RUSSIAN RIVER REGISTER

RULES • 2015

Rules for Technical Supervision During Construction of Ships and Manufacture of Materials and Products for Ships (RTSC)

Rules for Classification and Construction of Ships (RCCS)

Rules for Prevention of Environment Pollution from Ships (RPPS)

MOSCOW
RUSSIAN RIVER REGISTER

RULES
FOR TECHNICAL SUPERVISION
DURING CONSTRUCTION OF SHIPS
AND MANUFACTURE OF MATERIALS
AND PRODUCTS FOR SHIPS
(RTSC)

MOSCOW 2015

The Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships (RTSC) have been approved by the Order of Federal Autonomous Institution “Russian River Register” No. 36-п dated 09.09.2015 and brought into force since 19.07.2016 by the Order of Federal Autonomous Institution “Russian River Register” No. 29-п dated 11.07.2016.

The present re-edition of the Rules for Technical Supervision during Construction of Ships and Manufacture of Materials and Products for Ships (RTSC) includes amendments and additions approved by the following Orders of the Federal Autonomous Institution “Russian River Register”:
- Order No. 50-п dated 09.09.2016 (Notice No. 1);
- Order No. 78-п dated 07.11.2016;
- Order No. 100-п dated 27.12.2016;
- Order No. 24-п dated 09.03.2017 (Notice No. 2), came into force since 15.03.2017;
- Order No. 65-п dated 14.08.2017 (Notice No. 4), came into force since 20.08.2017.

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1 GENERAL PROVISIONS

1.1 APPLICATION

1.1.1 The present Rules for Technical Supervision During Construction of Ships and Manufacture of Materials and Products for Ships (hereinafter referred to as the Rules), which are based on and develop further the Regulations for Classification and Survey of Ships (hereinafter referred to as the Regulations for Classification), establish the types, procedures, methods and scope of technical supervision performed by the River Register in order to check compliance with requirements of the Rules for Classification and Construction of Inland Navigation and River-Sea Navigation Ships (hereinafter referred to as the RCCS) and Rules for Prevention of Environment Pollution from Ships (hereinafter referred to as the RPPS).

1.1.2 These Rules are used by the River Register for technical supervision during construction, conversion, modernization and repair of ships, manufacture of materials and products, repair of products to be used on the ships and during review and approval of technical documentation.

1.2 TERMS AND DEFINITIONS

1.2.1 Terms and their definitions related to the general terminology of the Rules are given in 2.1 Part 0 of RCCS.

1.2.2 For the purpose of these Rules the following terms and definitions are used:

.1 Random inspection — see 2.2.6 Part 0 of RCCS;

.2 Statement of conformity means the manufacturer's document confirming compliance of the manufactured items under technical supervision with the Rules and technical documentation approved by the River Register. The form of the Statement of Conformity is established by the River Register;

.3 Manufacturer means a legal entity or individual entrepreneur constructing a ship, manufacturing and supplying materials and/or products for ships or transferring a right to supply to another legal entity or individual entrepreneur, modernizing the products for ships, officially applying the trademark or other distinctive mark on ships and products, thus assuming the manufacturer's obligations;

.4 Product of mass production (mass produced product) means a product which belongs to periodically repeated batches of manufactured or repaired products;

.5 Type approval tests mean check tests of materials or products carried out to determine compliance of their properties (characteristics) with the approved technical documentation and Rules;

.6 Testing laboratory means a legally independent testing laboratory or subdivision of the organization performing the tests prescribed by the Rules during construction, conversion, modernization and repair of ships, manufacture of materials and products, repair of products (see 2.8.1.5);

.7 Approved is a term used by the River Register upon satisfactory results of checking compliance of materials and products with the requirements of the Rules;

.8 Type approval of a material or product means defining the compliance of type specimens of the material or product manufactured in the course of continuous production with the requirements of the Rules by the River Register;
9 Classification organization means an organization authorized by the RF Ministry of Transport for classification and survey of ships;

10 Test program means a document establishing the item, types, sequence and scope of the performed tests, procedure, terms, place and time frame of the tests, support and reporting for the tests as well as responsibility for their support and performance;

11 Test report means a document containing the information on the item under test, used methods, means and conditions of the tests, test results as well as evaluation of the test results;

12 Single delivery means a material or product delivered one time for the ships classed by the River Register or constructed to this class;

13 Ship repair means a set of operations on recovery of serviceable or operable condition of the ship for a specific period of time;

14 Certificate means a document of the River Register confirming that the considered materials or products comply with the requirements of the Rules and approved technical documentation;

15 "APPROVED" is a stamp used by the River Register to confirm compliance of technical documentation with the requirements of the Rules;

16 Bench tests mean tests performed using test equipment;

17 Technical documentation means design and process documentation as well as other technical documents for items under technical supervision which include data required to check compliance with the requirements of the Rules;

18 Type material or product means a material or product related to a group of materials or products with similar physical and mechanical properties or structural and technological features. They are used as intended without attributing to a specific ship or item under technical supervision;

19 Type specimen means a specimen of type material or product used during the test and inspection;

1.3 HEAD OFFICE ACTIVITIES

1.3.1 As regards technical supervision during designing, construction of ships, manufacturing of materials and products, the Head Office:

.1 reviews and approves engineering designs for construction of ships;

.2 reviews draft national standards;

.3 reviews and approves technical documentation for materials and products when approving a material or product type as well as technical documentation for overhaul of internal combustion engines;

.4 reviews and approves engineering designs for transfer of class for the ships;

.5 reviews and approves software applications used for designing;

.6 participates in technical supervision during trials of prototype ships (items) constructed according to the designs approved by the River Register;

.7 undertakes technical supervision during tests of material and product type specimens manufactured according to the documentation approved by the River Register and issues material or product type approval certificates;

.8 checks ship document copies issued by Branch Offices for prototype ships after construction or conversion;

.9 reviews and approves a list of replacements equivalent to the requirements of the Rules;

.10 undertakes technical supervision for compliance with the Rules during manufacture of materials and products when manufacturers are outside the activity of Branch Offices and issues respective documents;

.11 carries out surveys of firms engaged in manufacturing of materials/products and in work according to the requirements of the River Register, as well as testing laboratories performing tests prescribed by the Rules, if they are outside the activity of Branch Of-
1 General Provisions

1.12 ensures overall management of Branch Offices, makes technical and other decisions regarding issues arising from Branch Offices activities;

1.13 improves normative classification documents.

1.4 BRANCH OFFICE ACTIVITIES

1.4.1 As regards technical supervision during designing, construction, modernization, conversion and repair of ships, manufacture of materials and products, repair of ship equipment, the Branch Office:

1. reviews and approves engineering (detailed) designs:
   for floating objects, industrial ships, custom-built self-propelled and non-self-propelled ships of other types and purposes, except tugboats, icebreakers, high-speed craft, WIG craft and ships of new design;
   for hull stiffening or ship preparation for operation or single voyage (passage) outside the specified area of navigation;
   for conversion, modernization and repair of ships of all types and purposes, except for transfer of class for the ships;
   for repair of boilers;
   for repair of custom-built ship machinery;
   for repair of hoisting gear;

2. reviews and approves detailed documentation for ships under construction, conversion, modernization and repair;

3. reviews and approves technical documentation for materials and products for which type approval is not provided;

4. undertakes technical supervision for compliance with the Rules during construction, conversion, modernization and repair of ships, manufacture of materials and products;

5. undertakes technical supervision for compliance with the Rules during repair of ship machinery and overhaul of engines;

6. prepares and issues documents of the River Register for constructed, converted, modernized and repaired ships as well as submits copies of these documents to the Head Office in the specified extent;

7. reviews and approves standards of firms and process procedures;

8. carries out survey of firms and testing laboratories, except those outside the activity of the Branch Office, draws up and issues recognition certificates;

9. carries out other activities on behalf of the Head Office including those specified in 1.3.
2 GENERAL PROVISIONS ON TECHNICAL SUPERVISION

2.1 GENERAL REQUIREMENTS

2.1.1 Technical supervision during manufacture of items under technical supervision is performed by stage-wise inspections of these items during manufacture, including the final stage of manufacture (finished materials or products).

Inspections are carried out by the River Register's surveyor or the firm's person authorized by the River Register after inspection of the manufactured materials and products by the manufacturer's personnel and preparation of documents on workmanship, manufacture or installation of items under technical supervision by this firm.

During inspections, the River Register's Surveyor or the firm's person authorized by the River Register shall not make decisions different from those prescribed by the Rules.

For the Nomenclature of items under the River Register technical supervision (herein after referred to as the Nomenclature) and types of technical supervision, see Table A1.1.

2.1.2 All the activities related to technical supervision are carried out by the River Register upon request and normally against the contracts with the firms in charge of design, construction, conversion, modernization and repair of ships as well as manufacture of materials and products for shipbuilding and ship repair.

2.1.3 Quality checks of items under the River Register technical supervision are performed using the methods specified in these Rules and cover only the properties of items prescribed by these Rules.

2.1.4 While performing technical supervision the River Register does not replace the functions of the firm's and ship owner's quality control departments.

2.1.5 Technical supervision during manufacture of materials and products, construction, modernization and conversion of ships is performed according to the approved technical documentation and production processes.

If the materials and products specified in the Nomenclature are manufactured and/or tested according to national standards, the use of which provides compliance with requirements of the Rules, technical supervision is performed considering the requirements of these standards.

2.1.6 The procedure for review and approval of technical documentation on items under technical supervision, scope of surveys during technical supervision in the firm and process operations subject to inspection are determined in the relevant sections of the Rules.

2.1.7 The River Register on a contract basis may assign (entrust) technical supervision during construction of ships or manufacture of materials and products to another classification society or competent organization recognized by the River Register as well as accept an assignment of another classification society or other organization to perform technical supervision.

Scope and procedure for technical supervision as well as the form and list of documents issued in these cases are specified in respective agreements (see 2.7).
2.1.8 Materials and products which are items under technical supervision can be installed on board the ship if there are certificates or other documents issued by the River Register or documents of another classification organization issued on behalf of the River Register confirming compliance of concerned materials and products with requirements of the Rules.

2.1.9 Technical supervision of materials and components manufactured by the organization and used in this organization for manufacturing products as well as during construction or repair of ships is performed by the surveyor within technical supervision during manufacture of products, construction and repair of ships. Performance of technical supervision is confirmed by a record in the Notice of surveyor invitation (hereinafter referred to as the Notice), the form of which is given in Appendix 2.

When manufacturing the above materials and components to be further delivered to other organizations, including when they serve as interchangeable parts, technical supervision is performed according to the forms specified in the Nomenclature with issue of the documents specified in 2.2.6.

The Notice of submitting the work shall include information on the welders who carried out the submitted work, if the requirements for welding the structures and items are prescribed by the Rules (see 2.9.1) including their family name, name and patronymic (if any) as well as details of the Welder Approval Certificate.

2.1.10 New materials and products (including those under preservation) without documents of the River Register, may be allowed for installation on board ship or for manufacture of products according to the results of their survey as follows:

1. Shipbuilding or ship repair organization, manufacturer of products shall submit the manufacturer's documentation on materials and products in the scope sufficient to determine compliance of materials or products with requirements of the Rules as well as a test program which allows to assess compliance with the requirements of the Rules.

The documentation shall be sent with the Notice which includes the name of the material or product and its identification details (e.g., name of the manufacturer, serial or batch number);

2. The “Taken into consideration” stamp shall be put on the reviewed documentation and test program in case of compliance with the requirements of the Rules;

3. In case of compliance of the documentation with the requirements of the Rules, tests shall be performed in the testing laboratory recognized by the River Register according to the test program taken into consideration. According to the test results, the testing laboratory which tested the material or product shall draw up a test report;

4. The surveyor shall perform survey of the material or product in the scope specified by the Rules;

5. Compliance of the material or product with the requirements of the Rules is confirmed by issue of a Certificate (Form PP-1.25.1) for the products with a personal identification number. For the products without a personal identification number and materials – with a record in the Notice which was sent with the material or product to the surveyor to perform survey.

The test report and documentation taken into consideration (copy of documentation) are to be attached to the Notice on the basis of which the surveyor performed survey of the material or product.

The survey results apply only to the materials or products which were submitted under the Notice, specified in 2.1.10.1 and which were subject to the survey specified in this paragraph.

At repeated submission of the materials or products specified in this paragraph for survey to the River Register, survey shall be performed according to the requirements of this paragraph in full.

2.1.11 The procedure specified in 2.1.10 shall not be applied in the following cases:
1. Materials and products have a valid material or product type approval certificate;
2. A material or product is used for construction of the ship series;
3. Products with similar characteristics have a valid material or product type approval certificate.

2.1.12 Materials and products which are planned to be installed on ships during modernization, conversion or repair, are dismantled from the ships which are/were classed by the River Register as agreed with the Branch Office.

Dismantling of the materials or products which are planned to be installed on ships during modernization, conversion or repair, is performed in the presence of the River Register's surveyor.

A report on survey of the dismantled materials and products (Form PP-10.3) is prepared for the dismantled materials and products, except for the cases specified in the fourth and fifth subparagraphs of this para.

If the dismantled products have no documents required to determine their technical condition, and the main and auxiliary engines have no files, datasheets or other documents including information of the manufacturer on the assigned and remaining life (service life), a Report on survey of the dismantled products is not prepared and it is not allowed to install the products on the ships classed by the River Register.

A Report on survey of the dismantled products is not prepared if the product has River Register documents confirming their compliance with the requirements of the Rules (Forms PP-8.1, PP-8.3, PP-1.25) or a report on survey of the dismantled materials and products (Forms PP-10.3), as well as documentation required by RSSS to determine technical condition of products.

Main and auxiliary engines, in addition to the above, shall have files, datasheets or other documents including information of the manufacturer on the assigned and remaining life (service life).

The decision on possibility of installing the materials and products dismantled from other ships classed by the River Register shall be taken by the Branch Office performing technical supervision during modernization, conversion or repair of the ship by results of determining technical condition of materials and products.

Technical condition of materials or products specified in the first subparagraph of this para and planned to be installed on ships is determined according to Appendices 2 to 4 of RSSS as regards products or according to Part X of RCCS as regards materials.

According to results of determining technical condition, repair of products is performed in the required scope, if necessary. Technical supervision during repair of the products is performed according to the requirements of these Rules.

According to results of determining technical condition of the products, satisfactory results of mechanical tests and determining chemical composition of the materials as well as technical supervision during repair of the products, a Certificate (Form PP-1.25.1) is drawn up for the products with a personal identification number or a Certificate (Form PP-8.3) for a thoroughly repaired engine. For the products without a personal identification number and materials, records are made in the Notices which were sent with the material or product to the surveyor to perform survey.
2.2 FORMS OF TECHNICAL SUPERVISION

2.2.1 The following types of technical supervision during construction, conversion, modernization and repair of the ships, manufacture of the materials and products are prescribed by these Rules:

.1 Technical supervision of the surveyor (Form P) means technical supervision performed by the River Register;

.2 Technical supervision of the River Register and organization (Form OP) means technical supervision during manufacture of materials and products performed together with the River Register's surveyor and organization personnel;

.3 Technical supervision of the surveyor using a type approval (Form OT) means technical supervision during manufacture of materials and products performed by the River Register at type approval without participation in acceptance of the end material or product;

.4 Technical supervision in the form of Recognized documentation (Form ПД) means technical supervision when compliance of the material or product with the requirements of the Rules is confirmed only by review and approval of technical documentation without supervision during its manufacture or installation (assembly) on the ship;

.5 Technical supervision by another classification organization means technical supervision performed by another classification society on behalf of the River Register (under agreement with the River Register).

2.2.2 Forms of technical supervision specified in columns 2 and 3 of the Nomenclature apply to the materials and products subject to repeated deliveries. Technical supervision during single deliveries is performed according to 2.3.18 and 2.3.19. The results of documentation review and of the tests during single deliveries apply only to the declared item under technical supervision.

2.2.3 In the cases prescribed by the Nomenclature (column 3), the organization together with the River Register may select a form of technical supervision — P or OP.

The possibility of using a form of technical supervision (OP) is determined by the Branch Office (Head Office) by results of the manufacturer survey. The decision on the used form of technical supervision is specified in the Recognition Certificate.

2.2.4 Technical supervision during construction, modernization, conversion and repair of ships, approval of material and product type is performed only by the River Register's surveyor or personnel of another classification organization on behalf of the River Register or under agreement with the River Register (see 2.7).

The tests prescribed by the Rules shall be carried out by the testing laboratories with a Recognition Certificate of the River Register to perform these tests. The tests in the presence of the surveyor are performed if is prescribed by the Rules, or if the testing laboratory is not recognized by the River Register to perform these tests.

Participation of the surveyor in ship trials and tests of materials and products as well as in welders' qualification tests, is confirmed by the surveyor's signature under "Carried out at surveyor's technical supervision/survey" inscription applied to the document prepared by results of trials/tests (report).

2.2.5 For the procedure of technical supervision during manufacture of materials and products, see Table 225.

The applicant may send a request to the River Register for each procedure separately or for a few procedures of technical supervision.

In case of single deliveries (see 2.2.2), recognition of the manufacturer is not required.

2.2.6 According to results of technical supervision of the materials and products depending on the used form of technical supervision (third column of the Nomenclature), the following documents confirming their compliance with the requirements of the Rules are issued:
### Table 2.2.5

Forms and procedures of technical supervision during manufacture of materials and products

<table>
<thead>
<tr>
<th>Types of use of forms of technical supervision</th>
<th>Forms of technical supervision</th>
<th>Procedures of technical supervision</th>
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<td>Types of use of forms of technical supervision</td>
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<tr>
<td>Specification (column 2 of the Nomenclature)</td>
<td>Serial products (column 3 of the Nomenclature)</td>
<td>Manufacturer recognition (see 2.8)</td>
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1. Form P — for manufacture of the materials and products (Form PP-8.1), repair of the products — Certificate (Form PP-1.25), overhaul of the engines — Certificate (Form PP-8.3);

2. Form OP — Certificate (Form PP-8.1);

3. Form OT — manufacturer's document with information on Type Approval Certificate (see 2.3.13) specifying its date and number or attaching copy of this Certificate;

4. Form ПД — manufacturer's document with the date and number of the letter on approval of technical documentation according to which the material or product is manufactured.

2.2.7 One Certificate is issued for materials and products manufactured in batches.

In this case each product shall be delivered with the manufacturer's documents with references to this Certificate. The supporting documentation on the delivered product (batch or its part) shall include a copy of a Certificate endorsed by the manufacturer.

If the Certificate was issued for a unit of product, it shall be delivered with the original Certificate.

2.2.8 According to results of technical supervision, documents prescribed by RSSS are issued for the ship, depending on type of survey, which is the completion of technical supervision during construction, conversion, modernization or repair of the ship.

2.3 TECHNICAL SUPERVISION
BY THE SURVEYOR (FORM P)

2.3.1 To determine the scope and procedure of inspections, the items under technical supervision opposite which symbol P is placed in columns 3, 5 to 7 of the Nomenclature, the River Register and manufacturer shall prepare a checklist for the items and process operations (hereinafter the Checklist). The Checklist includes items under technical supervision specified in the Nomenclature as well as separate process operations and works carried out under technical supervision of the River Register. For the Form of the Checklist, see Appendix 3.

2.3.2 The Checklist is prepared on the basis of the requirements of the Rules considering specific conditions of technical supervision.

The Checklist is an Appendix to the Agreement on technical supervision.

Each presentation to the River Register, covering one or several uniform items under technical supervision or scope of works completed at the particular stage of manufacture shall correspond to each item of the Checklist. Construction sequence and conditions of manufacture of critical parts and product assembly shall be taken into account.

For the standard Checklist, see Appendix 4.

2.3.3 To perform inspections and participate in the tests of the items under technical supervision, a written Notice shall be sent to
the surveyor not later than one day before the date of the inspections and tests.

If the requirements of the Rules are violated, the surveyor shall impose requirements on elimination of the detected violations and repeated submission of the item under technical supervision for inspection or tests. After observing the requirement, a repeated Notice shall be sent to the surveyor.

2.3.4 The surveyor shall record the results of the inspections and tests of the items under technical supervision in the Notice as well as in the construction book (if any), the form of which is given in Appendix 5.

2.3.5 In addition to the inspections according to the Checklist, the surveyor checks quality of the manufactured parts, assemblies and structural components included in the items under technical supervision submitted according to the Checklist, observing the production processes approved by the River Register (see 3.1.10), compliance with the conditions of issue of a Recognition Certificate and/or Agreement on technical supervision. The results of the inspections are recorded in the Record Book of Technical Supervision, the form of which is given in Appendix 6.

2.3.6 When detecting defects which require elimination, the item under technical supervision shall be submitted for repeated inspection by the River Register after elimination of these defects.

2.3.7 According to results of the performed inspections and tests of the materials or products, the surveyor shall draw up respective documents of the River Register. In the cases specified in 2.1.12 and Appendix 1, the materials and products are sealed. Information on availability of the River Register seal on these materials and products is specified on the issued documents of the River Register.

Approval of material and product type

2.3.8 As regards items under technical supervision, opposite which symbol P is put in column 2 of the Nomenclature, type approval procedure is performed.

2.3.9 To receive a material or product type approval certificate, the organization shall send a request to the River Register.

Together with the request, technical documentation on the material or product (see 3.4) shall be submitted in the scope sufficient to determine compliance of the declared material or product with the requirements of the Rules.

2.3.10 During review and approval of technical documentation, scope and procedure of technical supervision during tests of the declared items under technical supervision is established. The scope of tests shall be not less than that prescribed by the Rules for type materials and products.

2.3.11 For different sizes of the product, tests of type specimen, the structure of which considers the main features of the whole range of products, shall be performed.

Tests of the materials and products shall be performed by the testing laboratories and manufacturer's Branch Offices recognized by the River Register (see 2.8.7).

During type approval, the test results performed maximum six years before the date of type approval in the presence of the River Register's surveyor or another classification society employee acting on behalf of the River Register (see 2.7) as regards type approval of this material or product may be considered.

2.3.12 The results of the inspections and tests are recorded in the type specimen survey report (Form PP-10.1).

2.3.13 A material/product type approval certificate (Form PP-11.1, PP-11.2, PP-11.3) is issued by the River Register in order to make sure that by results of the tests and inspections, the structure, properties, parameters and characteristics of the type material or product comply with the approved technical documentation and requirements of the Rules for the intended use on the ships and other items under technical supervision of the River Register.

The material or product type approval certificate does not replace a Certificate issued for the serial materials and products.
2.3.14 The material or product type approval certificate is valid before the expiry date of approval of technical documentation on the material or product (see 3.1.8).

2.3.15 After expiry of the material or product type approval certificate, the manufacturer shall undergo the procedure specified in 2.3.9 to 2.3.11.

When determining the scope of inspections and tests, the results of the manufacturer's survey during the procedure of recognition by the River Register, the results of technical supervision during manufacture of materials or products for the expired period as well as information on the scope and type of claims from the consumers and other persons concerned shall be considered.

2.3.16 The issued material or product type approval certificate shall expire before its validity period in the following cases:
- Structure of the product, its properties or other characteristics are changed without approval with the River Register;
- The requirements prescribed by the Rules as regards suitability of the material or product for further operation on the ship;
- If approval of technical documentation as regards material or product expires.

Technical supervision during manufacture of the materials and products performed by the surveyor

2.3.17 In the cases prescribed by the Nomenclature (symbol P in column 3), technical supervision during manufacture of materials and products is performed by the River Register surveyor.

2.3.18 To receive a Certificate for materials or products, the manufacturer shall send a request to the River Register with attached technical documentation on the materials or products in the scope prescribed by the Rules (see 3.4). According to results of review of technical documentation, the requirements to the scope of inspections and tests as well as its approval shall be determined (see 3.4.8).

If documentation on the materials or products was approved earlier and has valid approval status (see 3.1.8 and 3.1.9), the request (Notice) shall include the number of the letter on approval of technical documentation (repeated approval is not required).

2.3.19 If the results of inspections and tests (see 5 to 10 of these Rules) prove the compliance of the material or product with requirements of the approved technical documentation and Rules, the surveyor shall issue certificates (Form PP-8.1).

2.4 TECHNICAL SUPERVISION PERFORMED BY THE RIVER REGISTER AND ORGANIZATION (FORM OP)

2.4.1 In the cases, prescribed by the Nomenclature (symbol OP in column 3) if performance of technical supervision by the River Register together with the manufacturer is confirmed (see 2.2.3), Form of technical supervision OP is used.

2.4.2 To use this form of technical supervision, the organization shall send a request to the River Register. When confirming use of the Form of technical supervision OP (see 2.2.3), a contract on technical supervision is concluded with the organization.

2.4.3 The Form OP is used when meeting the following conditions:
- Use of this form is confirmed by a record in the Recognition Certificate at recognition of the manufacturer (see 2.2.3);
- The manufacturer has a Recognition Certificate confirming the ability of the organization to manufacture the declared products (see 2.8.11);
- The manufacturer has a Type Approval Certificate issued for the manufactured products, if it is prescribed by the Nomenclature (see 2.3.13);
- Technical documentation on the basis of which the materials and products are manufactured, has valid approval with the River Register (see 3.1.8, 3.1.9);
- The manufacturer assigned a person/persons authorized to control compliance with the requirements of the Rules, terms of the agreement and drawing up documentation.
submitted to the River Register (hereinafter the authorized person);

.6 An agreement on technical supervision during manufacture of materials or products is concluded between the River Register and manufacturer.

2.4.4 The manufacturer's authorized person controls compliance of the structures, properties, parameters and characteristics of the materials or products which are covered by the agreement, technical documentation approved by the River Register and requirements of the Rules.

Upon satisfactory results of control the authorized person sends a request on compliance to the River Register, the form of which is determined by the River Register and attaching the acceptance/check test reports.

2.4.5 Upon satisfactory results of review of the request on compliance and attached test results or other documents confirming compliance of the materials or products with the approved technical documentation and Rules, the River Register surveyor shall issue a Certificate (Form ÐÐ-8.1) or another type of the document for this type of the products if it is prescribed by the Rules.

2.5 TECHNICAL SUPERVISION IN THE FORM OF A TYPE APPROVAL (FORM ÏÒ)

2.5.1 In the cases specified in the Nomenclature (symbol ÏÒ in column 3), the Form of technical supervision ÏÒ is used during manufacture of the materials and products.

2.5.2 Technical supervision according to the Form ÏÒ includes performing the procedure of approval of the material or product type without further supervision of their manufacture.

2.5.3 The Form OP is used when meeting the following conditions:

.1 The manufacturer has a valid Recognition Certificate at the moment of material or product manufacture confirming ability of this organization to manufacture these products (see 2.8.11);

.2 The manufacturer has a Type Approval Certificate issued for the manufactured products and valid at the moment of material or product manufacture (see 2.3.13).

2.5.4 In order to confirm compliance of the welding consumables and their quality with the approved technical documentation as well as to confirm the possibility of using the Form OT, tests of these welding consumables are performed annually in the presence of the surveyor.

At annual tests of the welding consumables, the type approval tests shall be performed for the respective welding consumables, except for the tests for determination of the cold-cracking resistance and the sea water corrosion resistance of the weld metal and the welded joint.

A mark on the performed test shall be put on the back of the welding consumable approval certificate (Form PP-11.3).

2.5.5 Technical supervision according to the Form OT shall not be performed if the conditions specified in 2.5.3 and 2.5.4 are not met.

2.6 TECHNICAL SUPERVISION IN THE FORM OF RECOGNIZED DOCUMENTATION (FORM ÏÄ)

2.6.1 Technical supervision in the form of recognized documentation during manufacture of materials and products is used in the cases specified in the Nomenclature (symbol ÏÄ in column 3).

2.6.2 Quality control of the products according to the Form ÏÄ is performed by the manufacturer's quality control departments according to the approved technical documentation.

2.6.3 The Form OP is used when meeting the following conditions:

.1 Technical documentation on the materials or products has valid approval with the River Register (see 3 of these Rules);

.2 Materials and products comply with the approved River Register documentation.
2.6.4 In case of non-compliance of the materials and products with the approved documentation, the River Register does not allow to use them on the ships regardless of availability of the documents issued by the manufacturer.

2.7 TECHNICAL SUPERVISION PERFORMED BY ANOTHER CLASSIFICATION ORGANIZATION ON BEHALF OF THE RIVER REGISTER OR BY THE RIVER REGISTER ON BEHALF OF ANOTHER CLASSIFICATION ORGANIZATION

2.7.1 Technical supervision performed by another classification organization authorized for classification and survey of ships according to the laws of the Russian Federation, on behalf of the River Register or by the River Register on behalf of another classification organization is performed under an agreement on mutual substitution and/or according to a specific assignment.

2.7.2 The following shall be determined in the agreement on mutual substitution and/or assignment:

.1 items and scope of tests;
.2 applicable requirements of the Rules;
.3 procedure for technical documentation approval;
.4 issued documents;
.5 payment procedure for the work carried out within technical supervision.

2.7.3 During technical supervision performed by another classification organization on behalf of the River Register or by the River Register on behalf of another classification organization, certificates or other documents of the organization which performed technical supervision are issued for the items under technical supervision.

Unless otherwise specified in the agreement and/or assignment, certificates or other documents issued by the classification organization performing technical supervision on behalf of another classification organization, shall have the following mark:

On behalf _________________________
(name of the classification organization)
No.____ dated __________ 20____.

2.7.4 Unless otherwise specified in the agreement and/or assignment, the tests during technical supervision shall be performed using the methods and according to the River Register Rules.

2.7.5 Assignment on technical supervision from another classification organization is accepted by the Head Office. The Branch Offices carry out work on behalf of another classification organization only in case of the Head Office’s written instruction.

2.8 RECOGNITION OF ORGANIZATIONS

2.8.1 The River Register recognizes the organizations carrying out the following types of activities: design, construction, modernization, conversion, refitment and repair of ships, manufacture and repair of products, manufacture of materials to be installed on the ships. Furthermore, River Register recognizes the organizations carrying out works, the results of which are used by the River Register when performing classification, as well as the test laboratories performing tests required for construction of ships and manufacture of materials and products.

2.8.2 The conditions of the organization recognition by the River Register generally include the following:

.1 compliance of the test results performed according to the test program approved by the River Register with the Rules (for the following types of activities: construction, modernization, conversion, refitment and repair of ships, manufacture of products and/or materials for installation onboard the ships, repair of products, tests regulated by the Rules, survey of defects of ship’s components and shipborne facilities);

.2 availability of the resources in the organization to manufacture products, carry out works, render services complying with the Rules, as well as used methods for product quality control:
own or leased production areas (except for the cases when the works can be carried out without own or leased areas);
workers who are qualified for the works and tests prescribed by the Rules and/or approved technical documentation, production process (e.g., ultrasonic control and penetrant test specialists);
equipment (machines, bench equipment, welding equipment, test equipment, etc.) used by the organization to carry out the declared works as well as instruments;
approved technical documentation and production processes (see 3.1.10);
provision by the organization with the used production procedure, carrying out of the works or tests and internal control systems to provide appropriate level and stability of product quality, carrying out of the works and tests;
provision of reliable results of the inspections and tests by the organization by certification of test equipment, testing and calibration of instruments;
for the organizations assigning some of the production, design processes or tests to the concerned organizations (contract) — availability of documents which allow to provide monitoring and control of the assigned processes by the concerned organization (organizations) (contractors).

The clarified conditions for recognition of types of activities specified in 2.8.1, are determined in 2.8.3 to 2.8.7.

2.8.3 The organization engaged in activity specified in 2.8.1 shall submit the following establishing and registration documents according to national law of the country where the organization is registered:

for legal entities:
constitutive documents (charter, articles of association or provision, decision on assigning sole/another executive body);
a document (Certificate) confirming the fact of making an entry on the legal entity in the Unified State Register of Legal Entities (for organizations outside the Russian Federation — document confirming its registration as a legal entity of the respective state);
a certificate on registering the organization in a taxation body (for the organizations registered on the territory of the Russian Federation);

for individual entrepreneurs:
a document (Certificate) confirming the fact of making an entry on the individual entrepreneur in the Unified State Register of Individual Entrepreneurs (for an individual entrepreneur outside the Russian Federation — document confirming its registration as an individual entrepreneur of the respective state);
a certificate on registering the individual entrepreneur in a taxation body (for the individual entrepreneurs registered on the territory of the Russian Federation).

2.8.4 The following requirements additional to 2.8.2.2 are established for the organization constructing and repairing the:

1. availability of own or leased lifting facilities or equipment in the organization;
2. availability of welders with a Welder Approval Test Certificate (see 2.9);
3. availability of internal quality system in the organization for the carried out works including incoming inspection, functional inspection, outgoing inspection, periodic verification and/or calibration of instruments;
4. availability of the approved production processes for the works required by the Rules.

2.8.5 In addition to 2.8.2.2, the following requirements are established for the organization manufacturing materials and products to be installed on board the ships:

1. availability of welders with a Welder Approval Test Certificate (if the requirements to welding the structures and items are prescribed by the Rules);
2. availability of approved technical documentation with the help of which the materials and products are manufactured.

2.8.6 The following requirements additional to 2.8.2.2 are established for the specialized area (station) performing maintenance, inspection and tests of inflatable and personal life-saving appliances:

1. availability of the document of the inflatable life-saving appliance manufacturer
confirming the possibility to carry out these works according to its requirements (for inflatable life-saving appliances);

.2 availability of a closed, heated, ventilated and lighted room, the area and height of which provide the possibility of capsizing of the largest inflated rafts (or other efficient means for bottom inspection without raft capsizing shall be provided) and/or a room of the required height with a concrete floor for life-buoy tests. Temperature and moisture shall be controlled in the room;

.3 availability of a room for maintenance of the inflatable life-saving appliances equipped with:

- means and devices for maintenance of the life-saving appliances and release mechanisms according to the manufacturer's requirements to maintenance, inspections and tests of the inflatable life-saving appliances, including their gas inflation systems;
- materials and components for repair of the inflatable life-saving appliances, the quantity and quality of which shall be approved by the manufacturers.

The room for inspection and test of personal life-saving appliances shall be equipped with:

- a pool for flotation test. Water to test the life-saving appliances shall be fresh and shall arrive from a drinking water pipeline or shall be preliminary purified from suspended articles and oil products;
- a facility for strength tests;
- a set of calibrated loads of different weights when providing all the loading diagrams during the life-saving appliance tests;
- a compressor or an air pump for leakage tests;
- calipers and instruments to check the shape and linear dimensions of the life-saving appliances;
- pressure gauges and thermometers.

Places for separate storage of different types of life-saving appliances to be inspected, tested, repaired or delivered, shall be provided. Storage conditions shall comply with the manufacturer's requirements;

.4 availability of qualified personnel with the manufacturer's documents enabling to carry out works on maintenance and repair (for inflatable life-saving appliances);

.5 availability of a set of technical documentation required for maintenance, inspection and test of life-saving appliances.

2.8.7 Competency of the organization Branch Offices performing the tests prescribed by the Rules during construction, conversion, modernization and repair of the ships and floating objects, manufacture of the materials and products, repair of the products is checked during survey of these organizations.

Competency of legally independent testing laboratories performing the tests prescribed by the Rules is checked during their survey.

2.8.8 In order to receive a Recognition Certificate the organization sends a request to the River Register attaching reports with information (data) on compliance of the organization with the recognition conditions (see 2.8.2 to 2.8.7).

In case of detecting non-compliance of the organization with the recognition conditions at review of the submitted request and its attached information (see 2.8.2), the River Register refuses to perform survey of the organization by sending motivated causes of refusal in writing.

2.8.9 According to results of review of the request and its attached information in case of establishing their compliance with 2.8.2 to 2.8.7, the surveyor performs survey of the organization to evaluate its ability to carry out works/render services or manufacture products according to the requirements of the Rules, compliance of the organization with the recognition conditions specified in 2.8.2 to 2.8.6 as well as checking the data specified in the request and its attached information.

If the organization claiming to receive a Recognition Certificate assigns operations of the production process approved by the River Register (see 3.1.10) or tests prescribed by the Rules to other organizations (contractors), the River Register takes a decision on contractor survey. Contractor survey is performed by the organization claiming to receive a Recognition Certificate.
2.8.10 During survey of the testing laboratories (organization Branch Offices performing tests prescribed by the Rules during construction, conversion, modernization and repair of the ships and floating objects, manufacture of the materials and products, repair of the products), possibility of performing the test methods prescribed by the Rules is checked using the check tests performed in the presence of the surveyor according to the program approved by the River Register.

The scope of tests is established according to the requirements of the Rules. During survey of the organization manufacturing the materials and products, the River Register considers the test results of the items under technical supervision in this organization performed during approval of type material or product in the presence of the River Register surveyor not later than two previous days before the date of the organization survey.

2.8.11 According to results of the performed organization survey the surveyor draws up a Survey Report of the organization (Form PP-10.2) where the results of the performed survey and possible forms of technical supervision are specified.

According to results of review of the request and its attached information, as well as Survey Report, the River Register shall take a decision on issuing (refusing to issue) a Recognition Certificate for the organization for those types of works/services, the performance of which was confirmed during survey. The Recognition Certificate of the testing laboratories or organizations which have Branch Offices performing the tests prescribed by the Rules, specifies the list of tests for which the organization is recognized.

The Recognition Certificate is issued for those types of activities which are actually performed by the organization.

2.8.12 The period of validity of the Recognition Certificate is two years.

Upon expiry of the Recognition Certificate, the organization is subject to survey according to the procedure specified in the requirements in 2.8.8 to 2.8.11.

It is allowed not to submit the establishing and registration documents specified in 2.8.3 if they were not changed since last request submission. The report (see 2.6.8) shall include a reference to the previously submitted documents.

2.8.13 Compliance of the organization with the recognition conditions is checked in the following cases:

- violation of the requirements specified in 2.8.2 by the organization;
- amendment of technical documentation without approval with the River Register, if necessity of such an approval is established by the Rules;
- detection of inadmissible defects or violations of quality stability of the product manufactured by the organization;
- performance of works or tests with violated requirements established by the Regulations for Classification and Rules or submission of unreliable information on the results of the performed works or tests to the River Register;
- decrease of manufacturing facilities in the organization as well as other changes in the result of which performance of works by the organization for which a Recognition Certificate was issued, according to the requirements of the Rules becomes impossible;
- detection of deficiencies in the work of the organization when performing technical supervision in the organization.

Compliance with the recognition conditions is not checked for the organizations designing the ships. In case of repeated detection of previously detected violations which were not eliminated by the design organization during review of design documentation by the River Register, the River Register sends a notification to the design organization on the necessity of remedial actions aimed at increase of quality of the design works with further notification of the River Register on the taken actions. The Recognition Certificate is invalidated in case of detection of the deficiencies specified in the notification which were not eliminated.

In case of detecting a ground to check compliance with the recognition conditions,
the River Register notifies the organization on the performed test and its terms.

2.8.14 According to results of checking compliance of the organization with the recognition conditions, a report is drawn up, on the basis of which the River Register takes one of the following decisions:

.1 confirm validity of the Recognition Certificate;

.2 recommend remedial actions to the organization in the terms approved by the River Register on elimination of the detected deficiencies in the activity of the recognized organization and their consequences;

.3 suspend the Recognition Certificate for one or several types of activity for which the Certificate is issued, if the remedial actions specified in 2.8.14.2 were not taken within the terms approved by the River Register during the approved period for the remedial actions;

.4 cancel the Recognition Certificate for one or several types of activity for which the Certificate is issued, if the remedial actions were not taken within the terms approved by the River Register.

.5 cancel the Recognition Certificate, if:

the works, for which the Recognition Certificate was issued, are carried out with defects;

the works or tests are carried out with violation of requirements specified by the Rules;

decrease of manufacturing facilities in the organization as well as other changes in the result of which performance of works by the organization for which a Recognition Certificate was issued, according to the requirements of the Rules becomes impossible.

The River Register controls implementation of the remedial actions within the terms approved by the organization. According to results of the check, a report is drawn up which serves as a basis to suspend, confirm or cancel the Recognition Certificate.

In case of cancelling the Recognition Certificate for one or several types of activity, specified in the Certificate, the Recognition Certificate for the works, for which the Certificate was cancelled, is issued again according to the procedure specified in this section to receive the Recognition Certificate.

2.8.15 During validity of the Recognition Certificate, the organization:

notifies the River Register on any changes in its activity specified in the Recognition Certificate within 2 weeks;

provides access for the River Register to information on measures taken to provide quality, test procedures, tests, equipment, reporting documents and statistical data related to own activity specified in the Recognition Certificate.

2.8.16 The Recognition Certificate is reissued in the following cases:

.1 reorganization of the legal entity in the form of a transformation;

.2 change of the organization name or legal address, or of the individual entrepreneur name or place of residence not changing actual address where works are carried out;

.3 increase of scope of the works for which the Recognition Certificate was earlier issued;

.4 exclusion of the operations for which the Recognition Certificate was earlier issued.

2.8.17 The basis to reissue the Recognition Certificate in the cases specified in 2.8.16.1, 2.8.16.2 and 2.8.16.4 is a written request of the organization with the Certificate attaching copies of the documents which confirm the specified changes as well as the original valid Recognition Certificate.

