.

3.2.1.12 If other fire extinguishing systems using water supplied by fixed fire pumps are provided in ships, the capacity of these pumps shall be sufficient for the operation of the water fire main system having the capacity not less than 50 per cent determined by the Formula (3.2.1.5) and for parallel operation of one of the other systems requiring the largest quantity of water. In the case concerned the quantity of water for the water fire main shall be sufficient for delivering at least two jets of water through largest nozzles used in the ships, but more than six jets and more than 90 m^3/h for cargo ships are not required. Possible increase of water discharge through each hydrant due to the pressure rise in the pipes required for the operation of the other fire extinguishing systems and also the requirements stated in 3.2.1.9 are to be taken into consideration.

The quantity of water for fire fighting systems, other than for the water fire main system, shall be determined in accordance with the requirements in 3.3.2.2, 3.4.2, 3.5.2 (within one main vertical zone), 3.6.5 and 3.7.

3.2.2 Location of fire pumps.

3.2.2.1 In passenger ships of 1000 gross tonnage and upwards, sea valves, fire pumps and associated sources of power shall be so located as to ensure that a fire in any one compartment will not render all pumps simultaneously inoperative.

3.2.2.2 In catamarans and similar ships, for which not less than two pumps are required in compliance with Table 3.2.1.1, it is recommended that one pump be fitted in each hull.

In this case, water supply be each pump to the water fire main of any hull of the ship shall be ensured.

3.2.3 Basic requirements for fire pumps.

3.2.3.1 In all self-propelled ships, fixed fire pumps shall generally have an independent mechanical drive.

In cargo ships between 300 and 1000 gross tonnage, one of the pumps shall have an independent drive.

In cargo ships of less than 300 gross tonnage with the main propulsion machinery of power output less than 220 kW and in passenger ships of less than 150 gross tonnage with the main propulsion machinery of power output less than 220 kW, as well as in dinamically supported craft the pumps driven from the main engine may be used provided that the propulsion unit (engine-shaft-propeller) is so designed as to permit of fire pump operation when the ship is not under way.

On agreement with the Register, a V-belt drive from the main engine to the pump may be permitted in above ships, provided that transmission of torque is ensured even when one of the belts is broken.

3.2.3.2 Fixed fire pumps including an emergency pump may be used for other shipboard services, if the ship is provided with at least two independently driven pumps, one of which is at all times kept readily available for its direct purpose.

Where in conformity with Table 3.2.1.1 only one fire pump is fitted, it may be used for other purposes requiring short-time consumption of water (flushing out of decks, hawse pipes etc.). No restrictions are placed on floating cranes.

A fire pump may be used for emergency drainage of machinery spaces.

3.2.3.3 In cargo ships of 500 gross tonnage and upwards bilge, ballast and flue gas scrubber cooling (see 3.9.3.1) pumps may be used as fixed fire pumps provided that they comply with the design requirements for capacity and pressure head and also meet the requirements of 3.2.3.2 and 3.2.3.4.

3.2.3.4 Pumps and piping intended for fire fighting purposes shall not be used for the pumping of oil and other flammable liquids, nor as ballast pumps for tanks used for alternate carriage of oil fuel and water ballast.

3.2.3.5 Fire pumps shall be fitted with a pressure gauge on the discharge side.

Pumps capable of developing in the fire main a pressure exceeding the permissible value shall be provided with relief valves set to operate at a pressure not more than 10 per cent in excess of the fire main working pressure, and having the pipes to discharge water into the suction main.

3.2.3.6 Fixed fire pumps and their sea valves shall be located below the light-draught waterline of the ship.

A fixed emergency pump shall be installed in compliance with 3.2.4.

Fire pumps installed outside machinery spaces of category A shall have an independent sea valve in each compartment in which they are located.

3.2.3.7 All pumps, including the emergency pump, shall be placed in spaces with positive temperature.

3.2.3.8 On passenger ships of 1000 gross tonnage and over and on all passenger ships with periodically unattended machinery spaces containing fire pumps, the water fire main system is to constantly be under pressure providing immediate water discharge through one of the hydrants located inside the spaces and is to be fitted with a pump automatically switching on at a drop of pressure. On passenger ships of less than 1000 gross tonnage, the water fire main system shall enable the automatic and remote start-up of at least one fire pump from the navigating bridge. If the pump starts automatically or if the bottom valve can not be opened from location where the pump is remotely started, the bottom valve shall always be kept.

3.2.3.9 In cargo ships with a periodically unattended machinery space containing fire pumps or when only one person is required on watch provision is to be made for remote starting of one of the fire pumps from the navigating bridge and from the position where a permanent watch is provided when in port and for immediate water supply in the fire main without additional opening of the valves in the pump room. At the location of such arrangement a water pressure indicator shall be installed.

Where water fire main system is under pressure as required in 3.2.3.8, remote starting need not be provided.

On the ships of less than 1600 gross tonnage, fulfilment of this requirement may not be provided, if starting arrangement of the fire pump in machinery space is easily accessible.

3.2.4 Fixed emergency fire pump.

3.2.4.1 The emergency pump shall be driven by a compression ignition engine, gas turbine or an electric motor supplied with power from the emergency source of power.

3.2.4.2 The pump, its sources of power and sea valves shall be so located as not to be rendered inoperative by a fire within the spaces where the main fire pumps are located.

The emergency fire pump, its seawater inlet, piping suctions, delivery pipes and isolating valves shall be located outside the machinery space. If such arrangement can not made, the sea chest may be fitted in the machinery space, if the valve is remotely controlled in the same compartment as the emergency fire pump, and the suction pipe is as short as practicable. Short lengths of suction or discharge piping may penetrate the machinery space, provided they are enclosed in a substantial steel casing or insulated to A-60 class standard. These suctions shall have substantial wall thickness but not less than 11 mm and they shall be welded except for flange connection to the sea valve.

Location of the pump and its drive shall allow free access to them for maintenance and repair.

см.Б1 **3.2.4.3** Where the pump is located above the lowest possible waterline, efficient arrangements shall be made for self-priming.

The total suction head and the net positive suction head shall be such that under all conditions of heel, trim, pitch and roll likely to be encountered in service, the requirements of 3.2.4.6 are met.

3.2.4.4 The boundaries of the space containing the fire pump should comply with the requirements of Tables 2.3.3-1 and 2.3.3-2 for control stations. The space containing the fire pump shall not be contiguous to the boundaries of machinery spaces of category A or those spaces containing main fire pumps. Where this is not practicable, the common bulkhead between the two spaces shall comply with the requirements of Table 2.3.3-1 for control stations.

No direct access shall be permitted between the machinery space and the space containing the emergency fire pump and its source of power. When this is impracticable, an arrangement may be accepted where the access is by means of an air-lock where the door to the machinery space shall be made to A-60 class standard and the second door shall be made at least of steel, each of the doors being self-closing, or through a watertight door capable of being operated from a space remote from the machinery space and the space containing the emergency fire pump and unlikely to be cut off in the event of fire in those spaces. In such cases a second means of access to the space containing the emergency fire pump and its source of power shall be provided.

No hold-back hooks are permitted for the above doors.

3.2.4.5 Where a diesel engine or gas turbine is used to drive the pump, a service fuel tank containing sufficient fuel to enable the pump to run for at least three hours is to be provided in the emergency fire pump room.

Sufficient reserves of fuel are to be available outside the machinery space containing main fire pumps to enable the pump to run for additional 15 hours. The pump engine is to be started manually or from such starting device as to enable the engine to be started at least 6 times within a period of 30 min, and at least twice within the first 10 min. Where the power output of the engine exceeds 15 kW, an independent starting device is to be provided.

3.2.4.6 The capacity of the emergency fire pump shall be sufficient for the simultaneous operation of at least two fire hose nozzles of the largest size adopted in the ship, at a pressure in compliance with the requirements of Table 3.2.1.1, and is to be not less than 40 per cent of the total capacity of the fire pumps and in any case taking into account 3.2.1.2.

3.2.4.7 Where the emergency pump is also intended to serve other water or froth fire extinguishing systems, its capacity shall be adequately increased to provide the simultaneous operation of any other systems requiring the greatest supply of water.

3.2.5 Piping.

3.2.5.1 The diameters of the fire main and water service pipes are to be sufficient for the effective distribution of the maximum required discharge from two fire pumps operating simultaneously. In cargo ships the diameter need only be sufficient for the discharge of 140 m^3/h.

In ships of 500 gross tonnage and upwards and floating cranes (see 3.2.5.6) the pipes of the water fire main shall be rated at a working pressure of at least 1 MPa.

3.2.5.2 To prevent freezing, the pipelines of the water fire main system extended to open decks or non-heated spaces shall be provided with shut-off fittings mounted in heated spaces, and with water drainage arrangements.

3.2.5.3 Each fire pump shall be fitted with shut-off valves on the suction and discharge pipes.

The use of slide valves on the suction pipe is permitted.

In ships of 500 gross tonnage and upwards the valves on the discharge side of the pumps are to be of a non-return shut-off type.

3.2.5.4 In oil tankers, the water fire main shall comply with the following supplementary requirements:

.1 on the main pipe where it is led out of the poop and in easily accessible places on the cargo oil tank deck, cut-off valves shall be fitted approximately in each 30 m of the open deck length. Each of such valves shall be provided with an information plate to indicate that the valve must be kept permanently open under normal service conditions;

.2 before each cut-off valve on the main there shall be fitted twin fire hydrants of 70 mm diameter so located that they are equally spaced, over the length of the ship and the fulfilment of the requirements of 3.2.6.2 is ensured;

.3 before the cut-off valve fitted in the poop there shall be a branch pipe on either side, led out from the water fire main to the forward part of the poop deck; the diameter of each branch pipe is to be sufficient for supplying water through two fire hoses connected to two hydrants fitted at the end of each branch; in ships of 1000 gross tonnage and upwards the diameter of each hydrant provided shall be about 70 mm, and in ships of less gross tonnage this diameter is to be about 50 mm.

Where fire pumps are fitted forward of the cargo tanks, two more similar pipes branching from the main of the same diameter as above shall be provided on the after part of the forecastle deck, a cut-off valve being fitted on the main within the erection, after the branches.

3.2.5.5 Where vehicles carried in railway ferries are arranged in four or more rows, the water fire piping shall be so fitted that hydrants of 70 mm diameter may be provided both on the sides of the ship and between the rows.

On catamarans and similar ships, each of the hulls is to be provided with a water fire main system including water hydrants, hoses and nozzles.

3.2.5.6 On all ships of 500 gross tonnage and upwards, and on floating cranes facilities shall be available on the open deck enabling an international shore connection to be used on either side of the ship (see 5.1.18).

3.2.5.7 Where two or more fire pumps are installed in passenger ships, the water fire main system shall be arranged in way of superstructures as a ring one with shut-off valves fitted to keep the system operable when certain sections of the ring main are disconnected, and it shall be laid not below the bulkhead deck.

3.2.5.8 Isolating valves to separate the section of the fire main within the machinery space containing the fire pump or pumps from the rest of the fire main is to be fitted in an easily accessible position outside the machinery space.

The fire main is to be so arranged that when the isolating valves are shut all the hydrants on the ship, except those referred to above, can be supplied with water by a fire pump not located in this machinery space through pipes which do not enter this space.

Short lengths of the emergency fire pump suction and discharge piping may be permitted to penetrate the machinery space if it is impracticable to route it externally provided that the integrity of the fire main is maintained by the closure of the piping in a substantial steel casing.

3.2.6 Fire hydrants.

3.2.6.1. Each fire hydrant shall have a shut-off valve and a standard quick-acting coupling. Hydrants fitted on open decks shall also have quick-acting plugs, or equivalent device.

3.2.6.2 The number and arrangement of fire hydrants shall ensure at least the delivery of two water jets from different hydrants, one of the jets being delivered through a hose of standard length as stipulated under 5.1.4.1, to any area of the ship which is generally accessible to passengers and crew during the voyage and to any part of any cargo space that is empty, ro-ro cargo space or special-category space. In the latter case, two jets shall be delivered to any part of the space through standard length hoses. Besides, such hydrants shall be located near entrance to the protected spaces.

On open decks for containers two jets of water shall be delivered onto each accessible vertical side of the container by standard length hoses.

Where spaces in ships are separated by watertight or fire bulkheads bounding main vertical zones, the above requirements shall be complied with, even if the doors in the bulkheads are closed.

3.2.6.3 The distance between fire hydrants is not to exceed 20 m in spaces and 30 m on weather decks.

3.2.6.4 Fire hydrants are not to be placed at the ends of dead-end corridors, in special electrical spaces or closed or rarely attended spaces.

3.2.6.5 In ships carrying deck cargo, fire hydrants shall be protected against damage from such cargo.

3.2.6.6 A fire hydrant shall be fitted on the discharge pipe, directly between each fire pump and shut-off valve.

3.2.6.7 In a machinery space of category A there shall be at least two fire hydrants located on both sides of the ship. In the case of ships of less than 500 gross tonnage, the hydrant fitted in immediate proximity to the fire pump may be used as one of the above hydrants.

In the machinery spaces of category A of ships of less than 150 gross tonnage, when there is a hydrant fitted in immediate proximity to the fire pumps, other hydrants may be omitted.

3.2.6.8 In all ships there shall be fitted a fire hydrant located in the forward part of the propeller shaft tunnels.

3.2.6.9 All fire hydrants shall be painted red.

3.2.6.10 In passenger ships two fire hydrants shall be provided in the shaft tunnel, being one of the means of escape, in the proximity to the machinery space of category A.

Where some other space is used as a means of escape, two fire hydrants shall be provided therein at the entrance to the machinery space of category A. Provision of 3.2.6.8 need not be met in this case.

3.3 SPRINKLER SYSTEM[1]

3.3.1 General provisions.

3.3.1.1 The sprinkler system is to be of the wet pipe type but small exposed sections may be of the dry pipe type where in the opinion of the Register this is a necessary precaution. Any parts of the system which may be subjected to freezing temperature in service are to be suitably protected against freezing.

3.3.1.2 A sprinkler system shall be automatically set in operation at temperatures in the protected space rising to the values indicated in 3.3.4.2.

3.3.1.3 The water supply arrangements of every sprinkler system shall be fitted with a pressure tank, control valves, both automatically starting pump and air compressor with an air cylinder in order to maintain the working pressure in the system and ensure instantaneous delivery of water to the opened sprinklers.

3.3.1.4 The air cylinder, compressor, pump and the pipes of the sprinkler system, except for the piping connecting the sprinkler system to the water fire main system, shall be independent of all other systems.

3.3.1.5 A sprinkler pump and a pressure tank shall be arranged outside the protected space, at an adequate distance from the machinery spaces of category A. The main fire control station shall be provided with a pressure gauge.

3.3.1.6 In each individual case sprinkler systems whose rated parameters differ from those given in this Chapter are subject to special consideration by the Register.

3.3.2 Sprinkler pumps.

3.3.2.1 A pump shall be automatically brought into action by the pressure drop in the system and be capable of supplying water to the system before the standing fresh water charge in the pressure tank is completely exhausted.

Means are to be provided for testing the automatic operation of the pump on reduction of pressure in the system.

3.3.2.2 The pump and piping system shall be capable of maintaining the necessary pressure at the level of the highest sprinkler to ensure a continuous flow rate of water sufficient for the simultaneous coverage of the minimum floor area of 280 m^2 at the application rate specified in 3.3.4.1.

3.3.2.3 The pump shall be fitted on the delivery side with a test valve with a short open-ended discharge pipe. The effective area through the valve and pipe shall be adequate to permit the release of the required pump output while maintaining the pressure in the system specified in 3.3.2.2.

3.3.2.4 The pump is to have a sea inlet which is wherever possible to be in the space containing the pump.

3.3.2.5 Provision is to be made for connection of the main supply piping with the ship's fire main. A lockable non-return stop valve shall be fitted at the connection concerned.

3.3.2.6 There shall be not less than two sources of power for the pumps. Where the sources of power for the pump are electrical, the pump drive shall comply with the requirements of 4.3 and 19.1, Part XI "Electrical Equipment".

One of the sources of power for the pump may be an internal combustion engine which shall be so situated that a fire in any protected space will not affect the air supply to the machinery.

3.3.3 Pressure tank.

3.3.3.1 The pressure tank shall be fitted with:

.1 an automatic pressure maintaining device;

.2 a water level control device and alarms warning of a drop of water level and pressure in the tank below the normal values and led to the permanent watch position in the machinery space of category A;

.3 a relief valve;

.4 a pressure gauge.

3.3.3.2 The pressure tank shall contain a standing charge of fresh water equivalent to the volume of water which would be discharged in one minute by the sprinkler pump.

The volume of the pressure tank shall be equal to at least twice that of the charge of water specified above.

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[1] See also IMO Resolution A.800(19) "Revised Guidelines for Approval of Sprinkler Systems Equivalent to that Referred to in SOLAS regulation II-2/12."

Arrangements shall be made for maintaining such air pressure in the tank as to ensure that where the standing charge of fresh water in the tank has been used the pressure in that tank is not less than a working pressure at the sprinkler plus a hydrostatic pressure from the tank bottom to the highest sprinkler.

Suitable means of replenishing the air under pressure and of replenishing the fresh water charge in the tank are to be provided. Means are to be also provided to prevent the passage of sea water into the tank.

3.3.3.3 Pneumatic pressure tanks shall comply with the requirements for pressure vessels set out in Part X "Boilers, Heat Exchangers and Pressure Vessels".

3.3.4 Sprinklers.

3.3.4.1 Sprinklers shall be placed in an overhead position and spaced in a suitable pattern to maintain an average application rate of not less than 5 1/min per 1 m^2 over the area of the protected space.

The Register may permit the use of other application rate depending on structural features of the protected space.

While protecting windows by sprinklers, the requirements of 2.2.4.4 shall be met.

3.3.4.2 In accommodation and service spaces the sprinklers are to come into operation within the temperature range from 68 to 79°C, except that in locations such as drying rooms and galleys where high ambient temperatures might be expected, the operation temperature may be increased by not more than 30°C above the maximum deckhead temperature.

3.3.5 Control valves.

3.3.5.1 Control valves shall be fitted on the supply pipe of each section of the sprinkler system and shall ensure:

.1 delivery of water from the sources of water supply when any of the sprinklers fitted in the section comes into operation;

.2 giving of visual and audible alarm signal whenever any sprinkler comes into operation;

The signal shall be simultaneously produced both directly at the control valve, at the main fire control station and in the engine room compartment of permanent watchkeeping. It shall indicate the section containing the sprinkler which has opened. The alarm system is to be such as to indicate if any fault occurs in the system;

.3 the possibility of checking the operation of the system through a special test valve with the cross-section equal to that of the sprinkler.

The test valve for each section is to be situated near the stop valve for that section.

3.3.5.2 The control valves shall be fitted in special metallic enclosures or lockers outside the protected space.

Positions where control valves are fitted shall be easily accessible, illuminated and closed by a glazed door enabling the condition of all parts of the control valves and pressure gauge readings in particular to be watched.

A list or a plan shall be displayed at each control valve showing the spaces covered and location of the zone in respect of each section; also suitable instructions for testing and maintenance are to be available.

3.3.5.3 One of the control valves is to have a switch to enable the operation of alarms and indicators of each section of sprinklers to be tested.

3.3.6 Pipes.

3.3.6.1 Sprinkler system shall be subdivided into separate sections. Each section is permitted to contain not more than 200 sprinklers, a single section shall not be fitted in different main vertical zones. One section shall serve not more than two decks.

3.3.6.2 Provision shall be made in each section for purging the pipes with compressed air and flushing them with fresh water.

3.3.6.3 Each section of sprinklers shall be capable of being isolated by one stop valve only after which a gauge indicating the pressure in the system shall be provided.

The stop valve shall be fitted before the control valve and located together with it in metallic enclosures specified in 3.3.5.2.

The shut-off valve of each section shall be reading accessible, and the location shall be clearly and permanently marked.

Measures shall be taken to preclude unauthorized persons from operating the shut-off valves.

3.3.6.4 The suction pipes of the pumps feeding a sprinkler system shall be fitted with filters to prevent the clogging of the system and sprinklers.

3.3.6.5 The diameters of the pipes of a sprinkler system shall be such as to ensure the operation of sprinklers at the water pressure and the rate of discharge specified in 3.3.2.2 and 3.3.4.1.

3.3.6.6 The pipelines of the sprinkler system shall be fitted with non-return stop valves preventing sea water from penetrating into the pressure tank and the leakage of water from the tanks and the system.

3.4 PRESSURE WATER-SPRAYING SYSTEM

3.4.1 In machinery spaces of category A as well as in pump rooms specified in 1.5.7 pressure water-spraying system shall be supplied from an independent pump which shall be automatically put into action by a pressure drop in the system and from the water fire main. A non-return stop valve shall be fitted on the connection line with the water fire main.

In cargo spaces specified in 1.5.4.3 and 1.5.4.4 and in special category spaces (see 1.5.9) the pressure water-spraying system shall comply with the requirements of IMO Resolution A.123(V) "Recommendation on Fixed

Fire Extinguishing Systems for Special Category Spaces".

In other protected spaces the system may be supplied only from the water fire main.

Where high-pressure water-spraying system is used, the necessity for the reserve supply for such system will be determined in each case on agreement with the Register.

3.4.2 The capacity of, and the pressure head developed by, the automatically starting pump shall be determined on the basis of characteristics and number of spray nozzles of an approved type fitted in the largest protected space and the rate of discharge which shall be not less than:

.1 5 1/min per 1 m^2 of the area over which oil fuel is likely to spread or cargo space area;

.2 1,5 1/min per 1m^2 of the largest horizontal cross-sectional area of the fish meal hold.

In cargo, working and special spaces, where the system may be divided into sections, the above pump shall be capable of supplying two sections of the total length of at least 40 m.

3.4.3 In machinery spaces of category A of ships specified in 1.5.7 the pressure water-spraying system shall be kept charged under the required pressure up to the valves on the distribution pipes.

3.4.4 Filters preventing the system and spray nozzles from becoming clogged shall be fitted on the suction pipe of the pump supplying the system and on the connection pipe with the water fire main.

3.4.5 Distribution valves shall be placed in easily accessible positions outside the protected spaces.

Provision shall be made in the protected spaces, where people are permanently present, for remote control of distribution valves from these spaces.

3.4.6 Spray nozzles shall be placed in the protected spaces as follows:

.1 underneath the ceiling of the space;

.2 above equipment and machinery using oil fuel or other flammable liquids;

.3 above surfaces over which oil fuel or flammable liquids are likely to spread;

.4 above stacks of fish meal bags.

The spray nozzles shall be so disposed in the protected space that the area covered by one nozzle will overlap that covered by adjacent nozzles.

3.4.7 Water supply is to be provided at the required pressure to all sections of the system in any compartment to be protected. The pump and its controls are to be installed outside the spaces to be protected.

The pump may be driven by independent internal combustion machinery which is to be so situated that a fire in the protected space will not affect the air supply to the machinery. If the pump is electrically driven from the emergency generator, the generator is to comply with the requirements of Section 9, Part XI "Electrical Equipment".

3.5 WATER-SCREEN SYSTEM

3.5.1 The present Rules provide for the use of the water-screen system in the following cases:

.1 in special purpose ships where, subject to special agreement with the Register, water screens are permitted in lieu of "A" class divisions, in accordance with 2.2.1.2;

.2 for protecting doorways in compliance with 2.1.3.7.

3.5.2 The water-screen system shall be fed from the water fire main. The design capacity of the pumps supplying the water-screen system shall be sufficient to provide at least 70 1/min per linear metre of the screen length.

3.5.3 Water screens for the protection of doorways shall be arranged and operated from the corridor.

3.6 DRENCHING SYSTEM

3.6.1 The present Rules provide for the use of the water drenching system for drenching the racks of magazines (see 2.1.7.16 and Table 3.1.2.1).

3.6.2 The drenching system shall be fed from the water fire main. The pumps and associated sources of power shall be placed outside the space protected.

Water shall be supplied to the drenching system of exits from machinery spaces by means of a pump located outside the machinery spaces. It is recommended that additional water supply to the system shall be effected from sea water hydrophores.

3.6.3 The system shall be started from outside the space.

It is recommended that the system shall be put into action at an inadmissible temperature rise in the space.

3.6.4 The drenching system of magazines and the pressure water-spraying system of the cargo spaces fitted for the carriage of explosives may be used for their flooding in emergency.

3.6.5 The capacity of the pumps supplying the system shall be sufficient to ensure the following rates of water discharge for drenching magazine racks, 24 1/min per 1 m^2 of the total magazine floor area.

3.7 FOAM FIRE EXTINGUISHING SYSTEM

3.7.1 General provisions.

3.7.1.1 The foam fire extinguishing system provides for the use as an extinguishing medium of mechanical foam of the following types depending on the foam expansion ratio:

low expansion ratio (about 10:1);

medium expansion ratio (between 50:1 and 150:1);

high expansion ratio (about 1000:1).

Foam fire extinguishing systems may include units separately producing, but simultaneously supplying low expansion ratio foam and medium expansion ratio foam (combination foam).

3.7.1.2 Use is to be made of foam concentrate types approved by the Register (see 1.3.3.1).

A foam concentrate for generating low-expansion and medium expansion foam is to be capable of being used both with fresh water and sea water.

3.7.1.3 The capacity of foam fire extinguishing systems and the quantity of a foam concentrate shall be calculated depending on the foam expansion ratio, the rate of application of solution and operation time of the system given in Table 3.7.1.3 and in 3.7.2.1.

3.7.1.4 Tanks for the storage of foam-generating liquid concentrate shall be fitted with arrangements for filling and draining, a device for watching the level of the liquid and a manhole for cleaning and inspecting. The tanks shall be of sufficient capacity to contain the full required amount of foam concentrate.

If no excessive pressure is required to be created in tanks during the system operation, non-return valves shall be fitted between such tanks and the fire main.

Where a foam concentrate using fresh water is utilized in the high expansion foam system, the flooding of a space protected shall be stored in a tank installed in the station. The remainder of the water may be supplied from ship's storage tanks. Equipment (pumps, fittings, etc.) necessary for supplying fresh water to the tank shall be arranged outside the protected space, be fed from the emergency diesel-generator and have a capacity sufficient to ensure continuous operation of the system as required in Table 3.7.1.3.

3.7.1.5 The mixers for making aqueous solution of a foam concentrate of the required concentration shall be of an approved type. The mixers shall ensure operation of simultaneously used foam nozzles and/or foam generators.

3.7.1.6 The main control station of the fixed deck system is to be located in the fire-fighting station outside the cargo spaces in the vicinity of accommodation spaces and be easily accessible and ensure control of the system. Sampling device for measurement of the percentage of foam concentrate in a solution shall be fitted at the foam extinction station on the fire main at a maximum distance from mixers, the pressure gauge shall be fitted on the pipe supplying water to the system.

The main equipment of the deck system (tanks with a foam concentrate, pumps, mixers, etc) may be located in the machinery space.

3.7.1.7 Upon special agreement with Register the use of the deck main for the foam extinction and water fire systems is allowed.

3.7.2 Fixed deck systems.

3.7.2.1 The expansion ratio of the foam generated by the system is not generally to be greater than 12:1. If the system generates actually low-expansion foam with expansion ratio slightly in excess of 12:1, the quantity of the foam solution is to be calculated as for the system with foam expansion ratio 12:1. Where the system generates the foam with expansion ratio somewhat below 12:1, the quantity of the foam solution is to be proportionally increased.

Where medium expansion ratio foam is used in oil tankers, the amount of the foam concentrate shall be not less than the rated quantity and sufficient for the operation of the rated number of the foam generators and one monitor during 10 min.

3.7.2.2 On oil tankers foam is to be supplied by means of monitors and foam applicators (see 5.1.6 and 5.1.19) to the entire cargo deck area and to any cargo tank whose deck was ruptured.

см.Б1 **3.7.2.3** At least 50 per cent of the foam solution supply rate required in footnotes 2.1 and 2.2 of Table 3.7.1.3 is to be delivered from each monitor.

On ships of less than 4000 tons deadweight only portable foam generators or hand applicators may be employed. However, in such a case the capacity of each generator or applicator according to 5.1.19 or applicator according to 5.1.6.1 is to be at least 25 per cent of the foam solution supply rate required in footnotes 2.1 and 2.2 of Table 3.7.1.3.

см.Б1 **3.7.2.4** The number and position of monitors are to be such as to comply with 3.7.2.2, 3.7.2.6 and 3.7.2.8. The solution-delivering capacity of any monitor is not to be less than indicated is note 2.3 of Table 3.7.1.3.

3.7.2.5 It is recommended that a monitor shall be provided with a changing-over device for alternate supply of water and foam. Pipes branching from the water fire main and foam solution supply piping shall be connected to the changing-over device.

In lieu of the changing-over device suitably interlocked shut-off valves may be fitted.

3.7.2.6 The distance from the monitor to the farthest extremity of the protected area forward of that monitor is to be not more than 75 per cent of the monitor throw in still air conditions.

3.7.2.7 The foam fire main in easily accessible places of the cargo deck shall be fitted with cut-off sluice or disc valves spaced 30 m apart. Next to each of such valves there shall be provided an information plate to indicate that the valve shall be kept permanently open under normal service conditions.

Before each cut-off valve fitted on the foam piping there shall be twin fire hydrants, 70 mm in inside diameter, for coupling thereto fire hoses with air-foam nozzles located at such distance that the requirements of 3.2.6.2 are met.

Branches from the water fire main and foam piping to the monitors are also to be fitted before the cut-off valves.

Where medium-expansion foam is used, twin fire hydrants shall be substituted by valve chests with a

Table 3.7.1.3

Spaces	Rate of solution supply, in l/min·m^2, with the foam expansion ratio			Rated time of continuous operation, in min
	10:1	100:1[1]	1000:1	
Cargo oil tanks and cargo tank deck	6[2] 0,6 3	6[3]	—	20/30[4]
Tanks for oil products with a flash point 60°C and above (oil fuel tanks)	6[3]	4,5[3]	—	20
Dry cargo holds	—	4[3]	—	45
Machinry spaces and other spaces whose equipment is oil-fired	—	—	1[3]	—[5]
Paint lockers, storerooms for flammable liquids, flammable liquefied and compressed gases	—	4,5[3]	—	20
Hangars for helicopters, enclosed garages, as well as spaces listed in 1.5.4.3 and 1.5.8.1	—	—	—[6]	45

[1] The solution supply rates apply to combination-foam production as well.

[2] The rate of solution supply is not to be less than the greatest of the following:
- .1 6 l/min per square metre of the horizontal sectional area of the single tank having the largest such area;
- .2 0,6 l/min per square metre of cargo tanks deck area, where cargo tanks deck area means the maximum breadth of the ship multiplied by the total longitudinal extent of the cargo tank spaces;
- .3 3 l/min per square metre of the area protected by the largest monitor, such area being entirely forward of the monitor but not less than 1250 l/min.

[3] For the area of the largest horizontal section of the largest protected space.

[4] Sufficient foam concentrate is to be supplied to ensure at least 20 minutes of foam generation in oil tankers fitted with an inert gas system and 30 minutes in oil tankers not fitted with an inert gas system using largest rate of solution supply stipulated in Note 1.

[5] Sufficient foam concentrate is to be supplied to ensure foam generation in the volume equal to 5-fold volume of the largest protected space.

[6] The rate of solution supply is to be sufficient for filling of the protected space volume during 15 minutes.

number of fire hydrants equal to 50 per cent of the required number of foam generators.

3.7.2.8 In oil tankers, each foam fire extinction station shall be provided with a shut-off sluice or disc valve located on the foam fire main before it extends beyond the boundaries of the station.

Before the shut-off sluice or valve there shall be a branch led out to the forward part of the poop deck, both starboard and port, to monitors and twin fire hydrant, about 70 mm in inside diameter, for coupling thereto fire hoses with air-foam nozzles.

Where medium-expansion foam is used, twin fire hydrants shall be substituted by valve chests with a number of fire hydrants equal to 50 per cent of the required number of foam generators.

3.7.2.9 Foam smothering system for dry cargo spaces shall meet the following requirements:

.1 a shut-off valve shall be fitted where the foam fire main is led out to the open deck;

.2 provision shall be made for valve chests with fire hydrants to be fitted on the foam fire main on both sides. The distance between the valve chests of either side shall not exceed 40 m. The number of fire hydrants in each valve chest shall be equal to 50 per cent of the required number of foam generators.

3.7.2.10 If a ship is provided with a fixed low and/or medium-expansion foam system, there shall be provided branches from solution pipe line to entrances from the upper deck to machinery spaces as also to the oil fuel filling positions. Each branch shall be fitted with two hydrants for coupling thereto fire hoses with air-foam nozzles or foam generators.

3.7.2.11 In ships where medium-expansion mechanical foam is used, it is recommended that solution piping should be connected to water fire main to provide for the possibility of application of such foam for extinction of fires in accommodation and service spaces through the water fire main. For this purpose provision is to be made for an appropriate number of portable foam generators at hydrants in accommodation and service spaces.

3.7.2.12 The foam is to be delivered to the helideck the area of which is limited by the length of the operated helicopters from monitors or foam generators capable of delivering foam to all parts of the helideck in all weather conditions in which helicopters can operate. The system is to be capable of delivering a discharge rate specified in Table 3.7.2.12 for at least five minutes.

Table 3.7.2.12

Helicopter overall length, m	Discharge rate of foam solution, in l/min
up to but not including 15 m	250
from 15 m up to but not including 24 m	500
from 24 m up to but not including 35 m	800

3.7.2.13 Instead of monitors and foam generators, permanent or portable combination foam units may be used respectively.

3.7.3 High-expansion foam system.

3.7.3.1 In spaces protected by a high-expansion foam system provision is to be made in the upper part, opposite to foam delivery, for openings to discharge air during foam supply. Such openings are to be generally arranged beyond positions 1 and 2 as stipulated in 7.1.4, Part III "Equipment, Arrangements and Outfit". Where the outlets are otherwise arranged, they are to meet the requirements of 7.7 of the said Part.