The basis for reissue of the Recognition Certificate in the case specified in 2.8.16.3 is the procedure of the organization recognition according to 2.8.8 to 2.8.11.

A new number is assigned to the reissued Recognition Certificate. Validity period of the reissued Recognition Certificate starts from the date of its signing and is not extended.

2.9 WELDER APPROVAL

2.9.1 The conditions of receiving the Welder (Operator) Approval Test Certificate
for the following works are given in this chapter:

1. welding of hulls;
2. welding of ship's pipelines;
3. welding of ship boilers and pressure vessels;
4. welding of defects in forgings and castings.

2.9.2 To receive the Welder Approval Test Certificate the welder shall pass tests which include checking of his theoretical and practical knowledge. Approval tests shall be performed according to the procedure specified in Appendix 7.

The approval test of a welder may be combined with the qualification tests at the place of the welder’s work or training.

2.9.3 A request to receive the Welder Approval Test Certificate shall include the following data: full name, year of birth, place of work, date and place of certification issue. A copy of the welder’s certification, a report on work experience as a welder, copies of certificates on welding consumables and base materials of the samples which shall be used for operational tests are attached to the request.

2.9.4 Materials for manufacture of the samples shall be approved by the River Register and have relevant certificates.

Test assemblies shall be welded using welding consumables and procedures approved by the River Register.

2.9.5 If malfunctions of equipment (voltage drop, de-energising etc.), peeling of an electrode coat or other defects not depending on the welder, occur during the welding of test assemblies, the same number of test assemblies shall be re-prepared.

2.9.6 A protocol shall be drawn up on the basis of the test results. The protocol shall be signed by the surveyor who participated in the tests.

2.9.7 Upon satisfactory results of the tests the River Register issues a Welder Approval Test Certificate (Form PP-1.23), confirming welders’ approval for welding operations specified in 2.9.1 with the determined conditions (material, welding method, welding position).

The validity period of the welder approval certificate is two years.

2.9.8 The Certificate becomes invalid in the following cases:

1. If during validity of the Certificate the welder did not perform welding operations on the items under technical supervision of the River Register specified in the Welder Approval Test Certificate for more than six months in a row;
2. If during technical supervision (record in the Notice) the River Register determined that more than 10% of the welds performed by the welder do not meet the requirements of the Rules.

2.9.9 Confirmation of the works performed by the welder and specified in the Certificate shall be a record on the back of the Certificate by the welder’s senior or authorized employee of the employer confirming that the welder performed the works specified in the Certificate according to the requirements of the Rules during the last six months from the date of the last record or Certificate issue. This record is made every six months.

2.9.10 To receive a new Certificate, the welder shall pass the approval tests according to 2.9.2 to 2.9.7.
3 REVIEW AND APPROVAL OF TECHNICAL DOCUMENTATION

3.1 GENERAL

3.1.1 Technical documentation on construction, conversion, modernization and repair of the ships, manufacture of the materials and products, repair of the products as well as software applications used for designing are approved by the River Register to check compliance with the requirements of the Rules.

3.1.2 Technical documentation shall be submitted to the Head Office (see 1.3) or Branch Office (see 1.4) in the geographical boundaries of which the design organization operates. Technical documentation shall be submitted in the form of originals or copies signed (confirmed) by the organization which is the developer of technical documentation.

3.1.3 If documentation has engineering solutions providing the same level of safety which would be provided by compliance with the requirements of the Rules (equivalents), the organization developing technical documentation submits a list of these solutions with their contents and technical justification to the River Register.

3.1.4 Documentation shall be submitted for review in the scope which allows to ensure that the requirements of the Rules are met. For the standard list of technical documentation submitted for review to the River Register, see Appendix 8.

3.1.5 The design organization upon agreement with the River Register may select one of the following ways of technical documentation submission to the River Register for approval:

1. in two stages: first, documentation in scope of technical design and then detailed documentation shall be submitted;
2. in one stage: technical documentation shall be submitted in the scope which includes all the required data, provides the possibility to determine compliance of the designed ship or products with the requirements of the Rules and provides technical supervision during manufacture of the main structural assemblies (detailed design).

3.1.6 Documentation shall be submitted for review in two copies. One copy - in paper media, second copy - in electronic media (hereinafter the River Register copy) attaching paper design document list drawn up according to 3.1.7.1.

Detailed documentation (see 3.3) shall be submitted for review in one copy.

3.1.7 The following requirements shall be applied to the submitted documents:

1. documents in paper media shall:
   have the required signatures (at least of the developer and approver);
   be made in a legible manner;
   be free of erasures, postscripts, crossed out words and other corrections which were not specified;
   be free of damages, the presence of which does not allow ambiguous interpretation of the document contents;
2. documents in paper media shall:
   be in PDF (PDF/A);
   have built-in fonts used during designing;
   have a separate page for each drawing;
   have the drawing name or its name in the list of documents in the file names.
3.1.8 The period of validity of approval of technical documentation and software applications is six years. Upon expiry of this period or if the interval between the dates of approval of technical documentation and start of ship construction, manufacture of the materials and/or products exceeds three years, technical documentation shall be subject to reapproval in order to consider the changes in the Rules entered during the specified period.

Approval of technical documentation for repair, conversion or modernization of the ships as well as for repair of the products is performed without time limitation.

3.1.9 Validity of approval of technical documentation shall expire in the following cases:

1. if the interval between the dates of approval of technical documentation and start of the ship construction, manufacture of the materials and/or products exceeds three years;
2. amendment of the requirements prescribed by the Rules with respect to the ships, materials and products to be installed on the ships;
3. amendment of the previously approved technical documentation without approval by the River Register.

3.1.10 Production processes of construction and repair of the ships, manufacture of the materials and products shall be subject to approval by the River Register if the Rules establish the requirements with respect to process operations or production processes.

3.1.11 The production process shall specify the following: a list of operations, equipment, materials (in the cases prescribed by the Rules), control/test methods, instruments and correction methods (in the cases prescribed by the Rules).

The production process of assembly and welding of the ship structures and hull shall include the following:

1. description of the welding techniques and characteristics of the used welding equipment, production accessories and welding consumables during construction or repair of the hull;
2. block and section plans of construction or repair of the hull;
3. principal assembly and welding procedure of the type panels, two- and three-dimensional sections and blocks as well as hulls on slipway specifying the sequence of assembly-welding works, welding methods and conditions;
4. guidelines for welding procedures.

3.1.12 Approval of technical documentation by the River Register shall be drawn up by stamping the drawings or documents with numbers and dates of a conclusion letter.

The stamp samples shall be approved by the Head Office.

3.1.13 Approval of technical documentation by the River Register structural unit shall be valid for all River Register Branch Offices. This approval can be cancelled or changed only by the Branch Office which approved the specified technical documentation or by the higher (as to subordination) River Register Branch Office.

Technical documentation approved by one of the River Register Branch Offices shall be accepted by other Branch Offices for technical supervision without additional approval if by conditions of works during technical supervision of the River Register in a specific organization, correction or entering changes in the specified technical documentation is not required.

3.1.14 Changes entered by the developers in technical documentation previously approved by the River Register shall be approved by the River Register structural unit which reviewed technical documentation except for the cases specified in 3.1.13.

3.1.15 Changes entered in technical documentation during construction, conversion, modernization and repair of the ship, manufacture, repair of the product or manufacture of the material in the production process, shall be approved by the River Register Branch Office which approved the specified documentation or Branch Office which performed technical supervision. The Branch
Office which performs technical supervision may submit critical decisions for review and approval to the River Register Branch Office which approved the specified documentation.

The changes approved only for a specific item, do not apply to the next items without preliminary review and approval by the River Register.

Permission to deviate from technical design, detailed documentation, technical documentation on the materials or products, production process, shall be drawn up with a permission map for deviation (Appendix 9) with a reference to the Branch Office letter or approved document of the River Register.

3.1.16 During review of technical documentation, the River Register does not check correctness of computing operations used during calculations, including programs approved by the River Register. The River Register reviews the end results of calculations. The calculations shall be made according to the guidelines of the Rules or methods approved by the River Register.

In specific cases the River Register additionally examines reliability of the end results of calculations.

3.2 TECHNICAL DESIGNS OF THE SHIPS

3.2.1 Technical designs of the ships shall be submitted for review by the Head Office or Branch Office with an accompanying letter and a full list of documents submitted for review.

3.2.2 Designs can be submitted in separate parts (hull, machinery and electrical) upon agreement with the River Register. The first part of the documentation shall be submitted with the specification and general arrangement plans.

If according to the results of reviewing other parts of documentation remarks requiring corrections of the previously approved part are made, this part shall be corrected and approved by the River Register.

3.2.3 For the new types of ships, for which the requirements are not available or not fully covered in the Rules, the River Register may request additional documents and data as deemed necessary by the River Register.

3.2.4 The time for review of technical designs submitted for review in the scope prescribed by the Rules shall not exceed 30 working days.

3.2.5 For each reviewed design or entered changes the River Register shall draw up a written opinion.

If the River Register refuses to approve the design, the Register shall specify the grounds of refusal and its remarks in the reporting letter.

The reporting letter on design approval shall specify ship class, navigation area and freeboard depth as well as the list of approved documents and stamps on them. If required, restrictions on wind and wave conditions, type of carried cargo, etc. shall be specified. Then remarks (if any) subject to elimination during correction of the design or during development of the working drawings shall be specified.

The list of approved documents and stamps on them shall be specified in the reporting letter on approval of changes or additions entered in the documentation of the technical design approved by the River Register.

3.2.6 Approval of technical designs by the River Register submitted in paper media shall be drawn up by stamping the drawings or documents (see 3.1.12).

3.2.7 The River Register shall send the set of approved technical designs in paper media with the conclusion to the developer.

3.2.8 Technical designs on construction of a ship with expired approval (see 3.1.8, 3.1.9.1) shall be subject to correction in order to consider the changes in the Rules entered since design approval. The design submitted for review shall include an explanatory note with analysis of the design compliance with the Rules (changes) introduced after previous review of the design. In case of design non-compliance with the requirements of the Rules, the grounds of practicability on bring-
ing the design in compliance with the Rules or substantiating maintaining separate technical solutions on the initial design shall be specified in the same document.

It is allowed to include drawings from the set of detailed documentation in the designs submitted for re-approval. A notice on cancelling or restricting the use of the previously approved working drawings shall be submitted with new drawings of detailed documentation.

3.2.9 The procedure of review and approval of technical designs shall be also applied to technical documentation submitted to the River Register in one stage.

3.2.10 The Head Office reviews the designs approved by the Branch Office by the way of control. In this case at request of the Head Office, the Branch Office sends a copy of the approved design for check review, after which the design together with the conclusion is returned to the Branch Office by the Head Office. The Branch Office shall inform the design organization on the Head Office conclusion in case of remarks and provide control over elimination of the remarks.

3.3 DETAILED DOCUMENTATION

3.3.1 The conditions of the detailed documentation review (place, time, procedure and method of document preparation) shall be determined by the design organization upon agreement with the Branch Office.

3.3.2 Detailed documentation is prepared according to the technical design approved by the River Register considering the requirements of the Rules and national standards, if their use is mandatory according to the Rules.

3.3.3 Approval of the detailed documentation and changes entered in the specified documentation shall be drawn up in the form of a reporting letter. The approved detailed documentation shall be stamped (see 3.1.12). The stamp on approval shall be put on the first page of the document after elimination of all the remarks of the Branch Office.

3.3.4 The designer signs all the copies of the detailed documentation approved by the Branch Office.

3.3.5 After repeated approval of the technical design (see 3.2.8, 3.3.7), the detailed documentation shall be corrected.

The detailed documentation issued under a new number shall be approved by putting a stamp on it and the corrected documentation with the same number shall be approved by putting a stamp on the notice on change.

3.3.6 If approval of the detailed documentation, newly developed or corrected by results of re-approval of the technical design, the developer shall issue a list of materials of the detailed design approved by the Branch Office. Marks on the date of approval of each document shall be put on the list.

3.3.7 Anonymized documentation developed according to national standards is subject to approval by the Branch Office as part of the detailed documentation.

3.4 TECHNICAL DOCUMENTATION ON THE MATERIALS AND PRODUCTS

3.4.1 The River Register reviews and approves technical documentation on manufacture of the products and materials, repair of the products included in the Nomenclature. If the designer (developer of technical documentation) takes decisions in the technical documentation submitted for review and these decisions do not comply with separate requirements of the Rules, then grounds confirming that the taken decisions are of same efficiency as the decisions prescribed by the Rules from the point of view of safety shall be submitted for review by the River Register as part of technical documentation.

3.4.2 Technical documentation on manufacture of the products shall be submitted for review by the River Register according to 3.1.6.

For the standard list of the submitted documentation, see Section 5 of Appendix 8. Technical conditions or documents replacing
them (hereinafter technical conditions) shall include the following:

- description of the product characteristics;
- requirements of environmental protection;
- acceptance rules;
- operating instructions.

The "Description of the product characteristics" section includes the main parameters and characteristics (properties) of the product, scope of application, requirements to the materials, completeness and marking.

The "Requirements of environmental protection" section includes the requirements on product recycling.

The "Acceptance rules" section includes the product control procedure by the manufacturer's quality control departments and the scope of the submitted batches.

The "Operating instructions" section includes instructions on product installation at place of its operation/use and operating conditions, if such requirements are prescribed by the Rules as well as the parameters and characteristics of the product subject to operation inspection established by the manufacturer.

The submitted test program specifies the test procedure, the necessity of which is prescribed by the Rules, as well as test conditions and instruments.

3.4.3 If the materials and products (their parts) for the ships are designed and manufactured according to the requirements of national standards (see 2.1.5), then the documents subject to approval are the documents specified in Appendix 8: calculations, general arrangement drawings and drawings of critical parts, assembly drawings, schematic diagrams, test programs, etc.

3.4.4 Technical documentation on the assemblies or units, which include the components specified in the Nomenclature and delivered by the contractors (generators, reduction gears, prime movers of generators, compressors, pumps, deck machinery, automation systems, etc.) shall be approved after approval of technical documentation on the components.

The River Register approves technical documentation on the assembled product in case of availability of non-approved technical documentation on the materials and components, if the results of the functional, mechanical and climatic tests of these components as part of the assembled products and their electromagnetic compatibility tests (for electrical equipment) are recognized by the respective requirements of the Rules.

3.4.5 If the products are not developed as standard products, and they are developed for a specific ship, technical documentation on them is reviewed by the River Register as part of the ship's technical documentation.

3.4.6 Technical documentation on manufacture of the materials shall include data on the method of manufacture, chemical composition, mechanical and technological properties, scope and procedure of control and acceptance, drawing up the test results and marking procedure.

Test types, methods of control and rules of acceptance are established according to Part X of RCCS.

The test program shall be submitted together with technical documentation.

3.4.7 Review of technical documentation submitted in the scope prescribed by the Rules for one type of material or product shall not exceed 15 working days.

3.4.8 According to results of reviewing technical documentation (changes in the previously approved technical documentation) on the materials or products the River Register draws up a reporting letter. The reporting letter on approval of technical documentation or changes in the documentation includes a list of approved documents and stamps put on them (3.1.12).

3.4.9 The River Register shall send the set of approved technical documentation in paper media with the reporting letter to the developer.

3.5 SOFTWARE APPLICATIONS

3.5.1 Software application in this chapter means a set of connected program, graph and
text modules intended for solving the set calculation task using a computer.

3.5.2 Software applications intended for calculations according to the requirements of the Rules shall be subject to approval by the River Register.

The River Register takes into consideration software products used to ease computation, the possibilities of which are limited by calculation techniques or an application used to determine auxiliary values when developing technical documentation without approval.

3.5.3 In order to receive the software application approval certificate, the following materials shall be submitted to the River Register:

1. distribution disk or application demo;
2. user manual which includes requirements to computer configuration, information on the authors, description of input and output forms;
3. detailed description of the calculation methods implemented in the application with submission of all the used equations, their applications, specifying empirical coefficients, methods of solving computational tasks and in justified cases — convergence criteria, restrictions on scope of application, etc.;
   This description shall include correspondence analysis of the calculation method implemented in the application as well as accepted assumptions to the requirements of the Rules and references to literary sources;
4. test/check examples of calculations with a complete list of source data and explanation of features of their selection, all output forms and interpretation of calculation results.

Reliability of calculations made using the specified application may be checked by making calculations on initial data of the test task issued by the River Register and further comparison of summary data with the calculation results made using a reference application or results of full-scale and/or model experiments.

Test examples shall cover the whole range of possible use of the main parameters.

Information on recognition of this application by other classification societies or other competent organizations may be also submitted to the River Register. In these cases upon agreement with the River Register, the scope of the submitted materials may be reduced.

If the application considers the requirements of the Rules, it is necessary to mention this circumstance and provide a reference to the year of publication of the Rules.

Documentation shall have a number, name and shall be registered according to the established procedure.

3.5.4 Upon satisfactory results of review and check of the submitted application according to the requirements of these Rules, the River Register shall issue a software application approval certificate (Form ÐÐ-8.4).

3.5.5 If calculations included in technical documentation and made using software application with an approval certificate are submitted to the River Register, a reference to the number of Certificate issued by the River Register shall be given in the respective place.

3.5.6 If changes affecting approval are entered in the program modules of the application by its developer, the software application approval certificate may be cancelled by the River Register irrespective of its validity.
4 TECHNICAL SUPERVISION
DURING CONSTRUCTION AND REPAIR OF SHIPS

4.1 GENERAL REQUIREMENTS

4.1.1 The procedure of check tests of the items under technical supervision, types of inspections and tests are specified in the List (see 2.3.1).

4.1.2 Prior to installation of the engines and other technical facilities, devices, systems, equipment and supply the surveyor checks if the specified items have documents specified in 2.2.6.

4.1.3 Upon completion of hull works, installation of the engines and other technical facilities, devices, systems, equipment and supply the surveyor performs technical supervision during mooring and running trials per program developed according to the requirements of the Rules and design documentation of the ship approved by the River Register.

4.1.4 The program of mooring and running trials considers the requirements of technical documentation on the products as well as manufacturer's test programs for the products installed on the ship.

In case there are test methods approved by the River Register, the program of mooring and running trials shall include references to these methods.

4.1.5 The program of mooring and test trials shall be approved by the same Branch Office of the River Register which reviewed the materials of technical design.

4.1.6 The program of mooring and running trials includes the following sections:

1. preparation for trials;
2. mooring trials;
3. running trials;
4. inspection;
5. check sailing, check trials.

The surveyor participates in ship trials at all trial stages. During preparation for trials the surveyor checks the complete set of construction documents (manufacturer's acceptance certificates, test reports, construction book, quality control department's documents, etc.) and operating documents on the components.

4.1.7 Equipment control during trials is performed according to operating rules and operating manual.

4.1.8 The surveyor is not allowed to control equipment on his own or to interfere with the actions of the acceptance board (trial crew) assigned for trials. If the personnel's actions may lead to an emergency or damage of equipment, the surveyor may request to stop such actions through the representatives of the quality control department and person responsible for trials (responsible inspector).

4.1.9 During trials of the items under technical supervision all the works which interfere with trials or create a risk for the participants of the trials shall be stopped, the production areas near the item of trial shall be freed from foreign objects, lighting and ventilation shall be provided.

4.1.10 Mooring and running trials shall be performed according to the schedule approved by the surveyor.

4.1.11 If the trial results of the items under technical supervision do not comply with the
requirements of the Rules or approved documentation, they shall be subject to repeated trials after elimination of the causes which led to unsatisfactory results.

The methods of elimination of the defects and the scope of repeated trials shall be approved by the surveyor.

4.1.12 The possibility of interruption of the item trials in the modes which require continuous operation shall be considered in the test program and the matter of continuing the trials and their conditions (increase of length and scope) shall be approved by the surveyor considering the causes which led to stop of the trials.

4.1.13 During repeated forced interruption of one of the modes of continuous operation, the trials shall be stopped until elimination of the causes which led to interruption with further repeating of trials in full scope. Time of the trials shall be approved by the surveyor.

4.1.14 The trials of the items shall be interrupted in the following cases:

.1 in case of detection of faults or defects, elimination of which requires longer interruption than that specified in the program;
.2 in case of emergency state of the item;
.3 in case of deterioration of weather conditions which pose a threat to safety of the ship.

4.1.15 The decision on trial termination depending on the causes, requiring to stop the trials shall be taken by the ship constructor or customer. When detecting the cases specified in 4.1.14 the surveyor may request the person responsible for trials (responsible inspector) to stop the trials.

Irrespective of the person taking the decision to stop the trials, the item under technical supervision shall be subject to repeated trials, the length and scope of which shall be approved by the surveyor.

4.1.16 During termination of the item trials, a report shall be prepared specifying the causes of terminating the trials as well as requirements and measures on their elimination subject to performance before repeated trials.

4.1.17 Upon completion of the trials, an acceptance certificate with protocols and tables of acceptance tests shall be submitted to the surveyor for signing.

4.1.18 In case of ship construction in two or more shipbuilding organizations, the River Register documents shall be prepared by the surveyor who performed technical supervision during outfitting and trials of the ship.

The surveyor who performed technical supervision at initial stages of ship construction shall prepare a report on the carried out works with the list of the carried out works as per the List (see 2.3.5) and shall send it together with the certificates on the products, datasheets and files on the installed equipment to the Branch Office performing technical supervision during outfitting of the ship. The report shall include the required information to fill in the Certificates of seaworthiness and other documents of the River Register. It is not allowed to use the River Register forms to prepare a report.

4.1.19 Upon completion of the ship construction, availability of the fixed marking nameplates including the following information shall be checked:

.1 name, location and identification of the ship constructor;
.2 serial/hull number;
.3 year of ship construction;
.4 type of ship and its main parameters;
.5 project number (code);
.6 tonnage or passenger capacity;
.7 maximum capacity of main engines (for self-propelled ships);
.8 maximum speed (for self-propelled ships).

4.2 MOORING TRIALS

4.2.1 Mooring trials are performed to check the following:

.1 quality of the carried out hull works, location, complete set and quality of installation, adjustment and serviceability of the engines, devices, systems, equipment and supply as well as compliance of their parameters with
the requirements of the Rules and approved technical documentation;

2. readiness of the ship, its main and auxiliary engines, devices, equipment and supply for running trials.

4.2.2 Prior to start of mooring trials, the following shall be submitted to the surveyor:

1. documents certifying completion of installation and other works;
2. mooring trial program;
3. mooring trial plan subject to approval by the surveyor;
4. specification;
5. list of replacements equivalent to the requirements of the Rules (see 3.1.3), a permission map to deviate (see 3.1.15);
6. files and datasheets on ship machinery;
7. documents for devices;
8. description of items under technical supervision and maintenance instructions;
9. test procedures (including simulation with diagrams of simulators).

4.2.3 The date and time of mooring trials shall be determined by the ship constructor as approved by the surveyor.

4.2.4 Machinery, devices, equipment and systems which do not require running modes shall be checked and tested during mooring trials.

4.3 RUNNING TRIALS

4.3.1 Running trials shall be performed for the following:

1. to check the main parameters of the main engines and power plant as well as their compliance with the specifications;
2. to check operation of the power plant at maneuvering at ahead and astern running;
3. to check reversing properties of the main engines;
4. to check serviceability of the main engines and power plant under conditions close to operating conditions;
5. to check characteristics of manoeuvrability and controllability of the ship;
6. to check automation equipment under conditions close to operating conditions;
7. final check of the items except those which shall be subject to inspection and further check tests;
8. to check serviceability of deck machinery, devices, apparatuses, navigation, radio- and electrical equipment under conditions close to operating conditions;
9. to measure torsional vibration parameters of the system (engine - shafting - propeller) and vibration parameters of hull structures and technical facilities;
10. to confirm the possibility of assigning the River Register class to the ship prescribed by the project according to its purpose.

4.3.2 Prior to start of running trials, the following shall be submitted to the surveyor:

1. quality control department's documents certifying completion of mooring trials;
2. running trial program approved by the River Register;
3. running trial plan approved by the surveyor;
4. trial procedures;
5. information on the ship stability and floodability;
6. heeling test report and stability calculations (for the lead ship);
7. documents specified in 4.2.2.4, 4.2.2.5, 4.2.2.7 and 4.2.2.8.

4.3.3 After submission of the documents specified in 4.3.2 to the surveyor, as well as upon completion of mooring trials and elimination of the detected defects, a notice specifying the assigned date of running trials shall be sent to the surveyor.

The notice shall specify readiness of the ship for running trials and information on the quantity of participants of the trials, availability of collective and personal life-saving appliances and ship stores.

4.3.4 Upon satisfactory results of mooring trials, the surveyor shall confirm the possibility of ship sailing for running trials in writing.

4.3.6 The area of running trials and restrictions on weather conditions shall be approved by the surveyor for compliance with the conditions prescribed by the requirements of the
Rules and approved technical documentation. The area of running trials shall be safe, suitable for performance of the test program in full and to obtain reliable test results.

4.3.7 During running trials, operation of all the technical facilities, devices, systems and equipment shall be checked. The detected defects shall be eliminated and repeated trials shall be performed, if necessary.

4.3.8 The test results shall be recorded in the protocols and books specifying the values of the controlled parameters required to evaluate proper operation of technical facilities, devices, systems and other equipment.

4.3.9 Upon completion of running trials, the surveyor shall submit all the remarks detected during running trials to the organization in writing.

4.4 INSPECTION AND CHECK SAILING

4.4.1 Upon completion of running trials or trials in running mode without ship motion using simulation, elimination of remarks and meeting the surveyor’s requirements (see 4.3.9), the organization together with the surveyor shall prepare a list of items subject to inspection specifying the scope of works. The list shall be prepared considering the results of mooring and running trials as well as technical supervision of same type items.

4.4.2 During inspection, separate assemblies of the items under technical supervision shall be dismantled to determine their condition and necessity of check tests after inspection.

4.4.3 The inspection results shall be drawn up with a report with the following information:

- a list of the items under technical supervision subject to inspection;
- description of detected defects;
- causes of defects;
- a list of measures to eliminate the defects.

The surveyor shall sign the report only for the items under technical supervision of the River Register.

4.4.4 Prior to check sailing all the defects detected during mooring and running trials and detected violations of the Rules shall be eliminated.

4.4.5 Necessity of check sailing shall be approved by the surveyor. Check sailing is required in the following cases:

- Item under technical supervision was subject to inspection and check tests can not be performed without check sailing;
- Parameters describing proper operation of the item under technical supervision may be confirmed only during check sailing;
- According to results of mooring and running trials and/or inspection, complete replacement of the item or replacement of assemblies the serviceability of which was confirmed only during check sailing was required;
- The simulation devices do not allow to obtain the required modes or if such devices are not available.

4.4.6 Satisfactory results of mooring and running trials as well as check sailing shall be the ground for drawing up the River Register documents on the constructed ship.

4.4.7 If the ship is delivered to the customer by railway or other transport, the Branch Office which performed technical supervision during construction, shall assign register number to the ship, draw up a set of the River Register documents and send it to the Branch Office’s address in the area of operation of which the ship shall be operated. The report of initial survey shall specify the requirement on ship submission for occasional survey of the River Register Branch Office for registration.

The Branch Office in the area of operation of which the ship arrived, performs occasional survey with check test of the ship and its components in running mode, specifies the date of the next survey and registers the ship for classification of the Branch Office.
4.5 PECULIARITIES OF TECHNICAL SUPERVISION DURING TESTS OF PROTOTYPE SHIPS

4.5.1 Tests of the prototype ship are performed according to an extended program, compared to that of ships of a series, which includes checking the characteristics and determination of the parameters which shall be used for the ships of a series without such checks.

4.5.2 The trial program for the prototype ship include:
- 1. performing inclining test according to Part II of RCCS;
- 2. determining maneuvering capabilities;
- 3. measuring vibration parameters of the hull structures and separate items of ship equipment;
- 4. checking strength and seaworthiness at rolling (see 4.5.4);
- 5. measuring torsional vibration parameters of the system (engine-shafting-propeller);
- 6. running trials under conditions maximally close to operating conditions;
- 7. tests of the power plant in the scope larger than that for the ships of a series;
- 8. inspection in the scope larger than that for the ships of a series;
- 9. check sailing meeting the conditions of running trials.

4.5.3 Trials of prototype ships including pushed convoys in order to determine maneuvering capabilities as regards controllability and inertial properties shall be performed according to the procedure approved by the River Register.

4.5.4 Trials of prototype ships and ships of new structural types as well as ships with main dimension ratios outside the limits prescribed by the Rules shall be performed under design wind and wave conditions considering the following:
- 1. testing the ship and coupling strength with voltage measurement according to a specially developed program;
- 2. checking controllability at wind;
- 3. evaluating roll parameters;
- 4. general monitoring of the ship condition (wettability, operation of propellers and ship equipment at roll).

The specified tests are performed according to the program and within the terms approved by the River Register.

4.5.5 Upon completion of the prototype ship trials, the developer of the ship design shall determine the list of measures to be performed on the following ships of a series. This list shall be approved by the River Register.

4.5.6 In case of use of new materials, type specimens of products and equipment depending on the ship purpose, operational tests shall be provided according to the program approved by the River Register.

Operational test reports shall be submitted to the Branch Office within the approved terms after completion of the tests.

4.5.7 The necessity of performing operational tests shall not be an obstacle for drawing up and issue of the River Register documents for the ship.

4.6 PECULIARITIES OF TECHNICAL SUPERVISION DURING SIMULATION TESTS

4.6.1 The simulation tests shall be performed during construction of the ship series according to the procedure developed considering PД3Р.0202.

4.6.2 Expediency and methods of simulation tests shall be determined by the shipbuilding organization, designer and customer.

4.6.3 Simulation devices, methods of their fastening and their impact (vibration, etc.) shall not adversely affect the tested item or ship structures.

Adjustment of simulation devices and comparative tests shall be performed on the serial and prototype ships.

4.6.4 The requirements of this chapter do not apply to prototype ships and type specimens of items under technical supervision.
The purpose of joint simulation and full-scale tests on the prototype ships and standard items is evaluating the possibility of replacement of full-scale tests with simulation tests of the next serial items.

4.6.5 During simulation tests, all the control parameters of the tested item prescribed by the Rules shall be checked.

If simulation tests allow to determine only some of the parameters, other parameters shall be determined during full-scale tests.

4.6.6 In order to justify use of simulation methods, comparative tests (full-scale in open water and simulation) shall be performed on one ship with further analysis of their results, development and approval of operating program (procedure) of simulation tests for the ships of this series.

4.6.7 Comparative tests shall be performed according to the program (procedure) approved by the River Register.

4.6.8 The program (procedure) of comparative tests includes the following:
- 1. explanatory part which includes theoretical justification of the accepted simulation method of tests, diagrams (drawings) of simulation devices and their connections with the tested items, diagrams of training courses, information on quantity of the ships on which comparative tests are performed;
- 2. instructions on checking installation quality and requirements to tests in mooring mode;
- 3. instructions on performing simulation tests including instructions on control and measurement of the parameters as well as on providing values of the controlled parameters;
- 4. instructions on comparison procedure and on the required comparability of the parameters obtained during practical simulation and full-scale tests.

4.6.9 According to results of comparative tests on at least two ships, a document shall be drawn up and signed by the surveyor. The document shall include values of comparable parameters, information on test reproducibility and conclusion on possibility to perform simulation tests on the next ships of a series.

4.6.10 Simulation tests shall be performed according to the program (procedure) prepared by results of comparative tests and approved by the River Register.

4.6.11 The program (procedure) of simulation tests includes the following:
- 1. general provisions;
- 2. requirements to technical condition of the item submitted for tests;
- 3. requirements to technical condition of simulation device or other support device or equipment;
- 4. guidelines for preparation to tests and their performance including instructions on control and measurement of parameters. Values of the parameters which shall be obtained using simulation device shall be also specified;
- 5. diagrams of simulation devices and training courses;
- 6. instructions on control comparative tests and their intervals.

4.6.12 In case of use of simulation methods during tests of ship machinery and equipment after inspection the same simulation methods which were used to check items in running mode shall be used.

4.6.13 Check comparative tests using a complete program of full-scale tests shall be performed on serial ships tested using simulation methods in order to confirm reliability and stability of the results of simulation tests within terms approved by the River Register or on the ships with previously assigned hull number (e.g., each third, fifth, tenth, etc.)

The intervals (frequency) of comparative check tests shall be established by the shipbuilding organization considering stability of manufacture and installation quality of the items under technical supervision and reproducibility of full-scale and simulation tests.
4.7 PECULIARITIES OF TECHNICAL SUPERVISION DURING CONVERSION, MODERNIZATION AND REPAIR OF THE SHIPS

4.7.1 The River Register performs technical supervision during conversion, modernization and repair of the ships in service.

4.7.2 Technical supervision during conversion, modernization and repair of the ships is performed according to the approved technical documentation.

Technical documentation shall be submitted for approval for those parts of the hull, ship machinery and equipment which are subject to conversion, modernization, recovery or repair.

4.7.3 Technical documentation on repair shall be developed in the following cases:

The organization has no detailed or design documentation on the repaired ship, detailed or operating documentation on the repaired items under technical supervision

Impossibility to perform repair works on available technical documentation with respect to functionality of process equipment or technologies (production, control and test) which exist in the organization.

4.7.4 Technical supervision during conversion, modernization and repair of the ships is performed on a contract basis.

4.7.5 At technical supervision during repair of the ships the requirements of these Rules shall be met as regards the following:

.1 Nomenclature;
.2 procedure of design documentation approval (see 3 of these Rules);
.3 scope of technical supervision (type of inspections and trials, including mooring and running trials);
.4 use of materials and welding;
.5 scope of technical documentation submitted for review by the River Register.

4.7.6 Scope and methods of repair determined by the ship repair organization shall be approved by the surveyor.

4.7.7 Fault detection of the ship components shall be conducted by the ship owner considering the requirements of the Rules or standards specially developed for the ships of this project and related to determination of technical condition (see Appendices 2 to 4 to RSSS).

4.7.8 The results of check tests of scope and quality of the works carried out during technical supervision during conversion, modernization and repair of the ships, remarks and requirements of the surveyor shall be drawn up in the form of the documents prescribed by these Rules.
5 HULL AND HULL EQUIPMENT

5.1 GENERAL REQUIREMENTS

5.1.1 This section establishes requirements on technical supervision during manufacture of metal, reinforced concrete and plastic hulls as well as superstructures and wheelhouses irrespective of their participation in global bending of the hull.

5.1.2 Procedure and scope of inspections and tests of hull structures shall be determined according to the List (see 2.3.1) developed considering the peculiarities of production processes, methods of hull and superstructure construction, welding methods, control methods accepted in this shipbuilding organization.

5.1.3 At technical supervision of construction quality of hull structures the following shall be checked:

.1 availability of the certificates on flat steel, strip bar, profile iron, bar iron, pipes, cast and forged products, documents on welding consumables;

.2 compliance of data specified in the certificates and other documents on the materials, requirements of the Rules and technical documentation approved by the River Register as regards checked structure;

.3 compliance of the steel grade, material grade and cast number specified for the parts with the certificate data. If cast number for the parts is not available or replaced with a symbol, it shall be determined by the documents according to the procedure applicable in the organization;

.4 compliance of the material grades with the drawing requirements.

5.1.4 Visual examination is required to check the following:

.1 compliance of the structure of the item under technical supervision with the drawings and technical documentation, alignment, mating and connection of parts, assemblies and other components, quality of machining and established structural requirements;

.2 meeting the requirements of the Rules related to the item under technical supervision;

.3 absence of visible defects and deviations from the product shape, quality of removal of temporary mounting parts and facilities;

.4 compliance of the welded joint type and parameters of the completed weld with the requirements of the drawing and welding table, absence of external defects.

5.1.5 The following structural parameters are subject to random checks for compliance with the values specified in the drawings:

.1 thickness of parts made of sheet material;

.2 dimensions of parts of welded and rolled beams, knees, stiffeners, foundation components, coamings, shelves;

.3 distance between framing beams;

.4 distance between welded joints and beams, ends of knees;

.5 spaces between weld joints;

.6 dimensions of cutouts, distance between them, distance from the part and support edges, spherical radii;

.7 beam cuts, noses, gaps at ends;

.8 values of thickness variation, shifts of members and parts;

.9 straightness of members, angles of connecting to blades and beams;

.10 values of residual deformation parameters (bulges, dents, corrugations, ribbing
of panels and other construction welding deformations) which shall be within limits specified in production documentation (Appendix 8);

1.1 dimensions of weld structural components (weld width, shape and height of strengthening, weld leg, length and pitch of intermittent welds);

1.2 dimensions of structural components of rivet joints (width of laps and angle bar faces, pitch of rivet joint, distance between rows of rivets and from rivet axis to the plate edge, dimensions of the rivet components).

5.1.6 When checking quality of welding operations, the surveyor shall refer to the requirements of Part X of RCCS.

5.1.7 At periodical inspections of the organization welding industry (see 2.3.5) the surveyor shall check the following:

1. quality of welding consumables;

2. welding methods;

3. qualification of welders and specialists of non-destructive testing (see 2.8.2.2);

4. preparation of connections for assembly and welding, quality of tacks of the welded joints and welds;

5. meeting the technology including protection against bad weather conditions;

6. methods and scope of quality control of the welded joints.

5.1.8 During technical control according to the List, make sure that the welds have no defect in the form of: cracks in the weld and weld area, unfilled craters, preparation not filled with metal, shifts and narrowing of welds, slag, metal (tungsten), oxide and flux inclusions on the weld face, holes, pores, cavities, low spots between beads, saddles, piling and ripple, undercuts, not smooth transition of the weld to the base metal, irregular shape of the weld.

5.1.9 The surveyor shall check quality of the welds made by the organization personnel using non-destructive testing, if it is prescribed by the Rules. The following shall be checked:

1. availability of the approved monitoring diagram of the welds;

2. compliance of the control method approved by the River Register;

3. compliance of the quantity of the tested areas of the welds and their location with the monitoring diagram considering additional and check tests.

4. test results according to the documents of the organization.

5.1.10 Radiographs and gammagrams, reports on ultrasonic testing shall be subject to random checks. The welds shall be opened to determine the types of defect.

5.1.11 Hull tightness tests shall be performed according to the test patterns approved by the River Register and developed according to Appendix 10.

5.1.12 At technical supervision during hull tightness tests the following shall be checked:

1. preparation of a room (compartment) for testing;

2. methods and conditions of trials;

3. coverage of the structures and welds by the tests;

4. sequence and procedure of process operations and functional inspection by the organization;

5. accuracy of tightness estimation;

6. quality of elimination of unsound spots.

5.2 TECHNICAL SUPERVISION DURING MANUFACTURE OF ASSEMBLIES, SECTIONS AND BLOCKS

5.2.1 During manufacture of structural parts, assemblies, sections and blocks, it is necessary to perform functional inspection and stage-by-stage control established by the production processes and standards.

5.2.2 Test benches, jig plates, beds and other equipment prior to assembly shall be preliminary calibrated to provide permitted accuracy of the overall dimensions of the assemblies, sections and blocks, smoothness of their outlines according to the drawings and ordinates removed from mold loft.

5.2.3 During construction of the serial ship hulls, technical supervision at this stage in-
cludes periodic examinations of the manufactured sections and separate assemblies. Their tests are performed at the following stages of hull construction: as part of blocks, sections, hull parts in pre-slipway positions or as part of the hull on the slipway.

5.2.4 The following shall be performed at technical supervision during construction of sections:

.1 material test according to 5.1.3;
.2 external examination of sections according to 5.1.4, components of welded structures according to 5.1.8;
.3 checking dimensions according to 5.1.5;
.4 flaw detection of the welds according to 5.1.9;
.5 checking the conditions and results of the tightness tests according to 5.1.11 and 5.1.12.

5.2.5 Completely ready sections and separate assemblies shall be supplied to the places of block formation accepted by the organization’s quality control department and after the surveyor’s inspection if prescribed by the List.

5.2.6 Blocks shall be submitted for inspection according to the List after completion of the assembly-welding and fitting works as well as tightness tests.

5.2.7 At technical supervision during construction of blocks, make sure that:

.1 Quality of installation of sections included in the blocks provides continuity of the hull. Coupling of the longitudinal members determining global strength is carefully checked;
.2 Use of bottom-hole parts and assemblies improves the quality of intersection connections;
.3 Allowances in the sections, bottom-hole parts and assemblies are within tolerances established by technical documentation, cuts in the places of intersection connections allowing to make high quality butt welds;
.4 Field connections on the hull plating are welded first on the inside and then after removing weld root — on the outside of the hull;
.5 Deformation parameters do not exceed values specified in Appendix 11.

5.3 TECHNICAL SUPERVISION DURING CONSTRUCTION OF THE METAL HULL ON THE SLIPWAY

5.3.1 Sections and assemblies shall be supplied to the slipway completely ready and accepted by the shipyard’s quality control department and inspected by the surveyor if prescribed by the List.

Sections and blocks shall be checked for compliance with the approved technical documentation. The necessity and procedure of installing temporary reinforcements and parts, the values of allowances on mounting edges to provide proper quality of the slipway assembly by the River Register shall not be determined.

5.3.2 At technical supervision during the slipway assembly the surveyor shall check the following:

.1 proper installation of sections and blocks relative to the slipway base lines and previously installed sections and blocks;
.2 proper coupling of sections by plating and by members and preparation of intersection connections for welding;
.3 dimensions and quality of welds;
.4 values of welding deformations of the hull, superstructures and quality of deformation flattening (see Appendix 11).

5.3.3 If the sections or blocks were inspected and tested during their manufacture, the scope of technical supervision shall include inspection to make sure that there are no damages in the result of transportation and installation.

5.3.4 Hull spaces shall be submitted for inspections and tests according to the List after completion of all the works on assembly, welding, riveting and flattening as well as installation of all the saturating parts connected directly to the hull structures. The structures adjoining to the checked space, shall be finally welded at a distance of at least 1 m from this space.
5.3.5 During detection of cracks in the hull structures the surveyor shall notify the organization and check the structure condition. During detection of cracks, measures shall be taken on detection and elimination of the crack causes. Hull works in the areas specified by the surveyor shall be stopped. The damaged structures shall be removed from the hull or shall be corrected with complete removal of cracks according to the technology approved by the Branch Office.

5.3.6 When analyzing the results using non-destructive testing, straining ties and areas subject to vibration as well as quality of fillet and T-butt welds, welding of which is prescribed by full penetration shall be checked. Tightness tests of the welds shall be combined with tightness tests of the hull according to the diagram approved by the Branch Office. Tightness test results of the welds performed prior to hull testing, shall be checked according to the organization's documents.

5.3.7 At technical supervision during construction of the hull on the slipway, the surveyor shall check sequence of hull formation as well as tests of the hull position on the slipway and keeping slipway log by the organization.

5.4 TECHNICAL SUPERVISION DURING CONSTRUCTION OF REINFORCED-CONCRETE SHIPS

5.4.1 During technical supervision of a ship under construction, the following shall be checked:
.1 quality of the materials used for hull construction according to the certificates and laboratory analysis data;
.2 quality of the reinforced steel billets, proper manufacture of reinforcing cages and fabrics, installation and attachment of fittings with embedments and line ups;
.3 proper dosage of the concrete components, quality of concrete preparation, its laying and vibration compaction;
.4 compliance with temperature and moisture conditions, concrete hardening time as well as concrete strength before removal of the sections from the matrices;
.5 compliance of sections with the design requirements after their removal from the matrices and drawing up datasheets or logs of sections;
.6 readiness of the slipway, its leveling and markings;
.7 proper section installation on the slipway, installation, welding and grinding of bar joints, installation of embedments and line ups in field joints, preparation of the section edges for concreting;
.8 proper concreting of bar joints, concrete quality, compliance with temperature and moisture conditions at its hardening;
.9 compliance of the hull components with the design prior to its shift from the slipway position. The hull shall be inspected outside and inside and the dimensions of these components shall be checked. Prior to shift, concrete strength of bar joints shall be checked.

5.4.2 During manufacture of solid reinforced-concrete hull, proper installation of the formwork and thickness of the protective layer, obtaining the required temperature and moisture conditions at curing of concrete and time of formwork removal shall be checked.
At intervals in concreting, readiness of the surfaces of the previously laid concrete shall be checked.

5.4.3 At technical supervision during tests, the reinforced-concrete ship hull shall be checked according to the test patterns approved by the Branch Office and developed according to the methods and scope of tests as per GOCT 5 R.0276.

5.5 TECHNICAL SUPERVISION DURING CONSTRUCTION OF PLASTIC HULL SHIPS

5.5.1 At technical supervision during construction of the ship, the following shall be checked:
.1 results of the material laboratory analysis prior to their use. The main parameters shall comply with technical documentation on manufacture of these materials;
.2 quality of the equipment working surface;
.3 compliance of the equipment with detailed drawings and molding shapes

5.5.2 When preparing to formation of hull structures, the surveyor evaluates the following:
.1 quality of preparing and applying release agents;
.2 quality of preparing the binding materials and proper cutting of reinforcing materials.

5.5.3 During formation of the hull structures, the following shall be checked:
.1 proper laying of fiberglass, warp direction and quantity of layers, gaps between coupled panels;
.2 uniform impregnation and sealing of the reinforcing material;
.3 absence of foreign inclusions;
.4 process allowances for physical tests.

5.5.4 After formation of the hull structures, their holding period shall be checked according to technical documentation:

5.5.5 When inspecting the ready assemblies and sections, absence of the following shall be checked:
.1 unacceptable deviation of the section dimensions from those specified in the drawings;
.2 external and internal defects;
.3 unacceptable deviation from the given thicknesses, straightness and thickness variation.

5.5.6 Temperature and relative air humidity shall be reported during manufacture of the sections, blocks of the hulls and superstructures.

5.5.7 The surveyor shall check physical and mechanical properties of the hull structure material, determined using a destructive method according to the requirements of the Rules (by results of laboratory tests of dry samples).

5.5.8 The surveyor shall make sure that the hulls made of fiberglass are repaired using the same materials as for construction. The hull repair procedure shall be approved by the Branch Office.

5.6 TECHNICAL SUPERVISION DURING MANUFACTURE OF STRUCTURAL FIRE PROTECTION

5.6.1 At technical supervision during manufacture of fire protection structures on the ship under construction, the following shall be checked:
.1 certificates for materials;
.2 insulation thickness and dimensions of air gaps, quality of insulation fastening to metal base, compliance with the technology of applying insulating materials when forming fire bulkheads and decks;
.3 transition pieces of the electrical route pipes and ventilation ducts through fire divisions;
.4 equipment of dangerous spaces;
.5 equipment of liquid fuel and lubricant storage facility;
.6 compliance with the requirements related to the ship purpose.

5.6.2 During technical supervision of manufactured fire doors and other closures, the following shall be checked:
.1 serviceability and density of closures;
.2 their opening and closing by one person;
.3 operation of the closure of self-closing doors when controlled from local and remote (if any) stations;
.4 closures of ventilation ducts, ring spaces around smoke pipes, skylights of the machinery, boiler and pump rooms.

5.6.3 Quality of materials used for internal insulation and equipment shall be checked by the surveyor on the documents on the materials and visual inspection for compliance with the approved design documentation.
5.7 TECHNICAL SUPERVISION DURING MANUFACTURE OF EQUIPMENT OF SPACES, CLOSURES, FENCINGS, LADDERS AND COMPONENTS OF DEVICES CONNECTED TO THE UNDERWATER PART OF THE HULL

5.7.1 During technical supervision of corridors, exits, doors and ladders, compliance with the drawings and Rules shall be checked:
.1 passages intended for quick escape of people to lifeboat and liferaft embarkation areas;
.2 type and dimensions of doors;
.3 direction of door opening;
.4 length of dead-ends in corridors;
.5 width of exits from halls, accommodation and service spaces;
.6 width of main corridors in the area of accommodation spaces for passengers and the crew;
.7 width of inclined ladders and dimensions of the platforms.

5.7.2 Upon completion of the closure installation the surveyor shall check the following:
.1 compliance of device and closure structures with the drawings;
.2 contact of seal gaskets with bead edges;
.3 easy and free (smooth) opening, closing, shifting and battening of the closures;
.4 compliance of the coamings height with the drawing and requirements of the Rules;
.5 quality of welds in places of closure connection with the hull, superstructures and wheelhouses;
.6 fastening of removable boards for glasses;
.7 tightness test results.

5.7.3 During technical supervision of manufactured guard rails, bulwark and catwalks, the following shall be checked:
.1 quality of welded joints of bulwark and catwalks;
.2 compliance of the distance from the deck to the foot line of guard rails and distance between other guard rails with the requirements of the Rules;
.3 compliance of the bulwark and guard rails height with the requirements of the Rules.

5.7.4 Upon completion of the foil arrangement installation the following shall be checked:
.1 compliance of foil angles of attack with the design;
.2 fastening of the foil arrangement to the hull;
.3 availability and efficiency of the arresters preventing loosening of nuts.

5.7.5 Upon completion of the hovercraft flexible skirt installation the following shall be checked:
.1 installation and fastening of the flexible skirt;
.2 availability and efficiency of the arresters preventing loosening of nuts.

5.8 CHECKING HULL READINESS FOR LAUNCHING

5.8.1 The hull shall be launched according to the production process approved by the River Register (see 3.1.10).

5.8.2 Prior to approval for launching, the surveyor checks the documents of the organization and River Register drawn up in the process of technical supervision confirming stage-by-stage control and tests:
.1 hull structures;
.2 hull structure tightness;
.3 weld joints;
.4 installation of stern tubes, propeller shafts and propellers, rudders, nozzles, dampers, and thrusters if these operations are performed when the ship is afloat;
.5 bottom and side valves;
.6 tightness of joints between the navigation equipment and the hull;
.7 installation and fastening of hovercraft foil arrangement and flexible skirts;
.8 installation of the thruster;
9. Installation and reliability of manhole covers in the inner bottom plating and tanks, closures of openings in watertight bulkheads;
10. Plugging of temporary openings in the hull;
11. Application of load line and draught marks;
12. Main dimensions and hull shape with the dimension tables attached;
13. Completeness and quality of application of paint coatings to the underwater part of the hull (see 5.8.6 and 5.8.7).

5.8.3 Upon satisfactory results of the tests specified in 5.8.2, the surveyor shall draw up an approval for ship launching by making a record in the Notice and in the protocol on the ship readiness for launching.

5.8.4 According to results of inspection of all the ship compartments after launching, the quality control department shall draw up a report and submit it to the surveyor.

5.8.5 The ship's bottom shall be submitted for inspection in the dock or on the slipway, if:
1. The ship's bottom is damaged during launching;
2. Leakage is detected in the underwater hull;
3. Defects are detected or there are grounds to suspect inadmissible defects in the bottom which appeared during launching, outfitting or trials of the ship.

5.8.6 Diagrams of coating, painting and cementing, quality control of their use on inland navigation ships including performance of technical documentation shall not be selected by the River Register.

5.8.7 For river-sea navigation ships, the River Register performs technical supervision of painting of the underwater hull, cargo spaces and ballast tanks of dry cargo ships and tankers. During technical supervision the surveyor checks compliance of the used coating materials with the painting list approved by the River Register, availability of the documents (see 2.2.6.3) on coating materials (for interior spaces) and compliance with the application method on the hull structures.
6 POWER INSTALLATION AND SYSTEMS

6.1 GENERAL REQUIREMENTS

6.1.1 This Section establishes requirements for technical supervision during manufacture, installation and testing of the following products subject to technical supervision by the River Register according to Section 4 of the Nomenclature: main and auxiliary internal combustion engines, reduction gears and reverse reduction gears, disengaging couplings and flexible couplings, compressors, pumps, fans, separators, deck machinery, shafts, propellers, systems and piping, boilers, heat exchangers and refrigerating equipment.

6.1.2 Scope and procedure of checks and tests of the products specified in para 6.1.1 is determined by the List developed by the organization upon the Nomenclature and Rules requirements taking into account specifics of manufacture, assembly, installation, and control methods and procedures, adopted by organization in accordance with the Branch Office.

6.1.3 All materials, including forgings and castings, associated equipment and items, used in manufacture of products specified in para 6.1.1 and their parts or intended for assembling the set, should be provided with certificates or other documentation verifying the material, product and technological process compliance with the requirements of technical specification approved by the River Register. In case specified by the Nomenclature parts and items shall be stamped.

6.1.4 Technical supervision during manufacturing and installation of parts includes conformance inspection of the measurement results in all measure points and sections, specified in detailed documentation and installation and operating instructions to the product and results of non-destructive testing of parts as prescribed by the Rules, documentation agreed with the River Register. Linear and angular dimensions, mounting clearances, form deviation, roughness, hardness and material structure are subject to measurement.

6.1.5 Technical supervision of rectification of castings, forgings and welding constructions surface defects shall be based on requirements of technical documentation, agreed with the River Register and requirements of Part X of RCCS. Parts and items after defects rectification are subject to non-destructive control, if so required by Rules and technical specification.

6.1.6 In technical supervision during product and their components manufacturing, the Surveyor shall:

.1 verify the quality of material and heat treatment as well as availability of the associated equipment through the documentation;

.2 control hydraulic and atmospheric tests of the products;

.3 ensure the random visual inspection and the quality control of the processing, dimension compliance with detailed drawings, technology compliance and use of flaw detection prescribed by process documentation;

.4 verify the compliance of manufactured parts, assemblies and items under technical supervision to the technical documentation requirements;

.5 check for marking as per agreed technical documentation.
6.1.7 Products being subjected to a hydraulic test in accordance with the Rules requirements, shall be preliminary heat treated and machined.

For product hydraulic test residual deformations, sweating and leakage are considered as rejection sign.

6.1.8 Results of hydraulic test are to be recorded in the test log indicating the following information:

.1 description of the item;
.2 manufacturing number;
.3 drawing number;
.4 working pressure;
.5 hydraulic test pressure;
.6 test results and data on permitted defect rectifications;
.7 testing date.

Reliability of this information shall be certified by the signature of the representative from organization's QC service.

6.1.9 Tested items and parts shall be stamped in plain view with the detail number, mark of the manufacturer's QC service, working and test pressure values.

Ship machinery safety valves being hydraulically tested shall be adjusted as per Rules, air tested and sealed by organization's QC service.

6.1.10 Technical supervision of repair of the items specified in para 6.1.1 shall be provided by the organization approved for works of such type, granting the technical documents for repair agreed with the River Register.

6.1.11 Parts and hinged units replaced during repair are subject to the same tests as new ship machinery during manufacturing.

6.1.12 Once ship machinery is repaired, the River Register ensures the technical supervision of testing of parts and assembly units subjected to the same test types as new ship machinery during manufacturing.

6.1.13 Engines thoroughly repaired are to be verified for compliance to standards for emissions according to the test program developed in accordance with Appendix 12.

6.1.14 Upon satisfactory results of tests and checks, the River Register issues documents on products, as provided in Rules.

**General requirements to bench tests procedure**

6.1.15 After product manufacturing and acceptance by manufacturer's QC service, in cases stipulated by the Rules and agreed with technical documents, bench tests are executed in the presence of the Surveyor according to program approved by the River Register.

6.1.16 Prior to start product testing, the Surveyor shall be provided with the following:

.1 organization document on bench readiness for testing;
.2 arrangement of the equipment and instrumentation, as well as bench specification;
.3 documents on instrumentation checkout and calibration of bench or standard devices;
.4 document from organization's QC service on accomplishment of factory tests providing results of controlled parameters;
.5 technical documentation on manufacturing and delivery of the product, as well as associated equipment in case of its installation on the bench with the product subjected to the testing;
.6 description and maintenance instruction, drawings, results of parts and mounting dimensions measurement;
.7 completed logbook (datasheet) for the item under test;
.8 test program (when it is an integral part of the agreed technical documents).

6.1.17 Continuity of test modes can be disrupted only once not more than for 15 minutes due to failure while forced shutdown of the item under test. Once all the deficiencies are rectified, the item shall be tested again, from the mode where the forced shutdown occurred.

In cases of forced shutdown exceeding 15 minutes, or repeated tested item shutdown, or replacement of tested item components, the test is considered failed. It can be restarted only after analysis and removal of all
causes and defects, interrupting continuous operation of the item under test.

6.1.18 After bench tests, product units and parts shall be subject to inspection. Scope of the inspection and analysis shall be determined on the results of checks or tests and adjusted on the basis of detected defects nature.

6.1.19 In case of inspection with product partial dismantling it shall be concluded by control tests carried out in the presence of the Surveyor. Control tests shall be carried out in mode of rated load or expected working load.

Technical parameters got while control testing, shall be recorded in the product supporting documentation (file, datasheet, operating guidance, etc.)

6.2 TECHNICAL SUPERVISION DURING MANUFACTURE

Internal combustion engines

6.2.1 Technical supervision during manufacture of internal combustion engine parts and units involves checking of their conformance to the requirements of the Rules and agreed technical documentation in regard to the following:

1. structures, materials, chemical and heat treatment, mechanical and physical and chemical surface properties;
2. size, shape, location and roughness of base mating surfaces, axes straightness, mating parts setting
3. quality of welding;, threaded and other joints, fixation and locking of connecting parts;
4. adhesive uniformity and strength of antifriction, antiwear and other coatings;
5. presence of defects, their nature and repair;
6. flaw detection of forged and cast steel parts, welded joints;
7. hydrostatic tests (see 6.2.2);
8. availability of technological base, lugs and openings, final machining allowances;
9. deviation from the profile and contact area in gearings;
10. crankshafts static and dynamic balancing;
11. determination of harmful substances emissions in exhaust gases.

6.2.2 Parts, pipelines and units of internal combustion engines operating under excessive pressure shall undergo hydraulic test according to the requirements of Table 2.3.2 after final machining and before protective coating is applied.

<table>
<thead>
<tr>
<th>Table 6.2.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydraulic test pressure</strong></td>
</tr>
<tr>
<td><strong>Part / assembly description</strong></td>
</tr>
<tr>
<td>Cylinder cover — cooling space</td>
</tr>
<tr>
<td>Cylinder liner over the whole length of the cooling space</td>
</tr>
<tr>
<td>Piston crown — cooling space after assembly with a piston rod, if the latter forms a sealing</td>
</tr>
<tr>
<td>Cylinder block — cooling space</td>
</tr>
<tr>
<td>Exhaust valve (body) — cooling space</td>
</tr>
<tr>
<td>Turbocharger — cooling space</td>
</tr>
<tr>
<td>Exhaust piping — cooling space</td>
</tr>
<tr>
<td>Coolers1, each side</td>
</tr>
<tr>
<td>Engine-driven pumps (lubricating oil, fuel boosters, bilge) — working spaces</td>
</tr>
<tr>
<td>Engine-driven compressors including cylinders, covers and air coolers: the water side</td>
</tr>
<tr>
<td>Engine-driven compressors including cylinders, covers and air coolers from the air side</td>
</tr>
<tr>
<td>Casings of the high pressure fuel pumps (the pressure side), fuel atomisers and fuel pipes</td>
</tr>
</tbody>
</table>

1. Air coolers of turbochargers shall undergo hydraulic test only from the water side.

Notes: 1. $p$ — working pressure, MPa.
2. These hydraulic test norms do not apply to fuel pumps with plunger controlling edge.

6.2.3 The engine is to be assembled from parts and units, accepted by organization's QC service. Prior to assembling they are subject to inspection by the Surveyor.

6.2.4 In the course of technical supervision of the engine assembly, the following shall be checked;
.1 base frame positioning as per technical documentation;
.2 alignment of main bearings soles;
.3 fitting of main bearing inserts by soles and of journal-and-thrust bearing;
.4 crankshaft laying with check of journals fit to the bearings, shaft line, journals beat and crankshaft deflections;
.5 installation and fastening of cylinder block, mating surfaces fitting;
.6 tightening load of threaded joints;
.7 deflections (again) after anchor ties tightening and flywheel installation;
.8 installation and alignment of gas distribution drives, camshaft and hinged units;
.9 installation of cylinder and piston group parts;
.10 installation of assembled cylinder heads;
.11 installation and alignment of inhalers;
.12 installation of engine set;
.13 parts locking.

6.2.5 After assembling, running-in and adjustment, the Surveyor shall ensure the technical supervision of engine bench test performance according to the program agreed with the River Register.

6.2.6 In the course of technical supervision of bench test performance, the Surveyor shall base on requirements of 6.1.15 – 6.1.19 with regard to the following:
.1 main engines intended for operation with fixed pitch propeller shall be tested by propeller characteristic;
.2 engines intended for generators drive, pumps, compressors shall be tested by load characteristic;
.3 new design solutions as for the engine – transmission – propeller system shall be tested according to the program which takes into account those solutions;
.4 bench engines shall be tested along with all standard devices, apparatus and automatic control, general alarm system and protection devices;
.5 bench test duration shall be specified in accordance with Table 6.2.6.5. In this case, the following shall be considered:

<table>
<thead>
<tr>
<th>Mode No.</th>
<th>Engine operation parameter values, % of rated values</th>
<th>Engine test time, h, at rated rotation speed, rpm&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Engine operation</td>
<td>&lt;200</td>
</tr>
<tr>
<td>Idle run mode</td>
<td>1 not standardized</td>
<td>0</td>
</tr>
<tr>
<td>Ahead running under propeller load</td>
<td>2 25</td>
<td>63</td>
</tr>
<tr>
<td>3 50</td>
<td>80</td>
<td>63</td>
</tr>
<tr>
<td>4 75</td>
<td>91</td>
<td>83</td>
</tr>
<tr>
<td>5 100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>6 110</td>
<td>103</td>
<td>107</td>
</tr>
</tbody>
</table>

| Astern running mode | 7 not standardized | 1.0 | 1.0 | 0.5 | 0.5 |
| Minimum steady rotation speed mode | 8 not standardized | 0.5 | 0.5 | 0.25 | 0.25 |

| Total test time | 14 | 12 | 7 | 3.75 |

Note: Modes 7 and 8 shall be applied only if the engine design provides for running at these modes.

.6 systems of control, regulation, alarm and protection, locking and cutoff, starting reversing engine characteristics, regulators functioning shall be tested before activate engine's mode;

.7 testings of automated control system shall be based on individual program agreed upon with the River Register;
operation of the engine shall be tested in all modes specified by program methodology, work process parameters and characteristics specified in technical documentation and test program are to be recorded;

work process parameters shall be measured at least twice under engine steady operating conditions;

measuring torsional vibration parameters (in cases specified in para 6.1.1 Part IV RCCS).

6.2.7 Engine testings to ensure the compliance of their specifics concerning harmful substances emissions and opacity in exhaust gases with the standardized values are to be performed as per approved test program, developed in accordance with Appendix 12. Engine type and model as basic engine of the family for testing shall be chosen by the manufacturer.

During manufacture of one family series engines, their parameters and rated values concerning harmful substances emissions and opacity in exhaust gases shall be admitted based on the testing results of a family basic engine.

If the engine design was modified so that the changes introduced effect the content of harmful substances and opacity in exhaust gases shall be admitted based on the testing results of a family basic engine.

When performing engine testings after the overhaul to ensure the compliance of their specifics concerning harmful substances emissions and opacity in exhaust gases the maximum allowed values of their specifics shall be in accordance with the requirements of 6.2.3 and 6.2.6 of the Rules for Prevention of Pollution from Ships.

6.2.8 During technical supervision it shall be taken into account that after bench tests envisaged by test program, depending on check results specified in para 6.2.6, assembly units and engine parts are subjected to the inspection with visual and dimensional examination in the scope agreed with the Surveyor.

6.2.9 If at engine inspection it was partially dismantled, engine control tests shall be carried out with technical supervised by the River Register Surveyor check of working process parameters and engine efficiency, as well as of its arrangements and systems given below:

starting devices;

reversing unit;

alarm and protection system, safety devices;

automated control system;

rotation speed control system.

6.2.10 The Surveyor ensures that in case of unsatisfactory check results, after full elimination by manufacturer of defects affecting the performance of this unit or system, the repeated engine operation checks are carried out in accordance with 6.2.8.

6.2.11 The manufacturer shall provide along with engine the following documents:

technical file;

assembly and sub-assembly engine drawings in scope specified by technical specification;

hinged units files provided by manufacturers;

technical datasheet and operating and maintenance instructions containing detailed description of engine units and special-purpose tool;

spares list;

instrumentation datasheets;

post-assembly engine acceptance certificate issued by the organization;

engine bench test report (checking test);

post-test engine inspection certificate issued by the organization;

technical datasheet of harmful substance emissions and opacity in exhaust engine gases (prepared as per ГОСТ 31967);

record book of engine parameters for recording of all changes in configuration and adjustments (may be integral part of the data-sheet or engine file). The record book shall contain the description of all changes related to design characteristics of the engine, including adjustments, replacement of components or design changes of engine components allowing the evaluation of the emission level.
6.2.12 Accomplished tests and supporting documents checking shall be accompanied by the issuing of certificate (PP-8.1 form). This certificate shall contain the information on values of harmful substances and exhaust gases opacity, got while basic engine of the family testing (see 6.2.7).

Shafting

6.2.13 In technical supervision during shafting manufacturing the following shall be checked:
- conformity of material quality to the requirements of approved technical documentation, heat treatment mode and flaw detection results;
- work surface roughness, size and shape;
- shaft radial run-out, axial run-out of flange faces and thrust collar, external and internal surfaces concentricity or hollow shafts wall thickness;
- section shape and key slot preparation, key slot position about an axis of the shaft and cone;
- assembly and alignment keeping at shaft connections, interference fit and gaps of connection;
- surface for facing with sufficient clearance to ensure the interference as per drawings.

6.2.14 The completely finished shafts are subject to visual inspection. The following shall be determined by the Surveyor:
- surface defects parameters do not exceed the norms set by the drawing technical requirements;
- shaft journals shall be free from chippings, scratches, notches or burrs;
- shaft threads shall be clean, without burrs or strips;
- fillets shall be made smoothly, seams shall be free from sharp edges and burrs.

Upon satisfactory results of checks, flaw detection and measurements, shafts shall be stamped by the River Register, if prescribed by the Nomenclature.

6.2.15 During the manufacture and after facing final processing, the Surveyor shall verify the following:
- compliance of material properties to the requirements of technical documentation;
- flaw detection results;
- the absence of defects on facing external surfaces;
- sizes ensuring guaranteed interference fit while facing fitting on the shaft;
- results of hydraulic test for facing tightness or welded shells before fitting on the shaft (see 6.2.16).

6.2.16 The Surveyor shall verify that propeller shaft and stern tube facings are hydraulically tested by pressure not less than 0,2 MPa.

6.2.17 After fitting the facing on the propeller shaft and final processing, the Surveyor shall control the results of the following checks performed by the manufacturer:
- absence of defects on facing external surfaces;
- work surfaces size, shape, roughness and radial run-out;
- quality of facing welds, welded on shaft, by the leak test results (by air or oil) under pressure of 0,2 MPa and/or using liquid penetrant method;
- quality of sealings of shafting ends.

6.2.18 Water insulation of the shaft shall be verified for absence of saggings, blistering or entrapped air.

6.2.19 Finally manufactured couplings, connecting bolts, main bearings and thrust bearings, stern units, sealings and glands are to be verified by the Surveyor before their installation. Final control of flange half-couplings by the external and end surfaces shall be performed after their fitting on the shaft.

Gears, disengaging and elastic couplings

6.2.20 In the course of technical supervision during manufacturing of parts and assemblies of main engines gears and disengaging couplings, the Surveyor shall verify the following:
- treated shaft journals, surfaces for facing, teeth cutting parameters, gear rings, surfaces or sealing and connections, keyways, threads, deviation from the profile, radial run-out, end surfaces squareness to the shaft axis,
axial run-out, chemical and heat treatment, protective coatings comply with the requirements of technical documentation approved by the River Register.

.2 Critical parts were subject to flaw detection.
.3 Fitting in connections were carried out with required interference fit (clearance).
.4 Finally assembled and treated gear-wheels, pinions, shafts with couplings and half-couplings assemblies as per 4.3.2 Part IV RCCS shall be statically and/or dynamically balanced.

6.2.21 After execution of welding works and heat treatment, while inspecting finally treated parts of the gear boxes and couplings, the Surveyor shall control:
.1 welds, including flaw detection methods;
.2 treated bearing surfaces of foundations and flange connections of individual hull parts;
.3 boring of the soles for bearings and sealings;
.4 alignment of soles borings for bearings of each shaft;
.5 quality and reliability of connections of individual gear box parts or coupling;
.6 mutual alignment of in gear shaft axis.

Gear box is subject to the tightness test, and hydraulic coupling case – to the hydraulic test.

6.2.22 When assembling gears and couplings, the Surveyor shall control:
.1 fitting of bearing by soles, standard shaft or false shaft journals, clearances of journal and thrust bearings;
.2 centre-to-centre spacing and mutual alignment of shaft axis;
.3 gear backlashes and tooth contact;
.4 quality of coupling assembling, hinged units and systems serving gear;
.5 alignment of gear with drive motor and loading device;
.6 quality of coupling drive and driven parts assembling.

6.2.23 For bench tests, gears and disengaging couplings shall be equipped in accordance with the approved technical documentation. During bench testings, provisions 6.1.15 – 6.1.19 shall be taken into account.

6.2.24 When testings are completed, gears and disengaging couplings are subject to inspection and to control tests, where the following shall be verified:
.1 reversing provided by transmission design;
.2 disconnection of the transmission from the prime mover or driven load;
.3 alarm and protection systems, safety devices;
.4 automated control system;
.5 smoothness of changing of the prime mover rotation speed within minimum steady to the rated one.

**Propellers**

6.2.25 In the course of technical supervision during propellers and their parts manufacturing, the Surveyor shall control:
.1 design parameters and size compliance with the technical documentation approved by the River Register;
.2 quality of the material for blanks, forgings and castings intended for propellers and their parts manufacturing (through the documentation furnished);
.3 results of flaw detection, carried out in accordance with the technical documentation;
.4 absence of internal or surface defects as per technical documentation for propellers approved by the River Register;
.5 interchangeability and difference in weight between standard and spare blades of detachable-blade propellers;
.6 results of static and/or dynamic balancing of propellers and water-jet propeller rotors after machining and fully assembled.

6.2.26 The scope of the technical supervision of the specially designed propellers parts (for example, rotating-blade, columns, paddle wheels), as well as types, sequence of tests and checks carried out during the technical supervision of their manufacturing, shall be determined by the River Register.
Compressors, pumps, fans and separators

6.2.27 In the course of technical supervision during manufacturing of parts and assemblies of compressors, pumps, fans and separators, the Surveyor shall verify their compliance with the Rules and approved technical documentation. This verification shall be based on provisions 6.1.6 and other requirements of these Rules.

6.2.28 In the course of technical supervision during hydraulic tests of compressors, pumps, fans and separators parts, operating under excessive pressure, to be carried out after final machining and before protective coating, results of these tests shall be checked by the Surveyor as well. The correct choice of the hydraulic test pressure determined by the formula given below (MPa), shall be checked:

\[ p_{\text{test}} = (1.5 + 0.1k) \cdot p, \quad (6.2.28) \]

where \( k \) — coefficient adopted from Table 6.2.28;

\[ p \] — working pressure, MPa.

In all cases the test pressure shall be admitted not below the pressure corresponding to full opening of safety valve but not below 0.4 MPa for cooled chambers of parts and sealings of different types and not below 0.2 MPa in other cases.

In case the working pressure given in Table 6.2.28 is exceeded, test pressure shall be approved by the River Register.

6.2.29 Parts and units of pumps, fans, filled with oil products or their vapours under hydrostatic or atmospheric pressure, shall undergo tightness test. In welded structures it is sufficient to test only tightness of welds.

6.2.30 In the course of technical supervision during the assembling and installation of the compressors, pumps, fans and separators, the Surveyor shall verify the following:

.1 Shafts shall be placed in bearings, fitted by soles and journals;

.2 Required clearances in bearings and sealings, between operating elements and housings shall be maintained;

.3 Shaft shall be aligned with the prime mover;

.4 Required contact in gear meshes shall be provided;

.5 Protective and safety devices shall be adjusted.

6.2.31 After assembling, running-in and adjustment, the Surveyor shall ensure the technical supervision of bench test performance (see 6.1.15 – 6.1.19), where compressors, pumps, fans and separators serviceability shall be checked and all parameters specified by the technical documentation shall be recorded, as well as following devices shall be tested in operation:

.1 automation equipment;

.2 safety devices.

6.2.32 Safety devices shall be tested in operation and sealed by the manufacturer's QC service.

<table>
<thead>
<tr>
<th>Working temp, °C, up to</th>
<th>Value ( k ) at working pressure ( p ) up to, MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbon steel</td>
<td>molybdenum and molybdenum-chromium steel with Mo ( \geq 0.4 % )</td>
</tr>
<tr>
<td>cast iron</td>
<td>bronze, brass, copper</td>
</tr>
<tr>
<td>( p )</td>
<td>( p )</td>
</tr>
<tr>
<td>120</td>
<td>0</td>
</tr>
<tr>
<td>200</td>
<td>1</td>
</tr>
<tr>
<td>250</td>
<td>3</td>
</tr>
<tr>
<td>300</td>
<td>5</td>
</tr>
<tr>
<td>350</td>
<td>8</td>
</tr>
<tr>
<td>400</td>
<td>10</td>
</tr>
<tr>
<td>430</td>
<td>11</td>
</tr>
<tr>
<td>450</td>
<td>17</td>
</tr>
<tr>
<td>475</td>
<td>20</td>
</tr>
<tr>
<td>500</td>
<td>22</td>
</tr>
</tbody>
</table>

Boilers, heat exchangers and pressure vessels

6.2.33 Technical supervision of the boilers, heat exchangers and pressure vessels, their parts and units manufacturing and of process operations performing shall be carried out by the Surveyor in accordance with the technical documentation approved by the River Register.

6.2.34 Soundness of plates, forgings and castings, designed for parts and units of boilers, heat exchangers and pressure vessels shall
be determined by their surfaces visual inspection.

6.2.35 Scantling of parts before assembling of items under technical supervision shall be checked for compliance with those specified by the drawings and drawing technical requirements.

6.2.36 In the course of technical supervision during assembling of parts and units of items under supervision, the compliance of gaps between the members and tolerances specified in the technical documentation approved by the River Register, shall be checked. Align mated elements by creating excessive push-up load or cold shock straightening is not allowed.

6.2.37 Before welding, bevel and gaps are to be verified on their compliance with the drawings approved by the River Register. The bevel surface shall be free from cracks, delaminations or other defects.

6.2.38 Welding operations shall be carried out with welding consumables specified in the technical documentation approved by the River Register.

6.2.39 Welded joints quality control shall be performed after heat treatment (if applicable).

Methods and scope of quality control of the butt welded joints shall be specified in the technical documentation.

6.2.40 Fittings of boilers, heat exchangers and pressure vessels are subject to the hydraulic strength test (see 6.2.28) before installation at their standard places.

6.2.41 Parts and units of boilers, heat exchangers and pressure vessels are subject to the hydraulic strength test by a test pressure as per standards of ГОCT 22161, before being assembled.

Hydraulic test by a test pressure shall be carried out in the presence of the Surveyor when meeting the following requirements:

1. All assembly, welding and welds control operations are finished and accepted by the manufacturer's QC service (confirmed by the document on part or unit readiness for hydraulic test issued by the manufacturer's QC service);

2. Components of the item under technical supervision are not insulated or coated with other protective coating;

3. Part or unit was subject to the Surveyor examination.

6.2.42 Assembled boilers, heat exchangers and pressure vessels without fittings and insulation or other protective coatings shall be subject to internal survey and hydraulic strength test by a test pressure as per standards of ГОCT 22161.

**Refrigerating plants**

6.2.43 Technical supervision during manufacturing of the refrigerating equipment for transport, refrigerated and catching vessels shall be carried out as per approved technical documentation.

6.2.44 Technical supervision during manufacturing of the refrigerating equipment specified in 6.2.43 includes the following:

1. verification of technical documents;

2. verification of parts, units and assembling parts;

3. verification of welded and soldered joints quality;

4. technical supervision during hydraulic strength testing;

5. technical supervision during pneumatic tightness testing;

6. technical supervision during vacuum leakage testing;

7. technical supervision during bench testing.

6.2.45 Technical supervision during manufacturing of the refrigerating equipment shall be based on the applicable provisions of 6.2.1 to 6.2.39 and requirements of technical documentation approved by the River Register.

6.2.46 Testings as per 6.2.44.4 to 6.2.44.6 shall be based on the provisions 6.2.47 to 6.2.51.

6.2.47 The units operating under pressure of the refrigerant shall be hydraulically tested...
by a test pressure equal to at least 1.5\(p\), where \(p\) is the design pressure taken in accordance with 6.2.47, with the exception of reciprocating compressor crank cases for which a test pressure shall be not less than the design pressure.

The units operating under pressure of the liquid coolant or water shall be hydraulically tested by a test pressure of at least 1.5 of the working pressure but not less than 0.4 MPa.

### Table 6.2.47

<table>
<thead>
<tr>
<th>Refrigerant group</th>
<th>Symbol</th>
<th>Chemical formula</th>
<th>Design pressure, MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>R134a</td>
<td>C(_2)H(_2)F(_4)</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>R22</td>
<td>CHF(_2)Cl</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>R125*</td>
<td>C(_2)HF(_6)</td>
<td>2.0</td>
</tr>
<tr>
<td>II</td>
<td>R717</td>
<td>NH(_3) (ammonia)</td>
<td>2.0</td>
</tr>
<tr>
<td>III</td>
<td>R290</td>
<td>C(_3)H(_8) (propane)</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>R1270</td>
<td>C(_3)H(_6) (propylene)</td>
<td>2.0</td>
</tr>
<tr>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

**To be used at medium condensation points instead of R22 which is not permitted for newly built refrigerating plants since 01.01.2020.**

6.2.48 The units operating under pressure of the refrigerant shall undergo pneumatic leakage tests by a test pressure equal to at least the design pressure taken in accordance with 6.2.47 with the exception of reciprocating compressor crank cases for which a test pressure shall be not less than 0.8 times the design pressure.

6.2.49 The equipment operating under pressure below the atmospheric pressure shall undergo vacuum leakage tests at residual pressure not exceeding 0.8 kPa.

6.2.50 Fittings in assembly and automation devices with stopping arrangements in addition to the above tests shall undergo pneumatic closing-tightness tests by a test pressure equal to the design pressure taken in accordance with 6.2.47.

6.2.51 Compressors, refrigerant, liquid coolant and cooling water pumps, heat exchangers and other equipment, vessels operating under the refrigerant pressure, piping and fittings rated for 1.0 MPa and over, devices of automation, control and protection systems as well as devices for measuring and registration of temperature within refrigerating spaces after assembling shall be tested in accordance with the requirements of 6.2.28.

6.2.52 Technical supervision during bench testings and refrigerating equipment inspection shall be based on requirements of 6.1.15 – 6.1.19, taking into account the following:

1. The bench for compressor testing shall ensure compressor operation with full refrigeration cycle using specified refrigerant, oil and keeping of the refrigerant nominal parameters and environmental conditions (cooling water temperature +32°C, ambient temperature +50°C);
2. Compressor type specimen testings shall be carried out at the rated power and idle run to determine refrigerating capacity, volume flow, power and oil consumption;
3. Compressors with incorporated motors shall be tested in regard to their starting characteristics, temperature and insulation resistance;
4. Standard compressor test time shall be at least 500 h, 150 h of which shall accrue to the operation at maximum pressure difference and other 150 h – at maximum power;
5. Refrigerant pumps shall be tested using specified refrigerant;
6. Refrigerant pump test time shall be sufficient to determine its specified characteristics, but not less than 8 h;
7. Heat exchangers (type specimens) operating under refrigerant pressure, shall undergo bench thermotechnical tests (the temperature of refrigerant measurement) using specified refrigerant and taking into account item structure and designation. Bench equipment shall ensure the item operation with full refrigeration cycle.

### Systems

6.2.53 Fittings of the piping shall be produced in accordance with the requirements of 10.3 and 10.4 of Part IV RCCS as per technical documentation approved by the River Register.
6.2.54 In the course of technical supervision during piping fitting manufacturing, the Surveyor shall control the following:

1. compliance of material to the requirements of technical documentation;
2. quality of finishing and lapping of the working and sealing surfaces;
3. compliance of the springs, spool pieces, diaphragms used in fittings to the technical documentation requirements;
4. results of hydraulic tests (see 6.2.57);
5. adequate operation of local and remote drives of fittings;
6. control, safety and measuring fittings as well as self-acting valves. The given fittings shall be checked in operation on bench to confirm their performance characteristics, specified in the technical documentation.

6.2.55 Checking of the hydraulic pressure results is designed to ensure the correctness of the test pressure chosen that, in case of fittings intended for a design pressure exceeding 0.1 MPa, shall be determined by the procedure specified in 6.2.28 relevant to testings of compressor components, pumps, fans operating under excessive pressure, and in the other cases shall be:

1. at least 0.2 MPa – for fittings intended for a design pressure of 0.1 MPa and less, as well as for vacuum conditions;
2. at least 0.3 MPa – for outboard valve box and ice box fittings;
3. equal to the design pressure – for fittings assembled and being tested on leak tightness.

6.2.56 Type specimens of valves shall be additionally examined for at least 3 h under conditions of vibration, temperature and pressure limits, other special modes depending on fittings designation (checks for fire-resistance, noninflammability of inflammable mixture vapours, preventing the accidental admission of water, reliability at hydraulic impact, hydraulic resistance).

6.2.57 During manufacturing of pipelines of Classes I and II (see 10.1.2 of Part IV RCCS) and all steam, feeding, compressed air and fuel system pipelines with a design pressure over 0.35 MPa regardless of their class, the Surveyor shall carry out the technical supervision of pipelines hydraulic testings performed prior to insulation and application of coating, results of these tests shall be checked by the Surveyor as well. The correct choice of the test pressure that is considered to be of 1.5 of the design pressure, is also subject to the control.