3.7.3.2 The cross-sectional area of the foam ducts shall be not less than that of foam generator orifices. Foam pipes shall be so laid that the head loss therein is minimized and discharge orifices shall be so located that there are no obstructions for free foam discharge into the protected space.

3.7.3.3 A foam generator shall be of a design approved by the Register, ensuring the production of high-expansion mechanical foam from the aqueous solution of foam concentrate of an approved type.

3.7.3.4 A generator discharge orifice or foam duct at the place of its coming out beyond the station shall be provided with a closing device. This device shall open automatically concurrent with the foam discharge.

A manual control and position indicators "closed", "open"shall be provided.

3.7.3.5 To test a foam generator in operation, a special changing-over device shall be provided to discharge the foam to the open deck instead of the protected space. This device shall always be in a position to direct the foam discharge to the protected space and shall have an appliance for sealing in such position.

3.7.3.6 Where the area of the protected space is more than 400 m^2, at least two foam generators shall be provided to ensure foam discharge to the zones of the protected space, far distant from each other.

3.7.3.7 Equipment essential for the operation of the foam generators shall be supplied from the main and emergency sources of electrical power in accordance with the requirements of 4.3.1, 9.3 and 19.1.2, Part XI "Electrical Equipment".

3.8 CARBON DIOXIDE SMOTHERING SYSTEM

3.8.1 General provisions.

3.8.1.1 The amount of carbon dioxide, in kg, shall be calculated from the formula

$$G = 1{,}79V\varphi \tag{3.8.1.1}$$

where V = rated volume of the protected space, in m^3;
φ = factor equal to:
0,3 for dry cargo holds and other spaces, except those indicated below;

0,35 for machinery spaces, the rated volume of which is determined with regard to the full volume of casings;

0,4 for machinery spaces, the rated volume of which is determined without any regard to the volume of casings from the level at which the horizontal area of the casings is equal to, or less than, 40 per cent of the machinery space area and storerooms specified in 1.5.3.2.2 (see also footnote 3 to Table 3.1.2.1);

0,45 for spaces in which motor vehicles with fuel in their tanks are carried and for closed ro-ro cargo spaces.

For machinery spaces such value of the factor φ is to be taken which results in a greater value G.

In ships of less than 2000 tons gross tonnage, except for passenger ships, factors 0,35 and 0,4 may be reduced to 0,3 and 0,35, respectively.

3.8.1.2 Where a carbon dioxide smothering piping is used as a smoke detection one, the carbon dioxide distributing manifold may be placed together with the CO_2 release controls for each space protected by the smoke detection system near its detecting units. However, it is recomended that the provision of such manifold shall not preclude the possibility of discharging CO_2 into any of the protected spaces directy from the fire extinction station.

3.8.1.3 The total cross-sectional area of manifolds and the cross-section of the distributing manifold shall be not more than the sum of the cross-sections of the cylinder valves simultaneously opening for the largest by volume protected space (for high-pressure systems) and not more than the cross-section of the tank discharge valve (for low-pressure systems).

3.8.1.4 The cross-sections of distributing pipes for individual protected spaces shall be not more than the sum of the cross-sections of cylinder discharge valves simultaneously opening for the space concerned (for high-pressure system) or not more than the cross-section of the tank discharge valve (for low-pressure systems). The sum of the cross-sections of the discharge pipes shall not exceed the cross-section of the supply pipe except where the calculated pressure drop in any pipe cross section is not less than 1 MPa.

3.8.1.5 The supply of carbon dioxide shall be ensured as follows:

.1 85 per cent of the rated amount within not more than 2 min for machinery spaces, emergency diesel-generator and fire pump spaces and other spaces where oil fuel or other flammable liquids are used;

.2 2/3 of the rated amount within not more than 10 min for spaces for the carriage of vehicles with fuel in their tanks and spaces in which neither oil fuel nor other flammable liquids are carried or used.

3.8.1.6 The thickness of pipe walls shall be calculated in accordance with 2.3, Part VIII "Systems and Piping"; in this case, the design pressure p is assumed as equal to the design pressure of cylinders and tankers according to 3.8.2.1 and 3.8.3.1 and shall be not less than the values specified in Table 2.3.8 of the above Part.

3.8.1.7 Carbon dioxide shall be supplied to the protected spaces through nozzles arranged in the upper part of these spaces. Where the floor plates of the machinery spaces of category A are placed higher than one metre above the tank top, a number of nozzles (about 15 per cent of the total number) shall be fitted in the upper portion of the space below the plates.

3.8.1.8 The total sectional area of the outlets of the nozzles of the space concerned shall not exceed 85 per cent of the total cross-section of the distributing piping.

3.8.1.9 Perforated pipes may be used instead of nozzles in silencers, exhaust-gas boilers and smoke stacks. The total area of pipe perforations shall be by 10 per cent less than the pipe cross-section.

3.8.1.10 In addition to the alarms required by 4.3.4, signal whistles operated by the released carbon dioxide pressure shall be fitted on pipes laid in the spaces listed in 4.3.1.

3.8.1.11 The sealing materials for the valves and flexible hoses should be usable at low temperatures down to -60°C.

3.8.2 High pressure system.

3.8.2.1 The number of cylinders for storing liquid carbon dioxide shall be provided depending on the filling ratio (amount of carbon dioxide per 1 litre of cylinder capacity) which is not to be more than 0,675 kg/l at the design cylinder pressure 12,5 MPa and over and not more than 0,75 kg/l at the cylinder design pressure 15 MPa and over.

When filling cylinders, deviation of not more than by $\pm 0{,}5$ kg from the rated amount per cylinder is permitted.

In cases specified in 3.1.3.3 and 3.8.5 the filling ratio shall be reduced by 0,075 kg/l against the above values.

3.8.2.2 The cylinders shall be placed vertically in rows on the pads which may be made of wood and shall be accessible for inspection and checking of the amount of carbon dioxide contained therein. Each cylinder shall be marked with its ordinal number.

Pilot cylinders shall be fitted in the fire extinction station and be coated with a distinguished paint.

3.8.2.3 A pipe connecting a cylinder with a manifold shall be as a rule seamless and made of red copper. But use of special flexible hoses made of approved materials is permitted. A non-return valve shall be fitted on the pipe connecting the cylinder and the manifold.

Arrangement of the manifolds is to provide their complete draining.

3.8.2.4 A manifold of the carbon dioxide extinction station shall be fitted with a pressure gauge graduated to a value at least 1 MPa in excess of the hydraulic test pressure of the carbon dioxide cylinders. The value of the pressure gauge scale division shall not exceed 0,5 MPa.

3.8.2.5 A carbon dioxide extinction station shall have arrangements for weighing the cylinders or measuring the level of liquid therein.

3.8.2.6 Valves of cylinders.

3.8.2.6.1 The valve shall have protective devices complying with the following requirements:

protective diaphragms shall break at a pressure rise in the cylinders up to $(1,3 \pm 0,1)p$, in MPa (where p is design pressure of the cylinder);

for valves with slotted diaphragms which are additionally fitted with protective diaphragms the breaking pressure of slotted diaphragms shall be at least 1 MPa more than the highest value of the protective diaphragm breaking pressure;

there shall be provided a checking device to indicate that the protective device has operated.

3.8.2.6.2 The valve opening device shall be of the lever type and shall ensure the full opening of the valve by turning the lever to an angle not more than 90°. This device shall permit the valves to be opened individually or by groups.

3.8.2.6.3 The cylinder valves shall be fitted with scarfed pipes cut short at 5 to 15 mm from the cylinder bottom; the inside diameter of the said valve pipes and of the pipes connecting the cylinder valves with a manifold shall be not less than 10 mm.

3.8.2.6.4 if the design of the valves of pilot cylinders differs from that of the valves of all other cylinders, they shall be coated with a paint of another colour and have the inscription "starting".

3.8.2.7 The gas from the protective devices shall be discharged:

.1 to the atmosphere beyond the boundaries of the station through a separate pipe provided with an audible alarm at the outlet;

.2 to the distribution manifold where provision is to be made for:

two pipes, one of which is open-ended and fitted with a shut-off valve, and the other is provided with a protective diaphragm;

a signalling device to indicate the presence of pressure in the manifold whose readings are to be transmitted to the space where watch keepers are present all the time.

In this case, a checking device to indicate that the protective device has operated is not required for the valves.

3.8.3 Low-pressure system.

3.8.3.1 The rated amount of liquid carbon dioxide shall be stored in tank (tanks) at the working pressure of about 2 MPa which is ensured by maintaining a temperature of about −18°C.

A filling ratio of a tank shall be not more than 0,9 kg/l.

3.8.3.2 A tank shall be served by two self-contained refrigerating plants, each consisting of one compressor, a condenser and a cooling battery.

Each plant is to be capable of permanently maintaining prescribed temperature at its continuous operation during twenty four hours under environmental conditions specified in 2.3, Part VII "Machinery Installations".

When one of the plants is rendered inoperative, the other shall be automatically brought into operation.

One refrigerating plant may be used if it comprises two independently driven compressors and a condenser with 25 per cent heat transmission allowance.

Cooling batteries shall be separate for each plant or common, but they shall consist of not less than two isolated sections, each having a surface designed for full output.

In other respects, a refrigerating plant is to meet the requirements of Part XII "Refrigerating Plants" for unclassed plants, except for 3.3, 3.4, 3.5 and 6.2.6, as well as those of 2.1.1, 2.3.12, 2.3.13 and 7.2.2 for classed plants.

3.8.3.3 A tank shall be fitted with:

branches with shut-off valves for filling the tank;

a discharge pipe;

a device for direct monitoring of liquid carbon dioxide level, mounted on the tank;

two relief valves discharging to the atmosphere fitted on the permanent pipe connection of the tank with one of the relief valves;

a pressure gauge;

high and low pressure alarm devices;

lowest acceptable level alarm device.

The setting of the relief valve shall be at least $1,1 - 1,2p$, and its throughput shall be such that pressure in the tank with the valve fully open may not exceed $1,35p$ (here p is working pressure in the tank, in MPa).

The value of the design pressure of the tank shall be assumed equal to the greatest lifting pressure of a relief valve.

3.8.3.4 If fitted outside the tank, the level gange pipe of the device for remote monitoring of the level of liquid is to be shut off with two valves (open throughout the period of operation) and provided with one control hydrant only, nominally filled (100 per cent). The pipe and the control hydrant shall be thermally insulated.

3.8.3.5 The pipe of the device for direct monitoring of level is to be shut off with two valves (closed throughout the period of operation) and provided with a control hydrant at least, filled to 95 per cent of the nominal ratio, as well as with level monitoring hydrants to enable metering out when fire is extinguished in several spaces of different volume. The vertical length of the pipe by which level is gauged shall bear no insulation.

3.8.3.6 The tank and pipes led therefrom and permanently filled with carbon dioxide are to be provided with heat insulation preventing operation of the relief valve within 24 hours after the installation is de-energized, at the ambient temperature of 45°C and initial pressure equal to the starting pressure of the refrigerating plant.

3.8.3.7 Material for a tank shall meet the requirements of 3.3, Part XIII "Materials". Welds shall be radiographed as required for class II in Table 3.3.2-2, Part XIV "Welding".

3.8.3.8 Pipe portion between two shut-off valves where liquid carbon dioxids is retained shall be provided with relief values beginning to operate at a pressure of 1,35*p* and a forced lifting device or drain values..

3.8.3.9 The alarm system shall give visual and audible alarm signals:

when the maximum (not higher than the setting of the relief valve) and minimum (not less than 18 bar) pressure is reached in the tank;

when the level of liquid carbon dioxide in the tank is reduced to the minimum acceptable level;

in case of refrigerating plant failure;

when the discharge of carbon dioxide begins.

The alarm signals are to be given at the main fire control station and in engineers' cabins.

3.8.4 Release control.

3.8.4.1 It is recommended that remote control of carbon dioxide discharge into the spaces specified in 3.8.1.5.1 shall be provided from the main fire control station or from a position in the vicinity of the entrance to the space.

Release controls of the high pressure system at the fire extinction station shall ensure simultaneous opening of cylinder valves for the above spaces.

Two separate release controls shall be provided for the system, one for cylinder release and the other to open the valve through which carbon dioxide would be discharged into the protected space.

3.8.4.2 At the position from which the system is remotely started, an alarm shall be provided for gas discharge from its storage containers and for gas release into a protected space (for gas pressure in front of and after the starting shut-off valve).

Two separate controls shall be provided for releasing carbon dioxide into the protected space and to ensure the activities of the alarm. One control shall be used to discharge the gas from its storage containers. A second control shall be used for opening the valve of the piping which conveys the gas into the protected space.

The two controls shall be located inside a release box clearly identified for the particular space. If the box containing the controls is to be locked, a key to the box should be in a break-glass type enclosure conspicuously located adjacent to the box.

3.8.4.3 The pipes supplying carbon dioxide from pilot cylinders to servomotors shall be fitted with shutt-off valves interlocked with a device opening pilot cylinders.

3.8.4.4 In low-pressure systems, release of carbon dioxide is to be manual. Where an automatic control system is provided to supply rated amount of carbon dioxide to protected spaces, manual regulation of gas supply shall also be provided.

Where the system serves more than one spaces, facilities shall be provided to control the amount of released carbon dioxide such as an automatic flowmeter or a precision level indicator located at the control station(s).

3.8.5 Local carbon dioxide fire extinction stations.

In well-founded cases local stations with not more than five cylinders (not more than 125 kg of carbon dioxide) may be permitted for certain protected spaces.

In a machinery space carbon dioxide cylinders may be placed for fire protection of crankcases and silencers of internal combustion engines, of smoke stacks and other enclosed compartments located within the machinery spaces.

3.9 INERT GAS SYSTEM

3.9.1 General provisions.

3.9.1.1 The inert gas system may be used:

.1 as a principal means of fire extinguishing in dry cargo holds, provided an independent inert gas generator is installed;

.2 as a means of warning the outbreak of a fire by rendering and maintaining the atmosphere of the cargo tanks non-flammable at all times, except when such tanks are required to be gas free.

3.9.1.2 The system is to be capable of:

.1 maintaining the atmosphere in any part of any cargo tank with an oxygen content not exceeding 8 per cent by volume and at a positive pressure at all times in port and at sea except when it is necessary for such tank to be gas free; maintaining the atmosphere in any part of any dry cargo hold with an oxygen content not exceeding 14 per cent by volume;

.2 eliminating the need for air to enter a tank during normal operations except when it is necessary for such a tank to be gas free;

.3 purging empty cargo tanks with inert gas and air.

3.9.1.3 Inert gas with an oxygen content of not more than 5 per cent by volume is to be delivered to the cargo tanks.

3.9.1.4 The temperature of the inert gas supplied to the protected space is to be not in excess of:

.1 65°C for cargo tanks;

.2 50°C for dry cargo holds.

3.9.1.5 The inert gas supply may be treated flue gas from main or auxiliary boilers or separate gas generators. The Register may accept systems using flue gases from other sources or any combinations thereof provided an equivalent standard of safety is achieved. Each source of flue gas is to be provided with automatic combustion control to provide for the fulfilment of the requirement of 3.9.1.3.

In the systems using carbon dioxide measures are to be taken that the risk of ignition from generation of static electricity by the system itself is minimized.

3.9.2 Capacity.

3.9.2.1 The system is to be capable of delivering inert gas to the cargo tanks at a rate of at least 125 per cent of the maximum total capacity of the cargo pumps during discharging the ship.

3.9.3 Equipment.

3.9.3.1 A flue gas scrubber is to be fitted which will effectively cool the volume of gas and remove solids and sulphur combustion products. The cooling water is to be delivered by an independent pump. Provision is to be made for an alternative supply of cooling water from a stand-by pump without interfering with any essential services on the ship.

3.9.3.2 The gas scrubber is to be designed so that the capacity of the system will not drop for more than 3 per cent and the gas temperature at the outlet will not rise more than 3°C as against the design values under all normal conditions of heel and trim.

3.9.3.3 Provision is to be made in the gas scrubber housing for inspection holes and sight glasses made of impact-, and heat-resisting material for inspections and maintenance.

3.9.3.4 At least two blowers are to be fitted which together are capable of delivering at least the volume of gas required by 3.9.2.

3.9.3.5 Provision is to be made in the blower casing for maintenance devices.

3.9.3.6 Interior surfaces of the scrubber and blowers are to be made of corrosion-resistant materials or lined with a coating material.

3.9.3.7 Filters or equivalent devices are to be fitted to minimize the amount of water and solid particles carried over to the inert gas blowers.

3.9.4 Cargo tank protection against pressure (vacuum).

3.9.4.1 The inert gas system is to be so designed that the maximum pressure which it can exert on any cargo tank will not exceed the test pressure of any cargo tank.