The test excessive pressure of the pipelines of cargo pumping system intended for carriage of hazardous goods in bulk (except liquefied gases) shall be at least 1 MPa.

The test pressure for liquefied gas pipelines from the reservoirs to the pressure reducing valves shall be at least 2.5 MPa.

6.2.58 During manufacturing of the firefighting system pipelines and fittings, the Surveyor shall realize the technical supervision of hydraulic testings of such items, including checking of the results of hydraulic tests by test pressure corresponding to the Table 6.2.58.

When using the Table 6.2.58, the following shall be considered:

Assembled fittings shall undergo leakage test in closed position by pressure not less than 1.25p.

Valves of carbon dioxide reservoirs shall undergo tightness test by the maximal breakdown pressure of safety diaphragm.

Onboard systems shall be tested in the assembly after all installation operations have been finished.

6.2.59 The Surveyor shall control the recording in logbook of the hydraulic test results (see 6.1.8) with the indication of test pressure, numbers of certificates for pipes and data on welds testings.

6.2.60 Where it is impossible to carry out hydraulic tests of the pipelines prior to their installation onboard due to technical reasons, it is allowed to test separate pipe lengths, in particular, assembly joints.

6.2.61 Small bore pipes (less than 15 mm) of any class are not subject to testing by a test pressure.
### Test pressure during hydraulic testings of fire-fighting system pipelines and fittings

<table>
<thead>
<tr>
<th>Tested systems and assemblies</th>
<th>Test hydraulic pressure, MPa, during the tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in a workshop</td>
</tr>
<tr>
<td>1. Foam and water extinguishing system piping</td>
<td>—</td>
</tr>
<tr>
<td>2. Carbon dioxide system: pipelines from reservoirs to starting valves; transit pipelines led via spaces</td>
<td>—</td>
</tr>
<tr>
<td>2.1 carbon dioxide system: pipelines from reservoirs to starting valves; transit pipelines led via spaces</td>
<td>—</td>
</tr>
<tr>
<td>2.2 pipelines from starting valves to nozzles</td>
<td>—</td>
</tr>
<tr>
<td>3. Pneumatic pipelines</td>
<td>1.5p</td>
</tr>
<tr>
<td>4. Bottles, reservoirs, tanks: pressurized, including bottles without valves</td>
<td>1.5p</td>
</tr>
<tr>
<td>4.1 pressurized, including bottles without valves</td>
<td>1.5p</td>
</tr>
<tr>
<td>4.2 non-pressurized</td>
<td>Filled to the top of air vent</td>
</tr>
<tr>
<td>5. Valves</td>
<td>1p by air</td>
</tr>
</tbody>
</table>

**Notes:**
1. *p* — maximal working pressure in the system, for carbon dioxide system — design pressure in a bottle or reservoir, MPa.
2. Pipelines stated in 2.1 tested in the workshop by hydraulic pressure of 1.5p, may be tested on a ship by air with pressure of 1p.

### Internal combustion engines, gears, disengaging and elastic couplings

**6.3.3** Installation and assembling of main engines, gear components and shafting components shall be carried out after accomplishment of all hull operations and testing for tightness of compartments and double-bottom tanks in the engine room area and the shaft line, including completion of foundation manufacturing.

**6.3.4** During onboard installation of the main engine in dismantled condition, checks and technical supervision shall be carried out as per requirements of 6.2 including foundation preparation and base frame installation.

**6.3.5** The installation of items shall be carried out in accordance with the approved technical documentation depending on their type and construction.

**6.3.6** In the course of technical supervision during installation of gears and couplings, the following shall be checked:
1. Security of attachment of gearing cases to ship foundations;
2. Quality of installation of units and components used in torque transfer, on shafts.

**6.3.7** Technical supervision during installation and testing of items driven by main engine shall be carried out at the same time as pair of mechanisms, boilers, pipelines and fittings.

### 6.2.62 The organization's QC service stamp confirming conducted hydraulic test shall be impressed on the side of one of pipe flanges or enclosure.

### 6.2.63 Silencers and spark arresters of exhaust systems and boiler flues shall be tested as per program approved by the River Register.
technical supervision during installation and testing of main engines.

6.3.8 Once the installation operations are completed, items are subject to the inspection to check the quality of installation and its compliance with the detailed drawings approved by the River Register.

Shafting

6.3.9 The onboard installation of stern gear and shafting shall be carried out after completion of hull operations, including all operations related to foundations for main engines and shafting bearings, tests of compartments and tanks in the area of shafting and engine room, determination of the shafting theoretical axis.

6.3.10 Prior to stern gear and shafting installation all fixed loads that can cause deformation of the hull due to heavy weight, shall be placed and installed in their respective places, and change of hull position in the area of shafting and engine room shall not exceed ±3 mm relative to its position recorded at the beginning of operations.

6.3.11 In the course of technical supervision during installation of stern gear, the following shall be checked:

1. quality of the punching of shafting theoretical axis;
2. sizes, deviation from the shape and roughness of seatings and horn end faces, bosses, welded pad of after peak bulkhead, seatings of stern gear and bearing bushes;
3. compliance of mating surfaces setting with the drawing requirements;
4. forces for components pressing-in, security of their attachment and locking.

After installation, internal diameters are subject to the control measurement and stern tube bearings – to the inspection.

If stern tube was installed after watertightness test of the hull, corresponding hull compartment shall be tested again.

6.3.12 Prior to shafting installation the following shall be checked:

1. bearings foundations and bearing surface finish – deviations from flatness, roughness, thickness of foundation bearing plates;
2. shafts (propeller shaft, thrust shaft, tunnel shaft), bearings, couplings and stern gear through the visual examination and its documentation;
3. quality of propeller and half-coupling fitting to the propeller shaft;
4. clearances in sterntube and strut bearings by results of propeller shaft and bearing necks measurement.

6.3.13 After propeller shaft installation the following shall be checked:

1. clearances in bearings;
2. propeller shaft position in stern gear in axial direction;
3. quality of installation of stern seals or other stern gear sealings and gland packing laying.

6.3.14 Prior to propeller installation the following shall be checked:

1. availability of documentation and stamps;
2. surface soundness (by visual examination);
3. quality of preparation of hub bore mounting surface, tapered hub bore fitting-on;
4. keys fitting into keyed connection.

6.3.15 In the course of technical supervision during the installation of propeller or water-jet propeller rotors, the following shall be checked:

1. propeller axial shift in relation to the shaft;
2. pressing force and interference fit of connection;
3. uniformity and tight fitting of fairing nut to the hub and security of its locking;
4. tightening force and locking of the fastening elements of detachable blades;
5. clearances between the propeller blade and the nozzle or in the flow path of waterjet.

6.3.16 Prior to shafting installation and alignment the following shall be checked:

1. diameters of shaft journal and internal borings of bearing inserts by results of control measurement to determine clearances in bearings;
.2 quality of rolling bearings installation on shafts;
.3 shaft laying into bearings and bearings installation on foundation;
.4 shafts mutual alignment relative to each other by control marks when connecting in the shop;
.5 finish of fastening bolts and holes in the foundation and bearings.

6.3.17 Shafting shall be aligned in such a way as to prevent the exceeding of permissible values of shaft stress and bearing load at any ship loading condition and allowable wastage of shafts and bearings in operation.

6.3.18 The holes for flange connections bolts shall be treated jointly for both flanges of connected shafts by their actual dimensions, and bolt heads and nuts are to be checked for adequate contact with the flanges surface.

6.3.19 In the course of technical supervision during shafting installation and after assembling of all connections and securing of bearings, the following shall be checked:
.1 shaft position in the bearings and fitting of support inserts to the shaft journals
.2 clearances in the thrust bearing between the collar and segments, axial clearances between thrust collar and shafting fillets or bearing insert ends
.3 fitting of chocks to the support branches of bearing bodies
.4 finish of holes for templet bolts in the foundation and bearings
.5 security of attachment and locking of bolts
.6 crankshaft deflections of the main engine after its connection to the shafting

6.3.20 Final control of the shafting alignment shall be performed with the ship afloat after chocks fitting to the bearings, at displacement of at least 85% of the lightship displacement.

The Surveyor shall check the provided results of alignment parameters measurement (fractures and misalignment of the shaft axis), entered into the tables, indicating as well design and allowable values of these parameters.

6.3.21 Installation, assembling and control of fitting of the shaft turning gear, tachometer transmitter, shafting brake, devices for reducing power are to be performed as per technical documentation requirements approved by the River Register.

6.3.22 The Surveyor shall check the parameters of the main engine crankshaft alignment with the shafting or reduction gear simultaneously with or after shafting alignment. Measured values of parameters shall not exceed those specified in the manufacturer's technical documentation on installation of such items. Deviations in frame straightness and crankshaft deflections shall not exceed the norms determined by the manufacturer of the engine.

6.3.23 The Surveyor is to verify that in the process of alignment of engine crankshaft and electric generators at their rigid connection (at main units on electric ships), allowances specified in the technical documentation of the generator manufacturer are kept, and in the process of alignment of propulsion electric motor armature shaft and thrust shaft are kept allowances determined by the propulsion electric motor manufacturer.

Compressors, pumps, fans and separators

6.3.24 The technical supervision during installation of compressors, pumps, fans and separators shall be performed as per approved technical documentation. Scope of technical supervision is to be determined taking into account type, designation and design of the item under technical supervision.

Boilers, heat exchangers and pressure vessels

6.3.25 Installation of boilers, heat exchangers and pressure vessels shall be carried out in accordance with the requirements of technical documentation on installation approved by the River Register. Prior to start the installation, it is important to ensure that assembly and welding of ship foundations are completed and items have a document issued by the QC service and confirming their applicability.
6.3.26 The Surveyor shall perform the internal survey of the boiler with standard valves and instruments after completion of the assembling, boiler installation on the foundation and fixing, but prior to application of insulation, shell and lining.

Heat exchangers internal survey shall to be performed by the manufacturer's QC service.

Pressure vessels internal survey shall to be performed by the Surveyor.

If the boiler is fully assembled (with insulation, shell and lining) and provided with supporting documents, only accessible parts are subject to internal survey.

6.3.27 During boiler internal survey, the Surveyor shall verify the following:

1. Boiler components and welds shall be free from damages and defects.
2. Hot-water, waterwall and down-take pipes shall not be deformed but free from plugs (verify by the means of master balls).
3. Water level indicators shall be installed relative to heating surface as per Rules requirements.
4. Drums and headers internal equipment shall correspond to the drawing and is fixed.
5. Fittings and instruments installed on the boiler shall correspond to the drawings.
6. Instruments shall be provided with documents on calibration by metrological organization.
7. Boiler drums and headers as well as superheaters headers shall be protected against direct heat flow.

6.3.28 Hydraulic leak test of boiler (with all pipelines, fittings and instruments) shall be carried out under test pressure as per standards of ГОСТ 22161, in the presence of the Surveyor after boiler installation on the ship.

Main steam piping, feeding pressure piping, blow-off pipes, water gauge instruments and all fittings are subject to the hydraulic test with the boiler.

If the boiler is fully assembled (with insulation, shell and lining) and provided with supporting documents confirming hydraulic tests performance, the boiler hydraulic test on board the ship is not required.

Onboard hydraulic test of the steam piping is obligatory.

6.3.29 Tested boiler shall be kept under test pressure for at least 5 to 10 min. During keeping under test pressure, the purge pump shall be disconnected and pressure in the boiler shall not decrease. Then, the pressure is decreasing to the working value and maintained constant to the completion of the examination.

6.3.30 The boiler shall be considered as having passed the test if no leaks or sweating of welds, leakage in pipe expanded connection, fitting connecting flanges, instrument connections as well as no local bulges, residual deformation or signs of any connection damage are detected.

6.3.31 Technical supervision during hydraulic leak tests, air test and outer survey of the pressure vessels with all fittings and system piping which contains the pressure vessels, shall be performed after onboard installation of the system. The hydraulic test shall be performed under a test pressure equal to 1.5 of operating pressure in the system.

6.3.32 After hydraulic test, pressure vessels are subject to air test (ГОСТ 22161) for working pressure to check the tightness of connections.

After testing and adjustment in accordance with the requirements of the Rules, safety valves shall be stamped by the manufacturer's QC service.

6.3.33 After onboard installation, the Surveyor performs technical supervision for boiler steam sample, taking into account the following:

1. Test duration is 4 to 8 h at steam working pressure.
2. Boiler steam is not consumed, all boiler valves are closed except blow-down valve of superheater header.
3. Water level in the boiler is maintained in a working range.
4. Boiler insulation and shell are removed in such a way as to ensure meeting the requirements of 6.3.34.
If the boiler is fully assembled (with insulation, shell and lining) and provided with manufacturer supporting documents on results the boiler steam sample, boiler steam sample after its onboard installation is not required.

After steam sample, the boiler is subject to mooring and running trials. Waste-heat boilers are tested during the operation of engines at mooring and running trials.

6.3.34 In the course of technical supervision during boiler steam sample the following shall be checked:

.1 tightness of welding, riveted, threaded and expanded joints of the boiler, flange connections of fittings and steam pipelines
.2 tightness of the boiler and boiler flues shell
.3 presence and sizes of expansion clearances in the holes of boiler support on the foundation allowing thermal expansion of the boiler and clearances in the arrangements preventing displacement of the boiler
.4 presence and parameters of thermal distortion of the boiler components

When the results of boiler test in steam are satisfactory and defects detected in the course of testing are eliminated, insulation and shell installation is to be carried out.

Refrigerating plants

6.3.35 Technical supervision during installation and testing of the refrigerating plant on transport, refrigerated and catching vessels shall be based on the applicable provisions of 6.3.1 to 6.3.33 taking into account the following:

.1 Components and equipment of the refrigerating plant supplied to the shipyard are subject to the Surveyor’s check by certificates or documents of refrigerating equipment manufacturer;
.2 Equipment and items manufactured by the shipyard, are subject to the check and testing prior to installation as per 6.2.44 to 6.2.53.

6.3.36 After completion of assembly-welding works on the hull but prior to insulation installation, leak testing of the refrigerating plant room is subject to the technical supervision, taking into account the following:

.1 Test (excess) air pressure during leak testing is taken equal to 2 kPa;
.2 compressed air pressure drop for 1 h shall not exceed 25 % of the initial test pressure, i.e. 1 h after the pressure in the tested room shall be not less than 1.5 kPa.

6.3.37 In the course of technical supervision during the refrigerating plants installation, the Surveyor shall check the following:

.1 meeting the requirements of the Rules on the control stations equipment and places of maintenance, arrangement of the passes, escape and emergency routes as well as their closures;
.2 compliance of the refrigerant equipment arrangement (including control, monitoring, alarm and protection devices) with the requirements of the approved technical documentation
.3 proper installation of pipelines and their reliable protection against damages;
.4 fastening of the refrigerating equipment;
.5 alignment of the refrigerating plant units;
.6 quality of the insulation installation, including the type (brand) of insulating material, thickness and security of insulation attachment, quality of the insulation of installation assemblies in the area of framing, pipes passages, hatches and doors.

6.3.38 In the course of technical supervision during refrigerating plant systems manufacturing and installation, the Surveyor shall check:

.1 quality of welded butt-joints of the refrigerant pipelines – using one of non-destructive testing methods.

Overlapped joint weld, on the backing rings and other which can not be checked by the non-destructive testing, shall be tested by the hydraulic pressure equal to 1.5 of the working pressure;

.2 operation of isolation valves and refrigerant system pipelines after leakage testing of the system by stage-by-stage connection of
the system sections depending on the group of refrigeration consumers and pressure rise in these sections to 1.1 of working pressure;
3. penetrations of air cooling systems and ventilation ducts through watertight and fire protection structures;
4. arrangement of ventilation inlets and outlets, flame-breaking fittings on the ends of air channels and fans of non-sparking type in the explosion-hazardous spaces;
5. gas and air tightness of air channels before and after insulation operations;
6. insulation of air channels.

6.3.39 The refrigerant system shall be tested for leakage by the gaseous atmosphere test pressure equal to a working pressure (see 9.3.2 Part IV RCCS) for 18 h, after completion of installation. Total pressure drop caused by adsorption or leakage during the testing shall not exceed 2% of the initial test pressure.

In such testing shall be used dry air, carbon dioxide or nitrogen with the temperature of water vapor saturation up to 45°C.

After leak test, the pressure is to be relieved by sequential valves opening on the emergency drainage station to check the emergency drainage system of the refrigerant.

6.3.40 After passing the leakage tests the refrigerant system shall be drained and undergo vacuum leakage tests at residual pressure not exceeding 1 kPa.

6.3.41 In the course of technical supervision during the leak test of the refrigerant system it should be taken into account that all tests shall be performed for 12 h after vacuuming to the residual pressure up to 1 kPa.

The system is considered as passed the test if total pressure rise (due to steam-gas desorption and inrush of air in the course of testing) do not exceed 25% of the initial residual pressure.

When the leak testing is completed, the quality of drainage of the refrigerant system is to be checked.

The absolute water content after drainage according to the laboratory analysis data shall not exceed 0.15 g/m³.

6.3.42 Coolant and cooling water systems are subject to the leak test (see 6.2.48), being kept under working pressure for at least 1 hour.

6.3.43 Safety valves designed for refrigerating plant shall be checked and tested in the testing laboratory prior to their onboard installation, taking into account the following:
1. Valve is to be adjusted to blow at 1.1 to 1.2 of working pressure;
2. Valve is to be closed after actuation at a pressure of at least 0.85 of working pressure;
3. Valve trim tightness shall be checked by the immersing with secondary rise of pressure to the designed value after its closing upon actuation.

Systems

6.3.44 In the course of technical supervision during installation of systems and piping the following shall be checked:
1. complete set and compliance of the system's components with the requirements of the approved technical documentation;
2. quality of system's components cleaning and processing, corrosion-resistant coatings;
3. fact of performance and results of hydraulic tests of fittings, pipings, devices prior to their onboard installation;
4. proper arrangement and installation of pipings, fittings, instruments and automation equipment, compliance of the pipe bending radiiuses with those specified by drawings;
5. completion of the assembling, welding and leak testing of hull structures as well as after installation of all the saturating welding parts;
6. reliable and proper installation of bottom and side valves and sacrificial protection components;
7. installation of standard gaskets, fasteners, security of pipes and compressors attachments;
8. availability and safety of maintenance and repair of pipelines and fittings;
9. availability of arrangements for draining or blow-down of the medium, absence of pos-
sible liquid stagnation areas, preventing of water hammers, presence of pipeline pitches;

.10 providing with insulation, housings, barriers, protection against mechanical damages;

.11 providing with identification plates on the fittings, identification pipelines painting, position indicators of shut-off devices, operation of local and remote drives, their accessibility;

.12 arrangement and structure of branch suctions and inlets;

.13 safety of precautions against compartment flooding, hazardous and toxic gases and vapors penetration into accommodation and service spaces;

.14 availability of grounding and (random) grounding check of electrically conductive plastic pipelines.

When the assembling is completed, the systems shall undergo hydraulic strength and leak tests (see 6.2.57) on board the ship or air test, if such alternative is provided by the Rules.

6.3.45 In the course of technical supervision during testing of systems metallic piping, the test pressure shall be taken considering provisions 6.2.57.

6.3.46 All pipelines after assembly shall undergo leak tests in operating conditions, except:

.1 heating coils in tanks and oil and gas fuel lines that shall be tested by 1.5 \( p \), but not less than 0.4 MPa

.2 liquefied gas pipelines that shall be leak tested (by air, haloids etc) by a test pressure chosen depending on the working pressure.

6.3.47 In case where hydraulic tests of assembled piping systems are carried out on board, leak tests and strength tests of them may be combined.

6.3.48 Testing of air, overflow and sounding pipes shall be carried out together with the tanks they are connected with.

6.3.49 Plastic pipelines making part of ship's systems that ensure the main purpose of the ship, its survivability and floodability, shall be tested after installation by hydraulic pressure at least 1.5 times exceeding the design system pressure.

6.3.50 Plastic pipelines not stated in 6.3.46 shall undergo leak test by the working pressure.

6.4 MOORING TRIALS

General requirements

6.4.1 The purpose of the mooring trials is to check the quality of installation and the adjustment of the items stated in 6.1.1, compliance of their parameters and characteristics with the specification and to state if the ship is ready for running trials.

6.4.2 Prior to start the mooring trials, all operations related to installation, running-in and adjustment of ship machinery, equipment and systems shall be completed and accepted by the manufacturer's QC service (organization responsible for conversion, modernization and repair). Items are subject to the mooring trials after preparation to their direct application together with systems and devices serving these items or containing them.

6.4.3 The mooring trials of the items in operation as intended shall be carried out only on the standard equipment in modes and scopes specified by the test program methodology approved by the River Register.

6.4.4 Prior to start the mooring trials, the Surveyor shall verify that all operations related to installation, running-in and adjustment of ship machinery and systems components are completed.

For general provisions on technical supervision during mooring trials see 4.2.

6.4.5 In the course of the mooring trials the Surveyor performs the technical supervision on functional check of manual, remote and automatic control, locking devices, alarm system, protection, means of communication between the wheelhouse, the engine room and control stations.

6.4.6 In the course of technical supervision during the mooring trials, the recording of all
6.4.7 If operation of components of ship machinery was forcibly interrupted during the functional checking, continuation of the mode, increase of its duration or recurrence shall be approved by the Surveyor considering the causes which led to the interruption.

**Internal combustion engines**

6.4.8 In the course of technical supervision during the engine trial, the following shall be checked:

1. operational readiness of units and systems serving engines;
2. engine starting and reversing characteristics as per Rules, adequacy of air receivers or battery capacity;
3. automatic control systems of rotation frequency and operation of limit switches;
4. engine parameters as per technical documentation.

6.4.9 Load modes and duration of mooring trials of main and auxiliary engines shall correspond to the Table 6.4.9. Duration of mooring trials of prototype ships engine at 100% mode increases twice compared to that established in the Table 6.4.9.

<table>
<thead>
<tr>
<th>Engine operated on</th>
<th>Trials duration (h), at engine output (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>propeller, characteristic, load characteristic, output</td>
<td>up to 750</td>
</tr>
<tr>
<td>% of the rated value</td>
<td></td>
</tr>
<tr>
<td>—</td>
<td>Idle run</td>
</tr>
<tr>
<td>39</td>
<td>25</td>
</tr>
<tr>
<td>63</td>
<td>50</td>
</tr>
<tr>
<td>83</td>
<td>75</td>
</tr>
<tr>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>—</td>
<td>110</td>
</tr>
<tr>
<td>Astern run</td>
<td>—</td>
</tr>
</tbody>
</table>

6.4.10 Parameters shall be measured at steady engine thermal state at least twice at each mode after completion of all transient processes.

**Shafting, gears, disengaging and elastic couplings**

6.4.11 Shafting, gears and couplings shall be tested while operating together with the main engine. In the course of technical supervision the Surveyor shall check:

1. temperature of journal and thrust bearings;
2. absence of hits in stern gear, gears and couplings, bearings;
3. vibration of engines, bearings and foundations;
4. effectiveness of the stern gear seals;
5. water supply to the sterntube.

**Compressors, pumps, fans and separators**

6.4.12 Compressors, pumps, fans and separators shall be tested together with units and systems they make part of.

In the course of technical supervision during these tests the following shall be checked:

1. possibility of control from a local, remote, emergency and secondary stations;
2. adequate operation of automation, alarm and protection means, possibility of controlling of the drive;
3. specified items parameters as per technical documentation;
4. efficiency of safety, relief, disengaging and breaking devices;
5. tightness of connections and pipelines;
6. forces on the handles of manual drives.

**Systems**

6.4.13 In the course of technical supervision during the testing of compressed air system and its serving compressors, the Surveyor shall check the following:

1. actuation of safety, reducing and starting quick closing valves and readings of press-gauges;
2. duration of air receivers filling by the compressed air to required working pressure;
3. timeliness of automatic activation and deactivation of compressors, duration of their automatic purging during starting;
6.4.14 During the testing of the fuel system the following shall be checked:

1. operation stability of fuel priming pumps in the specified mode and remote disconnection possibility;
2. duration of daily service tanks filling;
3. alarm actuation of the minimum permissible fuel level in the tank;
4. technical condition and working efficiency of the electric equipment;
5. adequate operation of devices for remote closing of valves of daily service tanks and main tanks, as well as overflow pipes;
6. stable engine operation at their transferring from heavy fuel to diesel and back;
7. adequate operation of the heavy fuel preparation system (separators, filters, heaters, automatic maintaining of preset fuel temperature).

6.4.15 In the course of technical supervision during the testing of oil system, the Surveyor shall check in operation the system of remote control from the wheelhouse of engine oil circulation, thermostats and oil transfer pumps, system of main engines oil circulation with the hand pump and the mechanically-driven pump (from the local control station or from the central control station).

6.4.16 During the testing of the cooling system the following shall be checked:

1. water temperature at the inlet and outlet of coolers and engines;
2. water supply for cooling compressors of exhaust gas pipe and stern unit;
3. adequate operation of the device for automatic control of the cooling water temperature;
4. possibility to switch the inner cooling circuit over to overboard water or standby;
5. alarm actuation of the minimum water flow in the inner cooling cycle expansion tank.

6.4.17 During the testing of the ship system in operation the following shall be checked:

1. capability of being operated as prescribed by technical documents;
2. proper operation of fittings, their drives, safety and relief valves;
3. tightness of connections;
4. accuracy of readings of standard instruments and automation equipment;
5. absence of abnormal vibrations, heating, noise;
6. meeting special requirements due to system purpose and covered by the Rules.

Boilers, heat exchangers and pressure vessels

6.4.18 During mooring trials steam boilers, heat exchangers and pressure vessels shall be checked as per program approved by the River Register.

6.4.19 Readiness of the steam boiler for mooring trial shall be confirmed by the document of the shipyard's QC service.

6.4.20 During mooring trials of the steam boiler the following shall be checked:

1. operation of the fuel system, including oil-fuel priming pump, filters, fittings, fuel heaters, filling of daily fuel service tank;
2. operation of nozzles and quality of burning (visually);
3. operation of the feed and condensate system: feeding pump, filters, fittings, quality of condensate in the hot well and observation tanks, and water treating quality;
4. operation of fans, gate valves, air channel density;
5. tightness of the boiler and boiler flues casing;
6. operation of automation equipment;
7. operation of electrical equipment;
8. amplitude and vibration frequency of the boiler and its components.

6.4.21 The boiler is to be tested in all modes provided in the operating manual and test program. Tests of self-contained boilers during mooring trials are final.
6.4.22 Results of tests in steam of the boiler and steam piping shall be recorded in the report of initial survey of the ship.

6.4.23 Visual inspection of boilers with fittings, equipment, pumps, filters, heat exchangers, pipings and other system components shall be carried out in steam under working pressure.

6.4.24 During visual inspection of the boiler, the following shall be checked:

1. water level in the boiler by purging sight glass channels with steam and water, and purging of control cocks;
2. proper appliance of mark on the cock plug of the boiler pressure gauge;
3. serviceability of water level indicators;
4. seal or stamp (indicating the calibration period) on the pressure gauges and red line on the pressure gauge scale;
5. serviceability of remote drives of steam pipeline shut-off valves, fuel and lock valves;
6. actuation of blow-down and scum valves of the boiler;
7. safety valves adjustment, herewith, firstly on the boiler with superheater shall be activated the superheater safety valve and when pressure continue to rise – saturated steam safety valves installed on the boiler. The adjustment of safety valves shall be checked under manual boiler control;
8. serviceability of manual drives of safety valves actuation from the boiler room and outside;
9. serviceability of feeding devices (pumps, pipelines and fittings);
10. proper operation of boiler’s automation equipment, emergency alarm and protection;
11. constancy of boiler performance while switching from automatic control to manual and back;
12. absence of leakage, steaming and buckling in the flame sections accessible for examination, condition of furnace brickwork, serviceability of furnace door locking devices;
13. overall condition of fuel storage and their air pipes, pipelines, fuel pumps, nozzles;
14. quality of boiler and steam pipes insulation.

When the results of safety valves adjustment are satisfactory, one of valves installed directly on the boiler shall be stamped by a representative of the shipyard’s QC service.

6.4.25 Heat exchangers in operation shall be checked together with serviced systems, piping and devices to check the quality of their installation and operational reliability. The following shall be checked:

1. operation on specified parameters of the working medium;
2. serviceability of fittings, instruments and control devices;
3. adjustment of safety and alarm and protection devices;
4. fastening and design of arrangements compensating thermal expansion.

6.4.26 To check the quality of installation of the pressure vessels and their applicability as intended, they shall be tested as a part of ship systems under working pressure. The following shall be checked

1. serviceability of fittings, instruments and control devices
2. adjustment of safety devices, sealing of safety valves;
3. functioning of arrangements for moisture removal from the vessel;
4. seal or stamp on the pressure gauges (indicating the calibration period) and red line on the pressure gauge scale indicating permissible pressure.

Refrigerating plants

6.4.27 Testings of refrigerating plant in operation purposes to verify its operational efficiency on board, as well as plant reliability and safety.

6.4.28 The refrigerating plant in operation shall be tested in the presence of the Surveyor as per program approved by the River Register. All items of the refrigerating plant shall be checked both in automatic and emergency manual operation.
6.4.29 In the course of technical supervision during refrigerating plant testing the following shall be checked:

1. proper operation of the main and standby refrigerating equipment (compressors, separators, apparatuses, systems, heating controllers, instruments, shut-off and control valves, warning alarm and protection systems, remote control), and serviceability of electrical and automation equipment, systems servicing the refrigerating plant room and refrigerated spaces

2. possibility to achieve the lowest specified temperature in the cooled spaces and time required for that

3. possibility to maintain the specified temperature in the cooled spaces for 24 h connecting at regular intervals standby equipment under condition of its continuous operation for 10 to 12 h. In this case the refrigerating capacity of lead ships shall be determined as well

4. insulation efficiency by mean heat transfer coefficient and dynamic of air temperature change when the refrigerating plant (of lead ships) is not in operation during 24 h

6.4.30 In the case of refrigerating plant testing at a boiling and condensing temperature of the refrigerant different from designed ones by more than 1 °C (boiling temperature) or than 2 °C (condensing temperature), the refrigerating capacity shall be re-evaluated for design conditions.

6.4.31 The refrigerating capacity and mean heat transfer coefficient are considered to be confirmed if their difference from the designed values do not exceed 5 %.

6.4.32 The processed results of the refrigerating plant tests shall be submitted to the Surveyor for drawing up the River Register documents.

The conclusion about compliance of the plant characteristics and its equipment with specification shall be attached to the test report documentation for the plant in operation.

6.5 RUNNING TRIALS

6.5.1 Running trials are intended for complete functional check of the power plant and systems in operating conditions.

6.5.2 Running trials shall be performed after eliminating defects detected during mooring trials as per the program approved by the River Register. The running trials program provides for checking all the parameters prescribed by the vessel’s specification and technical documentation for ship machinery or similar technical documentation.

6.5.3 Load modes and operation period of the main engines in these modes during running trials shall comply with those in Table 6.5.3. Running trials duration for engines of the lead ships at 100 % mode increases twice compared to that established in the Table 6.5.3.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Rotation speed</th>
<th>% of the rated value for engine operating as per characteristic</th>
<th>Test duration (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minimum steady rotation speed mode</td>
<td>not standardized</td>
<td>0.25</td>
</tr>
<tr>
<td>2</td>
<td>Modes of operation under load</td>
<td>63</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>80</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>91</td>
<td>75</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>103</td>
<td>110</td>
</tr>
<tr>
<td>7</td>
<td>Mode corresponding to the astern running rating</td>
<td>not standardized</td>
<td>0.50</td>
</tr>
</tbody>
</table>

During running trials, diesel generators shall be checked in operation as intended.

6.5.4 Boilers, heat exchangers, compressors, pumps, fans, separators, pressure vessels, refrigerating plants, general systems and systems of the ship’s power plant shall be checked in operation during running trials as intended.

6.5.5 After running trials, steam boilers shall be submitted for internal survey.
The Surveyor shall be submitted the measurement results of flame tubes performed by the shipyard’s QC service after mooring and running trials, to compare them with the measurement results obtained when manufacturing the boiler in the shop, or specified in the technical documentation.

6.5.6 Deck machinery shall be tested together with their devices in modes provided by the test program approved by the River Register.

6.5.7 In cases provided by the Rules, during running trials they measure torsional vibration parameters of the shafting as per the separate program approved by the River Register.

Measurements shall be performed in propeller characteristic modes from minimum stable to maximum rotation frequency.

If a prohibited zone of rotation frequencies was found, numerical values of its boundaries shall be fixed in the ship datasheet, and prohibited zones on tachometer scales shall be marked according to 6.4.3 Part IV of RCSS. Availability of prohibited zones shall be fixed in the Certificate (PP-1.0 form) issued on board the ship.

6.5.8 In case of failure of boilers, heat exchangers and pressure vessels during technical supervision of their functional check during mooring trials, after remedying them, they perform technical supervision of boilers as per 6.4.18 to 6.4.25, heat exchangers and pressure vessels – as per 6.4.26 to 6.4.28. During running trials, waste heat boilers shall be tested as per 6.4.21 to 6.4.24.

6.5.9 In case of failure of refrigerating plants during technical supervision of their functional check during mooring trials, after remedying them, they perform technical supervision of refrigerating plants as per 6.3.44 to 6.3.49 during running trials. When testing, all the circuits of refrigerating plants shall be used. Refrigerating plant elements shall be checked both in automatic and emergency (manual) mode.
7 SHIP ARRANGEMENTS AND OUTFIT

7.1 GENERAL REQUIREMENTS

7.1.1 This section contains the requirements for the technical supervision during manufacture of ship arrangements, equipment and outfit and during installation and testing of the above items onboard according to the Nomenclature.

7.1.2 Materials to be used for manufacture of items shall comply with the requirements of Part V and Part X of RCCS.

7.1.3 The technical supervision during manufacture and testing of steering engines, steerable thrusters, transverse thrusters and deck machinery (windlasses, capstans, and anchor, mooring, towing and boat winches) shall consider the applicable requirements set out in 6 of these Rules.

7.1.4 When conducting the technical supervision during manufacture of deck machinery, cargo handling gears and their assemblies, follow 6 of these Rules.

7.2 TECHNICAL SUPERVISION DURING MANUFACTURE

General requirements

7.2.1 The technical supervision during manufacture of arrangements, equipment and outfit includes the following:

.1 verification of technical documents;
.2 check of materials;
.3 visual inspection of items;
.4 validation of measurements;
.5 check of nondestructive testing;
.6 tests.

Rudder and steering gear

7.2.2 When parts of rudder and steering gear, transverse thrusters and steerable thrusters are visually inspected, the following shall be checked in addition to the list in 7.2.1:

.1 assemblage of rudder (nozzle), quality of key slots;
.2 protection of internal cavities of items from corrosion or their fill-up;
.3 quality of machining of holes for tight fit bolts;
.4 installation of plugs and drain plugs on hollow structures of rudders and steerable nozzles after filling them up with inert mass.

Anchor arrangement

7.2.3 When anchors are inspected, the following shall be checked in addition to the list in 7.2.1:

.1 documents on drop tests;
.2 quality of welding of welded anchors;
.3 curvature of anchor shank;
.4 weight of anchor.

7.2.4 The technical supervision during manufacture of anchor chains and their component parts includes the following:

.1 check of documents on materials to be used;
.2 check of documents on accessories (for chains);
.3 visual inspection for compliance of dimensions (for chains);
.4 review of test results;
.5 check of marking;
.6 branding.
Coupling arrangement

7.2.5 For type approval, standard samples of coupling equipment shall be bench-tested by test load with strain-gauging of critical parts as per the program agreed upon with the River Register.

Values of test load and permissible stresses in the coupling equipment parts are specified in Part V of RCCS.

7.2.6 When conducting the technical supervision during manufacture of series-produced coupling equipment, check the following:
   .1 compliance of workmanship of main parts and coupling equipment as a whole with technical documentation for manufacture;
   .2 kinematics and interaction of all parts, opening of lock under design load and strength of lock under bench test with test load (without strain-gauging).

Load-handling device

7.2.7 When conducting the technical supervision during manufacture of cargo handling gears to be installed on ships to be classified by the River Register, check the following:
   .1 quality of parent and welding materials used to manufacture metal structures and compliance of the same with technical documentation agreed upon with the River Register;
   .2 availability of necessary documents for component parts as per the Nomenclature;
   .3 workmanship of parts and assemblies and quality of assemblage of cargo handling gear according to the List;
   .4 correctness of bench testing of assembled removable parts of cargo handling gear as per 7.2.9 to 7.2.11 as per the program agreed upon with the River Register.

7.2.8 Tested cargo handling gears shall be branded according to 6.17 Part V of RCCS.

7.2.9 All newly manufactured removable parts of cargo handling gears (blocks, hooks, chains, turnbuckles, rope sockets, etc.) shall be tested with test load under supervision of person competent for conducting this type of tests. This test shall be performed on the properly calibrated machine or by suspending a load of specified weight to parts under test according to Table 7.2.9.

The proof load shall be applied statically. The time of keeping the upper structure under the load is at least 5 min.

<table>
<thead>
<tr>
<th>Removable parts</th>
<th>Load weight $m_{SWL}$ (t) corresponding to permissible load SWL</th>
<th>Test load weight $m_{test}$ (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chains, shanks, shackles, hooks, etc. Single-sheave blocks without hoist cable bitter end attached to them Single-sheave blocks with hoist cable bitter end attached to them Multi-sheave blocks</td>
<td>$m_{SWL} \leq 25$ $m_{SWL} &gt; 25$ $m_{SWL}$</td>
<td>$2m_{SWL}$ $1.22m_{SWL}$ $4m_{SWL}$ $6m_{SWL}$</td>
</tr>
<tr>
<td>$m_{SWL} \leq n25$ $25 &lt; m_{SWL} \leq 160$ $m_{SWL} &gt; 160$</td>
<td>$2m_{SWL}$ $0.93m_{SWL} + 27$ $1.1m_{SWL}$</td>
<td></td>
</tr>
</tbody>
</table>

On completion of test, all parts shall be visually inspected for absence of defects or residual deformations. Blocks shall be disassembled for visual inspection of axes and sheaves.

All removable parts shall be submitted for visual inspection and tests with corrosion-resistant coat applied (except for paint coat).

Tested parts shall be branded according to the Nomenclature.

7.2.10 If removable parts of cargo handling gear are jointed in an assembly, test shall be applied to this assembly.

When this takes place, removable parts shall not be tested individually.

7.2.11 Standard samples of removable parts shall be tested with limit load equal to double test load within time specified by the manufacturer in the testing program.

Removable parts of cranes with lifting capacity of 100 t are not tested with limit load if
calculations and results of testing with test load have confirmed their strength.

Quantity of parts from a batch subject to this test shall be determined upon agreement with the River Register.

Sleeves and compression clamps for terminating wire ropes and thimbles shall be tested together with terminated rope.

A part is considered to have passed the test if it is not broken under limit load.

Parts tested with limit load shall not be repaired and used for the purpose specified.

Tests with limit load shall be witnessed by the surveyor. Test results shall be recorded in the report (see 2.3.12).

Hydrofoil system

7.2.12 When conducting technical supervision during manufacture of hydrofoil system, check the following in addition to the list in 7.2.1:

1. assemblage of hydrofoil system;
2. protection of internal cavities of items from corrosion or their fill-up;
3. fitting of plugs and drain plugs on hollow structures of hydrofoil system.

Deck machinery

7.2.13 When conducting the technical supervision during manufacture of deck machinery parts operated under excessive pressure, check results of hydraulic tests performed after final machining before application of protective coats. Hydraulic test pressure $p_{\text{test}}$ (MPa) for such tests shall be determined in accordance with the requirements of 6.2.28 imposed to test pressure for hydraulic tests of parts of compressors, pumps and fans operated under overpressure.

7.2.14 Parts and assemblies of deck machinery (bodies of reduction gears, trays, etc.) to be filled with petroleum products or their vapours under hydrostatic or atmospheric pressure shall be subject to tightness testing with dye penetrant method. In welded structures it is sufficient to test only tightness of welds.

7.2.15 After assembled, adjusted and run in and before installed onboard, deck machinery shall be bench-tested under load according to the program agreed upon with the River Register (according to Part V of RCCS).

Bench tests may be replaced with onboard tests.

Hydraulic drives

7.2.16 The elements of hydraulic drives being under load shall be strength-checked for the application of forces corresponding to the working pressure, here, the equivalent stresses in the elements shall not exceed 0.4 of the yield point of the element.

Life-saving appliances

7.2.17 The technical supervision during manufacture lifeboats, liferafts, life-saving apparatuses, lifebuoys and lifejackets shall be conducted in accordance with the requirements of 7.2.1.

Standard samples of life-saving appliances shall be tested according to the testing program agreed upon with the River Register and guidelines stated in Appendix 13.

Signal means

7.2.18 Standard samples of pyrotechnic signal means shall be tested according to the testing program agreed upon with the River Register and guidelines stated in Appendix 14.

7.2.19 When conducting the technical supervision for navigation lights, check the following in addition to the list in 7.2.1:

1. interchangeability of parts;
2. degree of protection (see Appendix 15);
3. insulation breakdown strength (see Appendix 15);
4. insulation resistance (see Appendix 15).

7.2.20 Bench tests of standard samples of lights, except for those mentioned in 7.2.18, shall be performed as per the agreed testing program developed according to Appendix 15 and shall include the following:

1. functional tests;
.2 vibration survival, vibration resistance and on impact tests;
.3 operation check at high and low ambient temperatures;
.4 check for corrosion resistance;
.5 check for heat resistance;
.6 check for moisture resistance;
.7 operation check under roll and pitch;
.8 check of degree of protection from contact with current carrying parts;
.9 lighting tests.

Ropes

7.2.21 The technical supervision during manufacture of wire, synthetic and natural fiber ropes consists in:
.1 check of materials to be used for manufacture of products as per accompanying documentation;
.2 review of results of tests performed as per the agreed testing program;
.3 visual inspection and measurement.

7.3 TECHNICAL SUPERVISION DURING ONBOARD INSTALLATION AND TESTS

Rudder and steering gear

7.3.1 On completion of installation of rudder and steering gear and thrusters, the surveyor shall check the following:
.1 certificates for chains and ropes, reports on hydraulic test of hydraulic system;
.2 reliable installation and fastening of main steering drive on ship’s foundation;
.3 correct application of gauge-marks of rudder (nozzle) midposition, correct graduation of rudder (nozzle) position indicator at quadrant;
.4 drive alignment;
.5 quality of installation of rudder stock bearings;
.6 correct fit of steering drive support surfaces to gaskets, gaskets to foundation support parts and heads of foundation bolts and nuts to drive surfaces and foundation flanges;
.7 tightness of joints of hydraulic system pipelines of rudder and steering gear and thrusters;
.8 ease of turn of rudder blade or steerable nozzle with drive disconnected;
.9 mounting connections of rudder stock with rudder blade or steerable nozzle, availability of River Register brand on rudder stock if provided for by the Nomenclature;
.10 installation of side stops of steering drive;
.11 sealing gland of rudder stock and impermeability of seal of tapered joints;
.12 installation and fastening of stand-by steering drive;
.13 clearances in hinges and bearings;
.14 clearances that regulate rudder or nozzle movement in axial direction (upwards) depending on steering drive design;
.15 availability of locking devices that eliminate loosening of moving parts of gear;
.16 rudder or steerable nozzle angles to contact with turn limiter on hull and size of contact surface area;
.17 compliance of indications of rudder indicators with position of rudders or nozzles.

7.3.2 During harbour acceptance trials of rudder and steering gear, the following shall be checked:
.1 operability of gear with drive from power source by continuous rudder or nozzle deflection from hard over to hard over during 30 minutes;
.2 possibility of gear operation from emergency power source during 15 minutes;
.3 time of rudder or nozzle deflection from hard over to hard over and from mid-position to port and starboard separately with power supplied from main and emergency power sources. When main engine is used as a drive for hydraulic pump of steering gear, time of rudder deflection shall be measured in slow and full speed modes;
.4 reliability of switching from main drive to standby one and back at least three times and at different positions of rudder or nozzle;
.5 operability of gear with stand-by drive by deflecting rudder or nozzle from hard over to hard over, time of turn from 20° at a side to 20° at another side and number of people required for this operation;
operability of steering engine limiters and quadrant turn angle;
7 operability of communication means of control positions and rudder indicators;
8 temperature of steering engine bearings, reduction gears and other parts;
9 rudder or nozzle deflection by means of tiller (steering tackles).

7.3.3 When conducting the technical supervision during harbour acceptance trials of transverse thruster, check the following:
1 operation of thruster during 30 minutes;
2 thrust of thruster by method of direct measurements in alternate operation to starboard and port side (on lead ships);
3 correct operation of signalling system in wheelhouse.

7.3.4 Running trials of rudder and steering gear of lead ships shall be performed simultaneously with check of maneuvering capabilities of loaded and light ship at design draughts and of tug boats and pushboats without convoys and with convoys.

7.3.5 During running trials of rudder and steering gear of ships mentioned in 7.3.4, the following shall be checked:
1 no-failure rudder (nozzle) deflection from hard over to hard over and from any arbitrary position to a side or along centreline at full, mean and slow speeds ahead and astern;
2 no-failure operation of gear in ship seaworthiness test modes;
3 time of rudder or nozzle deflection from hard over to hard over and from centreline to each side at full and slow speed ahead (for electric power drive with power supply from main and emergency power sources);
4 operability of test lamps, limit switches and overload alarm;
5 indications of rudder indicators and their compliance with rudder blade or nozzle positions;
6 force applied to hand drive wheel;
7 force applied to water-jet propeller reversing handle;
8 reliability and ease of changeover from main drive to standby one and back at different ship speeds and different deflection angles of rudders or nozzles.

7.3.6 Rudder and steering gear on series-produced ships shall be tested in accordance with 7.3.5.1 and 7.3.5.3 to 7.3.5.5.

Anchor arrangement

7.3.7 On completion of installation of anchor arrangement, the surveyor shall check the following:
1 installation and fastening of windlass or anchor capstans on ship foundation;
2 installation and fastening of anchor arrangement stoppers on ship foundation;
3 mounting of anchor chains — i.e. assembly of coupling links;
4 equipment of chain lockers;
5 installation of devices for fastening and unfastening of bitter ends of anchor chains;
6 assembled anchor chains and anchors for compliance with drawings, including availability of brands and compliance of assemblies and parts as per certificates;
7 sizes of welds of foundations for elements of anchor arrangements;
8 absence of angular misalignments of anchor chain in plan view;
9 installation of remote control system equipment.

7.3.8 During harbour acceptance trials, anchor arrangement shall be checked in operation by alternately hauling out several shots of each chain and hauling them in by means of electric power drive and hand drive.
The following shall be checked during trials:
1 correctness of running of chain links on sprocket wheels, through stoppers and anchor hawses;
2 operability of stoppers and belt brakes of windlass, capstan or anchor winch (two or three break operations while chain or rope is hauled out);
3 free run-out and run-in of chain and anchor from/to hawsehole and contact of anchor flukes with ship side;
reliability and rapidity of anchor release when sprocket wheels are disengaged from windlass shaft;

tightness of closed hawse and chain pipes;

no-failure operation of remote anchor release device;

compliance of anchor chain hauling speed with mechanism ratings;

self-stowage of all hauled anchor chain in chain locker.

During running trials on lead ships and convoys, anchor arrangement capability of providing safe anchorage and safe operation in navigation areas specified in the preliminary specifications.

The following shall be checked:

sufficiency of holding power of anchors to hold a single ship or a pushboat with convoy on current;

operability of anchor arrangement when hoisting anchors from design anchorage depths.

Operation of anchor arrangements on series-produced ships shall be checked at maximum depths of test area, as well as on river under current conditions.

When bow anchor arrangement is tested, the following shall be checked:

operability of belt brakes with dead drive by breaking an anchor chain or an anchor cable being hauled out;

operability of deck stoppers;

capability of hauling in each anchor by means of windlass with lifting it off the ground and hoisting speed;

capability of releasing both anchors by means of windlass with drive operating in all design operating modes;

capability of simultaneous hoisting of two hanging anchors and hoisting speed;

no-failure operation of remote anchor release device from wheelhouse;

operability of hand drive of windlass or anchor winch;

correct run of anchor chain links on windlass sprockets, through stoppers and hawses during all types of tests and correct run of anchor cable through cable layer.

When stern anchor arrangement is tested, the following shall be checked:

reliability of anchor release with anchor; arrangement drive disabled by brake;

capability of anchor release, lift-off from ground and hauling in by means of anchor handling gear and hauling speed;

operability of deck stoppers.

Towing and coupling arrangements

On completion of installation of towing arrangement, the surveyor shall check the following:

installation and fastening of towing winches on foundation;

compliance of type, diameter or circumference and length of towing rope with drawing or list;

adjustment of mechanical lock of towing hook;

correct installation of towing rope limiters;

operability of remote towing rope release device at all possible angles of deviation from centreline;

arrangement and design of guide rollers and blocks, no slipping off of rope or friction of rope against hull structures.

During harbour acceptance trials of towing arrangement, the following shall be checked:

movability of towing hook with rope attached to it;

capability of free release of towing rope from hook;

correct operation of remote rope release device from wheelhouse;

correct operation of towing winch during rope hauling in/out;

operability of towing winch mechanisms and brakes.

During harbour acceptance trials of lead tugboats and pushboats with convoy, the following shall be checked:
.1 operability of towing winch;
.2 no-failure operation of brakes and cable layers;
.3 capability of free movement of rope on towing arches and efficiency of rope stopping on limiters.

7.3.16 On completion of installation of coupling arrangement, the surveyor shall check the following:
.1 availability of coupling equipment;
.2 safe attachment of coupling equipment to foundation;
.3 availability of ship hull reinforcement at coupling equipment location.

7.3.17 During harbour acceptance trials of coupling arrangement, the following shall be checked:
.1 correct operation of luffing mechanism;
.2 correct operation of claws and locking hooks;
.3 operability of head cams by turning them with a winch and returning them with springs;
.4 correct operation of pressure shanks for two-locked couplings;
.5 correct operation of winch when lock is lifted and lowered throughout height of stop;
.6 correct operation of lock holder and release;
.7 correct operation of lock key and rope coupling sea-securing device;
.8 tensioning of ropes with tensioning station;
.9 operability of rope shortening device.

On completion of operability check of mechanisms, test convoys shall be checked during running trials by direct measurement of stresses or forces that occur in coupling and uncoupling shall be performed, and operation of devices preventing spontaneous unlocking shall be checked. Unlocking shall be performed from local and remote control posts.

Test coupling and uncoupling of coupling arrangement of pushboats and bow locks of nonself-propelled ships may be performed on benches that simulate aft end of barge.

Strength characteristics of coupling arrangement on lead ships and arrangement.

7.3.18 On completion of installation of mooring arrangement, the following shall be checked:
.1 installation and fastening of mooring capstans or winches and other equipment of mooring arrangement on foundations;
.2 positional relationship and height of installation of mooring arrangement components and availability of free areas and approaches to them;
.3 compliance of type, circumference and length of mooring ropes with drawing instructions (list of supply);
.4 quality of mounting of hydraulic system pipelines and pumps.

7.3.19 On completion of installation and testing of cargo handling gear, preliminary tests of all units idling shall be performed. If results of preliminary tests are satisfactory, cargo handling gear with appropriate documentation shall be submitted to the surveyor for final trials.

7.3.20 Before onboard testing of cargo handling gear, the surveyor shall check the following documents:
.1 notification on acceptance and readiness of gear for testing;
.2 data sheet or certificate (for cranes);
.3 testing program;
.4 certificates for chains, ropes, removable parts of cargo handling gear, materials of critical parts of machines, metal parts of cranes, spars and welding materials;
.5 reports of quality test of welded joints and information on certification of welders who performed critical welding;
.6 data sheets for mechanisms and units;
.7 specification for cargo handling gear;
.8 drawings and diagrams.

7.3.21 Before tests begin, the surveyor shall visually inspect the cargo handling gear to check the following:
.1 safe fastening of units to foundations and foundations to deck;
.2 correct assemblage of cargo handling gear;
.3 convenience of location of control posts;
.4 safe stowage of rope on drum;
.5 availability of safety devices, safety guards and fences.

7.3.22 Cargo handling gear installed onboard shall undergo static and dynamic tests with test load.

Dynamometer shall not be used instead of test load.

Luffing cranes shall lift a test load with maximum and minimum overhangs. If luffing cranes have variable outreach-dependent lifting capacity, they shall lift a test load at maximum and minimum overhangs for each fixed lifting capacity.

Lifting capacity limiter shall be off for testing with test load.

7.3.23 For static test of crane, a test load weighing 125% of nominal capacity shall be used. Here, crane beam shall be in a position corresponding to least crane stability, and load shall be lifted to height of 100 to 200 mm. Test load shall be retained by crane in fixed position for at least 10 minutes.

For dynamic test of crane, a test load weighing 110% of nominal capacity shall be used. All motions shall be performed at full speed.

Luffing during tests shall be carried in all range of possible outreach values between two permissible extreme positions of beam.

Reliable operation of brakes of cargo winches of beams and cranes shall be checked by quickly lowering a test load by about 3 m and abruptly braking it. This test shall be performed in at least two positions of beam.

Test load hanging with dead winch drive shall be checked too.

7.3.24 After tested with test load, crane shall be tested with a load equal to lifting capacity with hoisting, turning, luffing and travelling mechanisms operating at maximum speed. When this takes place, abrupt braking shall be applied to test operation of brakes of hoisting, turning, luffing and travelling mechanisms.

Operation of limit switches and outreach indicators shall also be checked.

If crane is capable of making different simultaneous motions (hoisting, luffing, turning and travelling), all permissible combinations of motions shall be checked.

Lifting capacity limiters shall be checked in operation by lifting a load corresponding to limiter setting.

7.3.25 While crane is tested, condition of steel structures, beams, mechanisms, critical parts and fastenings shall be monitored.

Special attention shall be paid to crane stability, uniform contact bottom parts of all supports with base and fastening and operation of counterbalance weight and braking device.

Ensure that at least 1.5 rope coils remains on winch drum at lowermost working position of load-handling device.

7.3.26 When testing travelling cranes, ensure that travelling roller do not separate from rails.

7.3.27 After tests, all metal structures, units and parts of cargo handling gear shall be visually inspected by the surveyor to detect possible defects.

If defects are detected, their causes shall be eliminated, defects shall be remedied by methods agreed upon with the River Register, and retests shall be performed.

7.3.28 If results of cargo handling gear tests are positive, the River Register documents shall be drawn up.

Boat handling gear and life-saving appliances

7.3.29 After installed onboard, each boat handling gear shall be tested with a boat being lowered and lifted. The load shall be in accordance with Part V of RCCS.

7.3.30 Before boat handling gear tests with test load begin, assembled launching arrangements shall be inspected. The surveyor shall check the following:
.1 quality of mounting and complete set of launching arrangements;
.2 availability of brands and markings of items, assemblies and parts and their compliance with submitted certificates;
.3 tightening of fastening screws, close fit of bed frame feet to foundations, quality of welds of foundations and reinforcements under foundations;
.4 reliable attachment of ends of boat falls on winch drums and of bitter ends of boat falls;
.5 boat davit outreach;
.6 possibility of observing the boat being lifted and lowered from winch control post;
.7 correct operation of hand drive of boat davit winches and screw drive of collapsible boat davits.

7.3.31 When boat handling gear is tested, the following shall be checked:
.1 reliable operation of winch hand brake with boat being lowered. Braking shall be smooth, but effective;
.2 smooth motion of travelling rollers along guides of rolling-down boats;
.3 run of falls on sheaves and guide rollers and in places closed by housings;
.4 boat lowering speed;
.5 uniform coiling of rope on winch drum;
.6 necessary length of falls for lowering a boat at each side to level of lowest ballasted ship waterline at 15° heel to any side;
.7 rope capacity of winch drum (sufficient elevation of winch drum shoulder at end faces over top row of completely stowed rope);
.8 boat lowering time.

7.3.32 Swinging arms of boat davits shall be tested by swinging out and swinging in arms and boat davits and lowering and lifting a boat with cargo equal to weight of complete set of outfit and launching team several times (not less than three times). The following shall be checked:
.1 smooth movement of arms of boat davits;
.2 smooth movement of travelling rollers on guides of roll-down boat davits;
.3 force applied to hand drive handle;
.4 automatic cut-off (blocking) of power supply of electric drive when hand drive is activated (hand drive handle is attached);
.5 availability and adjustment of limit switches.

7.3.33 Mechanically driven life-boats and motor boats shall be tested underway to check drive and (or) motor in operation. If radio equipment, navigation equipment, floodlights, sprinkling system and compressed air system (on tanker boats) are available, they shall be tested for intended use.

7.3.34 When liferafts are installed, compliance of type, quantity, holding capacity, location, brands and markings of liferafts with requirements of agreed technical documentation and availability of River Register certificates shall be checked.

7.3.35 The surveyor shall check compliance of quantity, location and fastening of life-saving devices on vessel with requirements of technical documentation agreed upon with the River Register, availability of River Register certificates and manufacturer documents, as well as operability and completeness of life-saving devices.

7.3.36 Lifejackets shall be visually inspected and checked for compliance with manufacturer documents and River Register certificates.

7.3.37 Outfit items of life-boats shall be checked for compliance with documentation agreed upon with the River Register and with requirements of Part V of RCCS. Outfit items of life-boats shall also be checked for completeness and proper location inside boat and availability of manufacturer documents.

7.3.38 During the technical supervision for signal means of ships under construction, the following checks shall be performed:
.1 compliances of signal means with documentation agreed upon with the River Register;
.2 installation of signal means on ships.
7.3.39 Check of compliance of signal means with agreed technical documentation shall include check of data sheets and certificates, check of signal means and comparison of accompanying documents with markings and brands applied to signal means.

7.3.40 Check of installation of signal means on ships shall include visual inspection and check measurements (checks) to ascertain the following:

1. Correct location of stationary signal means in vertical and horizontal planes and with reference to ship centreline;
2. Correct installation and fastening of signal means;
3. Ease of dismounting of signal means and replacement of replaceable parts;
4. Correct wiring of electric cables and protective earthing of signal means;
5. Effective protection against radio interference created by electrical signal means;
6. Quality of mounting of compressed air, vapour or other agent piping for actuating acoustical signal means;
7. Operability of structures and safety of devices and appliances for actuating pyrotechnic signal means and their storage locations.

7.3.41 When conducting the technical supervision for fire protection, navigation and emergency outfit and pyrotechnic and acoustical signal means, check the following:

1. Availability of documents on outfit items and their validity;
2. Complete set of outfit according to the design and Rules;
3. Location and fastening of outfit items on ship according to the design.

7.3.42 In addition to requirements of 7.3.41.1, installation of onboard fire extinguishers and availability of certificate of compliance of fire extinguishers with fire safety regulations (Federal law No. 123-ФЗ dated 02.07.2008).
8 ELECTRIC EQUIPMENT

8.1 GENERAL REQUIREMENTS

8.1.1 This section covers requirements to technical supervision during manufacture, onboard installation and testing of electric equipment stated in the Nomenclature.

8.1.2 Technical supervision of electric equipment by the River Register provides:

.1 approval of technical documentation, test program for electric equipment;
.2 technical supervision during manufacture and tests of electric equipment;
.3 technical supervision during installation and tests of on-board electric equipment.

8.1.3 Technical supervision of electric process and household equipment shall be limited to the following checks:

.1 insulation condition and resistance;
.2 using distribution systems;
.3 for serviceability of points of connection to power sources;
.4 explosion-proofness level of electric equipment during arrangement in explosion-hazardous spaces and areas;
.5 types, brands and cross-sections of the cables used;
.6 earthing.

8.1.4 All types of electric equipment, installation works, valves and material, which become unavailable for check after their fitting and completion of works, shall be submitted to the Surveyor at the stage of works when checks provided by the Rules are possible.

8.2 TECHNICAL SUPERVISION DURING MANUFACTURE

8.2.1 Technical supervision during manufacture of electric equipment includes:

.1 checking for availability of the approved technical documentation and test program;
.2 monitoring of the used materials to meet the requirements of 2.4 Part VI RCCS;
.3 item inspection;
.4 supervision during tests.

8.2.2 During inspection, the following shall be checked:

.1 the documents for materials used during manufacture;
.2 technical condition of components included in the survey item;
.3 installation quality of the item electric circuit;
.4 strength of connection and fastening of assemblies, live parts, welded, soldered, screwed or other structural and contact joints;
.5 presence of corrosion-resistant coatings;
.6 availability of necessary markings and inscriptions;
.8 technical condition of contact and protection terminations of cables and wires;
.9 serviceability of structures providing electric safety.

8.2.3 Type specimens shall be tested as per the approved test program, developed in accordance with Appendix 15. Test types shall be established by Part VI RCCS.
8.2.4 Type specimens of cable items shall be tested on flame retardence as per the procedure given in Appendix 16.

8.2.5 Serial items shall be tested as per 1 to 3 Appendix 15.

8.3 TECHNICAL SUPERVISION DURING ONBOARD INSTALLATION

8.3.1 When surveying foundations and other support structures for fitting electric and electronic equipment, the following shall be checked:

1. quality of the performed works, absence of sharp edges and other defects causing damages of the electric / electronic equipment to be fitted;
2. possible access for maintenance of electric and electronic equipment;
3. compliance of the position of electric / electronic equipment with the requirements of the Rules (fitting on the shell plating of the ship, walls of fuel, oil, water tanks, pressure vessels is not permitted) and the approved technical documentation;
4. remote location of electric/electronic equipment and its energized parts from the hull plating, deck and platform platings;
5. remote location of electric/electronic equipment from combustible materials, heat sources, emissions of gas, steam and water as well as pipelines, tanks, valves and other fittings which may accommodate damages of electrical equipment or cause combustion of nearby materials.

8.3.2 When surveying electrical propulsion systems, the following shall be checked:

1. absence of flange or thread connections of pipelines, valves and other fittings above electric machinery of electric propulsion installation;
2. arrangement of water coolers, their pipelines, availability of valves in water mains, of quick-release valves.

8.3.3 When surveying cable network, the following shall be checked:

1. removal of cable routes from potential places of oil and oil products;
2. proper structure of the cable support devices;
3. sufficient and periodical cable fastenings on support structures;
4. separate laying of cables with various purposes and voltages;
5. compliance of structures and methods of fitting pipes, compensators and methods of fastening cables, channels, conduits, risers, sleeves, bus line carcasses, pull cable boxes, specific sealing structures and other devices for laying cables through bulkheads and decks with the technical documentation requirements;
6. proper cable laying in explosion-hazardous spaces and areas and fire-hazardous spaces;
7. marking, terminations in cable conductors and wires.

8.3.4 When surveying storage batteries, the following shall be checked:

1. compliance of the battery room (locker) and arrangement of storage batteries with the Rules requirements;
2. secure attachment of batteries;
3. absence of trapped zones in the deck-head of battery rooms;
4. availability of autonomous ventilation in the battery room;
5. serviceability of blocking preventing from charging batteries prior to activating ventilation of an accumulator room;
6. explosion protection measures.

8.3.5 Technical supervision during on-board installation of Domestic, household and engineering electric equipment includes the following checks:

1. compliance of the electromagnetic interference level (as per supporting documents) with the requirements of 2.7 Part VI of the Rules. In case of no information presentation on the electromagnetic interference level, no electromagnetic interference influence, caused by the equipment, should be confirmed. The requirement applies to the equipped fitted in spaces for operation with radio communication aids, navigation aids, and to control systems of technical facilities including electronic components;
Electric Equipment

8.3.6 The Surveyor shall verify that after fitting at standard places, all the electric equipment as per the protection degree, completion, quantity, electric protection, cable network, arrangement in spaces and areas of the ship, easy maintenance, controllers and regulators, fencings, fire and explosion safety measures, electric shock protection, protective grounding and other characteristics and parameters complies with its purpose and ensures safe navigation of the ship.

8.3.7 The fitted electric equipment shall be inspected after laying, fixing and connecting all cables to the equipment.

8.3.8 When checking the installation of electric equipment for oil tankers, meeting the requirements of the Rules for the equipment of these ships shall be additionally controlled.

8.4 MOORING TRIALS

8.4.1 During mooring trials, all consumers shall be supplied from standard power sources.

When standard power consumers do not ensure the required load for ship's generators during mooring trials, specific loading appliances shall be used.

8.4.2 Parameters checked during mooring trials of the electrical propulsion system for the built ship, see Appendix 17.

8.4.3 During mooring trials of electrical propulsion system, the following shall be checked:

1. proper operation of the installation for starting and reversing in all reversal variants provided by the design documentation;

2. serviceability of starting aids for diesel generators, backup excitors, fans, coolers and lubricators;

3. possible unit control from local and remote stations;

4. sparking degree under brushes at load and reverses;

5. serviceability of protectors, alarms and blocking;

6. insulation resistance of electric machines, cable network and auxiliary units of electric propulsion system in cold and hot states;

7. proper readings of the propeller shaft revolution frequency indicators in the engine room and in the wheelhouse.

8.4.4 Generators of the ship's electric power plant shall be tested in all modes together with the main switchboard.

The following shall be tested:

1. serviceability of generators as per the test program;

2. stable parallel work at different loads and generator load transfer;

3. serviceability of voltage regulators and distributors of active and reactive loads between generators;

4. adjustment of automatic generator protectors;

5. sparking degree under the generator brushes;

6. insulation resistance;

7. serviceability of automatic synchronizers and load dividers.

8.4.5 During functional test of batteries, the following shall be checked:

1. electrolyte density and filling level in storage batteries;

2. insulation resistance;

3. operation of the charging device and battery in case of discharge;

4. actuation of automatic protectors (reverse-current protection, etc.);

5. battery discharge capacity in operation as intended and voltage of its clamps;

6. efficient ventilation of the room / locker (on board the prototype ships).
8.4.6 When testing power distribution devices, the following shall be checked:

1. serviceability of devices at the load conditions in all modes in load combinations / variants specified by the ship design;
2. possible control transfer from the main stations (consoles) to local ones and their uninterruptible operation in case of such control;
3. compliance of the set control element positions with actual operating modes for the controlled item;
4. adjustment of automatic protectors (by inspection of the actuation set points and by random tests of automates, except for short-circuit protection), interlockings and alarms;
5. readings of instruments and recorders;
6. insulation resistance.

8.4.7 When testing electric drives, they reveal characteristics of each electric drive and its compliance with its purpose.

In addition to these tests, the following shall be checked:

1. serviceability of the drive at the load conditions during the time determined by the test program (using instruments, if necessary);
2. possible control of the drive from the remote and local stations and deactivation by means of emergency switches;
3. proper operation of limit switches, brakes, lockings, control devices, automatic protectors and alarms;
4. compliance of heat protection settings with currents of the protected electric motors;
5. insulation resistance of electric motors and equipment in cold and hot conditions.

8.4.8 When testing control and alarm devices, the following shall be checked:

1. coordinated action of setters and actuators;
2. serviceability of alarms, devices, equipment;
3. actuation of general and fire alarm;
4. insulation resistance.

8.4.9 During tests of emergency electrical propulsion system, the following shall be checked:

1. reliable automatic start of emergency diesel generator;
2. reliable automatic connection of emergency generator to emergency switchboard busbars;
3. uninterruptible connection of consumers to the emergency power source supply (diesel generator or storage battery);
4. uninterruptible connection of consumers to the emergency short-term power source supply (if any);
5. parameter values of emergency diesel generator by measuring voltage, revolution frequency and current during operation of all emergency consumers.

8.4.10 Proper operation of interlocking arrangements for the electric drive of the boat winch when activating the manual drive and limit switches.

8.4.11 Serviceability of main and emergency lighting torches shall be checked.

8.4.12 Serviceability of navigation lights and their malfunction alarms shall be checked.

8.5 RUNNING TRIALS

8.5.1 During running trials, they check the operation of the ship's electrical propulsion system in all modes provided by the program, at actual loads and underway conditions, as well as proper operation of electric equipment. When developing the program, the duration of tests and checks of electric equipment shall be determined with regard to the time set in the corresponding sections of these Rules.

8.5.2 When testing ship's power plant, the following shall be checked:

1. sufficient power of generators for power supply of consumers in accordance with load mode table for all ship's operating modes, except for standby one;
2. uninterruptible activation of the emergency power source in case of no voltage of the main switchboard and no power from its necessary consumers;
.3 uninterruptible activation of the emergency short-term power source (if any) when commissioning the emergency diesel generator.

8.5.3 When testing electrical propulsion systems, the following shall be made:

.1 tests specified in 8.4.3.1, 8.4.3.4 and 8.4.3.5;
.2 measurement result analysis of the reverse length in different ship speeds.

8.5.4 Electric drives of pumps, compressors, separators, fans and other ship machinery shall be checked as intended in order to check the reliable (uninterruptible) operation, activation/deactivation, switching to the reserve set (if any), actions of remote consoles to activate/deactivate the electric drive, automatic activation of reserve electric drives as per the signals from the adjustable parameters of working medium on automated installations.

When checking the operating electric equipment, absence of loads, inadmissible temperature increases of hulls, shells, panels, bearings shall be checked. In addition, parameters of its own vibration and vibration caused by operation of main engines and other ship machinery or propellers shall be checked.

8.5.5 Electric drives of steering gears, their power supply systems (main and backup supply lines), control systems, rudder position indication system, electric drive operation / stop alarm system, shall be checked during the steering gear operation in all provided modes.

8.5.6 Steering gear drives shall be checked both during operation of two (if any) electric units of the steering drive, and of each power unit individually from all provided remote and local control stations when supplying electric drives of power units and control system from the main and backup supply line.

In this case, cycle of putting the rudder from side to side, provided in 7 of these Rules, shall be performed at least 5 times for each unit from each station and for each power supply line.

8.5.7 Electric drives of anchor and mooring arrangements, boat winches shall be checked during tests of the above arrangements, during the ship mooring/unmooring, unberthing, whilst at berth or at anchor.

8.5.8 During running trials, they measure insulation resistance of electric equipment both during its operation by means of boards for measuring insulation resistance, and by means of portable megger immediately after decommissioning with the equipment temperature set during operation.

8.5.9 Sparking degree of electric machines with collectors and contact rings shall be checked.

8.5.10 After running trials, they establish the inspection scope to open bearings of electric machines not heated during running trials in excess of the technical documentation norm.

8.5.11 When opening the electric machine, the following shall be checked:

.1 technical condition of stator winding support structures;
.2 location of winding wedges;
.3 technical condition and location of poles with their windings;
.4 secure attachment of rotating parts.
9 RADIO COMMUNICATION AIDS AND NAVIGATION EQUIPMENT

9.1 GENERAL REQUIREMENTS

9.1.1 This Section establishes requirements to technical supervision of the River Register during manufacture, on-board installation and tests of radio communication aids and navigation equipment in accordance with the Nomenclature.

9.1.2 Technical supervision of radio arrangements and navigation equipment by the River Register provides:
- approval of technical documentation, test program;
- technical supervision during manufacture and tests;
- technical supervision during installation and tests.

9.1.3 The River Register does not perform technical supervision during navigation equipment manufacture, but during mooring and running trials, checks the navigation outfit availability on board the ship in accordance with standards specified in Table 10.2.2. Part V RCCS.

9.2 TECHNICAL SUPERVISION DURING MANUFACTURE

9.2.1 Technical supervision of radio arrangements and navigation equipment by the River Register includes:
- checking for availability of the approved technical documentation and test program;
- checking documents for components (if components are prescribed by the approved documentation);
- item inspection;
- supervision during tests.

9.2.2 When examining the item, the Surveyor:
- shall verify the documents for materials used during manufacture;
- shall examine the inside and the outside of the item;
- shall inspect the proper operation of the item;
- shall check the availability of necessary markings and inscriptions.

9.2.3 Type specimens of radio communication aids and navigation equipment shall be tested as per the approved test program developed in accordance with 1 to 3, 6 to 14 of Appendix 15.

Type specimens of portable radio equipment used in Global Maritime Distress and Safety System (GMDSS) shall be additionally tested for compliance with 16 of Appendix 15 with buoyancy requirements. The tests shall be also performed for compliance with 17 of Appendix 15.

9.2.4 Serial items shall be tested as per 1 to 3 Appendix 15.

9.3 TECHNICAL SUPERVISION DURING ONBOARD INSTALLATION AND TESTS

9.3.1 When controlling the arrangement of equipment and devices, the following shall be checked:
- the availability of documents confirming the compliance of the item with the requirements of Rules;
- placement, installation of items as per approved documentation;
.3 easy arrangement, maintenance and repair of transmitters, receivers, indicators, control consoles, starters, converters, etc.;

.4 complete set of operating documents.

9.3.2 When checking installation, the following shall be verified:

.1 secure attachment of valves;
.2 secure attachment of antennas;
.3 antenna location relative to metallic parts of the ship;
.4 laying, fastening and cable penetrations through the watertight decks and bulkheads;
.5 compliance with brand drawings and cable cross-sections;
.6 condition of external cable coverings;
.7 excessive length of the cable before the entry of equipment;
.8 continuity of screening of power cable network and radio cables;
.9 hull grounding of cable network shells, radio equipment cases;
.10 insulation resistance of antennas (except for antennas with DC short-circuit structure), cable network and power supply sources;
.11 availability of fencings for live and rotating equipment parts;
.12 fitting of protective devices near the transmitter entries;
.13 resistance value of the protective grounding.

9.3.3 After installation and adjustment, radio communication aids and navigation equipment shall be subject to mooring and running trials as per the programs approved by the River Register. The equipment shall be supplied from the ship's main.

9.3.4 When testing radio communication aids, the following shall be checked:

.1 parameters and serviceability as per the approved test program in accordance with functional purpose of the radio station, with regard to the operating instructions;
.2 quality of reception and availability of interference in all the receiver bands;
.3 effective radio signal reception against interference caused by ship's electric equipment.

9.3.5 When testing public address and broadcasting devices, the following shall be checked:

.1 proper remote control of the public address device (start, deactivation, switching broadcasting lines, reset of programs and activation of forced broadcasting) from any command microphone stations regardless of the control element position for all the rest command microphone stations;
.2 transmission quality of service orders from command microphone stations to all accommodation and public spaces, as well as to open decks;
.3 available priority of service orders over broadcasting or audio recording if there is no additional command public address device for this purpose;
.4 operation of visual alarms in each microphone station, that is activated when starting the command public address device;
.5 remained serviceability of broadcasting line in case of short-circuit in loudspeaker branches;
.6 absence of plug adapters in loudspeaker branches;
.7 no clutter from electric equipment and radio communication aids.

9.3.6 When testing emergency position-indicating radio beacon, the following shall be checked:

.1 availability of applicable documents confirming the emergency position-indicating radio beacon registration in international coordination and calculation centre of the COSPAS-SARSAT system and compliance of entries in registration documents on the item model and number, name of the radio beacon, as well as available information on the expiry date of storage battery shelf life and date of the next due shore-based maintenance (not exceeding the established date during the check) in the radio beacon marking;
.2 availability of documents on testing laboratory checks.

9.3.7 When testing the navigation equipment, it is checked as per the approved test program in accordance with its purpose with regard to the operating instructions.
10 MATERIALS

10.1 GENERAL REQUIREMENTS

10.1.1 This Section establishes requirements to technical supervision during manufacture and installation of mechanisms listed in Section 9 of the Nomenclature.

10.2 TECHNICAL SUPERVISION DURING MANUFACTURE

10.2.1 Technical supervision during manufacture of the materials includes:
   .1 checking for availability of the approved technical documentation and test program;
   .2 supervision during tests;
   .3 survey during type approval;
   .4 survey during manufacture, as prescribed by the Nomenclature.

10.2.2 In case of technical supervision during materials, the Surveyor shall check the acceptance tests performed by the technical control bodies in the scope specified in the technical documentation.

10.2.3 In case of the type approval, the materials shall be tested in the Surveyor’s presence in accordance with the test program. The type specimen tests may be combined with tests in order to obtain the Recognition Certificate.

10.2.4 When surveying metals and alloys, forgings and castings, the Surveyor shall check:
   .1 documents of the performed tests prescribed by the Rules and agreed technical documentation;
   .2 company’s documents on the performed acceptance prescribed by the agreed technical documentation;
   .3 documents confirming the production manufacture as per the agreed process (as prescribed by the Rules);
   .4 inspection of defect absence on the surface;
   .5 presence of defects, their nature and repair;
   .6 marking.
11 EQUIPMENT FOR PREVENTION OF ENVIRONMENT POLLUTION FROM SHIPS

11.1 GENERAL REQUIREMENTS

11.1.1 This Section establishes requirements to technical supervision during equipment manufacture and tests for prevention of environment pollution from ships, as well as during on-board installation and tests listed in accordance with the Nomenclature.

11.1.2 Equipment, parts and units shall be manufactured and installed in accordance with the technical documentation approved by the River Register, specified in Appendix 8.

11.1.3 Equipment shall have a nameplate with its purpose, manufacturer’s name, type and model, serial number and year of manufacture.

11.2 TECHNICAL SUPERVISION DURING MANUFACTURE

11.2.1 Technical supervision during manufacture of equipment for prevention of environment pollution from ships includes:

.1 checking for availability of the approved technical documentation and test program;

.2 inspection of material and components, verification of supporting documents;

.3 checking for compliance of the manufactured parts and units with the technical documentation approved by the River Register;

.4 check of welding operations;

.5 hydraulic tests;

.6 check of equipment in operation.

11.2.2 Elements of systems included in the equipment shall be subject to hydraulic tests in accordance with the requirements 6 of these Rules.

11.2.3 A type specimen of the equipment shall be subject to bench tests as per the program approved by the River Register.

When replacing the bench tests with on-board tests, they shall be performed as per the program-procedure approved by the River Register.

Scope of acceptance tests for serial items shall be established when drawing up and approving the test program with regard to the standard specimen test results.

11.2.4 Proper installation of pipelines, valves and cables shall be checked by visual inspection. Tightness of valve and pipeline connections shall be checked during hydraulic test.

11.2.5 Actuation of safety devices of the filtering equipment and sewage treatment plant shall be tested under pressure not exceeding 1.1 of the operating pressure.

11.2.6 Prior to commencing installation of the incinerator lining, they inspect walls for absence of bulges, saggings and roughnesses exceeding 10 mm per 1 m.

After installation, proper lining of the incinerator shall be checked. The brickwork surface shall be flat. Separate ledge steps shall not exceed 3 mm, and roughness shall not exceed 10 mm per 1 m. Lining or its separate parts shall not shift.

The air hole diameter deviation from the set dimensions shall not exceed ±5 mm, and misalignment of the air hole and nozzle axes shall not exceed 2 mm.
After the final assembly, leak tests of the incinerator casing by air shall be performed (if provided by the technical documentation). Pressure and possible air leaks shall be in conformity with technical documentation approved by the River Register.

**11.3 TECHNICAL SUPERVISION DURING ONBOARD INSTALLATION AND TESTS**

**11.3.1** When checking the equipment installation, the Surveyor controls the compliance of the performed works with the requirements of the technical documentation approved by the River Register.

**11.3.2** Settling tanks, isolated ballast tanks, sewage and oily waters collecting tanks shall be checked for compliance with the operating documentation approved by the river Register, and shall be subject to tightness tests during the hull formation.

Structures, equipment and systems shall be considered to have passed the tests, if no leaks or sweating of welds, leakage in pipe expanded connection, as well as in fitting connecting flanges, and instrument connections are detected.

**11.3.3** When checking the installation of hoses included in ship's outfit and used for pumping oil, oil-containing and sewage water, it is necessary to check the marking allowing to identify items, as well as the manufacturer's documents, specifying the following:

- the type of liquid allowed for hose pumping;
- the date of manufacturing;
- the working pressure;
- the date of tests and the test pressure.

**11.3.4** Upon completion of installation works and hydraulic tests, the equipment shall be checked in operation, as per the program approved by the River Register, drawn up with regard to the requirements in Appendix 18.
NOMENCLATURE OF ITEMS
OF THE REGISTER TECHNICAL SUPERVISION

1 This Nomenclature (Table A1.1) establishes the list of items, whose technical supervision during manufacture, installation and tests is performed by the River Register as per the Rules, stamping these items in cases prescribed by this Nomenclature, as well as performing the applied forms of technical supervision. Numbers of Sections in Table A1.1, except for Section 11, repeat numbers of the RCCS corresponding parts.

2 The following symbols are used in this Nomenclature:

- P — technical supervision carried out by the River Register;
- OP — technical supervision carried out by the River Register and company's personnel;
- OT — technical supervision in the form of type approval;
- ПД — technical supervision in the form of recognised documentation;
- К — branding. During technical supervision in the form OP (supervision is performed by the Register and the company's personnel), stamping is not necessary.