3.9.4.2 One or more pressure-vacuum breaking devices are to be provided on the inert gas supply main provided they are not fitted on the gas venting system or individually on each tank. Control, location and design of these arrangements are to comply with 9,7, Part VIII "Systems and Piping".

3.9.4.3 A positive pressure not exceeding 21 kPa is to be maintained in the cargo tanks when they are filled or being filled with inert gas under normal working conditions.

3.9.5 Non-return valves.

3.9.5.1 At least two non-return devices are to be fitted in the inert gas supply main in the cargo area on deck. One of them is to be a deck water seal, and the other — a non-return valve or an equivalent device fitted forward of the deck water seal. They are to be located between the automatic valve required by 3.9.6.5 and the aftermost connection to any cargo tank or cargo pipeline.

3.9.5.2 The deck water seal is to be capable of being supplied by two separate pumps, each of which is to be capable of maintaining an adequate supply at all times and automatically starting each pump feeding the water seal and automatically filling the seal with water upon inert gas supply failure (for half-dry and dry water seals).

A drain pipe of the deck water seal is not to pass through machinery spaces. Discharge pipes are to be led directly overboard.

3.9.5.3 Provision is to be made to ensure that the water seal is protected against freezing in such a way that the integrity of seal is not impaired by overheating.

3.9.5.4 The deck water seal and all loop arrangements are to be capable of preventing return of hydrocarbon vapours at a pressure equal to the test pressure of the cargo tanks.

3.9.5.5 The non-return valve (see 3.9.5.1) may be of isolating type or of check type with a stop valve being additionally fitted in the inert gas supply main forward of the non-return valve.

3.9.5.6 A water loop or other approved arrangement is to be fitted to each associated water supply and drain pipe and each venting or pressure-sensing pipe leading to gas safe spaces[1]. Means are to be provided to prevent such loops from being emptied by vacuum.

3.9.5.7 Provision is to be made in the deck water seal for sight holes and glases for monitoring the water level and making inspections.

3.9.5.8 Materials used in non-return devices are to be resistant to the effect of acids generated during cooling, cleaning and by gases coming through the pipes.

3.9.6 Pipes.

3.9.6.1 The inert gas main may be divided into two or more distributing pipes forward of the non-return devices required by 3.9.5.1.

3.9.6.2 The distribution inert gas supply pipes shall be fitted with branch piping leading to each cargo tank. Branch piping for inert gas is to be fitted with either stop valves or equivalent means of control for isolating each tank.

Where stop valves are fitted, they are to be provided with locking arrangements to prevent the control of the valves by unauthorized persons.

The control system operated shall provide positive indication of the operational status of the stop valves.

3.9.6.3 In combination carriers the arrangement to isolate the inert gas system from the slop tanks is to consist of blank flanges.

3.9.6.4 Outlets of the pipes discharging inert gas into dry cargo holds are to be located in the lower part of the protected space. Such spaces of 500 m^3 in volume and more are to be provided with two pipe outlets located in the opposite parts of the space. Pipe outlets discharging inert gas into the cargo tanks are to be located in the upper part.

3.9.6.5 A gas regulating valve is to be fitted in the inert gas supply main. It is to be capable of automatically regulating the flow of inert gas to the cargo tanks as referred to in 3.9.8.8 unless means are provided to automatically control the speed of the inert gas blowers.

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[1] Gas safe space is a space in which the entry of hydrocarbon gases would produce hazards with regard to flammability or toxicity.

3.9.6.6 If a connection is fitted between the inert gas supply main and the cargo piping system, arrangements are to be made to ensure an effective isolation having regard to the large pressure difference which may exist between the systems. This is to consist of two shut-off valves, the valve on the cargo main being of a non-return type, and an arrangement to vent the space between the valves in a safe manner or an arrangement consisting of a spool-piece with associated blanks.

3.9.6.7 The valve separating the inert gas supply main from the cargo main and which is on the cargo main side is to be a non-return shut-off valve.

3.9.6.8 Piping systems are to be so laid as to prevent the accumulation of cargo or water in the pipelines under all normal conditions.

3.9.6.9 Suitable arrangements are to be provided for the safe venting of the section of the line between the valves referred to in 3.9.5.5 and 3.9.6.5 in case when the first of these valves is closed.

3.9.6.10 The diameter of the pipes is to be such as to ensure the gas flow rate in any section of the piping to be not more than 40 m/s.

3.9.6.11 The piping from the gas scrubber to the blowers and recirculation lines as well as drain pipe of gas scrubbing and cooling system are to be lined with corrosion-resistant coating.

3.9.6.12 Suitable arrangements to be located after the valve referred to in 3.9.6.5 are to be provided to enable the inert gas main to be connected to an external supply of inert gas.

3.9.6.13 The inert gas supply main may be used for the venting of the cargo tanks.

3.9.7 Instruments and alarms.

3.9.7.1 On the discharge side of gas blowers, instruments should be provided for continuous indication of the inert gas temperature and pressure.

3.9.7.2 Instrumentation is to be fitted for continuously indicating and permanently recording, when the inert gas is being supplied:

.1 the pressure of the inert gas supply main forward of the non-return devices required by 3.9.5.1;

.2 the oxygen content of the inert gas in the inert gas supply main on the discharge side of the gas blowers.

These devices are to be placed in the cargo control room; but where no cargo control room is provided, they are to be placed in a position easily accessible to the officer in charge of cargo operations.

3.9.7.3 In addition to the requirements of 3.9.7.2, the following meters are to be fitted:

.1 in the navigating bridge to indicate at all times the pressure (see 3.9.7.2.1) and the pressure in the slop tanks of combination carriers, wherever those tanks are isolated from the inert gas supply main;

.2 in the machinery control room or in the machinery space to indicate the oxygen content (see 3.9.7.2.2).

3.9.7.4 Suitable arrangements are to be provided on each cargo tank for measuring oxygen and hydrocarbon vapour concentration using portable instruments.

3.9.7.5 Suitable means are to be provided for the zero and span calibration of both fixed and portable gas concentration measurement instruments referred to in 3.9.7.2 and item 15 of Table 5.1.2.

3.9.7.6 Audible and visual alarms are to be provided to indicate:

.1 low water pressure or low water flow rate to the flue gas scrubber;

.2 high water level in the scrubber;

.3 increase of gas temperature, this alarm being operated when the temperatures referred to in 3.9.1.4 are reached;

.4 failure of inert gas blowers;

.5 oxygen content more than 14 per cent by volume in cargo holds;

.6 oxygen content in the inert gas main more than 8 per cent by volume;

.7 failure of the power supply to the automatic control system for the gas regulating valve and to the indicating devices referred to in 3.9.7.2;

.8 low water level in the deck water seal referred to in 3.9.5.1;

.9 gas pressure less than 1 kPa in the inert gas main. The alarm arrangement is to be such as to ensure that the pressure in slop tanks in combination carriers can be monitored at all times;

.10 high gas pressure (when the pressure reaches 10 kPa).

.11 insufficient fuel feeding (if inert gas generators are available);

.12 failure of power supply to the generator (if inert gas generators are available);

.13 failure of power supply to automatic generator control system (if inert gas generators are available).

3.9.7.7 Indicating units of the alarms required in 3.9.7.6.3, 3.9.7.6.4, 3.9.7.6.6 and 3.9.7.9 are to be placed in the machinery space and in the cargo control room, where provided, but in any case they are to be placed in a position where the alarm may be immediately received by responsible members of the crew.

3.9.7.8 Audible and visual alarms indicating the low water level in the water seal of half-dry and dry type are to operate on failure of the inert gas supply.

3.9.7.9 Additional audible alarms independent of the alarms required in 3.9.7.6.9 or automatic shut-down of the cargo pumps is to be provided to operate when the pressure in the main drops to 0,5 kPa.

3.9.8 Systems using flue gas of boilers. (These requirements are additional to those stated in 3.9.1 to 3.9.7).

3.9.8.1 The flue gas scrubber and blowers are to be located aft of all cargo tanks, cargo pump rooms and cofferdams separating these spaces from machinery spaces of category A.

The design and location of scrubber and blowers with relevant piping and fittings are to prevent the gas leakages into enclosed spaces.

3.9.8.2 Suitable shut-off arrangements are to be provided on the suction and discharge connections of each blower. Arrangements are to be provided to enable the functioning of the inert gas plant to be stabilized before commencing cargo discharge.

3.9.8.3 Flue gas isolating valves are to be fitted in the inert gas supply mains between the boiler uptake and the flue gas scrubber. The valves are to be provided with an indicator to show whether they are open or shut. Precautions are to be taken to maintain them gastight and keep the seatings clear of soot.

Arrangements are to be provided to ensure that boiler soot blowers cannot be operated when the corresponding flue gas valve is open.

3.9.8.4 If the blowers are to be used for gas freeing, their air inlets are to be provided with blanking arrangements.

3.9.8.5 A flue gas isolating valve (see 3.9.8.3) is to be made of materials capable of withstanding the flue gas temperature and resistant to the corrosive action of the gas.

3.9.8.6 The piping between the flue gas isolating valve and the scrubber is to be made of corrosion-resistant steel.

3.9.8.7 An additional water seal or other effective means of preventing flue gas leadage is to be fitted between the flue gas isolating valves (see 3.9.8.3) and scrubber.

3.9.8.8 The valve referred to in 3.9.6.5 is to be located at the forward bulkhead of the forwardmost gas safe space through which the inert gas supply main passes.

3.9.8.9 Automatic shutdown of the inert gas blowers and gas regulating valve are to be arranged on predetermined limits being reached in respect of 3.9.7.6.1, 3.9.7.6.2 and 3.9.7.6.8. Automatic shut-down of the gas regulating valve is also to be arranged in case of blower failure.

3.9.9 Inert gas generator system (the requirements for this system stated below are additional to those given in 3.9.1 to 3.9.7).

3.9.9.1 For inert gas generator (the machinery including blower, combustion chamber, scrubber, oil fuel pump, burner, automatic combustion control and supervisory equipment) use is to be made of oil fuel meeting the requirements of 1.1.2, Part VII "Machinery Installations".

3.9.9.2 The generators are to be located in the space referring to machinery spaces of category A.

3.9.9.3 In ships in whose tanks toxic substances may be carried the gas generators are not to be located in the machinery spaces and are to be located in a compartment reserved solely for their use according to the requirements of 3.9.8.1. Such a compartment is to be separated from the machinery spaces at least by a gastight steel bulkhead, having no doors or other openings, and from the accommodation spaces and cargo area by open decks, cofferdams or similar spaces. Adequate positive pressure type mechanical ventilation is to be provided for such a compartment. Access to such compartments is to be only from an open deck outside the cargo area. Access is to be provided on the end bulkhead of the superstructure or deckhouse, not facing the cargo area and/or on the outboard side of the superstructure or deckhouse at a distance of at least $L/25$, but not less than 3 m from the end of the superstructure or deckhouse facing the cargo area.

The inert gas supply main is not to be located in, or have any connection with systems located in machinery spaces, accommodation spaces and service spaces.

3.9.9.4 Despite the provisions of 3.9.3.4, the Register may permit only one blower if it is capable of delivering to the protected cargo spaces the total volume of gas required by 3.9.2, provided sufficient spares for the air blower and its prime mover are carried on board to enable any failure of the air blower and its prime mover to be rectified by the ship's crew.

3.9.9.5 Two oil fuel pumps are to be fitted to the inert gas generator. The Register may permit only one oil fuel pump, provided sufficient spares for the oil fuel pump and its prime mover are carried on board to enable any failure of the pump and its prime mover to be rectified by the ship's crew.

3.9.9.6 Where more than one inert gas generator is provided, suitable shut-off arrangements are to be fitted on the discharge outlet of each generator plant.

3.9.9.7 Arrangements are to be made to vent the inert gas to the atmosphere during starting-up or in case of equipment failure.

3.9.9.8 Where the inert gas generator is served by positive displacement blowers, a pressure relief device is to be provided to prevent excess pressure being developed on the discharge side of the blower.

3.9.9.9 Audible and visual alarms are to be provided to indicate:

.1 insufficient fuel oil supply;

.2 failure of power supply to the generator;

.3 failure of power supply to the automatic control system for the generator.

3.9.9.10 The gas regulating valve is to be automatically controlled to close and to interrupt the oil fuel supply to the generator on predetermined limits being reached in respect of 3.9.7.6.1 and 3.9.7.6.2.

Automatic shut-down of the gas regulating is also to be arranged in respect of 3.9.9.9.2.

3.9.10 System for the double hull and double bottom tanker

3.9.10.1 On tankers where the inert gas system is required, inertization of space in double hull may be accomplished through detachable branch pipes connected with the inert gas system of cargo tanks or via stationary pipelines.

3.9.10.2 If detachable branch pipes are used, connection arrangements on the system main shall be provided.

3.9.10.3 If stationary pipelines are used, a separate deck gate and non- retaining valve are to be provided.

3.9.11 Systems with inert gas supplied from cylinders.

3.9.11.1 The systems are designed for purposes stated under 3.9.1.1.2 in respect of fuel storage tanks mentioned in 2.1.11.

3.9.11.2 The cylinders of the systems, generally filled with nitrogen, and their spaces shall comply with the requirements of 12.7.3, Part VIII "Systems and Piping" and 6.4.5, Part X "Boilers, Heat Exchangers and Pressure Vessels".

3.9.11.3 The system piping of Class I and Class II, respectively, shall be tested on board in conformity with Section 20, Part VIII "Systems and Piping".

3.9.12 Nitrogen generator system.

3.9.12.1 The present requirements cover the system in which the inert gas (nitrogen) originates at separation of compressed air to the basic gases while passing through the nitrogen generator (group of empty fibres of semipermeable membranes or through adsorbent placed in hermetic casing). The system shall also comply with requirements 3.9.2.1, 3.9.4, 3.9.6.1 to 3.9.6.3, 3.9.6.12 (applicable to 3.9.12.8), 3.9.7.4, 3.9.7.5, 3.9.7.9 (applicable to 3.9.12.14.7) and 3.9.8.8 (applicable to 3.9.12.8).

3.9.12.2 Air compressor and nitrogen generator shall be placed in the engine room or in a separate room which is then referred to other engine rooms (see 2.4.2 of this part). It shall locate outside the cargo area and it shall have no direct access to the accommodation, service rooms and control stations.

3.9.12.3 The system shall produce inert gas with at least 95 per cent content of nitrogen and no more than 5 per cent of oxygen. The system shall be fitted with an automatic device which would enable emission of gas into the air while preparation of the system for the specification level and even during its faults.

3.9.12.4 The system is to have to air compressors of equal capacity. The system may have one compressor provided there are enough spare parts for it aboard to repair by the crew.

3.9.12.5 Equipment for processing of air ingoing into generator (aircooler, airheater, separator, filters) shall clean it from moisture, particles and oil and maintain specification temperature.

3.9.12.6 The nitrogen receiver may be installed in the cargo area. The room where it is installed shall have exit to the open deck, the door is to open outwards.

3.9.12.7 Tapping of air enriched with oxygen from the nitrogen generator and tapping of nitrogen from safety devices of the nitrogen receiver is to extend outside rooms to the places away from entrances, air intakes and openings of closed in spaces.

3.9.12.8 On the outlet from the nitrogen generator there shall be installed devices which maintain permanent pressure of the inert gas.

3.9.12.9 A flue gas isolating valve is to be installed between the nitrogen generator and receiver.

3.9.12.10 At least two retaining sealing arrangements are to be fitted in the inert gas system. One of them shall have double blocking and blowoff arrangement, another — the local locking device. They shall be installed on the main in the cargo area before branch pipes specified in 3.9.6.2.

3.9.12.11 There shall be mounted instruments for the permanent temperature and pressure indication: on the compressor delivery side; on the intake side of the nitrogen generator.

3.9.12.12 There shall be mounted instruments for the permanent temperature and pressure indication and registration during system operation:

.1 oxygen content in the inert gas after the nitrogen generator;

.2 pressure in the main before the retaning sealing valves required by 3.9.12.10.

3.9.12.13 Instruments specified in 3.9.12.12 shall be fitted in the cargo operations control station and in the central control station (or in the engine room).

см.Б1 **3.9.12.14** Audible and visual alarms are to be provided to indicate:

.1 low air pressure in the compressor specified in 3.9.12.11;

.2 high air temperature specified in 3.9.12.11;

.3 high level of water in the separator specified in 3.9.12.5;

.4 breakdown of electrical heater (if fitted) specified in 3.9.12.5;

.5 high oxygen content specified in 3.9.12.3 and 3.9.12.12;

.6 stop of energy supply of instruments specified in 3.9.12.12;

.7 drop of gas pressure referred to in 3.9.12.12;

.8 increase of gas pressure referred to in 3.9.12.12.

3.9.12.15 Automatic stop of compressor shall take place if alarm turns on as specified in 3.9.12.14.1 to 3.9.12.14.5 and 3.9.12.14.8. Automatic compressor protection is to comply with the requirements of 4.5, Part XV "Automation".