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<td>1.1 Outer shell plating with set. Decks and platforms</td>
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<td>1.2 Double bottom, inner sides</td>
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<td>1.3 Longitudinal and transverse bulkheads, built-in and removable tanks. Trusses or pillars</td>
<td>— P — P — —</td>
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<td>1.4 Shaft alleys</td>
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<td>1.5 Sunstructures, deckhouses, cargo hold coamings</td>
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<tr>
<td>1.6 Foundations for main and auxiliary engines and boilers</td>
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<td>1.7 Stems, sterns, keels, propeller shaft brackets</td>
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<td>1.8 Foil arrangements of hydrofoils, flexible rails of hovercraft</td>
<td>— P — P — P P</td>
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<td>1.9 Stem-tubes and rudder tubes, fixed nozzles, tubes and water-jet channels</td>
<td>— P — P — —</td>
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<tr>
<td>1.10 Fencings, handrails, gangways:</td>
<td>— P — P — —</td>
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<tr>
<td>.1 bulwark, guard rails, handrails, gangways</td>
<td>— ПД — P — —</td>
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<td>Item under technical supervision</td>
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</table>

### 3 Fire protection

#### 3.1 Structural fire protection:
- **1.** Bulkheads and inner decks
- **2.** Fire doors
- **3.** Fire dampers
- **4.** Fire-resisting divisions
- **5.** Penetrations in fire-resisting divisions of A, B and C classes
- **6.** Alarm and control systems for fire doors
- **7.** Flame arresters
- **8.** Spark arresters of exhaust systems and flues

#### 3.2 Fire-fighting equipment and fire-extinguishing systems

#### 3.2.1 Fire extinguishing, water-spraying and inert gas systems

#### 3.2.2 Items and valves for fire extinguishing, water-spraying and inert gas systems:
- **1.** Storage reservoirs for fire-extinguishing medium
- **2.** Pneumohydraulic tanks
- **3.** Pressure vessels and apparatuses of fire extinguishing systems
- **4.** Carbon dioxide, compressed air and nitrogen cylinders
- **5.** Fire-extinguishing system pumps
- **6.** Valves of fire extinguishing, water-spraying and inert gas systems
- **7.** Steam generators
- **8.** Aerosol generators
- **9.** Monoblock pumps
- **10.** Steam generator
- **11.** Gas analyzers
- **12.** Nozzles for water-spraying and water fog systems
- **13.** Nozzles of dual-purpose type (spray/jet type)
- **14.** Portable foam set

#### 3.2.3 Safety devices in venting systems to prevent the passage of flame into the cargo tanks of tankers

#### 3.3 Units for domestic purpose, domestic units and fire extinguishing systems

#### 3.3.1 Gaseous fuel systems used for domestic purposes
- **1.** Equipment for gaseous fuel systems, used for domestic purposes, except for that stated in 2.3.3

#### 3.3.2 Water extinguishing system for exhaust ducts from a galley range
- **1.** Equipment for systems of automatic or manual fire extinguishing for exhaust ducts from a galley range

#### 3.3.3 Domestic heaters working on oil fuel, liquid gas or solid fuel:
- **1.** Galley ovens
- **2.** Domestic liquefied gas units
- **3.** Heaters and stoves regulated by the Rules

#### 3.4 Fire alarm
- **1.** Fire detection and fire alarm systems, fire smothering system release warning system, including:
## Technical supervision by the River Register during manufacture and during ship construction

### Item under technical supervision

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<td>.1 smoke, light, heat detectors and manual detectors</td>
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<td>.2 devices and equipment for automatic fire extinguishing systems and fire alarm</td>
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<td>.3 alarm starting fire-protection devices</td>
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<td>.5 Fire outfit</td>
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<td>.1 fire outfit, except for that stated in 3.5.2</td>
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<td>.2 self-contained breathing apparatuses included in fireman’s outfit</td>
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### Power installation and systems

#### 4.1 Main and auxiliary engines:

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<td>.4 cylinder liners</td>
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<td>.5 cylinder covers</td>
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<td>.8 piston pins</td>
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<td>.9 connecting rods</td>
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<td>.10 crankshafts</td>
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<td>.11 main bearings, connecting rod bearings, connecting rod top head bearings</td>
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<td>.14 governors, overspeed diesel protective devices</td>
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<td>.15 connecting rod bolts</td>
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#### 4.2 Shafting:

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<td>.1 thrust, intermediate, propeller shafts</td>
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<td>.2 liner and water insulation of propeller shafts</td>
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<td>.6 stern gears and bulkhead seals of stern gears</td>
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<tr>
<td>.7 shafting coupling bolts</td>
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#### 4.3 Gears and disengaging couplings of main engines:

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<th>Item under technical supervision</th>
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<tbody>
<tr>
<td></td>
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<tbody>
<tr>
<td>.1 reduction gear and coupling cases</td>
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<td>.2 gear wheels</td>
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<td>.3 reduction gear shafts</td>
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#### 4.4 Propellers:

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<td>.4 air propellers</td>
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### Technical supervision by the River Register during manufacture during ship construction

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## Appendix 1

### Continuation of Table A1

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<th>during ship construction</th>
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<td>ПД</td>
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<td>4.8 Air conditioners for accommodation and service spaces</td>
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<td>П/ОП</td>
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<td>4.9 Systems</td>
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<tr>
<td>cargo heating, inert gas, smoke generation, explosion-hazardous</td>
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<tr>
<td>spaces, oil tanker gas-outlet systems; air, gas-outlet, overflow and</td>
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<tr>
<td>sounding pipeline systems, ventilation system; steam heating system</td>
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<tr>
<td>4.9.2 Power plant systems, including fuel, oil, cooling, compressed</td>
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<tr>
<td>air, feed water, gas-discharging, steam pipeline and blowing systems</td>
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<td>ОТ</td>
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<td>4.9.3 Valves for pressure of 1.0 MPa and over, including pipes and</td>
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<td>valves for pipelines of I and II classes (bottom, side valves, valves</td>
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<td>arranged on the collision bulkhead)</td>
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<td>4.9.4 Items and valves of hydraulic systems of the ship; slides,</td>
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<td>valves of hydraulic systems of the ship, pump units of the ship’s</td>
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<td>hydraulic systems, system, ship's manipulators, switches, ship's</td>
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<tr>
<td>ship's motors, hydraulic filters, pneumatic-hydraulic accumulators,</td>
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<td>ПВ</td>
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<td>hydraulic machines, hydraulic cylinders</td>
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<td>4.9.5 Pipeline connections</td>
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<td>4.9.6 Manual, remote and automatic valves, including</td>
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<td>.1 Units and parts of ship's valves</td>
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<td>4.9.7 Flexible joints and ship hoses</td>
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<td>4.9.8 Compensators</td>
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<td>4.9.9 Silencers and spark arresters of exhaust systems and flues</td>
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<td>4.9.10 Exhaust pipelines made of composite and silicone materials,</td>
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<td>rubber, plastic etc.</td>
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<td>4.10 Automation:</td>
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<td>propulsion systems and their elements, devices for emergency stop of</td>
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<td>main engines (electrical propulsion system) and propellers</td>
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<td>.2 Systems for automation and control of main engines</td>
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<td>.4 Ship equipment control systems (including controllers and</td>
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<td>4.11 Shock absorbers (vibroinsulators)</td>
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<td>4.12 Diesel generators, geared diesel units, air-injection units and</td>
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<td>diesels-pump units</td>
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### 5 Ship arrangements and outfit

<p>| 5.1 Steering gears, including:                                        | —    | ПД       | —           | P P P P   | —          | 4          | 4       | 4     | 4     |
| .1 Rudder stocks and rudder pieces                                    | —    | П/ОП      | —           | K P — — — — | —          | 4          | 4       | 4     | 4     |
| .2 Rudder blade and steering nozzle assembly                          | —    | П/ОП      | —           | P — — — — | —          | 4          | 4       | 4     | 4     |
| .3 Rudder stock bearings                                              | —    | П/ОП      | —           | P — — — — | —          | 4          | 4       | 4     | 4     |
| .4 Connection parts: of rudder stocks, rudder stock with rudder       | —    | ПД       | —           | P — — — — | —          | 4          | 4       | 4     | 4     |
| blade, with steerable nozzle, of tiller or quadrants with rudder stock| —    | ПД       | —           | P — — — — | —          | 4          | 4       | 4     | 4     |
| .5 Tillers, quadrants                                                 | —    | П         | —           | —        | 4          | 4          | 4       | 4     | 4     |</p>
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<td>.6 rudder angle, steering nozzle limiters and their parts</td>
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<td>.7 roll wiring parts of steering drives</td>
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<td>.8 parts of steering line pilotage</td>
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<td>.9 steering control systems, steering gears and steering machines</td>
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<td>5.2 Thrusters</td>
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<td>5.2.1 Assembled steerable propellers, thrusters</td>
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<td>.3 anchor stoppers</td>
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<tr>
<td>.4 device to drop bitter end of the anchor chain or rope</td>
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<tr>
<td>.5 deck and side anchor hawses</td>
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<td>.6 windlasses, capstans and anchor winches</td>
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<td>5.4 Mooring devices:</td>
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<td>.1 bollards, cleats, mooring chocks, rollers and stoppers</td>
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<td>.2 capstans and mooring winches</td>
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<td>.3 towing rails with parts for fastening them to the hull, towing arches</td>
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<td>.4 towing rope releasing arrangement</td>
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<td>.6 tensioning stations, rope shortening devices, shock absorbers</td>
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<td>.7 rotary stoppers</td>
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<td>.3 control stations</td>
<td>P</td>
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<tr>
<td>.4 fencings</td>
<td>P</td>
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<tr>
<td>.5 removable parts</td>
<td>P</td>
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<tr>
<td>.6 hooks</td>
<td>P</td>
</tr>
<tr>
<td>.7 lift equipment (landing doors, counterweights, buffers, safety devices)</td>
<td>P</td>
</tr>
<tr>
<td>.8 mechanisms for cargo handling appliances</td>
<td>P</td>
</tr>
<tr>
<td>.9 ship's cargo and mast devices</td>
<td>P</td>
</tr>
<tr>
<td>.10 cranes, beam cranes, ship's telphers</td>
<td>P</td>
</tr>
<tr>
<td>.11 elevators and other ship's cargo handling gears</td>
<td>P</td>
</tr>
<tr>
<td>.12 drive chains, tractive and cargo plate chains</td>
<td>P</td>
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<tr>
<td>5.7 Wheelhouse hoisting arrangement, hatch arrangements:</td>
<td></td>
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<tr>
<td>.1 metal structures</td>
<td>P</td>
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<tr>
<td>.2 safety equipment</td>
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<tr>
<td>.3 hoisting gears</td>
<td>P</td>
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<tr>
<td>.4 equipment of hatch closures (winches, drives, etc.)</td>
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<td>5.8 Life-saving appliances:</td>
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<td></td>
<td>Item</td>
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<tr>
<td>.1 lifeboats, life rafts and saving apparatuses</td>
<td>P</td>
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<tr>
<td>.2 davits and launching arrangements of lifeboats and liferafts, including launching arrangements of rescue boats, &quot;float-free launching&quot; arrangements of life-saving appliances, hydrostatic release units, including the release system for totally enclosed lifeboats, release mechanism for lifeboats and rescue boats, liferafts launched by means of fall(s)</td>
<td>P</td>
</tr>
<tr>
<td>.3 boat drive, including engines for lifeboats and rescue boats, outboard engines for rescue boats</td>
<td>—</td>
</tr>
<tr>
<td>.4 control device for launching lifeboats</td>
<td>—</td>
</tr>
<tr>
<td>.5 equipment for lifeboats and liferafts</td>
<td>P</td>
</tr>
<tr>
<td>.6 lifebuoys, lifejackets (including for kids), buoyant lifelines, immersion suits, thermal protective aids</td>
<td>P</td>
</tr>
<tr>
<td>.7 boat winches, topping winches, salvage winches</td>
<td>P</td>
</tr>
<tr>
<td>.8 line-throwing appliances</td>
<td>—</td>
</tr>
<tr>
<td>.9 self-activating smoke signals for lifebuoys</td>
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<tr>
<td>.10 radar reflectors for lifeboats and rescue boats, liferafts</td>
<td>—</td>
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<tr>
<td>5.9 Signal means:</td>
<td>—</td>
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<tr>
<td>.1 spar and signal mast rigging</td>
<td>—</td>
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<td>.2 navigation lights</td>
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<tr>
<td>.3 shapes and sound signals</td>
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<tr>
<td>.5 self-igniting lights of life-saving appliances</td>
<td>—</td>
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<tr>
<td>.6 shapes</td>
<td>—</td>
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<tr>
<td>.7 pyrotechnic signal means</td>
<td>P</td>
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<td>5.10 Navigation outfit</td>
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<td>5.11 Emergency outfit</td>
<td>—</td>
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<tr>
<td>5.12 Ship's ropes of all purposes (steel wire ropes, natural and synthetic fiber ropes)</td>
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<tr>
<td>5.13 Hull attachments, equipment of rooms and closures of openings in the hull, decks, superstructures and cockpits:</td>
<td>—</td>
</tr>
<tr>
<td>.1 manholes</td>
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<tr>
<td>.2 water-and-gastight and untight doors (including water-and-gastight doors with wedge clips, sliding doors, untight cabin folded and shutter doors, galleys, general-purpose untight doors) with organs and drives for controlling the closing of doors, alarms and indicators, closing of shell doors</td>
<td>P</td>
</tr>
<tr>
<td>.3 scuttles, windows and light hatches, hinged non-fixed deadlights</td>
<td>P</td>
</tr>
<tr>
<td>.4 deck ladders (stairs and ladders), accommodation ladders, pilot ladders, embarkation ladders, pilot transfer arrangements</td>
<td>—</td>
</tr>
<tr>
<td>.5 stanchions and jack rods, life rope racks</td>
<td>—</td>
</tr>
<tr>
<td>.6 different hull attachments: screw turnbuckles, D-shackles, thimbles, slip-hooks, sister-hook, sealing gaskets, fasteners, small hull attachments (doors, air-vents, curtains, etc.), etc.</td>
<td>—</td>
</tr>
<tr>
<td>.7 cargo hatch covers</td>
<td>P</td>
</tr>
<tr>
<td>.8 covers of companion, light, ventilation hatches, filling openings and tanks</td>
<td>P</td>
</tr>
<tr>
<td>.9 mouths and air pipe heads</td>
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### 6 Electrical equipment

<table>
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<tr>
<td>Item 10 drives of cargo hold covers</td>
<td>P</td>
<td>P/OP</td>
</tr>
</tbody>
</table>

#### 6.1 Electric propulsion plant:
- .1 Electric propulsion motors
- .2 Main and emergency power sources:
  - .1 Generators
  - .2 Accumulators and batteries
- .3 Power and lighting transformers, electric energy converters:
  - .1 Transformers
  - .2 Rotary and static frequency converters (rectifiers, inverters, frequency converters, soft starters)
  - .3 Electrical machinery amplifiers
- .4 Switchboards (main and emergency switchboards, monitoring, control and alarm panels):
  - .1 Protection, control and commutation facilities (circuit-breakers, disconnectors, relays, switches, fuse links, etc.)
  - .2 Reactors, condenser units for power factor increasing
  - .4 Cases of switchboards and electric cabinets
- .5 AC/DC motors of 0.5 kW and over:
  - .1 Ship critical technical equipment
  - .2 Ship non-critical technical equipment
- .6 Starting equipment of electric motors
- .7 Main lighting of spaces and places of essential services, escape routes and emergency lighting:
  - .1 Fixed lamps
  - .2 Fittings of lighting networks (switches, sockets, junction/branching boxes)
  - .3 Light evacuation indicators (photoluminous and electric)
  - .4 Safe electric lamps (manual torchlights), battery torchlights
  - .5 Floodlights
- .68 Electrical machine telegraphs, rudder / CPP blade position indicators, propeller shaft tachometers
- .6.9 Service telephone system
- .6.10 General alarm system (devices and contactors of light and sound signals)
- .6.11 Alarm system of watertight doors
- .6.12 Electric equipment in explosive spaces and areas (explosion-proof)
- .6.13 Cable network:
  - .1 Cables
  - .2 Wires
  - .3 Cable penetration seals
- .6.14 Lightening conductors and groundings, cathodic protection; hull grounding devices for oil tankers
- .6.15 Electric heaters of fuel and oil
### Continuation of Table A1.1

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<th>during ship construction</th>
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<td>2 3                     4 5 6 7</td>
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<td>6.16 Heating appliances:</td>
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<td></td>
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<tr>
<td>.1 heaters, electric fireplaces, electric galley heaters, electric water heaters</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>.2 heating cables</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>6.17 Equipment for cargo handling appliances</td>
<td>P OT</td>
<td>— P — —</td>
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<td>6.18 Equipment for air conditioners</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>6.19 Control system and alarm sensors</td>
<td>P OT</td>
<td>— P P P</td>
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<tr>
<td>6.20 Domestic and engineering electric equipment</td>
<td>— — —</td>
<td>— P — —</td>
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<tr>
<td>7 Radio communication aids</td>
<td></td>
<td></td>
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<tr>
<td>7.1 VHF radio installation, VHF radiotelephone station (300.025 to 300.500 MHz)</td>
<td>P P/OP</td>
<td>— P P P</td>
</tr>
<tr>
<td>7.2 MF radio installation, MF/HF radio installation</td>
<td>P P/OP</td>
<td>— P P P</td>
</tr>
<tr>
<td>7.3 Satellite communication aids</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>7.4 EGC receiver</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>7.5 HF direct-printing radio-telephone receiver for MSI reception</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>7.6 NAVTEX receiver</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>7.7 Satellite EPIRB of COSPAS-SARSAT system, VHF EPIRB</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>7.8 Distress position finding device: radar transponder or automatic identification system (AIS) transmitter</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>7.9 two-way VHF radiotelephone apparatus for life-saving appliances and for aircraft communication</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>7.10 Portable VHF radio installation, VHF radiotelephone station (300.025 to 300.225 MHz)</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>7.11 Public address and broadcasting devices, voice communication system, internal communication equipment</td>
<td>P P/OP</td>
<td>— P P P</td>
</tr>
<tr>
<td>7.12 Antenna assemblies</td>
<td>P P/OP</td>
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<tr>
<td>7.13 Security alert system</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>7.14 Converters for equipment power supply, chargers</td>
<td>P P/OP</td>
<td>— P P P</td>
</tr>
<tr>
<td>7.15 Spaces for radio equipment</td>
<td>— — —</td>
<td>— P — —</td>
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<tr>
<td>8 Navigation equipment</td>
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<tr>
<td>8.1 Magnetic compasses</td>
<td>P P/OP</td>
<td>— P P P</td>
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<td>8.2 Gyrocompasses</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>8.3 Remote heading transmitting devices</td>
<td>P P/OP</td>
<td>— P P P</td>
</tr>
<tr>
<td>8.4 Radar stations (electronic plotting aids, automatic tracking aids, automatic radar plotting aids)</td>
<td>P P/OP</td>
<td>— P P P</td>
</tr>
<tr>
<td>8.5 Logs (devices measuring speed and the distance run)</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>8.6 Echosounders</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>8.7 ship heading/trajectory control systems (autopilots)</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>8.8 Rate-of-turn meters</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>8.9 Receivers of global navigation satellite systems</td>
<td>P P/OP</td>
<td>— P P P</td>
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<td>8.10 Voyage data recorders</td>
<td>P P/OP</td>
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<tr>
<td>8.11 External audio signal reception systems</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>8.12 Shipborne transponder of the Automatic Identification System (AIS)</td>
<td>P P/OP</td>
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<td>branding mooring trials running trials</td>
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<tr>
<td>1</td>
<td>2 3 4 5 6 7</td>
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<td>8.13 Electronic chart systems (electronic navigational chart and information display system (ECDIS), ECS)</td>
<td>P P/OP</td>
<td>P P P P</td>
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<tr>
<td>8.14 Underway watch control systems</td>
<td>P P/OP</td>
<td>P P P P</td>
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<td>8.15 Radar reflectors</td>
<td>— — — — — — — —</td>
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<tr>
<td>8.16 Ship identification and long-range tracking systems</td>
<td>P P/OP</td>
<td>P P P P</td>
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<td><strong>9 Equipment of ships carrying hazardous goods</strong></td>
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<tr>
<td>9.1 Cargo systems of chemical carriers and gas carriers, including:</td>
<td></td>
<td></td>
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<tr>
<td>9.1 items and valves for cargo systems of chemical carriers and gas carriers: cargo hoses, valves, connections of pipelines, safety valves, bellows expansion joints</td>
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<td>10.1 Metals and their alloys:</td>
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<td>1.1 rolled plates and sections</td>
<td>P P/OP</td>
<td>K — — — —</td>
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<tr>
<td>1.2 pipes for boilers, heat exchangers and ship’s pipelines</td>
<td>P P/OP</td>
<td>— — — —</td>
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<tr>
<td>1.3 material for rivets and rivets</td>
<td>— — — — ——</td>
<td>P P P P</td>
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<tr>
<td>1.4 reinforcing-bar steel for reinforced-concrete shipbuilding</td>
<td>— — — — ——</td>
<td>P P P P</td>
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<tr>
<td>1.5 material for chains and parts of their connection</td>
<td>— — — — ——</td>
<td>P P P P</td>
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<td>10.2 Forgings and castings:</td>
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<tr>
<td>2.1 stems, brackets for propeller shafts</td>
<td>P P/OP K</td>
<td>P P P P</td>
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<tr>
<td>2.2 rudder stocks of steering nozzles</td>
<td>P P/OP K</td>
<td>P P P P</td>
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<tr>
<td>2.3 steering arms, quadrants, parts of rudder blade and steering nozzles</td>
<td>— P/OP</td>
<td>P P P P</td>
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<td>2.4 stern tubes and sleeves</td>
<td>— P/OP</td>
<td>— — — —</td>
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<td>2.5 anchors</td>
<td>— P/OP</td>
<td>— — — —</td>
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<tr>
<td>2.6 anchor chains</td>
<td>— P/OP</td>
<td>— — — —</td>
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<tr>
<td>2.7 towing hooks</td>
<td>P P/OP</td>
<td>— — — —</td>
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<tr>
<td>2.8 propellers</td>
<td>P P/OP</td>
<td>— — — —</td>
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<tr>
<td>2.9 crankshafts, propeller, intermediate and thrust shafts</td>
<td>P P/OP K</td>
<td>P P P P</td>
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<tr>
<td>2.10 connecting rods</td>
<td>— P/OP</td>
<td>— — — —</td>
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<tr>
<td>2.11 pinions, wheels and gear shafts of main elements for power plant</td>
<td>— P/OP</td>
<td>P P P P</td>
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<tr>
<td>2.12 bottoms, manifolds and connections of boilers for heat exchangers and pressure vessels</td>
<td>— P/OP</td>
<td>P P P P</td>
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<td>10.3 Non-metal materials:</td>
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<td>3.1 glass reinforced plastics</td>
<td>P P/OP</td>
<td>— P P P</td>
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<td>3.2 concrete for hull structures and superstructures</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>3.3 foams</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>3.4 lining materials, lining, framing, floor coverings and coatings of hull structures (corrosion-resistant, antifouling, paint, noise, vibro-absorbing, non-slip, etc.), finishing, etc.</td>
<td>P P/OP</td>
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<tr>
<td>3.5 photoluminescent, light-reflecting materials, etc.</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>3.6 laminated textiles</td>
<td>P P/OP</td>
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<tr>
<td>3.7 materials for filling openings, non-metal, for pipelines passing through A or B type divisions</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>3.8 materials for fuel pipelines, their valves and fittings</td>
<td>P P/OP</td>
<td>— P P P</td>
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<tr>
<td>3.9 textiles, carpets, furniture</td>
<td>— — — — ——</td>
<td>P P P P</td>
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<tr>
<td>10.4 Insulation materials, fireproof, fireproof compositions, including materials for surfaces and floor coverings with low flame spread properties, paints, varnishes and other finishes, materials restricting flame spreading</td>
<td>P</td>
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<td>10.5 Welding materials:</td>
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<tr>
<td>.1 welding electrodes</td>
<td>P</td>
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<tr>
<td>.2 welding rod, wire flux combination/shielding gas</td>
<td>P</td>
<td>OT</td>
<td></td>
<td></td>
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<tr>
<td>.3 primary protective coats allowing welding without their removal</td>
<td>P</td>
<td>OT</td>
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</table>

#### 11 Equipment for prevention of pollution from ships

11.1 Systems, equipment and arrangements for prevention of pollution by oil:

| .1 pumping, delivery and discharge systems of oil-containing water, including automatic monitoring, recording and control systems of oil discharge for oil tanker | — | ПД | | P | P | P |
| .2 automatic monitoring and control system for ballast and washing water discharge | — | ПД | | P | P | P |
| .3 collecting tanks, settling tanks | — | ПД | | P | | |
| .4 filtering equipment, including oil filtration equipment | P | P | P | P | P |
| .5 alarm devices | P | P | P | P | P |
| .6 device for automatic interruption of oil-containing water discharge | P | P | P | P | P |
| .7 detectors of the oil-water phase division boundary in settling tanks | P | P | P | P | P |

11.2 Emergency oil spill localization pack

| .1 floating boom barrier | P | P | P | P |
| .2 floating anchor buoy; | P | P | P | P |
| .3 anchor chains and towing ropes | — | ПД | | P | P | P |
| .4 sorbent | P | ОТ | | P | P | P |
| .5 device for sorbent supply | P | ОТ | | P | P | P |
| .6 oil and waste sorbent collecting device | — | ПД | | P | P | P |

11.3 Systems, equipment and devices for prevention of sewage pollution:

| .1 pumping, delivery and discharge system for sewage | — | ПД | | P | P | P |
| .2 collecting tanks. | — | ПД | | P | P | P |
| .3 sewage treatment plant | P | P | P | P | P | P |

11.4 Equipment and arrangements for prevention of pollution by garbage:

| .1 garbage containers | — | ПД | | P | P | P |
| .2 incinerators | P | P | P | P | P | P |
| .3 garbage treatment plants | — | ПД | | P | P | P |

11.5 Monitoring equipment and devices of harmful substances, exhaust gases opacity and for reducing prevention of air pollution from ships:

| .1 cleaning systems designed for reducing the content of harmful substance in exhaust gases | — | ПД | | P | P | P |
FORM OF NOTICE ON SURVEYOR INVITATION

To Surveyor
Branch Office
of the Russian River Register

Notice No. _______________________
dated "____" ___________ 20 ___

_______________________________________
(organization name)
Ship, hull No.  
Project No.  

This notice submits to you the following for check test:

_______________________________________
(production description, content of the work to be submitted)

The operations were performed in accordance with drawings No. _____, specification No. ,
test program No. , technical documentation No. 

The operations stated in 2.9.1 RTSC, were performed by welders
(full name; Welder Approval Test Certificate No.)

_______________________________________
The submitted production meets the requirements of drawings, technical documentation, processes and fully completed.

Representative of QC service
(signature) (full name)

Conclusion on verification results

_______________________________________
_______________________________________

Surveyor of
Branch Office of the River Register

(signature) (full name)

“____” ___________ 20 ___

Conclusion on verification results read and understood:

Representative of QC service
(signature) (full name)

“____” ___________ 20 ___
APPENDIX 3
(mandatory)

LIST OF ITEM CHECK INSPECTIONS AND PROCESS OPERATIONS TO BE SUBMITTED TO THE BRANCH OFFICE (FORM)

<table>
<thead>
<tr>
<th>Description of item under technical supervision</th>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or technical documentation</th>
<th>Procedure of the item monitoring by the auditor</th>
<th>Drawing up a conclusion by the Surveyor and branding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Notes:
1. The list shall be drawn up as per the requirements of the Rules, with regard to the Nomenclature, forms and technical supervision methods of this company.
2. Repairable non-replaced parts shall not be stamped by the River Register.
3. Stamp of the River Register:
The Standard List of the item check tests and process operations (Table A4.1) was prepared as per items under technical supervision and does not establish sequence of their submitting to the Surveyor. Sequence of submitting to the Surveyor shall be determined in each particular case with regard to manufacture, assembly, installation and items under technical supervision and the ship as a whole.

The list is to be specified as per the scope of works on construction, modernization, conversion or repair of the ship.

**Table A4.1**

<table>
<thead>
<tr>
<th>Description of item under technical supervision</th>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</th>
<th>Procedure of item check inspection by the Surveyor</th>
<th>Drawing up a conclusion by the Surveyor and branding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 Technical supervision during construction</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.1 Hull</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 1.1.1 Material for metal hull construction (rolled plates and sections, electrodes) | 1. Certificates for metal-roll and welding materials  
2. Notice on checking the quality of the materials | 1. Checking the quality of the material as per certificates  
2. Check tests, if necessary | Entry in the Notice |
| 1.1.2 Material for reinforced hull construction (valves, concrete, cement) | 1. Material certificates  
2. Quality control department's documents for checking the quality of cement, sand, coarse aggregate, water, valve steel and concrete  
3. Notice on checking the quality of the materials | 1. Checking the quality of the materials as per certificates  
2. Checking for documents on selection of the concrete composition and strength / frost-resistance testing of specimens | Entry in the Notice |
| 1.1.3 Material for plastic hull construction (resin, reinforcement materials) | 1. Material certificates  
2. Quality control department's documents on the sample strength test  
3. Notice on checking the quality of the material | 1. Checking the quality of the material as per certificates  
2. Check tests, if necessary | Entry in the Notice |
| 1.1.4 Metal hull sections | 1. Section drawings  
2. Information on qualification of welders  
3. Flaw detection and tightness test results | 1. Checking for documentation submitted by the QC service  
2. Random check for compliance | Entry in the Notice |
### Appendix 4

**Continuation of Table A4.1**

<table>
<thead>
<tr>
<th>Description of item under technical supervision</th>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</th>
<th>Procedure of item check inspection by the Surveyor¹</th>
<th>Drawing up a conclusion by the Surveyor and branding</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Notice on checking the assembly-welding work</td>
<td>with the design requirements and for assembly and welding workmanship</td>
<td>1. Checking for documentation submitted by the QC service</td>
<td>Entry in the Notice</td>
</tr>
<tr>
<td>1.1.5 Metal hull units</td>
<td>1. Unit drawings 2. Certificates for welding materials and information on qualification of welders 3. Notice on checking the assembly-welding work 4. Notice on checking the quality of welds, including non-destructive test of welds 5. Notice on the watertightness check (if necessary)</td>
<td>2. Random check for compliance with the design requirements and for assembly and welding workmanship 3. Random watertightness test</td>
<td></td>
</tr>
<tr>
<td>1.1.9 Load line</td>
<td>1. Drawing of load line 2. Notice on checking the load line</td>
<td>1. Checking the proper application of the load line</td>
<td>Entry in the Notice</td>
</tr>
<tr>
<td>1.1.10 Hull</td>
<td>1. Drawings of foundations and rein-</td>
<td>1. Checking for documentation</td>
<td>Entry in the Notice</td>
</tr>
<tr>
<td>Description of item under technical supervision</td>
<td>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</td>
<td>Procedure of item check inspection submitted by the Surveyor</td>
<td>Drawing up a conclusion by the Surveyor and branding Notice</td>
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<tr>
<td>-------------------------------------------------</td>
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<td>-------------------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
</tr>
<tr>
<td>1.2 Ship arrangements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2.1 Steering gears and thrusters</td>
<td>1. Design technical documentation, device drawings 2. Certificates for steering machine, thruster, for components and equipment included in arrangements, in case of their individual delivery 3. Datasheet or file for steering machine, thruster 4. QC service reports for performed works at intermediate stages (functional inspection), hydraulic test of hydraulic system 5. Notice on the installation check 6. Results of installation, mounting clearances, alignment of the drive 7. Notices of mooring and running trials</td>
<td>1. Checking for documentation submitted by the QC service 2. Random check of the workmanship, adherence to production processes 3. Checking the availability of brands 4. Checking for compliance of devices with the design technical documentation 5. Functional test during running and mooring trials</td>
<td>Entry in the Notice</td>
</tr>
<tr>
<td>1.2.2 Anchor arrangement</td>
<td>1. Design technical documentation, device drawings 2. Certificates for windlasses, capstans and anchor winches, anchors, anchor chains and their connection parts, for components and equipment, included in the arrangement in case of their individual delivery</td>
<td>1. Checking for documentation submitted by the QC service 2. Random check of the workmanship 3. Checking the availability of brands, if prescribed by the Rules</td>
<td>Entry in the Notice</td>
</tr>
<tr>
<td></td>
<td>3. Datasheet or file for windlass, capstan and anchor winch 4. Datasheets (reports) of anchors, anchor chains and their connection parts, anchor stoppers, device to drop bitter end of the anchor chain or rope, deck and side anchor hawses 5. Quality control department's reports for performed works at intermediate stages (functional inspection) 6. Notice on the installation check 7. Notices of mooring and running trials</td>
<td>4. Checking for compliance of devices with the design technical documentation 5. Functional test during running and mooring trials</td>
<td></td>
</tr>
<tr>
<td>1.2.4 Coupling</td>
<td>1. Device drawing</td>
<td>1. Checking for documentation</td>
<td>Entry in the</td>
</tr>
</tbody>
</table>
### Appendix 4

#### Continuation of Table A4.1

<table>
<thead>
<tr>
<th>Description of item under technical supervision arrangement</th>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</th>
<th>Procedure of item check inspection submitted by the Surveyor</th>
<th>Drawing up a conclusion by the Surveyor and branding Notices</th>
</tr>
</thead>
</table>

#### 1. 4 Equipment of ship spaces, crew and passengers protection

<table>
<thead>
<tr>
<th>1. 4.1 Arrangement plans for</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General arrangement plans for</td>
</tr>
<tr>
<td>Description of item under technical supervision</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>1.5 Fire protection</td>
</tr>
<tr>
<td>1.6.3 Boilers, heat exchangers, etc.</td>
</tr>
<tr>
<td>Description of item under technical supervision</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td>Pressure vessels</td>
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<tr>
<td>8. Notices on readiness of the boiler, pressure vessels (with standard valves and instruments) for internal survey</td>
</tr>
<tr>
<td>9. Notices on readiness of the boiler, pressure vessels (with all pipelines and valves) for hydraulic test by test pressure</td>
</tr>
<tr>
<td>1.6.4 Refrigerating plant of transport refrigerator and catching vessels</td>
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<tr>
<td>1.7 Systems and pipelines</td>
</tr>
<tr>
<td>1.7.1 Systems and pipelines: bilge, ballast, liquid cargo, inert gas, smoke generation, ven-</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
### 1.8 Electrical, navigation equipment and radio communication means

#### 1.8.1 Electrical equipment installation and cable laying with fastening

1. Drawings (plans) for installation, connection of equipment and laying of cable routes with attachment and grounding joints, approved by the River Register
2. Certificates for installed items
3. Insulation resistance measurement and grounding check results
4. Documents confirming the results of controlling the proper installation by the company’s personnel

#### 1.8.2 Domestic, household and engineering electric equipment

1. Drawings (plans) for installation, connection of equipment and laying of cable routes with attachment and grounding joints, approved by the River Register
2. Insulation resistance measurement and grounding check results
3. Documents containing the results of braiding and conductor shields

## Continuation of Table A4.1

<table>
<thead>
<tr>
<th>Description of item under technical supervision</th>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</th>
<th>Procedure of item check inspection by the Surveyor</th>
<th>Drawing up a conclusion by the Surveyor and branding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explosion-hazardous spaces, gas-outlet systems of oil tankers; air, gas-outlet, overflow and sounding piping systems ventilation system of the engine room; steam heating system; hydraulic drives of ship machinery; fuel, oil, water cooling, compressed air, feed water, gas-discharging, steam pipeline and blowing systems</td>
<td>4. Quality control department’s documents on the hydraulic test in the shop</td>
<td>4. Check test of the system in operation</td>
<td></td>
</tr>
</tbody>
</table>

**4. Quality control department’s documents on the hydraulic test in the shop**

- Notice on checking the system onboard installation
- Notice on hydraulic test of the assembled system
- Notice on functional test of the system and check of the used ship machinery or equipment as intended.

**4. Check test of the system in operation**

- Checking for documentation submitted by the QC service
- Checking for compliance of composition, arrangement, fitting, installation of electric equipment and laying of cables, grounding installation of the electric equipment, cable braiding and conductor shields with the design documentation requirements
- Functional test during running and mooring trials

**5. Notice on checking the system onboard installation**

- Checking for documentation submitted by the QC service
- Checking for compliance of composition, arrangement, fitting, installation of electric equipment and laying of cables, grounding installation of the electric equipment, cable braiding and conductor shields

**6. Notice on hydraulic test of the assembled system**

- Checking for documentation submitted by the QC service
- Checking for compliance of composition, arrangement, fitting, installation of electric equipment and laying of cables, grounding installation of the electric equipment, cable braiding and conductor shields

**7. Notice on functional test of the system and check of the used ship machinery or equipment as intended.**

- Checking for documentation submitted by the QC service
- Checking for compliance of composition, arrangement, fitting, installation of electric equipment and laying of cables, grounding installation of the electric equipment, cable braiding and conductor shields
<table>
<thead>
<tr>
<th>Description of item under technical supervision</th>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications controlling the proper installation by the company’s personnel</th>
<th>Procedure of item check inspection by the Surveyor¹ with the design documentation requirements</th>
<th>Drawing up a conclusion by the Surveyorand branding</th>
</tr>
</thead>
</table>
| 1.8.3 Communication means and navigation equipment | 1. Drawings (plans) for installation, connection of equipment and laying of cable routes with attachment and grounding joints, approved by the River Register
2. Certificates for installed items
3. Insulation resistance measurement and grounding check results
4. Documents containing the results of controlling the proper installation by the company’s personnel | 1. Checking for documentation submitted by the QC service
2. Checking for compliance of composition, arrangement, fitting, installation of equipment and laying of cables, grounding installation of the electric equipment, cable braiding and conductor shields with the design documentation requirements
3. Functional test during running and mooring trials | Entry in the Notice |

<table>
<thead>
<tr>
<th>1.9 Mooring and running trials</th>
<th>1. Checking for complete set of construction documents and sufficient documentation for components</th>
<th>Entry in the Notice</th>
</tr>
</thead>
</table>
| 1.9.1 Preparation for trials | 1. Set of construction documents and documentation for components
2. Notice on readiness for tests | 1. Checking for documentation submitted by the QC service
2. Functional test during mooring trials | Entry in the Notice |
| 1.9.2 Mooring trials | 1. Mooring trials program
2. Documents certifying completion of installation and other works at the construction stage of tests, signed by the personnel of the company’s QC service, and in cases stated in the List — by the Surveyor;
3. Schedule of mooring trials approved by the branch
4. Specification
5. List of replacements equivalent to the requirements of the Rules and approved technical documentation
6. Files and datasheets for ship machinery
7. Documents for devices
8. Description of the items under technical supervision and maintenance instructions
9. Test procedures (including simulation) with diagrams of simulators
10. Notice on mooring trials | 1. Checking for documentation submitted by the QC service
2. Functional test during mooring trials | Entry in the Notice |
| 1.9.3 Running trials | 1. Running trials program
2. Quality control department’s documents certifying completion of mooring trials
3. Schedule of running trials approved by the auditor
4. Test procedures
5. Information on the ship stability and | 1. Checking for documentation submitted by the QC service | Entry in the Notice |
| | | 2. Functional check during running trials | |

¹ Surveyor
### Table A4.1

<table>
<thead>
<tr>
<th>Description of item under technical supervision</th>
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<th>Drawing up a conclusion by the Surveyor and branding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodability</td>
<td>6. Heeling test report and stability calculations (for the prototype ship)</td>
<td>1. Checking for documentation submitted by the QC service</td>
<td>1. Entry in the Notice</td>
</tr>
<tr>
<td></td>
<td>7. Forms of reports and logbooks developed by the company for recording test results</td>
<td>2. Checking the defect elimination</td>
<td>2. Issuing documents of the River Register³</td>
</tr>
<tr>
<td></td>
<td>8. Notice on performance running trials, indicating the assigned date of running trials, number of running trials participants, availability of collective and personal life-saving appliances and ship outfit</td>
<td>3. Functional test during check sailing</td>
<td></td>
</tr>
</tbody>
</table>

### 1.9.4 Inspection and check sailing

1. List of items to be inspected, indicating scope of works (including internal survey of steam boilers)
2. Quality control department's documentation on the inspection results, including:
   - list of the items under technical supervision subject to inspection;
   - description of the detected defects;
   - cause of defects;
   - defect elimination measures;
3. Notice on defect elimination
4. Notice of check sailing (if necessary)

### 2 Supervision during manufacture of ship machinery, equipment and arrangements

#### 2.1 Internal combustion engines

##### 2.1.1 Base frames, crankcases (bedplates)

1. Part drawings
2. Material certificates
3. Measurement result tables (checklist)
4. Non-destructive test / testing results
5. Notice on the item check
6. Notice on defect elimination
7. Notice of check sailing (if necessary)

##### 2.1.2 Cylinder units, unit heads

1. Part drawings
2. Material certificates
3. Measurement result tables (checklist)
4. Non-destructive test / testing results
5. Notice on the item check

##### 2.1.3 Cylinder liners, cylinder covers, pistons, piston pins

1. Part drawings
2. Material certificates
3. Measurement result tables (checklist)
4. Non-destructive test / testing results
5. Notice on the item check

##### 2.1.4 Connecting rods

1. Part drawings
2. Material certificates

1. Checking for documentation submitted by the QC service
2. Random check of the workmanship, adherence to production processes
3. Checking for compliance with drawings

1. Entry in the Notice
2. Issue of documents by the River Register³

1. Checking for documentation submitted by the QC service
2. Random check of the workmanship, adherence to production processes
3. Checking for compliance with drawings

1. Entry in the Notice
2. Issue of documents by the River Register³

1. Checking for documentation submitted by the QC service
2. Random check of the workmanship, adherence to production processes
3. Checking for compliance with drawings

1. Entry in the Notice
2. Issue of documents by the River Register³
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</tr>
</thead>
<tbody>
<tr>
<td>2.1.5 Connecting rod bolts, bolts and studs of main bearings, cylinder covers</td>
<td>1. Part drawings</td>
<td>1. Checking for documentation submitted by the QC service</td>
<td>1. Entry in the Notice</td>
</tr>
<tr>
<td></td>
<td>2. Material certificates</td>
<td>2. Random check of the workmanship, adherence to production processes</td>
<td>2. Issue of documents by the River Register</td>
</tr>
<tr>
<td></td>
<td>3. Non-destructive test / testing results</td>
<td>3. Checking for compliance with drawings</td>
<td>3. Issue of documents by the River Register</td>
</tr>
<tr>
<td></td>
<td>4. Notice on the item check</td>
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</tr>
<tr>
<td>2.1.6 Crankshaft</td>
<td>1. Part drawing</td>
<td>1. Checking for documentation submitted by the QC service</td>
<td>1. Entry in the Notice</td>
</tr>
<tr>
<td></td>
<td>2. Material certificates</td>
<td>2. Random check of the workmanship, adherence to production processes</td>
<td>2. Stamping by the River Register</td>
</tr>
<tr>
<td></td>
<td>3. Measurement result tables (checklist)</td>
<td>3. Checking for compliance with drawing</td>
<td>3. Issue of documents by the River Register</td>
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<tr>
<td></td>
<td>4. Heat treatment results</td>
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<td>5. Non-destructive test / testing results</td>
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<td>6. Balancing results</td>
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<td>7. Notice on the item check</td>
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<tr>
<td>2.1.7 Camshaft (reverse shaft)</td>
<td>1. Part drawing</td>
<td>1. Checking for documentation submitted by the QC service</td>
<td>1. Entry in the Notice</td>
</tr>
<tr>
<td></td>
<td>2. Material certificates</td>
<td>2. Random check of the workmanship, adherence to production processes</td>
<td>2. Issue of documents by the River Register</td>
</tr>
<tr>
<td></td>
<td>3. Measurement result tables (checklist)</td>
<td>3. Checking for compliance with drawing</td>
<td>3. Issue of documents by the River Register</td>
</tr>
<tr>
<td></td>
<td>4. Heat treatment results</td>
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<tr>
<td></td>
<td>5. Non-destructive test / testing results</td>
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<td>6. Notice on the item check</td>
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<tr>
<td>2.1.8 Gears</td>
<td>1. Part drawings</td>
<td>1. Checking for documentation submitted by the QC service</td>
<td>1. Entry in the Notice</td>
</tr>
<tr>
<td></td>
<td>2. Material certificates</td>
<td>2. Random check of the workmanship, adherence to production processes</td>
<td>2. Issue of documents by the River Register</td>
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<tr>
<td></td>
<td>3. Measurement result table (checklist)</td>
<td>3. Checking for compliance with drawings</td>
<td>3. Issue of documents by the River Register</td>
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<tr>
<td></td>
<td>4. Heat treatment results</td>
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<td>5. Notice on the item check</td>
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<tr>
<td>2.1.9 Shock absorbers</td>
<td>1. Part drawings</td>
<td>1. Checking for documentation submitted by the QC service</td>
<td>1. Entry in the Notice</td>
</tr>
<tr>
<td></td>
<td>2. Material details</td>
<td>2. Random check of the workmanship, adherence to production processes</td>
<td>2. Issue of documents by the River Register</td>
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<tr>
<td></td>
<td>3. Test Results</td>
<td>3. Checking for compliance with drawings</td>
<td>3. Issue of documents by the River Register</td>
</tr>
<tr>
<td></td>
<td>4. Notice on the item check</td>
<td></td>
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</tr>
<tr>
<td>2.1.10 Assembling</td>
<td>1. Technical documentation</td>
<td>1. Checking for documentation submitted by the QC service</td>
<td>Entry in the Notice</td>
</tr>
<tr>
<td></td>
<td>2. Quality control department’s documents for performed works at intermediate stages (functional inspection)</td>
<td>2. Random check of the engine assembly workmanship</td>
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<td></td>
<td>3. Documentation for components</td>
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<td></td>
<td>4. Notices on the check</td>
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</tr>
<tr>
<td>2.1.11 Bench tests</td>
<td>1. Technical documentation</td>
<td>1. Checking for documentation submitted by the QC service</td>
<td>Entry in the Notice</td>
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<tr>
<td></td>
<td>2. Description and maintenance instruc-</td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th>Description of item under technical supervision</th>
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<th>Procedure of item check inspection by the Surveyor¹</th>
<th>Drawing up a conclusion by the Surveyor and branding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuation of Table A4.1</td>
<td>1. Technical documentation</td>
<td>1. Checking for documentation submitted by the QC service</td>
<td>1. Entry in the Notice</td>
</tr>
<tr>
<td>2.1.12 Inspection</td>
<td>2. Notice on readiness for inspection</td>
<td>2. Functional test after assembling and eliminating defects detected during bench tests and inspection in modes prescribed by the program</td>
<td>2. Issuing documents of the River Register</td>
</tr>
<tr>
<td>2.1.13 Check tests</td>
<td>3. Quality control department's documents on the engine inspection after testing</td>
<td>3. Checking starters, reversing arrangement, alarm and protection system, safety devices, automated device system, rotation speed control system</td>
<td>3. Stamping by the River Register</td>
</tr>
<tr>
<td>2.2 Gears, couplings, shafts and propellers</td>
<td>1. Technical documentation</td>
<td>1. Checking for documentation submitted by the QC service</td>
<td>1. Entry in the Notice</td>
</tr>
<tr>
<td>2.2.1 Reduction gear and disengaging coupling</td>
<td>2. Notice on readiness for check tests</td>
<td>2. Random check of the workmanship, adherence to production processes</td>
<td>2. Issue of documents by the River Register</td>
</tr>
<tr>
<td>cases, gear wheels, reduction gear shafts</td>
<td>3. Engine file</td>
<td>3. Checking for compliance with drawings</td>
<td></td>
</tr>
<tr>
<td>2.2.2 Assembly</td>
<td>1. Technical documentation</td>
<td>1. Checking for documentation</td>
<td>Entry in the Notice</td>
</tr>
</tbody>
</table>

¹ Surveyor is the technical expert responsible for the inspection.
## Appendix 4

### Continuation of Table A4.1

<table>
<thead>
<tr>
<th>Description of item under technical supervision</th>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</th>
<th>Procedure of item check inspection by the Surveyor and branding</th>
<th>Drawing up a conclusion by the Surveyor and branding</th>
</tr>
</thead>
</table>
| **2.2.3 Bench tests, inspection, check tests of disengaging coupling gears** | 2. Table of mounting clearances, alignment measurements (checklist)  
3. Quality control department's documents for performed works at intermediate stages (functional inspection)  
4. Documentation for components  
5. Notice on the check  
1. Technical documentation  
2. Description and maintenance instruction, drawings, results of parts and mounting dimensions measurement  
3. Company's documents: on the bench readiness for tests; equipment and instrumentation arrangement and bench datasheet; on checkout and calibration of the bench instrumentation or standard devices;  
4. Functional test during check tests after assembling and eliminating defects detected during bench tests and inspection | 1. Checking for documentation submitted by the QC service  
2. Random check of reduction gear / disengaging coupling assembly workmanship  
1. Entry in the Notice  
2. Issuing documents of the River Register  
3. Stamping by the River Register | 1. Entry in the Notice  
2. Issuing documents of the River Register  
3. Stamping by the River Register |
| technical documentation for associated equipment in case of its installation on the bench with item under test;  
4. Completed file (datasheet)  
5. Quality control department's document on performing shop trials (running-in, adjustment, acceptance)  
6. Notices on readiness for bench tests, for inspection, for check tests | 4. Functional test during check tests after assembling and eliminating defects detected during bench tests and inspection | | |
| **2.2.4 Thrust intermediate, propeller shafts, shaft bearings, couplings** | 1. Part drawings  
2. Material certificates  
3. Measurement result table  
4. Non-destructive test (flaw detection) results  
5. Quality control department's documents for performed works at intermediate stages (functional inspection)  
6. Datasheet (file)  
7. Notice on the check | 1. Checking for documentation submitted by the QC service  
2. Random check of the workmanship, adherence to production processes  
3. Checking for compliance with drawings | 1. Entry in the Notice  
2. Stamping by the River Register (for shafts)  
3. Issue of documents by the River Register |
| 1. Part drawings  
2. Material certificates  
3. Non-destructive test, balancing, testing results  
4. Quality control department's documents for performed works at intermediate stages (functional inspection)  
5. Measurement result table  
6. Datasheet (file)  
7. Notice on the check | 1. Checking for documentation submitted by the QC service  
2. Random check of the workmanship, adherence to production processes  
3. Checking for compliance with drawings | | |
<p>| <strong>2.2.5 Propellers, bosses, blades, vertical axis propellers, propulsion and steering units, thrusters, assembled steerable propellers and mechanisms, parts and units, delivered for their com-</strong> | | | |
| | | | |</p>
<table>
<thead>
<tr>
<th>Description of item under technical supervision</th>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</th>
<th>Procedure of item check inspection by the Surveyor¹</th>
<th>Drawing up a conclusion by the Surveyor and branding</th>
</tr>
</thead>
</table>
| 2.2.6 Shaft liner                             | 1. Part drawings  
2. Material certificates  
3. Test Results  
4. Quality control department's documents for performed works at intermediate stages (functional inspection)  
5. Measurement result tables  
6. Notice on the check | 1. Checking for documentation submitted by the QC service  
2. Random check of the workmanship, adherence to production processes  
3. Checking for compliance with drawings | 1. Entry in the Notice  
2. Issue of documents by the River Register² |
| 2.2.7 Stern-tubes and rudder tubes, fixed nozzles, tubes and water-jet channels | 1. Part drawings  
2. Material certificates  
3. Test Results  
4. Quality control department's documents for performed works at intermediate stages (functional inspection)  
5. Measurement result tables  
6. Notice on the check | 1. Checking for documentation submitted by the QC service  
2. Random check of the workmanship, adherence to production processes  
3. Checking for compliance with drawings | 1. Entry in the Notice  
2. Issue of documents by the River Register² |
| 2.3 Boilers                                   | 1. Drawings of units and parts  
2. Certificates for metal-roll and welding materials  
3. Process  
4. Information on qualification of welders  
5. Control bar test results and radiographies (if necessary)  
6. Quality control department's documents for performed works at intermediate stages (functional inspection)  
7. Quality control department's documents on hydraulic test of parts and units, heat treatment, on weld quality control  
8. Notice on the check | 1. Checking for documentation submitted by the QC service  
2. Checking the availability of brands and for compliance of marking with documents, confirming the material quality  
3. Random check of the workmanship, adherence to production processes  
4. Checking for compliance with drawings | 1. Entry in the Notice  
2. Issue of documents by the River Register² |
| 2.3.2 Boiler fittings                         | 1. Documents for valves  
2. Notices on readiness for hydraulic tests | 1. Checking for documentation submitted by the QC service  
2. Random inspection  
3. Hydraulic tests of valve, visual inspection before and after the test | 1. Entry in the Notice  
2. Issue of documents by the River Register² |
| 2.3.3 Boiler assembly  
Internal survey and hydraulic test of boilers. Steam test of the boiler (if necessary) | 1. Technical documentation  
2. Boiler datasheet (file)  
3. Boiler drawings (longitudinal, transversal sections, etc.)  
4. Documentation for components  
5. Information on qualification of welders  
6. Quality control department's documents for performed works at intermediate stages (functional inspection) | 1. Checking for documentation submitted by the QC service  
2. Random check of the boiler assembly workmanship  
3. Internal survey, hydraulic tests, visual inspection | 1 Entry in the Notice  
2. Stamping by the River Register  
3. Issue of documents by the River Register² |
### Table A4.1: Description of item under technical supervision

<table>
<thead>
<tr>
<th>Item under technical supervision</th>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</th>
<th>Procedure of item check inspection by the Surveyor</th>
<th>Drawing up a conclusion by the Surveyor and branding</th>
</tr>
</thead>
</table>
| 2.4.1 Reservoirs (barrel, bottom), tube plates | 1. Drawings of units and parts  
2. Certificates for metal-roll and welding materials  
3. Process  
4. Information on qualification of welders  
5. Control bar test results and radiographies (if necessary)  
6. Quality control department’s reports for performed works at intermediate stages (functional inspection)  
7. Quality control department’s documents on hydraulic test of parts and units, heat treatment, on weld quality control  
8. Notice on the check | 1. Checking for documentation submitted by the QC service  
2. Checking the availability of brands and for compliance of marking with documents, confirming the material quality  
3. Random check of the workmanship, adherence to production processes  
4. Checking for compliance with drawings | 1. Entry in the Notice  
2. Stamping by the River Register  
3. Issue of documents by the River Register |
| 2.4.2 Fittings | 1. Documents for valves and head  
2. Notices on readiness for hydraulic tests | 1. Checking for documentation submitted by the QC service  
2. Random inspection  
3. Hydraulic tests of valve, visual inspection before and after the test | 1. Entry in the Notice  
2. Issue of documents by the River Register |
| 2.4.3 Internal survey and hydraulic test of boilers, pressure vessels, heat exchangers | 1. Technical documentation  
2. Datasheets or files for pressure vessels, heat exchangers  
3. Drawings of pressure vessels, heat exchangers  
4. Documentation for components  
5. Quality control department’s documents for performed works at intermediate stages (functional inspection)  
6. Notices on readiness in the assembled condition without valves for internal survey, hydraulic test  
7. Notice on the check | 1. Checking for documentation submitted by the QC service  
2. Random check of the boiler assembly workmanship  
3. Internal survey, hydraulic tests, visual inspection | 1 Entry in the Notice  
2. Stamping by the River Register  
3. Issuing documents of the River Register |
| 2.5 Electric equipment | 1. Technical documentation  
2. Acceptance documents of the quality control department and its agreement deadline | 1. Checking for documentation submitted by the quality control department and its agreement deadline | 1. Entry in the Notice  
2. Stamping by the River Register |

**2.4 Pressure vessels, heat exchangers**

- **2.4.1 Reservoirs (barrel, bottom), tube plates**
  - 1. Drawings of units and parts
  - 2. Certificates for metal-roll and welding materials
  - 3. Process
  - 4. Information on qualification of welders
  - 5. Control bar test results and radiographies (if necessary)
  - 6. Quality control department’s reports for performed works at intermediate stages (functional inspection)
  - 7. Quality control department’s documents on hydraulic test of parts and units, heat treatment, on weld quality control
  - 8. Notice on the check

- **2.4.2 Fittings**
  - 1. Documents for valves and head
  - 2. Notices on readiness for hydraulic tests

- **2.4.3 Internal survey and hydraulic test of boilers, pressure vessels, heat exchangers**
  - 1. Technical documentation
  - 2. Datasheets or files for pressure vessels, heat exchangers
  - 3. Drawings of pressure vessels, heat exchangers
  - 4. Documentation for components
  - 5. Quality control department’s documents for performed works at intermediate stages (functional inspection)
  - 6. Notices on readiness in the assembled condition without valves for internal survey, hydraulic test
  - 7. Notice on the check

**2.5 Electric equipment**

- **2.5.1 Generators, propulsion motors**
  - 1. Technical documentation
  - 2. Acceptance documents of the quality control department
  - 3. Notice

- **2.5.2 Electrical equipment**
  - 1. Technical documentation
  - 2. Acceptance documents of the quality control department
  - 3. Notice

- **2.5.3 Electrical equipment**
  - 1. Technical documentation
  - 2. Acceptance documents of the quality control department
  - 3. Notice
### Description of item under technical supervision

<table>
<thead>
<tr>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure of item check inspection by the Surveyor:</td>
</tr>
<tr>
<td>2. Inspection and check of units and parts</td>
</tr>
<tr>
<td>3. Functional tests</td>
</tr>
</tbody>
</table>

### Drawing up a conclusion by the Surveyor and branding

<table>
<thead>
<tr>
<th>2.5.2 Electric distribution systems (main and emergency switchboards, grouped boards, control and alarm boards and panels, other boards)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</td>
</tr>
<tr>
<td>Procedure of item check inspection by the Surveyor:</td>
</tr>
<tr>
<td>1. Checking for documentation submitted by the quality control department and its agreement deadline</td>
</tr>
<tr>
<td>2. Inspection and check of units and parts</td>
</tr>
<tr>
<td>3. Functional tests</td>
</tr>
</tbody>
</table>

### Issue of documents by the River Register

<table>
<thead>
<tr>
<th>2.6 Deck machinery and ship auxiliary equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</td>
</tr>
<tr>
<td>Procedure of item check inspection by the Surveyor:</td>
</tr>
<tr>
<td>1. Checking for documentation submitted by the quality control department and its agreement deadline</td>
</tr>
<tr>
<td>2. Inspection and check of units and parts</td>
</tr>
<tr>
<td>3. Functional tests</td>
</tr>
</tbody>
</table>

### Drawing up a conclusion by the Surveyor and branding

<table>
<thead>
<tr>
<th>2.6.1 Steering machines, thrusters, blowers (for air-cushion ships), anchor and towing machinery (capstans, windlasses, winches), air compressors, towing winches, winches of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</td>
</tr>
<tr>
<td>Procedure of item check inspection by the Surveyor:</td>
</tr>
<tr>
<td>1. Checking for documentation submitted by the quality control department and its agreement deadline</td>
</tr>
<tr>
<td>2. Inspection and check of units and parts</td>
</tr>
<tr>
<td>3. Functional tests</td>
</tr>
</tbody>
</table>

### Issue of documents by the River Register
## Continuation of Table A4.1

<table>
<thead>
<tr>
<th>Description of item under technical supervision</th>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</th>
<th>Procedure of item check inspection by the Surveyor</th>
<th>Drawing up a conclusion by the Surveyor and branding</th>
</tr>
</thead>
</table>
| 2.6.2 End and side automatic coupling devices    | 1. Technical documentation  
2. Datasheets, files  
3. Test program  
4. Notice | 1. Checking materials as per their file  
2. Inspection and check of parts and units  
3. Participation in bench tests | 1. Entry in the Notice  
2. Entry in the file  
3. Stamping by the River Register  
4. Issue of documents by the River Register |

### 2.7 Units and parts of ship's arrangements and outfit

| 2.7.1 Lifeboats and devices | 1. Technical documentation  
2. Documents for materials  
3. Test programs  
4. Notice | 1 Checking for documentation submitted by the quality control department  
2. Inspection and check  
3. Participation in testing | 1. Entry in the Notice  
2. Issuing documents of the River Register  
3. Stamping by the River Register |

| 2.7.2 Lifebuoys, lifejackets, life vests | 1. Technical documentation  
2. Documents for materials  
3. Test programs  
4. Acceptance documents of the quality control document  
5. Notice | 1. Checking for documentation submitted by the QC service  
2. Inspection and check  
3. Participation in testing | 1. Entry in the Notice  
2. Issuing documents of the River Register |

| 2.7.3 Navigation lights | 1. Technical documentation  
2. Test program  
3. Documents confirming the results of testing the manufactured items by the company's personnel  
4. Notice | 1. Checking for documentation submitted by the QC service  
2. Inspection and check of torches  
3. Functional tests during standard tests of serial specimens | 1. Entry in the Notice  
2. Issuing documents of the River Register |

| 2.7.4 Rudders, nozzles, stocks of rudders and nozzles | 1. Technical documentation  
2. Documents for materials  
3. Report on execution of measurements  
4. Notice | 1. Checking for documentation submitted by the QC service  
2. Inspection and check  
3. Participation in testing | 1. Entry in the Report  
2. Stamping by the River Register  
3. Issue of documents by the River Register |

| 2.7.5 Anchors, anchor chains | 1. Technical documentation  
2. Documents for materials  
3. Notice | 1. Checking for documentation submitted by the QC service  
2. Inspection and check  
3. Participation in testing | 1. Entry in the Notice  
2. Issue of documents by the River Register |
<table>
<thead>
<tr>
<th>Description of item under technical supervision</th>
<th>Documents submitted by QC service, confirming the item compliance with the project, standards or specifications</th>
<th>Procedure of item check inspection by the Surveyor¹</th>
<th>Drawing up a conclusion by the Surveyor and branding</th>
</tr>
</thead>
</table>
| 2.7.6 Towing hooks and arches | 1. Technical documentation  
2. Documents for materials  
3. Notice | 1. Checking for documentation submitted by the QC service  
2. Inspection and check  
3. Participation in testing | 1. Entry in the Notice  
2. Issue of documents by the River Register² |

**2.8 Radio communication means and navigation equipment**

| | 1. Technical documentation  
2. Acceptance documents of the quality control document  
3. Notice on the check | 1. Checking for documentation submitted by the QC service  
2. Inspection and check of units, antennas  
3. Participation in testing | 1. Entry in the Notice  
2. Issuing documents of the River Register |

¹ Scope of technical supervision by the auditor is determined by these Rules.
² When manufacturing items to be delivered to other companies.
## CONSTRUCTION BOOK FORM

<table>
<thead>
<tr>
<th>No.</th>
<th>Description of the item under test (materials, assemblies, parts, etc.)</th>
<th>Control notice</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>production foreman</td>
<td>Date</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

## FORM OF TECHNICAL SUPERVISION RECORD BOOK

<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Project number, ship hull number</th>
<th>Surveyor's comment</th>
<th>Company's measures</th>
<th>Entry of the QC service on the comment elimination</th>
<th>Surveyor's entry on the comment elimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>
## TESTING PROCEDURE FOR WELDERS’ PERMIT

1 Tests for receiving manual and semiautomatic welding permit shall be performed according to Table A7.1 and Fig. A7.1-1 to A7.1-8.

2 Tests for receiving automatic welding permit shall be performed according to Table A7.2.

### Table A7.1

<table>
<thead>
<tr>
<th>Item, type of construction</th>
<th>Thickness, mm</th>
<th>Welding position</th>
<th>Type of test assembly</th>
<th>Type of inspection and quality estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>≤5</td>
<td>Horizontal</td>
<td>( P_{1d} + P_{2h} )</td>
<td>mark III</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>( P_{2h} )</td>
<td>mark II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>( P_{h} + (P_{h-v}, P_{10}) + P_{2} )</td>
<td>mark II</td>
</tr>
<tr>
<td></td>
<td>6 to 25</td>
<td>Horizontal</td>
<td>( P_{1d} + P_{2h} )</td>
<td>Two fracture test specimens from each fillet joint according to 3.4 Appendix 12 Part X RCCS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>( P_{2h} )</td>
<td>mark II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>( P_{h} + (P_{h-v}, P_{10}) + P_{2} )</td>
<td>mark II</td>
</tr>
<tr>
<td></td>
<td>&gt;25</td>
<td>Horizontal</td>
<td>( P_{1d} + P_{2h} )</td>
<td>mark III</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>( P_{2h} )</td>
<td>mark II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>( P_{h} + (P_{h-v}, P_{10}) + P_{2} )</td>
<td>mark II</td>
</tr>
<tr>
<td><strong>Tubes</strong></td>
<td>≤5</td>
<td>Horizontal</td>
<td>( P_{1v} + P_{3} )</td>
<td>mark II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>( P_{3} )</td>
<td>mark II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>( P_{h} + P_{2} )</td>
<td>mark II</td>
</tr>
<tr>
<td></td>
<td>&gt;5</td>
<td>Horizontal</td>
<td>( P_{1v} + P_{3} )</td>
<td>mark II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>( P_{3} )</td>
<td>mark II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>( P_{h} + P_{2} )</td>
<td>mark II</td>
</tr>
<tr>
<td><strong>Pressure vessels</strong></td>
<td>(0.5 – 1.5)( t )</td>
<td>All</td>
<td>( P_{1v} + (P_{h-v}, P_{10}) )</td>
<td>mark II</td>
</tr>
<tr>
<td>(plates)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pressure vessels</strong></td>
<td>(0.5 – 1.5)( t )</td>
<td>All</td>
<td>( P_{6} )</td>
<td>mark II</td>
</tr>
<tr>
<td>(piping)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Welding-up of faults in</strong></td>
<td>—</td>
<td>Horizontal</td>
<td>( P_{8} )</td>
<td>mark II</td>
</tr>
<tr>
<td><strong>forgings and castings</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 7

For welded joints made by fillet welding electrodes.

1 According to Fig. A7.1-1 to A7.1-8: $P_{1d}$ — butt joints in horizontal position; $P_{1v}$ — butt joints in vertical position; $P_{1h-v}$ — horizontal butt joints in vertical plane; $P_{10}$ — butt joints in overhead position; $P_{2h}$ — angular joints in horizontal position; $P_{2v}$ — angular joints in vertical position; $P_{20}$ — angular joints in overhead position.

2 May be supplemented by dye-penetrant or magnetic particle methods.

3 The River Register determines test assembly areas from which test specimens shall be machined.

4 The test assembly diameter is determined proceeding from the structure type.

5 For obtaining weld approval in piping constructions.

Note: $t$ — sample thickness.

---

Fig. A7.1-1. Sample $P_1$

Fig. A7.1-2. Sample $P_2$

Fig. A7.1-3. Sample $P_3$
Fig. A7.1-4. Sample $P_a$
Fig. A7.1-5. Sample $P_3$
Fig. A7.1-6. Sample $P_u$
Fig. A7.1-7. Sample $P_7$

Fig. A7.1-8. Sample $P_8$
## Table A7.2

### Scope of tests for receiving automatic welding permit

<table>
<thead>
<tr>
<th>Item</th>
<th>Thickness or diameter, mm</th>
<th>Type of test assembly</th>
<th>Type of inspection and quality estimation</th>
<th>Visual</th>
<th>Radiographic (ultrasonic)</th>
<th>Destructive&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plates</td>
<td>(0.5÷2) t</td>
<td>$P_t$</td>
<td>According to Table 8.3.2-1 Part X RCCS</td>
<td></td>
<td>According to 8.3.3 Part X RCCS — mark III</td>
<td>Four bend test specimens according to 5.3 and 6.1 Appendix 12 Part X RCCS</td>
</tr>
<tr>
<td>Pipes</td>
<td>$\geq 0.5D$</td>
<td>$P_3$</td>
<td>According to Table 8.3.2-2 Part X RCCS</td>
<td></td>
<td></td>
<td>Four bend test specimens according to 5.3 Appendix 12 Part X RCCS</td>
</tr>
<tr>
<td></td>
<td>(0.5÷2) t</td>
<td>$P_4$ (P&lt;sub&gt;6&lt;/sub&gt;)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> May be supplemented by dye-penetrant or magnetic particle methods.

<sup>2</sup> River Register determines sections of samples for cutting sample manufacture material.

**Notes:**

1. t — thickness of the test assembly, D — diameter of the test assembly.
2. To be chosen according to the welding procedure and the availability of automatic welding equipment.
STANDARD LIST OF TECHNICAL DOCUMENTATION SUBMITTED TO THE RIVER REGISTER FOR APPROVAL

This Appendix determines the lists of technical documentation submitted to the River Register for approval.

The specified lists are generic and determined by design organization (manufacturer) on agreement with the River Register depending on the design features of ships and ships' elements.

The operating documentation for the ship machinery construction items, electrical, radio and navigation equipment is submitted with due regard to the Nomenclature. The documentation scope is determined by the design organization on agreement with the Branch office.

The documentation marked with * and all the operating documents shall be stamped APPROVED. The documentation not marked with * in Sections 1 to 5 of this Appendix shall be stamped TAKEN INTO CONSIDERATION.

1 Technical design

1.1 The technical design of a ship shall include the following general design documents:

.1 list of technical design documents;
.2 explanatory note to the design;
.3* specification including Section for prevention of pollution from ships;
.4* list of equivalents to the requirements of the Rules (if admitted) with substantiation;
.5* program and method of acceptance trials for the prototype ship of the series (submitted after approval of engineering design);
.6* loading, unloading and ballasting instructions for a cargo ship (submitted after clarifying the mass loads while detailed designing);
.7* stability and floodability data (submitted after clarifying the mass loads while detailed designing);
.8* general arrangement plan indicating the technical means, devices and equipment:
   side view;
   inboard profile specifying the watertight bulkheads, decks, platforms and other elements;
   plans of decks, holds, bridges, platforms and other elements;
.9* general arrangement plan of equipment in wheelhouse;
.10 arrangement plan of explosion and fire hazardous areas and rooms (if any);
.11 lines drawing of a ship's hull;
.12 calculations of mass loads and centre of gravity position, trim and initial stability for various loading conditions;
.13 static and dynamic stability diagrams with table of heeling and capsizing moments and heel angles for various loading conditions (calculation of stability diagram arms may be omitted) stability assessment for various loading conditions initial data tables when calculating by means of software applications;
.14 calculation of ships floodability in accordance with the requirements of 4.2 Part I RCCS, initial data tables when calculating by means of software applications;
.15 freeboard calculations;
calculations of ship maneuverability including maneuverability table;
.17 calculations of gross tonnage;
.18 list of materials, components and equipment to be delivered with documents specified in 2.2.6.

1.2 The technical design shall contain the following hull documentation:
.1* midship section and hull cross-sections with the main framing members;
.2* design drawing of hull and superstructures engaged in global bending, with framing table;
.3* shell expansion for ships with sophisticated hull shape;
.4 calculations for selection of design and dimensions of the hull members, initial data tables for calculating by means of software applications;
.5 calculations of global and local vibration;
.6 calculation of strength and stability of hull members (for single-hull steel ships and catamarans over 50 m in length, ships with hull made of light alloys, hydrofoils, hovercraft and ships with plastic hull);
.7 initial data table for calculating by means of software applications;
.8 calculations of hull strength (for ships with reinforced-concrete hull);
.9 calculations of transverse ship strength (for undecked cargo ships and ships with ratio \(B/H\) exceeding the prescribed value);
.10 calculation of superstructure strength (for passenger ships with large window cut-outs);
.11 general view of ship hatchway cover with strength calculations of hatchway covers and main drive components;
.12 calculation of hull global strength at the end of the ship’s service life;
.13 calculation of icebreakers’ ice strength.

1.3 The engineering design shall contain the following documentation for equipment and room insulation:
.1 data on the used finishing, structural and insulation materials indicating their installation places, burning quality, quantity of combustible materials per 1 m² of each room floor area;
.2* room insulation and furnishing diagram.

1.4 The technical design shall contain the following documentation for ship arrangements:
.1* arrangement plan of signal means and navigation lights;
.2 selection of device elements and outfit items according to the Rules, or calculations substantiating the selection of these elements;
.3* general arrangement plan of new-type devices.

1.5 The technical design shall contain the following documentation for power unit and systems:
.1* arrangement plan of the main and auxiliary engines and equipment in the machinery spaces and central control station rooms with indication of the passages and escape routes according to 1.9 Part IV RCCS;
.2* shafting with stern-tube, propeller (steering thruster), shafts and couplings;
.3 calculation of shafting (including torsional vibrations), propeller and selection of shafting elements according to the Rules;
.4* schematic diagrams (indicating operating parameters, diameter, pipe wall thickness, pipe materials, valves and fittings) of cooling, oil, fuel supply, start air, gas exhaust (may be shown on the general view of room), steam pipeline, feed and condensate systems.

1.6 The technical design shall contain the following documentation for ship’s systems:
.1* schematic diagrams (indicating operating parameters, diameter, pipe wall thickness, pipe materials, valves and fittings) of ventilation, fire-fighting, drainage, ballast, bilge oily water removal, oil heating systems; hydraulic pneumatic actuator system of auxiliary technical means and deck mechanisms; liquefied gas domestic facility; air, overflow and measuring pipelines; compressed air system; oily water pumping, delivery and discharge system;
.2 calculation of ship's ventilation, firefighting, bilge, ballast, compressed and start air systems;
.3 calculation of tanks capacity of the oily water pumping, delivery and discharge systems.

1.7 The engineering design shall contain the following documentation for refrigerating plant:
.1* general arrangement plan of refrigerating plant;
.2* schematic diagrams of coolant, coolant fluid, ventilation, air cooling and cooling water systems, and control, monitoring, alarm and protection systems;
.3 main calculations for refrigerating plant.

1.8 The technical design shall contain the following documentation for oil tankers (in addition to the documents stated in 1.5 and 1.6 of this Appendix):
.1* arrangement plan of equipment in pump room;
.2* schematic diagrams of cargo handling, stripping, inert gas and vent systems.

1.9 The technical design shall contain the following documentation for automation:
.1* arrangement plan of the main remote control and automation means (control stations and consoles);
.2* schematic diagrams and organizational charts of the remote control, automation and warning alarm systems of the main ship's technical means and systems with indication of the power supply sources;
.3* schematic diagrams of fluid level alarm of the oily and sewage waters pumping, delivery and discharge systems.

1.10 The technical design shall contain the following documentation for electrical equipment:
.1* circuit diagrams of electrical power distribution from main and emergency sources: power mains, lighting (to section switchboards);
.2* circuit diagrams of main and emergency switchboards, control desks and switchboards of non-standard design;
.3* circuit diagrams of electric drives for ship equipment stated in 5.3.1, 7.5 to 7.10 and 4.2 Table 4.5.2 Part VI RCCS;
.4* circuit diagrams of main and emergency lighting mains;
.5* circuit diagrams of navigation and signal lights;
.6* circuit diagrams of general and fire alarms;
.7* circuit diagrams of the main current, excitation, control, monitoring, signal, protection and interlock of electric propulsion plant;
.8* earthing diagram for ships with non-conductive hulls;
.9* diagram of lightening conductors (may be shown on ship's general view);
.10 calculation of the required power plant capacity to ensure all ship's operation modes, substantiation for selection of generator quantity and capacity as well as calculation of capacity of emergency power supply sources;
.11 calculation of cable cross-sections with indication of their grades, currents and protection degree;
.12 calculation of short-circuit currents and voltage changes;
.13 calculation of dynamic and thermal capacity at short circuit (at nominal power of generator or parallel operating generators over 100 kW) for buses, communication and protection hardware of the main distribution switchboard and cables of essential devices;
.14 lightning protection calculation;
.15 list of measures to ensure electrostatic and galvanic sparking safety (for oil tankers).

1.11 The technical design shall contain the following documentation for communication and navigational equipment
.1* electric block diagram of navigational equipment, radio communication means, public address system, voice communication means, onboard internal communication equipment, receivers of broadcasting station signals (audio and video broadcasting stations) and broadcasting satellite service;
.2* drawings (not less than two views) showing arrangement of equipment in rooms
intended for the installation of radio and navigational equipment;

.3* arrangement drawings of antennas (three views) may be shown on ship’s general view;

.4 calculation of MF/HF antenna parameters and radio range;

.5* arrangement drawing of the main/steering (reserve) marine compass.

1.12 The technical design shall contain the following documentation for equipment for prevention of pollution from ships:

.1* plans of arrangement of equipment and devices for the prevention of pollution from ships;

.2* calculations of the navigation autonomy due to ecological safety conditions;

.3* schematic diagrams of oily and sewage waters pumping, delivery and discharge systems including collecting tanks and standard discharge connections;

.4 technical description and operation principle of water supply and discharge systems;

.5* onboard test program of the equipment;

.6* diagram of sealing stop fittings of overboard discharge system for oil-containing and sewage water;

.7* diagram of collection system for leaking fuel and oil;

.8* for oil tankers (except for documents stated in 1.12.1 to 1.12.7) the following documents shall be submitted:

- calculations of the capacity of cargo, settling and pure ballast tanks;
- the diagram of location of all tanks on board of a ship;
- the diagram of compartments subdivision and emergency stability calculations;
- the diagram of emergency oil pumping;
- the diagram of location discharge outlets;
- the diagram of oil residues pumping system to the settling tank;
- operating manual for tanks intended for pure ballast (if applicable);
- operating manual for the automatic monitoring control system for ballast and washing water discharge;

.9 operating manual for emergency oil spill localisation pack.

2 Technical documentation for ship conversion, modernization, re-classification and repair

2.1 The technical documentation shall be submitted for those parts of hull, ship’s technical means and equipment which subject to conversion, modernization, restoration or repair.

If the characteristics of strength, stability, manoeuvrability, etc. are changed due to ship conversion, the correspondent calculations or substantiations shall be submitted.

2.2 When changing the hull design, converting or modernizing a ship, the technical documentation in a scope specified for the ship under construction (see 1) shall be submitted to the River Register.

2.3 In order to re-classify a ship, the following documentation shall be submitted to the River Register:

.1 explanatory note with substantiations for re-classification;

.2 analysis of ship compliance with the RCCS requirements for a new class for all ship elements;

.3* list of equivalents to the Rules requirements for a new class, with substantiations;

.4 analysis for compliance with the requirements of international normative documents (for ships engaged on international voyages). The following documents shall be submitted for reference:

- .5* supplement to specification;
- .6* test program;
- .7* instruction on loading and unloading or related supplement;
- .8* stability and floodability data or related supplement;
- .9 global and local strength calculations;
- .10 additional calculations for selection of reinforcements and hull scantlings;
- .11 freeboard calculation and load line drawing;
- .12 substantiations confirming the capability to operate the main engines, propulsion
and steering unit and ship's power plant without degradation of their technical characteristics determined by the delivery documentation and the Rules;

.13 technical documentation for ship reclassification related to hull reinforcement, further equipment and outfit including general arrangement drawings;

.14 calculations of ship maneuverability including maneuverability table;

.15 special standard values of residual thicknesses and local residual deformations that differ from those prescribed by the RSSS;

.16 technical documentation from the list specified in 1.12 when such a documentation is required due to installation of new equipment for prevention of pollution from ships, the availability of which prescribed by the RSSS, if an inland navigation ship is reclassified to О-ПИ, М-ПИ or М-СП class.

3 Project of ship passage outside the specified navigation area

3.1 The ship passage project includes:

.1 explanatory note with indication of passage area and conditions, description of measures for ensuring the passage safety (including organizational measures);

.2 calculation of strength, stability and freeboard required by the Rules for passage area and conditions;

.3 drawings of hull and superstructure reinforcements;

.4* drawings and diagrams of opening covers in hull and superstructures as well as installation of structures to improve seakeeping (rakes, protection of superstructures, wheelhouses and other technical solutions for ship conversion);

.5* drawings of towing and/or pushing arrangements, arrangement plan of towing bitt;

.6* arrangement drawings of navigation lights and daytime signals of the towed ship;

.7 description of power plant, electrical, radio and navigation equipment;

.8 description of steering, anchor, mooring arrangements, fire protection, life-saving appliances and signal means;

.9* list of emergency outfit and its arrangement plan;

.10* guidance to the master of the passed ship or tugboat including the specified weather limits, instructions on ship ballasting, consumption of ship's stores and damage control in case of emergency.

4 Technical documentation for preparing a ship for transportation of bulky and/or heavyweight cargoes

4.1 The documentation shall include:

.1* arrangement plans of the transported cargo with indication of dimensions, centre of gravity coordinates and weight of each cargo unit, fastening methods and means (distance bars, stops, lashes, etc.);

.2* arrangement plans of navigation lights and lightening conductor, if they are subjected to alterations;

.3* reinforcement drawings — bulkheads and partial bulkheads, trusses, web girders, support structures distributing the load from cargo; leveling platings, arrangements for prevention of cargo shift when rolling and mooring;

.4 additional calculations of global and local strength of a ship and specific loads on support structures with regard to load distribution irregularity when handling and transporting the cargo. When determining the local loads from the concentrated cargoes inertial loads due to rolling are considered;

.5 calculations of anchoring strength and related forces with regard to inertia forces when rolling and mooring. The anchoring may be omitted, if friction force exceeds shearing forces. Based on the strength calculations the permissible pressure limit on support surface of the cargo or along the leveling platings is determined;

.6* additional guidance on handling the equipment developed on basis of the strength and stability calculation results indicating the capability and requirement of ballasting as well as indicating the sequence, method and
diagram of handling with drawings of additional structures;
7* additional stability data drawn up based on calculation of stability, floodability and trimming. When checking the emergency stability, the requirements of Part II RCCS shall be met;
8* guidance to the master for ensuring the cargo transportation safety including organizational measures, transportation route, specified weather limits.

5 Technical documentation
5.1 The technical documentation for internal combustion engines and reduction gears shall include:
1* specifications;
2* general view drawings and essential component drawings;
3* schematic diagrams of fuel, lubricating, cooling, starting, electric equipment, remote control, automation, gas control alarm and protection systems;
4* programs of bench tests and test to verify engine exhaust gas compliance with normative values of harmful substances and opacity;
5* strength calculations of essential engine components, calculations of crankcase ventilation arrangement and safety valves, data on the maximum and average specific pressures in bearings (main, crankpin, thrust bearings), strength calculation of shafts and reduction gear tooth, calculation of reduction gear bearings, calculation of torsional vibrations in links of the planned torsional system;
6 technical data sheet of emissions (not applicable to reduction gears).

5.2 The technical documentation for the retrofitted engines shall include:
1* specifications for the retrofitted engine;
2* general view drawing of the converted engine with all assemblies and components included in conversion work scope;
3* test program;
4 copy of specifications developed and issued by the Manufacturer of basic engine to be retrofitted;
5 technical data sheet of emissions.

5.3 The technical documentation for steam and water boilers shall include:
1* specifications;
2* assembly drawing with longitudinal and transverse sections in scale not less than 1:10 and connections in scale of not less than 1:2;
3 calculation of boiler strength in accordance with the Strength Calculation Manual for Boilers, Heat Exchangers and Pressure Vessels;
4 calculation of safety valve cross-sections;
5* assembly and welding procedures;
6* schematic diagrams of warning alarm and protection automation;
7* program of testing a specimen and serial item.