3.9.12.16 Automatic locking of arrangements specified in 3.9.12.8 shall take place if power is disconnected from the compressor.

3.9.12.17 Alarm required by 3.9.12.14 is to be installed in the engine room and control station of cargo operations if such post is provided but in any case this should be such room where alarm might be immediately received by the responsible crew member.

3.10 DRY POWDER SYSTEM

3.10.1 General requirements.

3.10.1.1 An extinguishing powder approved by the Register for this purpose shall be used in the dry powder system.

3.10.1.2 Nitrogen or other inert gas approved by the Register for this purpose shall be used as a propellent gas.

3.10.1.3 The system shall consist of:

powder installations that contain dry powder contai-ners, propellent gas cylinders and a distribution manifold;

hose stations;

pipes and fittings for bringing the system into action and powder supply to the hose stations.

3.10.1.4 Provision shall be made for a remote release of the system from any hose station.

The system shall be brought into action in not more than 30 s after the opening of the release cylinder at the remotest hose station operating from the powder installation concerned.

3.10.2 Quantity of dry powder and propellent gas. Capacity and number of nozzles.

3.10.2.1 A rated quantity of dry powder shall be stored in each container of the powder installation to provide a minimum 45 continuous discharge time at rated consumption for all attached monitors and hand hose lines.

3.10.2.2 Each nozzle is to be capable of discharge at a rate not less than 3,5 kg/s, the powder throw range being not less than 8 m. In determining a maximum distance of coverage of each hand hose line the length of its hose is to be taken into account.

The capacity of each fixed monitor is to be at least 10 kg/s, maximum distance of coverage for monitors having a capacity 10, 25 and 45 kg/s shall be 10, 30 and 40 m, respectively.

3.10.2.3 The number of hand hose lines and monitors shall provide the delivery of the dry chemical powder to any part of the cargo tank deck and cargo piping from two hand hose lines or a combination monitor/hand hose line.

At least one hand hose line or monitor shall be located aft of the cargo area.

3.10.2.4 In gas carriers one monitor shall be provided in the cargo area to protect cargo manifold and capable of discharge locally and remotely.

3.10.2.5 The quantity of dry powder for the protection of spaces indicated in 1.5.1.2 and 1.5.3.2.2 shall be determined on the basis of 10 second operation of the system with a dry powder discharge rate 0,1 kg m^{-3} s^{-1}.

3.10.2.6 The quantity of the propellent gas shall provide for a single entire release of the dry powder from the powder container.

3.10.3 Powder installations.

3.10.3.1 The powder installations shall be positioned aft of the cargo tank area.

Where the length of the cargo tank deck exceeds 150 m, one powder installation may be located thereon.

3.10.3.2 The dry powder system shall consist of at least two self-contained installations and in gas carriers with a cargo capacity of less than 1000 m^3 only one such installation may be fitted.

3.10.3.3 Ships fitted with bow or stern cargo loading and discharge manifold shall be provided with an additional dry powder installation complete with at least one monitor and one hand hose line.

3.10.3.4 Where a fire extinguishing installation has two or more hose stations, an independent pipe with release valves is to ensure proper dry powder delivery from the manifold to each station.

The powder installation shall provide for independent and simultaneous operation of all those stations.

3.10.4 Hose station.

3.10.4.1 Each hose station shall consist of remote-release cylinders with a non-kinkable hand hose line not more than 33 m in length or of a monitor.

3.10.4.2 All hose station equipment, other than a monitor, shall be stored in a watertight box or cabinet.

3.10.4.3 Each nozzle shall be fitted with an on/off operation and discharge device.

3.10.4.4 The cross-section of the nozzle shall be equal to that of the fire hose line or less than that by not more than 50 per cent.

3.10.4.5 Release cylinders shall be provided with pressure gauges.

3.10.4.6 Instructions on putting the system into action shall be available at the hose station.

3.10.5 Dry powder containers, pipes and fittings.

3.10.5.1 Provision shall be made in the container for a dry powder discharge pipe cut short at about 100 mm from the bottom.

3.10.5.2 A device is to be provided in the lower part of the container for gas flow into the container preventing the powder from flowing back into the gas pipe.

3.10.5.3 The filling ratio of the containers shall be taken equal to not more than 0,95.

3.10.5.4 Pipes and fittings shall have no contractions and abrupt expansions of cross-section.

3.10.5.5 The cross-sectional area of the manifold in the powder installation shall be not less than the total area of the pipes connected thereto for simultaneous discharge of dry powder or shall be not more than twice that area.

3.10.5.6 Provision shall be made on the distribution manifold for an arrangement for purging the pipes after use.

3.10.5.7 A bending radius of the dry powder pipe shall be not less than 10 pipe diameters.

3.10.5.8 The dry powder shall be discharged into the spaces indicated in 1.5.1.2 and 1.5.3.2.2 through nozzles. Their construction, arrangement and number shall provide for uniform spraying of powder in the entire volume of the space. The pressure at the remotest nozzle shall be taken at least equal to a minimum pressure necessary for effective spraying of powder.

3.11 AEROSOL FIRE EXTINGUISHING SYSTEM[1]

3.11.1 General requirements.

3.11.1.1 The fire extinguishing aerosol (which is produced while combustion of solid fuel aerosol generating compounds) generators used in the aerosol fire extinguishing systems shall be of the type approved by the Register.

3.11.1.2 The aerosol fire extinguishing system shall include:

generators of fire extinguishing aerosol;
remote control device;
predischarge alarms;
cables.

3.11.1.3 Design mass of the aerosol generating agent, in kg, shall be derived from the formula

$$G=(V+\sum_{J=1}^{n} V_{arj}\cdot P_{arj}\cdot Pa^{-1})\cdot k\cdot q \qquad (3.11.1.3)$$

where V = design volume of the protected space, in m^3;
V_{arj} = volume of the j-th air receiver, in m^3, see 3.1.2.5;
n = number of air receivers in the protected space;
j = serial number of air receiver;
P_{arj} = working pressure in the j-th air receiver, in MPa;
P_a = atmospheric pressure, in MPa;
q = normative fire-extinguishing capacity of aerosol, in kg/m^3;
k = factor of safety equal to 1,5.

3.11.1.4 Normative fire extinguishing concentration of aerosol depends on the type of generator and usually doesn't exceed 0,2 kg/m^3.

3.11.1.5 The following measures shall be taken at system actuation:

automatic activation of the emergency alarm systems in the protected space in accordance with the requirements of 4.3;

automatic disconnection of ventilation in the protected space.

3.11.1.6 For machinery spaces, emergency diesel generator and other spaces where liquid fuel or combustible liquids are used, the generator's working regime (feed of design quantity of aerosol) shall not exceed 2 min.

3.11.1.7 Arrangement of generators in the protected space shall ensure equal distribution of fire extinguishing aerosol. If there are shadow zones formed by equipment and boundaries fire extinguishing aerosol shall be fed directly to the shadow zones.

3.11.1.8 When generators are installed, they shall be oriented so that (keeping due note of 3.11.2.2 requirements) jets of fire extinguishing aerosol do not cause thermal action on the ways of evacuation, ship equipment, cables, emergency lighting, emergency alarm system, fuel and oil tanks and pipes.

3.11.2 Fire extinguishing aerosol generators.

3.11.2.1 Fire extinguishing aerosol generator consists of a casing, which contains an aerosol generating agent, starting device, electrical connection, devices for mounting to the ship structures. Casing of the generator shall be fitted with the arrangement (nozzle) for the release of an aerosol.

3.11.2.2 Each type of generator shall have information about the distance (along the aerosol jet) from its exit out of the generator to the end of the thermal zone with a temperature +70°C.

3.11.2.3 Time from the start up of the generator until operating duty shall not exceed 10 s (see 3.11.1.6).

3.11.2.4 Time of operating duty shall not be less than 20 s (see 3.11.1.6).

3.11.2.5 Design number of generators (pieces) can be calculated by formula

$$N=G/m \qquad (3.11.2.5)$$

where G = design mass of aerosol generating agent, in kg;
M = mass of a charge in one generator, in kg.

3.11.2.6 Casing of generator, its foundation and details fastening it to the foundation shall be made of noncombustible materials.

3.11.2.7 Generators shall be fitted with arrangements for automatic (spontaneous) starting, if the ambient temperature exceeds 250°C.

3.11.3 The fire extinguishing remote control device.

3.11.3.1 The remote control device shall comply with Section 2, Part XI "Electrical Equipment".

3.12.3.2 The remote control device shall enable simultaneous distant starting of all generators in the protected space.

3.11.3.3 If several spaces are protected by the remote control device, it shall enable divided start-up of generators in each space.

3.12.3.4 There shall be two sources of power supply — main and auxiliary — for the remote control device.

3.11.3.5 The remote control device shall enable automatic control of the running order of starting circuits (for instance, disconnection, fault to frame etc.) and signalling of the fault on the front panel.

3.11.4 Local stations of the aerosol fire extinguishing.

3.11.4.1 Local stations with one or two generators and the starting arrangement may be fitted near entrance to the space (without remote control device) in justified cases.

3.11.5 Cables.

3.11.5.1 Cabling shall comply with the requirements of Section 16, Part XI "Electrical Equipment".

3.11.5.2 Starting cables shall be shielded and the shield shall be grounded.

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[1] See also IMO MSC/Circ.1007 "Guidelines for the Approval of Fixed Aerosol Fire-Extinguishing Systems".

Table 3.11.1

Nos	Systems and assemblies to be tested	Hydraulic test pressure	
		in shop	on board ship
1	Foam and water fire extinguishing systems (see also Section 15, Part VIII "Systems and Piping"):		
	.1 pipes	—	In action
	.2 pipes of sprinkler system	—	1p
2	Pipes of dry powder system	1,5p	1p (by air)
3	Carbon dioxide systems		
3.1	High-pressure systems:		
	.1 pipes from cylinders to release control valves; transit pipe lines passing through spaces (see 3.1.4.1.4)	—	1,5p
	.2 pipes from release control valves to nozzles and pipes from safety devices	—	5 MPa
3.2	Low-pressure systems:		
	.1 pipes from tank to release control valves	—	1,5p
	.2 pipes from release control valves to nozzles and pipes from safety devices	—	1p
4	Pipes and scrubber of the inert gas system	—	1p (by air)
5	Pneumatic pipes	—	1,5p
6	Cylinders, containers and tanks:		
	.1 operating under pressure, including cylinders without valves	1,5p	—
	.2 operating without pressure	By filling up to the top of the air pipe	In assembly with system
	.3 cylinders with screwed-in valves	1p (by air)	—
7	Fittings	1,5p, but not less than 0,2 MPa	—

Notes:

1. p is the maximum working pressure in the system, and for carbon dioxide p is a design pressure of a cylinder or a tank, in MPa.
2. Fittings in assembly shall be tested for the tightness of closing by a pressure of at least 1,25p, the valves of carbon dioxide cylinders — by the highest breaking pressure of protective diaphragms according to 3.8.2.6.1.
3. The systems shall be tested in assembly on board ship upon completion of all erection work.
4. Pipes specified in 3.1.1 and 3.2.1, after being tested by a pressure of 1,5p, may be tested on board by an air pressure of 1p.
5. Pipes of the water fire main system in ships of 500 gross tonnage and upwards (see 3.2.5.1) are to be tested by a pressure of at least 1,0 MPa.

3.12 TESTING OF FIRE EXTINGUISHING SYSTEMS

3.12.1 Fire extinguishing systems shall be tested in compliance with Table 3.11.1.

3.12.2 The operational testing of the systems is to be conducted in conformity with Register — approved programs to verify their serviceability, operation of release devices, and where prototype ships are concerned, to confirm the stipulated time for the fire-extinguishing medium discharge into the protected space.

On prototype ships, a test discharge of the rated amount of carbon dioxide into one of the protected spaces is required for high-pressure carbon-dioxed systems.

The test discharge may be omitted if reasonable substantiations are submitted to the Register.

4 FIRE DETECTION AND ALARM SYSTEMS

4.1 GENERAL REQUIREMENTS

4.1.1 All items of electrical equipment, devices, feeders and wiring of fire detection and alarm systems shall fully comply with 7.5 and 7.6, Part XI "Electrical Equipment" and Fire Safety Systems Code.

4.1.2 The control panel shall be located on the navigating bridge or in the main fire control station.

Indicating units shall, as a minimum, denote the section a detector or manually operated call point has operated. At least one unit shall be so located that it is easily accessible to responsible members of the crew at all times, when at sea or in port, except when the ship is out of service. One indicating unit shall be located on the navigating bridge if the control panel is located in the main fire control station.

Passenger ships carrying more than 36 passengers shall have the detection alarms for the systems required by 4.2.1.2 centralized in a continuously manned central control station. In addition, controls for remote closing of the fire doors and shutting down the ventilation fans shall be centralized in the same location. The ventilation fans shall be capable of reactivation by the crew at the continuously manned control station. The control panels in the central control station shall be capable of indicating open or closed position of fire doors, closed or off status of the detectors, alarms and fans.

4.1.3 Announcing an outbreak of fire to the crew, passengers, and special personnel shall be by means of the general alarm system, requirements for which are set out in 7.4, Part XI "Electrical Equipment".

4.1.4 In the fire detection system alarms giving indication of fire and its location as well as of fault conditions in the detector circuits shall permit of readily indicating an area or a space from which a signal has come and a circuit where a fault occurred.

Fire detection system shall cause audible and visual signals of the emergency alarm system, distinct from audible and visual signals of any other system, which do not warn of fire, in sufficient number of places so that they can be heard and seen on the navigating bridge and by engineer on watch. In absence of the watch on the navigating bridge, the audible signal shall be sounded by responsible crew member to the place of watch.

In passenger ships visual signals shall be arranged on the mimic diagram. Audible signals shall be capable of being cut off. The circuit shall be so designed as upon receiving a second signal an audible signal previously cut off operates again.

4.1.5 The location of fire detectors shall meet the following requirements:

.1 where the fire detection system does not include means of remotely identifying each detector individually, no section covering more than one deck within accommodation and service spaces and control stations are generally to be permitted, except for a section that covers an enclosed stairway. The number of spaces served by one section is not to exceed 50. If the detection system is fitted with remotely and individually identifiable fire detectors, the sections may cover several decks and serve any number of enclosed spaces;

.2 in passenger ships, if there is no fire detection system capable of remotely and individually identifying each detector, a section of detectors shall not serve spaces on both sides of the ship nor on more than one deck and neither shall it be situated in more than one main vertical zone except that the Register, if it is satisfied that the protection of the ship against fire will not thereby be reduced, may permit such a section of detectors to serve both sides of the ship and more than one deck. In passenger ships fitted with individually identifiable fire detectors, a section may serve spaces on both sides of the ship and on several decks but may not be situated in more than one main vertical zone;

.3 a section of detectors shall not contain more than 100 detectors;

.4 a section of fire detectors which covers machinery spaces of category A is not to include fire detectors of control stations, accommodation spaces or service spaces.

4.1.6 Suitable instructions for testing and maintenance of the system shall be displayed adjacent to a fire alarm station.

4.1.7 Provision shall be made for automatically testing the correct operation of the automatic fire alarm and detection system.

см.Б1 **4.1.8** Fire alarm and detection system is not to be used for any other purpose, except for closing fire doors from the control station and other similar purposes. Where fire doors are at the same time watertight doors (see 7.12, Part III "Equipment, Arrangements and Outfit") they are not to be automatically closed upon operation of fire alarms.

4.2 FIRE DETECTION SYSTEMS

4.2.1 Automatic fire detection systems.

4.2.1.1 Automatic fire detection systems shall be provided in the following ships:

.1 passenger ships;

.2 cargo ships of 500 gross tonnage and upwards (see also 4.2.1.2.5);

.3 all ships with unattended machinery spaces of category A (see 4.2.3).

4.2.1.2 The following spaces shall be fitted with the automatic fire detection systems:

.1 all accommodation and service spaces except for sanitary spaces, saunas and provision stores;

.2 storerooms for explosives, storerooms for readily flammable materials, storerooms for combustible materials, welding workshops;

.3 control stations (other than main fire control stations, accumulator battery rooms and generator rooms);

.4 cargo spaces in passenger ships except for the cases when, to the Register satisfaction, it has been proved that the ship is engaged in so short voyages that it is inexpedient to apply this requirement;

.5 cargo spaces of ships carrying dangerous goods other than bulk goods, including ships under 500 gross tonnage;

.6 special category spaces;

.7 closed ro-ro cargo spaces;

.8 closed cargo spaces other than those mentioned in 4.2.1.1.6 and 4.2.1.1.7, which are intended for the carriage of motor vehicles with fuel in their tanks;

.9 corridors, stairways and escape routes in the area of accommodation spaces;

.10 incinerator room;

.11 zones presenting high fire risk (such as locations of oil purifiers, oil fuel pump units or their rooms, etc.) when said zones are so located that they are not under continuous sight from the centralized control position in attended machinery spaces of category A ;

.12 spaces listed in 4.2.7, Part VII "Machinery Installations".

.13 spaces specified in 2.2.1.6.

For cargo ships the requirements of 4.2.1.2.1 to 4.2.1.2.3 are to be met only when method IIIC fire protection is used.

In passenger ships carrying not more than 36 passengers there shall be installed throughout each separate zone, whether vertical or horizontal, in all accommodation and service spaces and, where it is considered necessary by the Register, in control stations, except spaces which afford no substantial fire risk such as void spaces, sanitary spaces, etc., either:

a fixed fire detection and fire alarm system so installed and arranged as to detect the presence of fire in such spaces; or

an automatic sprinkler, fire detection and fire alarm system so installed and arranged as to protect such spaces and, in addition, a fixed fire detection and fire alarm system so installed and arranged as to provide smoke detection in corridors, stairways and escape routes within accommodation spaces.

Passenger ships carrying more than 36 passengers shall be equipped with an automatic sprinkler, fire detection and fire alarm system in all service spaces, control stations and accommodation spaces, including corridors and stairways. Alternatively, control stations where water may cause damage to essential equipment may be fitted with an approved fixed fire extinguishing system of another type approved by the Register. A fixed fire detection and fire alarm system shall be so installed and arranged as to provide smoke detection in service spaces, control stations and accommodation spaces, including corridors and stairways. Smoke detectors need not be fitted in private bathrooms and galleys. Spaces having little or no fire risk such as voids, public toilets and similar spaces need not be fitted with an automatic sprinkler system, or fixed fire detection and alarm system

4.2.1.3 In the automatic fire detection and fire alarm system detectors are to be operated by heat, smoke or other factors approved by the Register. Flame detectors are only to be used in addition to smoke or heat detectors. Heat detectors are to be certified to operate within temperature limits of 54 to 78°C in the spaces with normal temperatures, and within temperature limits of 80 to 100°C in spaces with higher temperatures, such as certain areas in machinery spaces of category A, drying rooms, galleys, saunas, etc. when the temperature in all the above-mentioned spaces is raised to those limits at a rate less than 1°C per minute.

Heat detectors fitted in boiler air supply casing and uptakes are to operate at a temperature exceeding a maximum working temperature of flue gases by 100°C.

Heat detectors shall reliably operate at a temperature at least 5°C in excess of the temperature at which the sensor is set.

In spaces referred to in 4.2.1.2.9 smoke detectors are to be fitted operating before the smoke density exceeds 12,5 per cent obscuration per metre, but not until the smoke density exceeds 2 per cent obscuration per metre.

Smoke detectors fitted in machinery spaces of category A are to operate before smoke density reaches 50 per cent obscuration per metre.

Use may be made in machinery spaces of category A of the detectors which reveal a seat of fire on appearing temperature pulsation (heat-pulse detectors). The detectors are to be set to a temperature pulse frequency of 1,9 to 2,3 Hz and above and to operate when an amplitude is exceeded by (2±0,5)°C, whatever the room temperature may be.

The type of automatic detectors shall be so chosen that after the operation test they come back to normal operation without any components being replaced.

4.2.1.4 Detectors shall be so placed in the upper part of each protected space bounded by bulkheads, decks and enclosures that free flow of hot gases is ensured thereto. These detectors shall be protected against impacts and physical damage.

Detectors which are located on the overhead are to be a minimum distance of 0,5 m away from bulkheads. The maximum spacing of detectors is to be in accordance with Table 4.2.1.4.

Table 4.2.1.4

Type of detector	Maximum floor area per detector, in m^2	Maximum distance apart between centres, in m	Maximum distance away from bulkheads, in m
Heat	37	9	4,5
Smoke	74	11	5,5

The Register may permit departures from the requirements of Table 4.2.1.4 based upon test data agreed with the Register.

When heat-pulse detectors are used in machinery spaces, the deck area served by one detector is to be 50 m^2, and distance between centres is to be not more than 6 m.

Except for spaces with the limited height and where their use is especially justified, the fire detection system based only on the heat detectors is not allowed.

4.2.1.5 In cargo spaces mentioned in 4.2.1.2.4, 4.2.1.2.5 and 4.2.1.2.8 an automatic smoke detection system may be applied which operates by air sample extraction from the space.

4.2.1.6 The automatic smoke detection system operating on the principle of air sampling from spaces shall comply with the following additional requirements:

.1 the system shall be capable of continuous operation at all times. Systems operating on a sequential scanning principle may be permitted on agreement with the Register;

.2 the sampling pipe arrangements shall be such that the location of the fire can be readily identified;

.3 the system shall be constructed and installed so as to prevent the leakage of any toxic or flammable substances or fire extinguishing media into any accommodation and service space, control station or machinery space;

.4 at least one smoke accumulator shall be located in every enclosed space for which smoke detection is required. However, where a space is designed to carry oil or refrigerated cargo, or other cargoes for which a smoke sampling system is required, means may be provided to isolate the smoke accumulators in such compartments on agreement with the Register;

.5 smoke accumulators shall be located for optimum performance and shall be spaced so that no part of the overhead deck area is more than 12 m measured horizontally from an accumulator.

Where systems are used in spaces which may be mechanically ventilated, the position of the smoke accumulators shall be considered having regard to the effects of ventilation.

Smoke accumulators shall be positioned where impact or physical damage is unlikely to occur;

.6 not more than four accumulators shall be connected to each sampling point;

.7 smoke accumulators from more than one enclosed space shall not be connected to the same sampling point;

.8 sampling pipes shall be self-draining and protected from impact or damage from cargo working;

.9 the sensing unit shall operate before the smoke density within the sensing chamber exceeds 6,65 per cent obscuration per metre;

.10 at least two sample extraction fans shall be provided.

The fans shall be of sufficient capacity to operate with the normal conditions of ventilation in the protected area;

.11 the fire alarm station shall have means permitting observation of smoke in the individual sampling pipe;

.12 means shall be provided to monitor the airflow through the sampling pipes so designed as to ensure equal quantities are extracted from each interconnected accumulator;

.13 sampling pipes shall be a minimum of 12 mm inside diameter. Where the pipes are used in conjunction with fixed gas fire-extinguishing systems, the minimum size of pipe shall be sufficient to permit the fire extinguishing medium to be discharged within the appropriate time;

.14 sampling pipes shall be provided with arrangement for periodically purging with compressed air;

.15 the control panel is to be located on the navigating bridge or in the main fire control station. Clear information is to be displayed on or adjacent to the control panel about the spaces covered.

4.2.1.7 Provision shall be made for checking the operation of detectors by means of devices supplying hot air of particular temperature or by using smoke or aerosol having the relevant range of density or particle sizes, or by applying other conditions inherent in a fire to which the automatic detector shall respond.

4.2.2 Manual alarms.

4.2.2.1 Manual fire alarms shall be provided in the ships which in compliance with 4.2.1.1 are equipped with automatic fire detection system.

4.2.2.2 In ships referred to in 4.2.2.1, the buttons of manual fire alarms shall be fitted in the following positions:

.1 in the corridors of accommodation, service and working spaces;

.2 in lobbies;

.3 in public spaces having an area of more than 150 m^2;

.4 in machinery spaces of category A and in main control stations;

.5 in working spaces referred to in 1.5.8.1;

.6 in special category spaces;

.7 at exits from accommodation and machinery spaces to cargo spaces for motor vehicles with fuel in their tanks.

4.2.2.3 At each exit from the spaces specified in 4.2.2.2.3 to 4.2.2.2.6, a button shall be fitted. The buttons shall be easily accessible in corridors on each deck and located so that any part of the corridor is located not far than 20 m from the button.

4.2.2.4 The sections of automatic fire alarms may also be used for manual fire alarms.

4.2.2.5 All buttons of manual fire alarms shall be painted red and adequately illuminated both in normal and emergency conditions. The button shall be protected with glass.

4.2.2.6 Any required fixed fire detection and fire alarm system with manually operated call points shall be capable of immediate operation at all times.

4.2.3 Protection of unattended machinery spaces.

4.2.3.1 Unattended machinery spaces of category A, as well as heated air ducts and main boiler uptakes, essential auxiliary boilers with a steam capacity over 3 t/h and boilers with thermal liquids (including exhaust gas boilers) in such spaces are to be provided with an automatic fire alarm and fire de-tection system (see also 2.2.4, Part IX "Machinery").

4.2.3.2 In addition to the requirements of 4.2.1, a fire alarm and fire detection system of machinery space of category A shall meet the following requirements:

.1 an indicating unit shall be fitted at the main fire control station, on the navigating bridge or another accessible place protected from fire in machinery space of category A;

.2 a light signal shall indicate the location (zone) of fire;

.3 a fire alarm shall give visual and audible alarm signals distinct from those given by any other system which shall be provided at the locations sufficient to be heard and observed by the watch officer on the navigating bridge and by the responsible operator;

.4 in case of power supply failure or any fault in the system an audible alarm signal distinct from fire alarm shall be given in addition to a visual signal.

4.2.3.3 Type and location of detectors shall ensure rapid indication of fire and not permit of false operations under normal operating conditions of a machinery space.

Provision shall be made for detectors of at least two types operating by different factors of fire detection.

In spaces of less than 2,5 m in height use of heat detectors only may be permitted on agreement with the Register.

4.2.3.4 The arrangement of detector sections shall provide for the indication of fire location. Air movement due to machinery operation shall not affect the efficient operation of the fire alarm and fire detection system.

4.2.3.5 Detectors with controlled sensitivity shall have holding devices and an indicator of the preset sensitivity.

4.2.3.6 Where provision is made for temporarily cutting off an individual detector or a section of detectors, this shall be clearly marked. When a preset period of time expires, a cut-off detector or a section of detectors shall automatically cut in.

4.2.3.7 Facilities shall be provided to release manually the fire alarm from the following places:

corridors having entrances to machinery spaces of category A;

wheelhouse;

control station in the engine room.

4.3 FIRE WARNING ALARMS

4.3.1 Automatic alarms to warn that the fire extinguishing medium is released shall be provided in the spaces attended by crew members on their duties or accessible to them under normal service conditions, fitted with doors or access hatches for this purpose, including closed roll-on/roll-off cargo spaces and holds in container-ships carrying thermal containers. In other cargo spaces, as well as in small spaces (compressor rooms, paint and lamp lockers, etc), no fire warning alarms are required.

4.3.2 The signal warning of putting a total flooding system into action shall be given only within the space into which the extinguishing medium is to be discharged.

4.3.3 Control of fire warning alarms shall be interlocked both with the local and the remote control of the system, no matter from which control position the system is started for operation. The warning signal shall be transmitted to the protected space so that people can leave the space before the fire extinguishing medium is discharged therein. and should sound during 20 s at least.

4.3.4 The signal shall be clear, distinct and readily audible in a noisy space, and shall be of a tone distinct from all other signals. In addition to the audible signal, there shall be a visible signal: "Gas! Go away!" and for the spaces protected by the aerosol fire extinguishing systems — "Aerosol! Go away!".

4.3.5 Audible alarm in the cargo pump room of oil tankers shall be:

pneumatic, operated by dry and clean air; or

electrically-operated, intrinsically safe; or

electrically-operated, the electric actuating mechanism being located outside the pump room.

5 FIRE FIGHTING OUTFIT, SPARES AND TOOLS

5.1 FIRE FIGHTING OUTFIT

5.1.1 Items of fire fighting outfit shall comply with Fire Safety Systems Code and be of approved type and ready for use at any time.

Fire fighting outfit shall be located in a readily accessible place.

5.1.2 Depending on the purpose and size of the ship the standards for supplying portable fire fighting appliances, apparatus and consumable materials shall be in compliance with Table 5.1.2.

The ships below are to be provided with extra items of outfit in addition to those mentioned in Table 5.1.2, as follows: ships carrying dangerous goods — in conformity with 2.8.8 and 2.8.9, oil recovery ships — in conformity with 2.11.18 to 2.11.20, ships with helicopter decks — in conformity with 2.1.10.11 as well as ships with the marks **П** and **ПВ** in the class notation in accordance with 2.13.13.

5.1.3 The couplings of all portable items of outfit (fire hoses, fire hose nozzles, portable foam gene-rators, etc.) shall be of the standard quick-acting type and size adopted for the given ship. All couplings and items of outfit shall be made of a material resistant to marine environment.

Items of fire fighting outfit installed in the dangerous areas, rooms and spaces as well as on the open decks of oil tankers and oil recovery vessels, gas carriers and chemical tankers shall be of type preventing spark formation.

5.1.4 Fire hoses shall comply with the following requirements:

.1 they shall have a length of 10 to 15 m for hydrants fitted within spaces, and for hydrants fitted on the open decks of ships with a breadth of up to 30 m, their length shall be 15 to 20 m, for hydrants fitted on ships with a breadth of more than 30 m, their length may be up to 25 m.

All cranes on ships of less than 500 gross tonnage shall be fitted with hoses, which length is 10 to 15 m;

.2 they shall be made of approved materials resistant to wear and destruction by microorganisms (rotting);

.3 fire hoses in assembly with nozzles shall be stowed at hydrants or on open places on reels or in baskets. On open decks they shall be kept in spray-proof ventilated lockers or enclosures. The lockers and enclosures shall be marked with letters "FH" (fire hydrant) painted red;

.4 in interior locations in passenger ships carrying more than 36 passengers fire hoses shall be connected to the hydrants at all times:

.5 on cargo ships:

.5.1 of 1000 and more gross tonnage, the number of fire hoses is determined one fire hose per each 30 m of length and one spare fire hose, but not less than five hoses per ship. This number doesn't include any hoses required for machinery or boiler spaces. The Register may require to increase number of hoses in order to ensure sufficient number of hoses and their accessibility at any time, considering the type of ship and character of voyages made by the ship. A ship carrying dangerous goods shall be equipped with three additional hoses and nozzles in excess of those required above;

.5.2 of less than 1000 gross tonnage, the number of fire hoses is calculated in accordance with 5.1.4.5.1. However, the number of hoses shall be not less than three.

5.1.5 Standard nozzle sizes shall be 12, 16 and 19 mm or close thereto.

Nozzles sizes greater than 12 mm need not be used in accommodation, service and working spaces. In ships under 150 gross tonnage nozzles having 10 mm in diameter are permitted to be used. For machinery spaces and exterior locations, the nozzle size shall be such as to obtain maximum discharge possible from two jets at the pressure at each hydrant mentioned in Table 3.2.1.1 from the smallest pump, but nozzles sizes greater than 19 mm need not be used.

Nozzles are to be of an approved dual-purpose type with a shut-off device.

5.1.6 Air-foam nozzles for delivery of low-expansion foam (see 3.7) from fixed fire extinguishing system shall comply with the following requirements:

.1 on cargo tank deck of oil tankers each nozzle shall be capable of delivering 4 m^3/min of foam at a distance not less than 15 m (see also 3.7.2.3);

.2 in ship's spaces each nozzle shall be capable of delivering at least 2 m^3/min of foam.

5.1.7 Foam extension pipes with a hook-shaped bell-mouth at the end (for low-expansion foam) and extension pipes fitted with light supports at the middle (for medium-expansion foam) shall be of about 4 m in length.

An extended air-foam nozzle having a hook-shaped bell-mouth may be used in addition to the usual air-foam nozzle instead of a foam extension pipe.

5.1.8 A portable foam set supplied from the water fire main system shall consist of:

.1 an air-foam nozzle or foam generator delivering foam at a rate of at least 1,5 m^3/min;

.2 two portable vessels with foam concentrate of not less than 20 litres capacity each;

.3 foam mixer (if air-foam nozzle or foam generator is not provided with an ejector);

.4 a hose for connecting a vessel to the nozzle, foam generator or mixer.

Complete sets shall be located near the hydrants.

5.1.9 Portable fire extinguishers shall be of an approved type and shall comply with the following requirements:

Table 5.1.2

Nos	Description of items of outfit	Number of items of outfit to be available in each ship
1	Fire hoses with couplings (see 5.1.4):	
	.1 for water	In accordance with the number of hydrants fitted on board ship
	.2 for foam solution	In accordance with the number of fire hydrants to which foam solution is supplied from fixed foam fire extinguishing system. If the size of the water hoses required by 1.1 is suitable for handling foam solution, such hoses may be taken into account to complete the number of hoses to be coupled to the hydrants fitted on the upper decks
2	Fire hose nozzles:	
	.1 dual-purpose nozzles for producing a compact and a sprayed jet (see 5.1.5)	In accordance with the number of hydrants fitted on board ship
	.2 air-foam nozzles (see 5.1.6)	In accordance with the number of hydrants whereto foam solution is supplied from fixed foam fire extinguishing system
	.3 foam extension pipes (see 5.1.7)	In accordance with the number of air-foam nozzles for fire extinction in cargo tanks of oil tankers
	.4 portable foam generators or portable combination-foam production units (see 5.1.19)	Twice the rated number of foam generators
	.5 extension pipes (see 5.1.7)	50 per cent of the number of portable foam generators or combination-foam production units intended for fire extinction in the cargo tanks of oil tankers
3	Portable foam set (see 5.1.8)	**.1** In machinery spaces of category A and in the spaces with steam turbines, 1 set for each space **.2** For oil fuel storage tanks (except for double bottom tanks), 1 set for each space adjacent to the walls or decks of the tanks. Where the walls of the tanks are adjacent to machinery spaces of category A, the sets contained in the latter spaces may be regarded as sets required for protecting the oil fuel storage tanks **.3** In each fuel distributing station and each cargo hose room, 1 set **.4** In working spaces referred to in 1.5.8.1, 1 set per fire hydrant fitted, but not more than 3 sets are required for each space. A space of less than 150 m^2 need not have more than 1 set **.5** In special category spaces, 2 sets **.6** On open deck of container ships, 2 sets **.7** In ro-ro cargo space for the carriage of motor vehicles with fuel in their tanks, 3 sets Where spaces mentioned in 3.1 to 3.6 are protected by a fixed foam fire extinguishing system, portable foam sets need not be provided In this case, cock-ended branches from the foam fire extinguishing system shall be led to these spaces A set consisting of a hose and an air-foam nozzle is to be stored near the hydrants The number of hydrants and sets shall be as specified above
4	Portable foam fire extinguishers, dry powder fire extinguishers and carbon dioxide fire extinguishers (see 5.1.9). The use of dry powder fire extinguishers is permitted in all spaces instead of foam and carbon dioxide fire extinguishers	The minimum number of fire extinguishers at control stations, accommodation and service spaces shall be determined on the basis of 2 fire extinguishers for every 30 m or part thereof, of the deck length on which such spaces are situated, but not less than the number required in accordance with the following provisions: **4.1** Control stations: **.1** 1 foam fire extinguisher for each space, 1 fire extinguisher being permitted to be fitted in the corridor for a group of small spaces with a total area of up to 50 m^2, provided that the entrances to the spaces are adjacent and situated in the same corridor. Not required in unattended spaces of ships of less than 300 gross tonnage; **.2** 1 carbon dioxide fire extinguisher for each space or group of spaces (as specified in 4.1.1 of this Table) containing electrical or radio equipment, as also for chart houses and chart compartments; **.3** 1 foam fire extinguisher for each space containing an emergency diesel-generator or a fire diesel-driven pump

Table 5.1.2 — continued

Nos	Description of items of outfit	Number of items of outfit to be available in each ship
		4.2 Accommodation and service spaces: **.1** for every 30 m, or part thereof, of the length of the corridors communicating with accommodation and service spaces, 1 foam fire extinguisher; **.2** for every 100 m^2, or part thereof, of area of public spaces, 1 foam fire extinguisher. For spaces less than 15 m^2 in area fire extinguishers fitted near them may be used; **.3** in galleys and bakeries with oil-fired equipment, 1 foam fire extinguisher for each space; **.4** in galleys and bakeries with electrical, steam, coal- or gas-fired equipment, having the area of more than 50 m^2, 1 foam or carbon dioxide fire extinguisher; **.5** in other domestic service spaces, 1 foam fire extinguisher (where fire extinguishers are available in the corridor, at the entrance to the space, provision of fire extinguishers within the space is not compulsory); **.6** in each stairway enclosure and in each lobby, 1 foam fire extinguisher; **.7** in storerooms for readily flammable and combustible materials, 1 foam fire extinguisher for each space. Where the storeroom area is less than 50 m^2, the fire extinguishers may be kept in the corridor in close vicinity of the entrance to the space concerned or group of small spaces (with a total area not more than 50 m^2). In addition to the above number of fire extinguishers, within the other ship's spaces the number of fire extinguishers shall be determined as follows. **4.3** In machinery spaces containing internal combustion engines and oil fuel units — at least two foam fire extinguishers. In spaces containing oil fuel units — two foam fire extinguishers. **4.4** In machinery spaces containing oil-fired boilers — two foam fire extinguishers nearby each boiler front. If oil-fired units are located in this space — two additional foam fire extinguishers. **4.5** In machinery spaces containing internal combustion engines, oil-fired boilers and oil fuel units, the number of fire extinguishers is determined in accordance with 4.3 and 4.4. On ships of less than 150 gross tonnage, one foam fire extinguisher is enough. **4.6** In spaces containing electric machinery or equipment: 1 carbon dioxide fire extinguisher, for spaces containing main internal combustion or steam machinery, if the total power of the main machinery is less than 740 kW; 2 carbon dioxide fire extinguishers, for spaces containing main internal combustion or steam machinery, if the total power of the main machinery is equal to, or more than, 740 kW; 1 carbon dioxide fire extinguisher for each electric generator or group of generators, the total power being 500 to 1000 kW; 1 carbon dioxide fire extinguisher for each space or group (not more than three) of small spaces containing auxiliary machinery with electrical drives and for special electrical spaces. The carbon dioxide fire extinguishers required by this sub-item shall be provided in the above spaces whether or not provision is made for foam extinguishers required by other sub-items of this Table. **4.7** In separate spaces containing switchboards, 2 carbon dioxide fire extinguishers per space. In space having an area of 15 m^2, 1 carbon dioxide fire extinguisher, near the entrance to the space.

Table 5.1.2 — continued

Nos	Description of items of outfit	Number of items of outfit to be available in each ship
		4.8 At the entrance to accumulator battery rooms, other than those for radio stations and emergency lighting, 1 carbon dioxide fire extinguisher per space. **4.9** In compartments for auxiliary machinery, 1 foam fire extinguisher, when the space area is 50 m^2 and more, otherwise the fire extinguisher placed near the entrance to such space may be sufficient. **4.10** For oil fuel tanks, other than those of double bottom, not less than 2 foam fire extinguishers in each space adjacent to the walls or decks of the tanks. If such adjacent spaces are already provided with fire extinguishers, no additional fire extinguishers are required. **4.11** In pump rooms, fuel distributing stations, petrol pipe line trunks, cargo hose spaces: 1 foam fire extinguisher for every 30 m^2 for floor area. **4.12** In working spaces, 2 foam fire extinguishers, if the space area is under 100 m^2, plus 1 foam fire extinguisher for every 250 m^2 or part thereof, if the space area is more than 100 m^2. **4.13** In welding shops and in storerooms for welding equipment, 1 foam fire extinguisher and one carbon dioxide fire extinguisher per space. **4.14** In special category spaces, cargo spaces for motor vehicles with fuel in their tanks and in ro-ro cargo spaces on each deck, 1 fire extinguisher for each 20 m of deck length on both sides. At entrances to such spaces from accommodation and machinery spaces, 1 foam fire extinguisher. It is not required in spaces specified in 1.5.4.3.3.
5	Foam fire extinguishers of at least 45 l capacity or at least 16 kg carbon dioxide or dry powder fire extinguishers (see 5.1.10 and 5.1.11)	**.1** In machinery spaces containing internal combustion engines with the total power output of not less than 375 kW — one fire extinguisher. Additional number of fire extinguishers is determined in relation to fulfilment of the requirements 5.1.10.3. The above principle of choosing the number of fire extinguishers refers to machinery spaces containing internal combustion engines and oil fuel units; **.2** In machinery spaces containing internal combustion engines, oil-fired boilers and oil fuel units one of fire extinguishers specified in 5.1 may be omitted provided there is a fire extinguisher with a volume of 135 l;. **.3** In the working spaces, referred to in 1.5.8.1 1 fire extinguisher mentioned in 5.1.11 for every 300 m^2 or part thereof, of each working space (bounded by watertight and gastight bulkheads). **.4** In spaces containing electric generators or propulsion motors with the total power output being 1000 to 5000 kW, 1 fire extinguisher mentioned in 5.1.11 for each space. **.5** In separate spaces containing electric switchboards if the switchboard length is more than 5 m and the space is not protected by means of a fire smothering system, 1 fire extinguisher mentioned in 5.1.11 for a space.
6	Foam fire extinguishers, at least 136 l capacity, or at least 45 kg carbon dioxide fire extinguishers or dry powder fire extinguishers (see 5.1.10 and 5.1.11)	**.1** in machinery spaces containing oil fuel units as well as oil-fired boilers — one fire extinguisher per each space. In boiler rooms of cargo ships with domestic boilers of less than 176 kW the fire extinguisher is not required. **.2** In spaces containing electric generators and propulsion motors with the total power output 5000 kW and over, 1 fire extinguisher mentioned in 5.1.11 for a space. Three fire extinguishers in accordance with item 5 of this Table may be used instead of one fire extinguisher prescribed by this item.
7	Metal receptacles containing sand or sawdust (see 5.1.12)	1 receptacle in each firing space in each boiler room with oil-fired boilers, and each space containing a part of the oil fuel unit, as well as near lamp and paint lockers, fuel filling and distributing positions and in other fire hazardous areas where oil fuel or other flammable liquids are liable to spread (except for machinery spaces). 1 receptacle containing sand or dry sawdust impregnated with soda may be replaced by 1 portable foam fire extinguisher.

Table 5.1.2 — continued

Nos	Description of items of outfit	Number of items of outfit to be available in each ship
8	Blankets (see 5.1.13)	**.1** 1 blanket for every 40 m, or part thereof, of open deck length of oil tankers and passenger ships. **.2** In all other ships not referred to in 8.1 of this Table, 1 blanket, if the ship is from 300 to 1000 gross tonnage, and 2 blankets, if the ship is of 1000 gross tonnage and upwards. **.3** In machinery spaces of category A in ships of more than 300 gross tonnage, 1 blanket for each space. **.4** In working spaces indicated in 1.5.8.1, 1 blanket for each space.
9	Sets of fire fighting tools (see 5.1.14)	For ships of less than 2000 gross tonnage, 1 set. For ships of 2000 to 4000 gross tonnage, 2 sets. For ships of 4000 to 10000 gross tonnage, 3 sets. For ships of 10000 gross tonnage and upwards, 4 sets.
10	Fireman's outfit (see 5.1.15)	**.1** In passenger ships, 2 sets and additionally for every 80 m, or part thereof, of the total length of all accommodation and service spaces on the deck they are situated, or if there are more than one such deck on the deck with the maximum total length of the above spaces 2 sets in accordance with 5.1.15 and 2 sets of personal outfit in accordance with 5.1.15.1.1, 5.1.15.1.2 and 5.1.15.1.3. In passenger ships carrying more than 36 passengers, two additional fireman's outfits should be provided for each main vertical zone. However, for stairway enclosures which constitute individual main vertical zones and for the main vertical zones in the fore or aft end of the ship, which do not contain spaces of categories (*6*), (*7*), (*8*) or (*12*) (see 2.2.1.3), no additional fireman's outfits are required. **.2** In oil tankers and combination carriers of 500 gross tonnage and upwards, 4 sets. **.3** In cargo ships of 500 gross tonnage and upwards, 2 sets. **.4** In ships with helicopter decks an additional fireman's outfit shall be provided according to 2.1.10.7.
11	Portable electric or pneumatic drills (see 5.1.16)	In all ships of 4000 gross tonnage and upwards, 1 drill per ship.
12	Portable fire motor-pumps[1] complete with suction and delivery hoses and fire hose nozzles (see 5.1.17)	**.1** In ships where the fixed water fire main system is not fitted according to 3.2.1.6, 1 pc per ship. **.2** Where no fixed emergency fire pump is fitted (see 3.2.1.2), 1 motor-pump per ship.
13	International shore connection (see 5.1.18)	In all ships of 500 gross tonnage and upwards, and on the floating cranes, 1 set.
14	Foam concentrate	Full amount of foam concentrate required by 3.7.
15	Gas analyzers:	
	.1 for vapours of flammable liquids and gases	In ships carrying motor vehicles with oil fuel (other than diesel oil) in their tanks and in ro-ro ships, 1 pc. In oil tankers and combination carriers, 2 pcs.
	.2 for oxygen content	In tankers fitted with inert gas system — 2 portable gas analyzers capable to operate in the inert gas atmosphere in addition to the above. Calibration devices for gas analyzers are to be provided in oil tankers and combination carriers. In oil tankers and combination carriers equipped with an inert gas system, 2 pcs.
16	Fog applicator (see 5.1.20)	In passenger ships of unrestricted service carrying more than 36 passengers: **.1** in each machinery space of category A, 2 pcs; **.2** for each pair of breathing apparatuses (see 5.1.15.2), 1 pc; **.3** in each special category space, 3 pcs; **.4** in each ro-ro cargo space, 3 pcs.
17	Fire buckets (see 5.1.21)	In ships having no water fire main system, 3 buckets.

[1] In non-propelled oil tankers, the motor-pump shall be replaced by a portable hand pump of at least 6 m^3/h capacity with a nozzle 10 mm in diameter and a nozzle pressure of at least 0,20 MPa. The pump shall be provided with two suction hoses, each 4 m long, fitted with a non-return valve, two delivery hoses, each 20 m long, and a hose nozzle of dual-purpose type with an outlet 10 mm in diameter.

.1 no fire extinguishing medium shall be used which, either by itself or under anticipated conditions of application, would give off toxic gases in amounts dangerous to human health;

.2 fire extinguishers shall have safety devices preventing the pressure therein to rise above permissible limits;

см.Б1 **.3** for 100 per cent of the first ten fire extinguishers and 50 per cent of the remaining fire extinguishers capable of being recharged onboard shall be provided with spare chargers. Not more than 60 per cent of total spare charges are required. Instructions for recharging shall be available on board;

.4 for fire extinguishers which cannot be recharged onboard, additional portable fire extinguishers of the same quantity, type, capacity and number, as determined in 5.1.9.3 above, shall be provided in lieu of spare charges;

.5 fire extinguishers shall be mounted in special brackets of quick-detachable type at easily visible places and in such a way that their serviceability is not impaired by the weather, vibration and other external factors.

They shall be located at the height of not more than 1,5 m from deck and not closer than 1,5 m from sources of heat;

.6 where several fire extinguishers are provided in the space in compliance with Table 5.1.2, some of them shall be located near the entrances, and the remainder shall be placed where a fire is most likely to break out within the space.

Where only one fire extinguisher is required for a particular space, it shall be located near the entrance to such space;

.7 the capacity of portable foam fire extinguishers shall be not less than 9 litres and not more than 13,5 litres and their total mass when charged shall not exceed 23 kg;

.8 where fire extinguishers containing other extinguishing media are used, they shall not be less effective than 9-litre foam fire extinguishers, whereas their overall dimensions and mass shall not exceed those of a 13,5-litre foam fire extinguisher.

In carbon dioxide and powder fire extinguishers the quantity of fire extinguishing medium is not to be less than 5 kg.

Fire extinguishers, items 4, 5 and 6 of Table 5.1.2, are to be selected with regard for the purpose of the powder extinguishing medium;

.9 in the machinery spaces fire extinguishers shall be so located that an extinguisher is not more than 10 m walking distance from any point in the space;

.10 carbon dioxide fire extinguishers shall not be located in accommodation spaces. In control stations and other spaces containing electrical or electronic equipment or facilities required for ship safety, fire extinguishers shall be provided, charged with the fire extinguishing medium, which does not conduct electricity and does not cause harm to equipment and facilities;

.11 portable fire extinguishers shall be provided with the device showing that they have already been used.

5.1.10 Foam fire extinguishers of at least 45 and 136 l shall meet the following requirements:

.1 fire extinguishers shall be located within the protected space, in regular fixed places near the exits.

Only fresh water shall be used for charging the fire extinguishers;

.2 the air for an air-foam extinguisher shall be kept in a cylinder provided solely for that particular extinguisher. The quantity of air in the cylinder shall be at least 25 per cent in excess of the rated amount. The air cylinder shall be fitted with a pressure gauge;

.3 fire extiguishers shall be provided with hoses winded on reels, as well as with airfoam nozzles or foam generators. In order to increase the range of action for 136-litre fire extinguishers, fixed piping for attachment of hoses thereto may be laid, the total length of pipes and hoses not exceeding 30 m. In all cases, the location of fire extinguishers and the length of pipes and hoses shall be such that the foam may reach any part of the space.

5.1.11 Carbon dioxide or dry powder fire extinguishers of at least 16 and 45 kg shall meet the following requirements:

.1 carbon dioxide fire extinguishers shall not be used in spaces of such volume that the complete discharge of the carbon dioxide contained in the cylinders is liable to cause concentration of carbon dioxide in excess of 5 per cent;

.2 an extinguishing medium shall be delivered to any part of the protected space through fire hoses of 10 to 15 m in length and through pipes if necessary;

.3 fire extinguishers shall be placed near the exits in the spaces and shall be protected against mechanical damage.

5.1.12 Metal receptacles containing sand or dry sawdust impregnated with soda shall comply with the following requirements:

.1 the capacity of the receptacles shall be at least 125 l;

.2 each receptacle shall be provided with a readily opening watertight cover, a scoop and a device for holding the cover in the open position.

5.1.13 Fire smothering blankets shall comply with the following requirements:

.1 they shall be sufficiently stout and durable;

.2 as a rule, they are to be made of non-combustible material; clean unraised thick felt may be used;

.3 blankets shall be stowed in special cases or lockers;

.4 they shall have an area of at least 3 m^2 and be similar to a square or circle in shape.

5.1.14 Complete sets of fire fighting tools shall comply with the following requirements:

.1 one complete set shall include one fire axe and one light-weight fire crowbar;

.2 the sets of fire fighting tools shall be stowed on regular boards. The fastening of the tools shall permit of ready availability of the tools for use;

.3 in ships for the carriage of motor vehicles with fuel (other than diesel oil) in their tanks one set of tools shall be placed near the exits from the accommodation and machinery spaces to cargo spaces.

5.1.15 The fireman's outfit shall include:

.1 personal outfit consisting of:

.1.1 protective clothing made of a material capable of protecting the fireman's skin against the heat radiated by the fire, against burns and against scalding by steam; the outside surface shall be waterproof; tarpaulin and polyvinylchloride clothes are not allowed for the outer material of fireman outfit. The type of the top material shall be approved by the competent body;

.1.2 boots and mittens of rubber or of some other dielectric material;

.1.3 a rigid helmet ensuring effective protection against impacts;

.1.4 a portable safe manual lantern with a minimum burning period of 3 hours; In ships carrying dangerous goods, in oil tankers and other ships having cargo spaces and spaces where a flammable gas, vapour or dust/air mixture is present or may arise, provision is to be made for explosion-proof lamps with explosion group 1Exd or 1Exp. The explosion group and temperature class are to be consistent with the category of the cargo carried. For example, they are 1Exd IIAT3 and 1Exp IIT3 for oil, kerosene and a number of gasolines.

.1.5 a fire axe with a helve made of hard wood; if the helve is made of some other material, it shall be insulated with some suitable dielectric material;

см.Б1 **.2** a breathing apparatus consisting of a self-contained compressed air-operated breathing apparatus, the volume of air contained in the cylinders of which is to be at least 1200 litres and the cylinders shall comply with the requirements of 6.4.5, Part X "Boilers, Heat Exchangers and Pressure Vessels", or other self-contained breathing apparatus which is to be capable of functioning for at least 30 min.

Each breathing apparatus shall be provided with a flexible fireproof lifeline, about 30 m in length. The lifeline shall be subjected to a test by statical load of 3,5 kN for 5 min. The lifeline shall be fastened directly to the apparatus or to a separate belt by means of a snaphook to preclude spontaneous separation of the line from the apparatus.

Provision shall be made for two spare charges for each breathing apparatus or two spare breathing apparatuses per each required apparatus.

Passenger ships carrying not more than 36 passengers and cargo ships equipped with properly installed devices for complete recharge of air cylinders by clean air may have only one spare charge for each breathing apparatus or one spare breathing apparatus per each required apparatus.

On passenger ships carrying more than 36 passengers provision shall be made for at least two spare charges for each breathing apparatus or two spare breathing apparatuses per each required breathing apparatus.

Fireman's outfits are to be stored in widely separated positions and to be easily accessible and ready for use.

In passenger ships at least two fireman's outfits and one set of personal equipment are to be available at any one position. Within each main vertical zone, at least two sets of fireman's outfits should be stored.

5.1.16 Portable electric drills shall be provided with an electric cable of sufficient length. The use of pneumatic drills instead of electric ones is permitted. The electric or pneumatic drills specified in item 11 of Table 5.1.2 may be reckoned in the number of the items prescribed for other types of ship's outfit.

5.1.17 Portable disel fire motor-pumps shall comply with the following requirements:

.1 the pump shall ensure simultaneous operation of at least two fire hose nozzles with an outlet diameter of at least 12 mm at a pump discharge pressure of at least 0,2 MPa and at vacuum in suction piping not less than 0,05 MPa; centrifugal pumps shall be fitted with a self-priming device;

.2 the pump motor shall be capable of being readily started either by hand or by special starters both at above-zero and below-zero ambient temperatures. The motor shall be provided with a quantity of fuel to ensure the operation of the pump for 1,5 hours without refuelling; the ship shall carry an additional reserve of fuel for refuelling;

.3 each motor-pump shall be provided with suction hoses, to a total length of 8 m, fitted with a suction strainer and a non-return valve, two delivery hoses, each 10 m long, two-dual purpose fire hose nozzles with an outlet diameter of at least 12 mm and a branch coupling for connecting two hoses;

.4 the dimensions and type of coupling for the delivery hoses and nozzles shall correspond to those used in the fixed water fire extinction systems fitted in the ship;

.5 the motor-pumps shall be provided with tools and accessories in compliance with the manufacturer's specification;

.6 motor-pumps for use in ships navigating under northern latitudes shall be placed in heated spaces, together with the suction and delivery hoses and nozzles.

5.1.18 The international shore connection (Fig. 5.1.18) for water supply from shore shall be in accordance with the following specification:

outside diameter of flange — 178 mm;
inside diameter of flange — 64 mm;
bolt circle diameter — 132 mm;
holes — 4 equispaced holes 19 mm diameter equidistantly placed, slotted to the flange periphery;

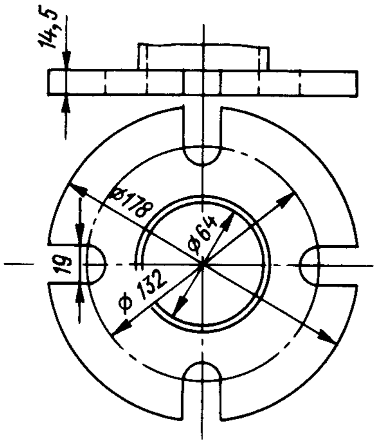

Fig. 5.1.18
International shore connection (ship)

flange thickness — at least 14,5 mm;

bolts — 4 pcs, each 16 mm in diameter and 50 mm in length;

bolt nuts — 4 pcs, 16 mm in diameter;

washers for bolts — 8 pcs.

On one side the shore connection shall have a flat-faced flange with dimensions as above, and on the other a quick-acting coupling which shall correspond to the ship's hydrants and hoses both in dimensions and design.

The shore connection, gasket, bolts and nuts shall be made of materials suitable for 1,0 MPa.

The shore connection complete with gasket, four bolts, four nuts and eight washers shall be stowed together with other items of fire fighting outfit in an easily accessible position.

5.1.19 Portable medium expansion mechanical foam generators and portable combination-foam production units shall comply with the following requirements:

.1 concentrate solution discharge at a pressure of 0,6 MPa, not less than 360 l/min (see also 3.7.2.2);

.2 foam jet range, at least 8 m;

.3 rated number of foam generators/units shall be determined from the formula

$$N = Q/q \qquad (5.1.19.3)$$

where Q = solution capacity of the system, in l/min;
q = solution capacity of a foam generator/unit, in l/min.

50 per cent of the foam generators/units and extension pipes required by items 2.4 and 2.5 of Table 5.1.2 shall be placed in the poop, the remainder, in the forecastle and midship superstructure, if any.

5.1.20 For applicator shall consist of L-shaped pipe with long side of about 2 m fitted for connection to fire hoses and short side of about 0,25 m equipped with fixed nozzle for producing water for or fitted for connecting water-spraying nozzle.

These applicators shall be stored near the fire hydrants and those for breathing apparatus near the latter.

5.1.21 Fire buckets shall be provided with the hemp rope of sufficient length and shall be stowed on the open decks in easily accessible places. The buckets shall be painted red and bear inscription "fire".

5.2 SPARES AND TOOLS

5.2.1 A ship shall carry spares and tools, the number of which shall be not less than that specified in Table 5.2.1. The quantities prescribed in the Table apply to fixed fire extinguishing systems only.

In ships of less than 150 gross tonnage, as well as in ships and floating cranes of restricted area of navigation **III** provision shall be made for spare parts and tools specified in 1.1, 1.2, 1.5, 1.6, 1.7, 4.4 and 8.2 of Table 5.2.1.

5.2.2 The spares and tools for the systems shall be kept in the fire extinction stations.

Spares shall be suitably marked.

6 EMERGENCY ESCAPE BREATHING DEVICES

6.1 GENERAL

6.1.1 Emergency escape breathing devices shall comply with Fire Safety Systems Code and be of the type approved by the Register.

6.1.2 Emergency escape breathing devices shall operate using compressed air or oxygen evolved during chemical reaction in the closed cycle of the air exchange. They shall not be used by crew members for fighting fires, entering oxygen deficient voids or tanks, or worn by fire-fighters. In these events, a self-contained breathing apparatus specified in 5.1.15.2, which is specifically suited for such applications, shall be used.

6.1.3 The number of emergency escape breathing devices and their location (including spare ones) is specified on fire control plans (see 1.4) The number of spare devices shall be not less than 2 for passenger ships and 1 for cargo ships.

Table 5.2.1

Nos	Description of spares and tools	Number per ship
1	Water fire main system:	
	.1 a fire hose of each length and diameter fitted complete with couplings	1 pc of each
	.2 connection couplings for each size fitted (if the ship is provided with hydrants of various diameters)	2 pcs
	.3 quick-acting couplings (hose couplings)	2 pcs (of each diameter)
	.4 quick-acting couplings (hose couplings) for ships of 4000 gross tonnage and upwards	4 pcs (of each diameter)
	.5 rubber rings for packing of joints between couplings, hoses and apparatuses	5 per cent of total number, but not less than 10 pcs
	.6 hose clamps	4 pcs (for ships of less than 300 gross tonnage, as many as the number of hoses, but not more than 4)
	.7 wrenches for engaging or disengaging couplings (where nozzles are fitted by means of a special wrench)	2 pcs
	.8 fire hydrant of each size fitted, in assembly	1 pc of each size
	.9 handwheel to fire hydrant of each size fitted	1 pc of each size
	.10 valve disks with packing rings to fire hydrants of each size fitted	1 pc of each size
2	Sprinkler system:	
	.1 sprinkler heads, in assembly	5 pcs per section
	.2 wrenches for sprinkler heads (where heads are fitted by means of a special wrench)	1 pc per section
	.3 parts for control valve	1 set, according to delivery specification
3	Pressure water-spraying, water-screen, drenching systems:	
	.1 spray nozzles of various types fitted in the system	5 per cent of total number of spray nozzles fitted
	.2 wrench for spray nozzles (where nozzles are fitted by means of a special wrench)	1 pc
4	Foam fire extinguishing system:	
	.1 hydrant of each size fitted, in assembly	1 pc
	.2 fixed air-foam nozzle or foam generator	1 pc
	.3 gauge glasses for tanks	1 pc
	.4 rubber rings for joints	10 pcs
5	Carbon dioxide smothering system:	
	.1 cylinder valves, assembled; for the number of cylinders:	
	below 50	1 pc
	50 to 100	2 pcs
	100 and over	3 pcs
	.2 wrenches for assembling and disassembling cylinder valves and other special valves	1 set per station
	.3 plugs to be fitted on pipes leading from cylinder valves, when cylinders are removed	25 per cent of the number of cylinders
	.4 protective diaphragms	In accordance with the number of cylinders
	.5 thrust bushes and washers for protective devices	10 per cent of the number of cylinders
	.6 non-return valves	5 per cent of total number, but not less than 1 pc
	.7 discharge nozzles of each type and size fitted	2 pcs
	.8 scales for weighing cylinders or carbon dioxide level gauge	1 pc
	.9 parts of tank carbon dioxide contents gauges	In accordance with delivery specification
6	Inert gas smothering system:	
	.1 control valve (sluice valve) for admitting inert gas into protected spaces	1 pc
	.2 parts for automatic control	In accordance with delivery specification

Table 5.2.1 — continued

Nos	Description of spares and tools	Number per ship
7	Dry powder system:	1 set of each
	.1 parts of release arrangements for hand hose lines and monitors	1 — 2 pcs
	.2 nozzles of each type and size	1 set
	.3 wrenches for assembling and disassembling valves, hand hose lines, nozzles	
8	Aerosol system:	
	.1 generator of fire extinguishing aerosol	One generator of each type used
9	Miscellaneous items, for all systems:	
	.1 instruments and gauges: pressure gauges, vacuum gauges, thermometers of each type fitted in systems	1 pc of each
	.2 adequate quantity of packing material for onboard repairs	1 set
	.3 fuses for automatic closing of fire doors and dampers	In accordance with number of doors and dampers thus controlled
	.4 spare parts for pumps, fans, compressors and engines serving fire extinguishing systems	In accordance with Section 5, Part VII «Machinery Installations»
	.5 spare parts and tools for remote control equipment of fire extinguishing systems	In accordance with delivery specification approved by the Register
	.6 spare parts and tools for fire alarm systems	In accordance with delivery specification approved by the Register
	.7 flame arresters (inserts) of each type and size fitted	1 — 2 sets
	.8 spare parts for electrical equipment of fire extinguishing systems	In accordance with Section 21, Part XI «Electrical Equipment»

6.2 SPECIAL REQUIREMENTS

6.2.1 Emergency escape breathing devices shall have service duration of at least 10 min.

6.2.2 Emergency escape breathing devices shall consist of a helmet or similar article, which fully covers face and it shall include a clear window for viewing. The helmet and its face part shall be made of flame resistant materials.

6.2.3 The inactivated emergency escape breathing devices shall be capable of being carried hands-free.

6.2.4 Emergency escape breathing devices shall be designed so that to enable quick and easy dressing.

6.2.5 If the emergency escape breathing devices are intended for training purposes their marking shall distinct from those which are to be normally used.

6.3 ARRANGEMENT IN SPACES OF THE SUPERSTRUCTURE

6.3.1 On all ships at least two emergency escape breathing devices shall be provided in accommodation spaces.

6.3.2 On passenger ships at least two emergency escape breathing devices shall be provided in each main vertical zone.

6.3.3 On passenger ships, carrying more than 36 passengers in addition to those required in 6.3.2, two additional emergency escape breathing devices shall be provided in each main vertical zone.

6.3.4 Requirements of 6.3.2 and 6.3.3 are not applied to stairway enclosures comprising separate main vertical zones and to vertical zones in both ends of a ship which do not have spaces of (*6*), (*7*), (*8*) and (*12*) categories specified in 2.2.1.3.

6.4 ARRANGEMENT IN MACHINERY SPACES

6.4.1 On all ships emergency escape breathing devices shall be stored in easily visible and accessible places on the escape routes and ready for use in case of fire. When selecting the place of storage of emergency escape breathing devices and their number, general arrangement of the machinery space and number of watchkeepers and those working in the space shall be considered. In addition, control stations and workshops in the machinery spaces shall be fitted with such devices. The above requirement may be omitted, if the crew attending the machinery space is equipped with the individual portable devices.

7 ALTERNATIVE DESIGN AND ARRANGEMENTS

7.1 PURPOSE

7.1.1 The purpose of the Section is to provide a methodology for alternative design and arrangements for fire safety.

7.2 GENERAL

7.2.1 Fire safety design and arrangements may deviate from requirements set out in Sections 2 to 6, provided that the design and arrangements meet the fire safety objectives and the functional requirements.

7.2.2 When fire safety design and arrangements deviate from the prescriptive requirements of the Chapter, engineering analysis, evaluation and approval of the alternative design and arrangements shall be carried out in accordance with the Section.

7.3 ENGINEERING ANALYSIS

The engineering analysis shall be prepared and submitted to the Register, based on the respective IMO guidelines and shall include, as a minimum, the following elements:

.1 determination of the ship type and space(s) concerned;

.2 identification of prescriptive requirement(s) with which the ship or the space(s) do not comply;

.3 identification of the fire and explosion hazards of the ship or the space(s) concerned;

.3.1 identification of the possible ignition sources;

.3.2 identification of the fire growth potential of each space concerned;

.3.3 identification of the smoke and toxic effluent generation potential for each space concerned;

.3.4 identification of the potential for the spread of fire, smoke or of toxic effluents from the space(s) concerned to other spaces;

.4 determination of the required fire safety performance criteria for the ships or the space(s) concerned addressed by the prescriptive requirement(s);

.4.1 shall be based on the fire safety objectives and on the functional requirements of the Chapter;

.4.2 shall provide a degree of fire safety not less than that achieved by using the prescriptive requirements; and

.4.3 shall be quantifiable and measurable;

.5 detailed description of the alternative design, measures and arrangements, including a list of the assumptions used in the design and any proposed operational restrictions or conditions; and

.6 technical justification demonstrating that the alternative design and arrangements meet the required fire safety performance criteria.

7.4 EVALUATION OF THE ALTERNATIVE DESIGN, MEASURES AND ARRANGEMENTS

7.4.1 The engineering analysis required in 7.3 shall be evaluated and approved by the Register taking into account the guidelines developed by IMO.

7.4.2 A copy of the documentation, as approved by the Register, indicating that the alternative design and arrangements comply with the Section shall be carried on board a ship.

7.5 RE-EVALUATION DUE TO CHANGE OF CONDITIONS

7.5.1 If the assumptions and operational restrictions that were stipulated in the alternative design, measures and arrangements are changed, the engineering analysis shall be carried out again under the changed condition and shall be approved by the Register.

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