5.4 The technical documentation for cargo handling gears shall include:
1* specifications;
2* general view drawings of cargo handling gear, bearing metal structures, machinery;
3 kinematic diagram;
4* schematic diagrams of electrical equipment;
5 diagrams of safety arrangements and means (describing their operation principle);
6 calculation of forces and stresses in components of the cargo handling gears;
7* program of testing a specimen and serial item.

5.5 The technical documentation for coupling equipment shall include:
1* specifications;
2* bench test program;
3* assembly drawings of lock and tensioning station;
4* essential component drawings;
5 calculation of components strength.

5.6 The technical documentation for deck machinery and ship auxiliary equipment shall include:
1* specifications;
Appendix 8

.2 general arrangement drawings;
.3 assembly drawings of essential components;
.4* schematic diagrams of control, gas control alarm automation and protection;
.5* calculations agreed in the Rules;
.6* program of testing a specimen and serial item.

5.7 The technical documentation for steerable and fixed propellers shall include:
.1* specifications;
.2 general arrangement drawings;
.3 assembly drawings of essential components;
.4* schematic diagrams of electrical equipment, hydraulic, lubricating, alarm and protection systems, kinematic diagram (if they are not presented in specifications);
.5* calculation of input (primary) and output shafts, gear drives, calculation and selection of bearings;
.6* program of testing a specimen and serial item.

5.8 The technical documentation for gear and hydraulic drives shall include:
.1* specifications;
.2* general view drawings with sections;
.3kinematic diagram;
.4calculations agreed in the Rules;
.5schematic diagram of control, gas control alarm automation and protection;
.6* program of testing a specimen and serial item.

5.9 The technical documentation for electrical equipment shall include:
.1* specifications;
.2* electric schematic diagrams, diagrams of automation, gas control alarm and protection;
.3 calculations agreed in the Rules;
.4* program of testing a specimen and serial item.

5.10 The technical documentation for communication and navigation equipment shall include:
.1* specifications;
.2* program of testing a specimen and serial item;
.3 diagrams.

5.11 The technical documentation for equipment for prevention of pollution from ships shall include:

For filtering equipment:
.1 technical description and operation principle of separator or filter, operating and maintenance manual;
.2* specifications;
.3* general arrangement drawings with sections (separator or filter design with main dimensions, used materials and coatings);
.4* assembly drawings of pumps and other devices being a part of filtering equipment;
.5* drawings of welded joints (in casings, base frame and other parts) containing welding data;
.6* diagrams of maintenance systems within the filtering installation;
.7* principal electrical circuit of the installation as well as control, adjustment, monitoring, alarm and safety diagram;
.8* program of testing a specimen and serial item;
.9 list of the essential elements with mechanical characteristics of the material and test hydraulic pressure;

For alarm device:
.10* technical description indicating the operation principle and technical parameters, operating manual, reliability data;
.11* specifications;
.12* general arrangement drawings;
.13* specification indicating used materials and assembling parts;
.14* principal and function diagrams;
.15* program of testing a specimen and serial item;

For automatic monitoring and control systems for ballast and washing water discharge:
.16* technical description indicating the operation principle and technical parameters, operating manual, and reliability data;
.17* specifications;
.18* general arrangement drawings;
specification indicating used materials and assembling parts;

principal and function diagrams;
drawings of fittings for emergency shut-off the discharge;

For sewage treatment plant:
technical description and operating manual;
specifications;
general arrangement drawings with sections (the design, the main dimensions, used materials and coatings);
principal electrical circuit;
control, adjustment, monitoring, alarm and safety diagram;
program of testing a specimen and serial item;

For incinerator:
technical description and operating manual;
specifications;
general arrangement drawings with sections (the design, the main dimensions, used materials and coatings);
general drawing arrangement of atomisers;
drawings of loading unit;
diagram of fuel system within the installation;
principal electrical circuit;
control, adjustment, monitoring, alarm and safety diagram;
program of testing a specimen and serial item;

For garbage container (removable):
technical description;
specifications;
general arrangement drawings with sections (the design, the main dimensions, used materials and coatings);

For garbage treatment plant:
technical description and operating manual;
specifications;
general arrangement drawings with sections (the design, the main dimensions, used materials and coatings);
principal electrical circuit.

Operating documentation for a ship to be agreed with the Branch Office

The following drawings and documents for hull and superstructure are submitted to the Branch office for approval:

midship section and cross-sections;
design drawing of hull with framing table;
design drawing of superstructures;

Note: Hereinafter the "superstructures" means superstructures and wheelhouses engaged in global bending of a ship.

shell expansion of hull and inner sides;
deck and inner bottom plating;
diagram book of standard assemblies and structures for hull and superstructure;
welding table;
diagram of welds radiographic inspection;

stems, keels, propeller brackets, stern-tubes, sleeves, fixed nozzles;
two-dimensional sections of decks, platforms, bottom sides, longitudinal and transverse watertight bulkheads, inner sides and double bottom plating, except for identical sections within the area of cylindrical section;
three-dimensional sections of double bottom, extremities of ship and superstructures, except for identical sections of the double bottom and double sides within the area of cylindrical section;
blocks of ship hull;
foundations under the main engines, thrust bearing, coupling equipment, cargo cranes;
cargo, deck, escape hatches and skylights and their covers, watertight doors, windows, scuttles and other hull fittings according to the Nomenclature;
bulwarks and guard rails, metal fender bars, pushing stops, coupling girders;
arrangement plan of manholes, ladders, external exits indicating the coaming height and overall dimensions;
arrangement plan of bottom inlets and scuppers;
fire-proof bulkheads and doors;
.19 guidance and diagram of hull tightness test;
.20 assembly and welding procedures for manufacturing standard and sophisticated assemblies, sections, blocks, procedure for hull assembly on slipway;
.21 hull and superstructure blocking plan;
.22 load line and draught scales;
.23 diagram of process cut-outs and openings;
.24 welding and welding-in procedure of thick-walled and forged items (brackets, stems, stern-tubes, thrusters' pipes).

For the reinforced-concrete hull, the following drawings are submitted additionally:
.25 section connections;
.26 reinforcement of monolithic areas of sections;
.27 reinforcement of ship hull in areas of cut-outs, installation sites of ship machineries, devices and hull fittings;
.28 installation drawings of embedments.

6.2 For the steering gear and thruster, the following documentation (drawings) shall be submitted to the Branch office for approval:
.1 general arrangement plan of steering gear;
.2 rudder, rudder stock, quadrant, main and reserve rudder drives, steerable nozzle, damper on waterjet-propelled ships, installation of rudder, nozzle, rudder shaft tube, mainpiece, rudder stock bearings, tiller, rudder angle limiters and nozzles;
.3 general arrangement plan of thruster.

6.3 For the anchor arrangement, the following documentation (drawings) shall be submitted to the Branch office for approval:
.1 general arrangement plan of anchoring arrangement;
.2 senhouse slip fastening;
.3 anchor hawses;
.4 remote-controlled anchor release device.

6.4 For the life-saving appliances, the following documentation (drawings) shall be submitted to the Branch office for approval:
.1 general arrangement plan of boat appliance;
.2 davits, their fastenings and tackles;
.3 lifeboats and their securing in the stowing for voyage;
.4 life-saving buoyancy aids (liferafts, benches, etc.) and their arrangement plans.

6.5 For the mooring and towing arrangements, the following documentation (drawings) shall be submitted to the Branch office for approval:
.1 general arrangement plan of mooring and towing arrangements, towing hook, arches, towing rope frame limiters, bitts, hawses;
.2 remote and local towing rope release device.

6.6 For the coupling arrangement, the following documentation (drawings) shall be submitted to the Branch office for approval:
.1 general arrangement plan of coupling arrangement;
.2 installation of coupling arrangement;
.3 installation drawings of release drives.

6.7 For the hydrofoil system, the following documentation shall be submitted to the Branch office for approval:
.1 drawings of bearing planes, stays, brackets, stabilizers, flaps;
.2 assembly drawings;
.3 installation diagram of hydrofoil system.

6.8 For the bending arrangements, the following documentation (drawings) shall be submitted to the Branch office for approval:
.1 general arrangement plan of bending arrangement;
.2 hydraulic cylinders, rotating frame, pump station, thrust metal structures;
.3 design of arrangement components connecting to ship hull (foundations, hull reinforcement).

6.9 For the cargo hatch covers, the following documentation shall be submitted to the Branch office for approval:
.1 general arrangement plan of hatchway cover;
.2 design drawings of hatchway cover;
For the cargo handing gears, the following documentation shall be submitted to the Branch office for approval:

1. general view drawing of cargo handing gear;
2. drawing of control cabin with equipment;
3. drawings of assemblies and components: of metal structures (derrick, gauge head, foundation of thrust-rotating arrangement, stay of fixed units, levers and tie rods of counterbalances, guy ropes of gauge head, etc.), gear assemblies (lifting, locking, turning, change in radius and transfer), lifting capacity limiter assembly, radius indicator, hook assembly, attachments of guy and cargo ropes, attachments of slip ring unit, installation of limit switches, units, hooks, fencings;
4. process documentation for installation.

For the systems, the following documentation shall be submitted to the Branch office for approval:

1. installation drawings (indicating the operating pressure and hydraulic test pressure) of cooling, lubrication, fuel supply, air supply, vent, steam pipeline, feed and condensate systems of the power plant;
2. drawings of equipment of the system units and ship machineries being a part of the systems (at aggregate design method, except for panels);
3. installation drawings (indicating the operating pressure and hydraulic test pressure) of ship’s ventilation, fire-fighting, drainage, ballast, bilge, oily water discharge, cargo heating systems; hydraulic pneumatic actuators of ship auxiliary equipment and deck machinery; liquefied gas domestic facility; air, overflow and measuring pipelines, compressed air systems;
4. installation drawings of refrigerator machine, refrigerant, air cooling and cooling water systems of the ships fitted with refrigerating plant;
5. installation drawings of cargo handling, stripping, vent systems of the tankers;
6. calculation of steam piping (if available) for thermal expansion including summary table of stresses and safety factors for all the piping sections;
7. assembly drawing of collecting tanks indicating their capacity;
8. assembly drawings of discharge connections with the indication of materials used and hydraulic test pressure.

For the shafting and propellers, the following documentation (drawings) shall be submitted to the Branch office for approval:

1. shafting with stern-tube and propeller;
2. thrust, intermediate and propeller shafts of the shafting;
3. thrust and main bearings;
4. couplings with bolts;
5. stern-tube;
6. propeller shaft lining;
7. propeller;
8. input (primary) and output shafts, gearing, propeller of steerable thruster.

For the power plant, the following documentation shall be submitted to the Branch office for approval:

1. assembly drawings for installation of the main and auxiliary engines, steam and water boilers on the foundations;
2. drawings of silencers and spark arresters.

For automation, the following documentation shall be submitted to the Branch office for approval:

1. schematic diagrams and assembly drawings of remote control systems (with engines, thrusters, pitch changing mechanism, etc.);
2. assembly drawings of control stations and consoles.

For the electrical equipment, the following documentation shall be submitted to the Branch office for approval:

1. electric schematic diagrams of joints and connections, as well as assembly drawings of the main and emergency switchboards, control consoles, section power and light switchboards, monitoring, control and alarm switchboards and panels;
.2 Circuit diagrams of electric drives for ship equipment stated in 5.3.1, 7.5 to 7.10 and 4.2 Table 4.5.1 Part VI RCCS;
.3 Circuit diagrams of electric machines, propulsion plant, ship power plant generators, power mains; lighting, communication and alarm, monitoring, protection, locking and navigation light mains;
.4 Drawings of cable routes throughout all ship rooms and spaces via watertight bulkheads, decks and platforms;
.5 Arrangement and installation drawings of electrical equipment in all ship rooms and spaces with fastenings and earthing units;
.6 Earthing drawings for ships with non-conductive hulls.

6.16 For the communication and navigation equipment, the following documentation shall be submitted to the Branch office for approval:
.1 Arrangement and fastening drawings of antennas, design of antenna leads and their guards;
.2 Arrangement and installation drawings of equipment in all ship rooms and spaces with fastenings and earthing units;
.3 Drawings of routing and fastening cable routes throughout all ship rooms and spaces with fastenings;
.4 Diagrams and drawings of devices for protection of radio signal reception against interference;
.5 Drawings of echosounder trunks, arrangement and fastening of echosounder vibrators and cable routing;
.6 Installation drawing of the main / steering (reserve) marine compass.

6.17 In addition to the documents specified in 6.1 to 6.16, the following documentation shall be submitted to the Branch office for approval:
.1 Specification for ship’s and hull parts, arrangements, engines, shafting, boilers, power plant and ship systems, electrical and radio equipment;
.2 Program (for serial ships) and acceptance trials procedure;
.3 General view and arrangement of ship rooms;
.4 Fire control (general arrangement) plans indicating the following: arrangement of control stations; arrangement of fire-retarding and fire-resistant structures; arrangement of rooms protected by the fixed fire-extinguishing systems, indicating the location of devices and fittings to monitor their operation; arrangement of fire-fighting and emergency appliances; means of access to different compartments, rooms, on decks indicating the escape routes, corridors and doors; arrangement of fire hydrants; diagram of ventilation system including the central fan control system with indication of its location, and fans;
.5 Installation diagram of navigation lights;
.6 List of outfit regulated by the Rules;
.7 Docking plan;
.8 Assembly and welding procedures of ship structures and hull (developed by the Constructor and approved by the Branch office which carries out technical supervision during construction);
.9 Program and procedure of comparative and simulation ship trials;
.10 Summary of the River Register remarks elimination on technical design (without stamping);
.11 List of operating design materials approved by the Branch office.
PERMISSION MAP FOR DEVIATION
FROM TECHNICAL DESIGN, DETAILED DOCUMENTATION,
TECHNICAL DOCUMENTATION FOR MATERIALS OR ITEMS,
PROCESS PROCEDURE

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Drawing No.</th>
<th>Item's component description</th>
<th>Quantity</th>
<th>Shop№</th>
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I ask to permit the further production and acceptance

Deviation content

Deviation causes

Head of Shop (Department)

Conclusion

(organization name)

---------------------------------------------------------------------

Head of Design Department | Chief Technologist (chief welder, chief metallurgist) | Chief Construction Manager of Ship
---------------------------------------------------------------------

Agreed

Representative of QC Department | Representative of Designer | Representative of Customer | Surveyor of the River Register
---------------------------------------------------------------------

Note: The deviation permit shall be agreed with the surveyor only for those structures documentation of which are agreed with the River Register.

Permitted

Chief Engineer
HULL TIGHTNESS TESTING

1 GENERAL PROVISIONS

1.1 Scope of application

1.1.1 This Appendix specifies the procedures and norms of tightness testing (capability of a structure not to pass water or other fluids) of metal hulls of the inland and river-sea navigation ships classified by the River Register.

1.1.2 The Appendix applies to the ships under construction and in service.

1.2 General requirements

1.2.1 The tightness testing which scope includes process exposure on the hull by test mediums with assessing the tightness of structures based on changes of test medium parameters or by detecting places of its penetration are carried out on all the hull structures, equipment, devices and hull fittings which may contact with water or other fluids under operating conditions and in emergency cases stipulated by the calculations and which shall not pass it keeping their serviceability.

1.2.2 In order to carry out the tightness testing, the compartments and hull structures are divided into 2 groups:

.1 group "a": compartments and tanks which during operation are temporary or permanently filled with fluid as well as forepeak, afterpeak, hollow rudders, nozzles, hollow elements of foil arrangements, air boxes, watertight compartments of the motorboats without inner bottom;

.2 group "b": compartments and structures of hull, superstructures and wheelhouses not included in group "a", but according to the operating conditions shall be watertight including dry compartments of floating docks and thruster rooms which shall meet the tightness requirements.

1.2.3 The testing of hull, its compartments and separate structures shall be carried out according to the tightness testing diagram and table developed in accordance with this Appendix and agreed with the Branch office. The tightness testing diagram and table include the design documents defining the Nomenclature, arrangement, test methods and norms of compartments covered by the tightness requirements. When developing these documents provision shall be made to ensure the strength of hull structures and slipway sites according to the conditions of hull flooding testing.

When testing ship hull in floating dock the dock stability is assessed additionally.

1.2.4 All hull members including the inside parts which provide floating of a ship after launching from a slipway as well as structures inaccessible for inspection and defect elimination afloat, shall be tested on the slipway or in dock before ship launching.

Watertight hull structures accessible for inspection over the entire contour when ship is afloat (except for double bottom plating and watertight structures inside the double-bottom space) may be tested afloat, if they were not tested on slipway or in dock.

1.2.5 When performing assembly and welding operations providing the watertight of the hull structures, fittings and equipment
previously subjected to tightness testing, the local and global strength are checked.

Testing conditions and rejection parameters are agreed with the surveyor.

1.2.6 Before tightness testing the quality of welded and riveted joints are checked in accordance with 8 Part X RCCS — for welded joints, OST 5.9367 — for riveted joints of steel structures, OST 5.1031 — for riveted joints made of aluminum alloys.

1.2.7 The surface of tested structures and joints shall be cleaned, and the control surface of the structures shall be dry.

1.2.8 The structures and joints to be subjected to tightness testing shall not be painted, paved and covered with special coatings until completion of testing, except for cases specified in 1.2.9.

1.2.9 Before tightness testing the structures including intersectional connections may be fully primed and painted at the manufacture site meeting the following conditions:

.1 main plates making part of the tight contour shall be at least 12 mm thick, and framing webs restricting the tested contour and welding to the main plates — at least 8 mm thick;

.2 before painting (pavement or applying the special coatings) all the intersectional connections of structures making part of the tight contour are carefully inspected;

.3 before priming and painting butt and tee joints related to the structures of group "a" and located below the waterline are subjected to tightness testing by wetting with petrol or blowing with compressed air;

.4 double-sided welds of tee joints without continuous fusion are subjected to tightness testing by wetting with petrol or blowing with compressed air after the final formation of weld from one side or by applying an air pressure to the closed contour after the welding from both sides;

.5 all operations on the structures related to installation, assembly, welding, leveling, riveting of the hull structures and fittings as well as installation, assembly, welding and riveting of all the saturating parts shall be completed. At the same time, all assembly-welding operations on the structures creating the tested contour from the side of adjacent hull structures shall be completed.

1.2.10 The structures tested and adopted on section of preliminary assembly may be primed and painted, except for section of 30 to 40 mm wide adjacent to the mounting edges. The specified sections may be primed only in case of applying the prime not affecting the welding quality.

1.2.11 The tightness testing of field joints made on slipway is carried out by wetting with petrol or blowing with compressed air before its priming.

1.2.12 The structures not subjected to tightness testing after their assembly which are designed to be located outdoor during the extended period of time may be primed with one layer, except for the intersectional welded connections and sections of 30 to 40 mm wide from each weld side.

1.2.13 If the shipyard provides stable manufacture quality of the hull structures, upon agreement with the Branch office the flooding testing of ships in a series may be replaced by air pressure testing which conditions are specified in note 1, Table A10.4.1.

Prior to make a decision to carry out tightness testing of the structures by applying an air pressure, verification calculation of the tested structure strength shall be made.

If the design strength is insufficient to perceive the excessive pressure equal to 30 kPa, the air pressure may be reduced to 20 kPa upon agreement with the Branch office.

Other test methods may be used observing the requirements given in 3.7 of this Appendix.

2 TEST CATEGORIES

2.1 General

2.1.1 The test categories are determined by the scope and methods of tightness testing of the hull structures as well as hull fittings,
equipment and devices depending on the structure purpose and process sequence of its formation. The testing is divided into 3 categories: preliminary, main and verification.

2.1.2 Local tightness testing includes the tightness testing of an eliminating point of penetration defect.

2.1.3 General tightness testing includes the tightness testing of the entire structure using the methods specified for items' group to which this structure refers.

2.2 Preliminary testing

2.2.1 The preliminary tightness testing of intersectional connections of the hull structures are carried out while manufacturing the hull sections and blocks in order to decrease the test scope on the slipway.

The scope and methods of the preliminary structure testing are determined by the shipyard in accordance with the adopted construction technique.

2.2.2 The preliminary testing of the structures which will further be assembled and welded (except for assembly and welding along the mounting edges) are taken as the main testing, if the methods and norms of this testing comply with the methods and norms of the main testing.

2.2.3 Technical supervision for the preliminary testing is carried out by the surveyor by way of performing a sampling inspection.

2.3 Main testing

2.3.1 The main tightness testing is carried out by flooding in accordance with the testing diagram and table (design documents determining the nomenclature, arrangement, methods and norms of testing the compartments and structures covered by the tightness requirements) agreed with the Branch office.

2.3.2 Before the main tightness testing the assembly and welding as well as straightening operations of the structures included in the watertight contour to be tested shall be completed.

2.3.3 Technical supervision for the main testing is carried out according to Table A10.4.1.

2.4 Verification testing

2.4.1 The verification tightness testing of the compartments and structures of group "a" designed to store liquids is carried out by applying an excessive air pressure of 20 kPa upon completion of installation workmanship from both sides of the tested structures in accordance with testing diagram and table agreed with the Branch office.

2.4.2 The verification testing of tankers' tanks and cargo holds by flooding under pressure is carried out while checking the standard pumps and systems during the mooring and running trials.

2.4.3 Technical supervision for the verification testing is carried out by sample inspections. The verification testing is carried out witnessed by the surveyor.

3 TEST METHODS

3.1 Flooding testing

3.1.1 Hydrostatic pressure (head) during the flooding tightness testing is specified in accordance with the requirements given in Section 4 of this Appendix and determined in the testing diagrams and tables (see 1.3.3).

3.1.2 When checking the compartments and structures for which the testing head exceeds the structure height, in order to create the required head in the tested structure the head funneled pipe or rubber hose of at least 25 mm in diameter is installed. The standard air and measuring pipes may be used.

The pressure corresponding to the specified hydrostatic pressure may be created by means of low-duty booster pumps with diameter of delivery branch of less than 1.25 diameter of the head pipe.

3.1.3 When testing the structures using the head pipe, air-cushions in the upper parts of the tested structures are not allowed. To meet this condition openings of 8 to 10 mm in di-
ameter for air discharge are provided. Upon completion of the testing these openings are welded up and subjected to tightness testing by wetting with petrol or blowing with compressed air.

3.1.4 For testing the process fresh water without pollutants is used. Sea water may be used for testing of all the structures except for fresh water tanks, if the following conditions are met:

1. sea water shall not contain oil contaminates and other pollutants;
2. upon completion of testing and discharge of water the structure surfaces shall be washed with fresh water;
3. time of sea water in the structures shall not exceed two days from the moment of flooding.

3.1.5 The tested structures are inspected 1 hour after the test pressure is established.

3.1.6 Upon completion of testing the water from structures is removed. If pumping arrangements or standard openings are not provided, the water may be removed via the preliminary drilled and temporary plugged openings. Quantity, dimensions, locations of the openings are determined by the technical documentation approved by the surveyor. After discharging the water these openings are welded up and subjected to tightness testing witnessed by the surveyor.

3.1.7 In the event of environmental temperature below 0 °C the testing is carried out using the pre-heated water in the pre-heated structure. The water temperature is selected so that during testing the external surfaces of the tested structure have positive temperature, are not moisten and provide ingress of water through the leakinesses without freezing.

3.1.8 The structures are considered watertight if the tested surface is free from leaks in a form of jet, runs, drops and moisture.

3.2 Testing by water jet under pressure

3.2.1 The tightness testing by water jet under pressure is carried out using an applicator with a nozzle of at least 12 mm in diameter.

3.2.2 The water pressure in the hose shall provide the water jet of at least 10 m high.

3.2.3 The water jet is directed perpendicularly to the tested surface or into the connection when testing the closings. A distance from the nozzle to the tested section shall not exceed 1.5 m, and applicator travel speed along the tested connection shall not exceed 0.2 m/s.

3.2.4 Welded joints may be watered from any side, and riveted joints — only from the side opposite to caulking. If the welded and riveted joints are located vertically, they are watered from bottom to top.

3.2.5 Testing by water jet under pressure is carried out when the ambient temperature is above 0°C.

When the temperature is below 0°C, the testing may be carried out using the water heated to the temperature of plus 40 to 70°C. The tested structure sections are pre-heated to the temperature above 0°C.

3.2.6 The structures are considered watertight if the tested surface is free from leaks in a form of jet, runs, drops and moisture.

3.2.7 Structures and arrangements for closing openings which are not subjected to tightness requirements of the Rules are tested by divergent water jet.

3.3 Air pressure testing

3.3.1 The testing is carried out by applying the excessive air pressure of 30 kPa.

3.3.2 The tested structure shall be provided with two pressure gauges with a scale factor not more than 2 kPa as well as with a safety valve.

The liquid differential pressure gauges may be used.

The connections for pressure gauges, safety valves and air hoses are arranged on the opening covers, temporary plugs or in other places accessible for maintenance.

3.3.3 In order to stabilize the air pressure before testing, the time when the structure is
Appendix 10

under pressure starts 15 min after the end of supplying air to the compartment.

3.3.4 During air pressure testing of welded joints and other connections using a brush or compressed air the polymeric foaming agents are applied in order to detect the air leakage points based on occurrence of firm bubbles and foam envelopes as well as change of colour. If the polymeric foaming agents are not available, small structures may be tested using foaming agents in the form of soap emulsions.

3.3.5 Welded joints and structures tested at ambient temperatures below 0°C are dried by heating up to complete removal of water before wetting with an antifreezing foaming agent.

3.3.6 The defective points are marked on the structure with a chalk.

3.3.7 Leakinesses of overlap welds are detected using the polymeric foaming agents by supplying the compressed air under the excessive pressure of 50 kPa into the gap between contacting places via a nozzle screwed into the opening of lining or welded reinforcing pad.

3.3.8 The structure is considered watertight, if when wetting the joints and other connections with foaming agent the air bubbles or foam envelopes do not occur, and the pressure drop after conditioning for 1.0 hour does not exceed 5%, and for the structures intended for storage of diesel fuel and/or other light oil products — 1%.

3.3.9 Upon completion of testing the polymeric foaming agents are removed from the structure surface using water or a wet cloth.

3.4 Testing by wetting with kerosene

3.4.1 The tightness testing by wetting with kerosene is carried out in order to monitor the welded joints (except for overlap welds).

3.4.2 When testing by wetting with kerosene, the monitored side of the welded joint is covered with a chalk solution. The welds are wetted with kerosene from the opposite side when the chalk solution is dried. The kerosene is applied by a paint brush or a pad.

If the chalk solution is water-based, after the applying on the welded joints it is dried. Upon completion of testing, the chalk covering is removed by a cloth.

3.4.3 At ambient temperature below 0 °C the monitored welded joints are heated up to positive temperature and dried.

The chalk solution is antifreeze-based and keeps the white colour.

3.4.4 The hold time when testing butt and single-sided angle or tee joints with kerosene is determined depending on the thickness of joint’s plate or leg and its space position according to Table A10.3.4.4.

<table>
<thead>
<tr>
<th>Thickness of joint’s plate or leg (mm)</th>
<th>Hold time (min.) at joint’s position</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>vertical and horizontal</td>
</tr>
<tr>
<td>&lt;6</td>
<td>40</td>
</tr>
<tr>
<td>6-24</td>
<td>60</td>
</tr>
<tr>
<td>&gt;24</td>
<td>90</td>
</tr>
</tbody>
</table>

When testing the angle and tee joints with double sided welds as well as at negative ambient temperature, the hold time is doubled.

3.4.5 The structure is considered watertight, if on the monitored surface covered with chalk solution the kerosene marks do not occur.

3.5 Testing by blowing with compressed air jet

3.5.1 The testing by blowing with compressed air jet is used as an auxiliary method for local testing: testing of welding points of separate elements and parts, eliminating defective welded joints as well as doors, comings and other elements located inside the hull and superstructures.

3.5.2 When testing by blowing with compressed air jet, the hose pressure shall be 390 to 490 kPa.

The jet is directed perpendicularly to the tested surface. The hose end is fitted with a nipple of 10 to 20 mm in diameter and is lo-
cated at a distance of not more than 100 mm from the tested joint’s surface. The travel speed of the hose nozzle shall be not more than 0.02 m/s. The foaming agents (see 3.3.4 of this Appendix) are applied from a side opposite to blowing proactively (if the polymeric foaming agents are used) or synchronously (if the soap solutions are used).

3.5.3 The structure tightness assessment shall be performed in accordance with 3.3.8 of this Appendix.

3.6 Testing by divergent water jet

3.6.1 The tightness testing by divergent water jet is used to check the tightness of decks, platforms, doors and hatch covers. The divergent water jet is a descending jet branch released from the applicator upwards by the angle to the horizon.

3.6.2 When testing by divergent water jet, the requirements specified in 3.2.4 to 3.2.6 of this Appendix shall be met.

3.7 Testing by other methods

3.7.1 The methods of hull tightness testing other than those specified in 3.1 to 3.6 (e.g. luminescent method, air pressure using the leak seekers, vacuum method) may be used after experimental tests under supervision of the River Register. When selecting the test method, its application shall be specified: main and/or replacing, hull structures, types of connections and main parameters of welded joints, thicknesses of welded parts as well as methods of applied welding.

3.7.2 The procedure specification for method other than those specified in 3.1 to 3.5 shall be agreed with the Branch office.

4 METHODS AND NORMS OF TIGHTNESS TESTING

4.1 The tightness test methods and norms are given in Table A10.4.1.

<table>
<thead>
<tr>
<th>Compartments and structures</th>
<th>Methods and norms for ship classes</th>
<th>Additional guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forepeak and afterpeak not intended for flooding</td>
<td>By flooding to a height of 0.3 m above the bulkhead deck or up to level of the upper edge of the hatch coaming (by smaller pressure)¹</td>
<td>By flooding to the load waterline level, above this level — testing by water jet under pressure or wetting with kerosene</td>
</tr>
<tr>
<td>Double-bottom compartments</td>
<td>By flooding up to a height of 0.6 m above the inner bottom plating or to the top of air pipe (whichever provide the greater pressure)¹</td>
<td>By flooding up to a height of 0.35 m above the inner bottom plating or to the top of air pipe (whichever provide the greater pressure)¹</td>
</tr>
<tr>
<td>Double-side compartments</td>
<td>By flooding up to the top of air pipe¹</td>
<td>By flooding up to the top of air pipe¹</td>
</tr>
<tr>
<td>Tanks and compartments outside the double bottom</td>
<td>By flooding up to the top of air pipe, but not below the load waterline¹</td>
<td>By flooding up to the top of air pipe, but not below the load waterline¹</td>
</tr>
<tr>
<td>Storage tanks for liquid oil products of ship store and oily-water</td>
<td>By flooding up to the top of air pipe, but not below the</td>
<td>By flooding up to the top of air pipe, but not below the bulkhead deck¹</td>
</tr>
</tbody>
</table>

¹ Afterpeak is tested with the installed stern and rudder tubes. Tanks located in forepeak and/or afterpeak are tested by flooding up to the top of air pipe.
<table>
<thead>
<tr>
<th>Compartments and structures</th>
<th>Methods and norms for ship classes</th>
<th>Additional guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>collecting tanks outside the double bottom</td>
<td>bulkhead deck&lt;sup&gt;1&lt;/sup&gt;</td>
<td>By flooding up to the top of expansion trunk&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cargo compartments of tankers and cargo holds of other ships which may receive liquid cargo or ballast</td>
<td>By flooding up to the top of air pipe, but not less than 2.5 m from the plating restricting the cofferdam top&lt;sup&gt;1&lt;/sup&gt;</td>
<td>By flooding up to the top of air pipe&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cofferdams</td>
<td>By flooding up to the level of 1.25 of the hull depth, but not less than pressure in the blowing system</td>
<td>By flooding up to the level of 1.25 of the hull depth, but not less than pressure in the blowing system</td>
</tr>
<tr>
<td>Sea chests and ice boxes, sea water boxes</td>
<td>By flooding up to the top of air or overflow pipe</td>
<td>See Note 1</td>
</tr>
<tr>
<td>Independent water, fuel and lubricating oil tanks</td>
<td>By flooding up to the top of air or overflow pipe</td>
<td>When testing the ice boxes (when heating them with vapour), the testing water pressure in all the cases shall not be less than the design pressure in the heating system. For the ships with hull depth less than 5 m, the flooding height is taken equal to 0.5 of the hull depth, but not less than 1.5 m. The verification testing is omitted.</td>
</tr>
<tr>
<td>Black water tanks and sewage water collecting tanks</td>
<td>By flooding with pressure equal to 1.5 water column pressure from the tank bottom to the lower toilet bowl&lt;sup&gt;1&lt;/sup&gt;</td>
<td>For the ships of O class the water column in pipes shall be at least 1 m above the upper point of the tank</td>
</tr>
<tr>
<td>Chain lockers of tankers and swimming pools</td>
<td>By flooding up to the upper edge of the chain locker (pool)</td>
<td>—</td>
</tr>
<tr>
<td>Hollow rudders, cavities of fixed and steerable nozzles, hollow elements of foil arrangements</td>
<td>By flooding&lt;sup&gt;1&lt;/sup&gt; with pressure $p$, kPa, determined by the formula: $p = 12.5T + \frac{v^2}{60}$, where $T$ — draught of a full loaded ship, m;</td>
<td>For the ships of O class, the head shall be not less than for rudders (nozzles) of the ships of O-Π class&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
## Compartments and structures of group "b"

<table>
<thead>
<tr>
<th>Compartments and structures</th>
<th>Methods and norms for ship classes</th>
<th>Additional guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double side compartments not intended for storage of liquids</td>
<td>For ships with double bottom — testing by water jet under pressure above the double bottom level. For ships with single bottom — by flooding up to a height of 0.35 m from the outer bottom plating and testing by water jet under pressure above this level. The bulkheads of serial ships may be tested by wetting with kerosene, the outer shell — by swamping the ship to the draught which is less than draught of a light ship by 0.05 m. The compartments as a whole may be tested by applying air pressure using the polymeric foaming agents.</td>
<td>—</td>
</tr>
</tbody>
</table>
| Vertical cofferdams | By flooding up to the top of air pipe or to the height of hatch coaming (by greater pressure)

1. See Note 2 |

| Cargo holds of dry cargo ships, machinery, boiler and engine rooms | For ships with double bottom — testing by water jet under pressure above the double bottom level. For ships with single bottom — by flooding up to a height of 0.35 m from the outer bottom shell and testing by water jet under pressure above this level. The underwater part of the outer hull shell may be tested by swamping the ship to the draught which is less than draught of a light ship by 0.05 m. | See Note 2 |

| Compartments in tween-deck space Double-bottom compartments | Hose test by water jet under pressure By flooding up to a height of 0.6 m above the double bottom | Hose test by water jet under pressure By flooding up to a height of 0.35 m above the double bottom plating

1. See Note 2 |

### Additional guidelines

- **v** — ship’s speed, knots. The water head shall be at least 50 kPa.
<table>
<thead>
<tr>
<th>Compartments and structures</th>
<th>Methods and norms for ship classes</th>
<th>Additional guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunks of log and echo sounder, air boxes, buoyancy compartments</td>
<td>By flooding up to the level of bulkhead deck&lt;sup&gt;1&lt;/sup&gt;</td>
<td>—</td>
</tr>
<tr>
<td>Thruster rooms</td>
<td>Hose test by water jet under pressure &lt;sup&gt;1&lt;/sup&gt;</td>
<td>—</td>
</tr>
<tr>
<td>Propeller shaft tunnel including enclosures and trunks of emergency exit; tight trunks including trunks of the engine and boiler rooms; ventilation ducts situated inside the hull, superstructures and wheelhouses</td>
<td>Hose test by water jet under pressure ditto</td>
<td>See Note 2</td>
</tr>
<tr>
<td>Chain lockers</td>
<td>ditto</td>
<td>ditto</td>
</tr>
<tr>
<td>Anchor hawses and chain pipes</td>
<td>ditto</td>
<td>ditto</td>
</tr>
<tr>
<td>Superstructures and wheelhouses including open parts of engine and boiler room trunks and funnel casings</td>
<td>ditto</td>
<td>ditto</td>
</tr>
<tr>
<td>Open deck parts of a ship hull, superstructures and wheelhouses outside areas tested by flooding with excessive pressure or applying air pressure</td>
<td>Hose test by water jet under pressure Coamings are tested by water jet or by wetting with kerosene</td>
<td>—</td>
</tr>
<tr>
<td>Coamings of hatches and ventilation pipes situated on the open parts of the upper deck, superstructure and wheelhouse deck</td>
<td>By flooding up to the height of doors' coaming, above this level — testing by divergent water jet. The flooding testing may be replaced by the testing by wetting with kerosene. In winter season the whole area of decks may be tested by wetting with kerosene.</td>
<td>The flooding testing is carried out after completion of installation prior to apply any coatings on decks. Hold time when testing by flooding is 30 minutes.</td>
</tr>
<tr>
<td>Decks and enclosures in the rooms where water may accumulate (showers, bathrooms, washrooms, laundries, galleys, toilette scuppers, etc.)</td>
<td>By flooding up to the height of doors' coaming, above this level — testing by divergent water jet.</td>
<td>—</td>
</tr>
</tbody>
</table>

**Closures for openings in tight hull parts**

1. Doors in watertight

<p>| By flooding up to the level set | — |</p>
<table>
<thead>
<tr>
<th>Compartments and structures</th>
<th>Methods and norms for ship classes</th>
<th>Additional guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>hull bulkheads</td>
<td>M-CTI, M-DP, M, O-DP</td>
<td>O, P, J</td>
</tr>
<tr>
<td></td>
<td>level set for the corresponding compartment</td>
<td></td>
</tr>
<tr>
<td>2. Doors in the external walls of superstructures and wheelhouses</td>
<td>Hose test by water jet under pressure</td>
<td>Testing by water jet under pressure or divergent water jet depending on the structural design prescribed by the project</td>
</tr>
<tr>
<td>3. Doors and closures for openings in the tight structures situated inside superstructures and wheelhouses</td>
<td>Testing by water jet under pressure or blowing with compressed air jet</td>
<td>Testing by water jet under pressure (blowing with compressed air jet) or divergent water jet depending on the structural design prescribed by the project</td>
</tr>
<tr>
<td>4. Shell doors</td>
<td>Hose test by water jet under pressure</td>
<td>Testing by water jet under pressure or divergent water jet depending on the structural design prescribed by the project</td>
</tr>
<tr>
<td>5. Covers of skylights and hatchways, side scuttles of hull superstructures and wheelhouses</td>
<td>ditto</td>
<td>ditto</td>
</tr>
<tr>
<td>6. Covers of openings in the tight decks, platforms and bulkheads</td>
<td>ditto</td>
<td>ditto</td>
</tr>
<tr>
<td>7. Metal closures for cargo holds of dry cargo ships</td>
<td>ditto</td>
<td>ditto</td>
</tr>
<tr>
<td>8. Metal closures for cargo holds of tankers transporting liquid cargoes (including oil products) in holds</td>
<td>Testing of cargo compartments during the main testing</td>
<td>Testing of cargo compartments during the main testing</td>
</tr>
</tbody>
</table>

Notes: 1. If the flooding testing on the slipway or in dock is impracticable, it is carried out after launching. Before launching all the cargo compartments are tested by applying air pressure. One central and two side compartments determined upon agreement with the surveyor are tested by flooding. These compartments are tested simultaneously. The mutual position of the tested compartments shall correspond to the most severe load conditions. If during testing the structure defects or tightness breaks are detected, all compartments shall be tested.

2. The testing by water jet under pressure may be replaced by testing the welded joint by wetting with kerosene (except for overlap welds) or by blowing with compressed air jet. The plate surfaces are carefully inspected. No defects and metal integrity loss are permitted.

3. Methods and norms of the tightness testing during repair and special surveys of ships shall comply with the requirements specified in this Table. Fuel and water tanks are tested by flooding up to the top of air pipe, and cargo compartments and cofferdams of tankers — up to the upper edge of the expansion trunks and hatches. The scope of testing during repair is specified depending on the nature of repair and shall be agreed with the surveyor.
PERMISSIBLE WELDING DEFORMATIONS OF SHELL AND HULL FRAMING AND DEVIATIONS DURING SHIP’S HULL ASSEMBLY

1. Sag values of cambers, ribbing, dents and "boxes" (angular camber) of the hull structures’ shell shall not exceed the values specified in Table A11.1. Sag values of cambers, "boxes" and ribbing of the bottom shell of 4 to 7 mm thick for high-speed craft within spacing shall not exceed 3 mm.

2. Local deformations of the hull framing structures (sags, skewness, wall cambers) shall not exceed the values specified in Table A11.2.

Welding deformations of hull structures outside the limits specified in this Appendix shall be eliminated. The applied correction methods and technique shall comply with the manufacturing procedure of this structure.

3. The permissible deviations during hull assembly are given in Table A11.3.

<table>
<thead>
<tr>
<th>Structure’s group</th>
<th>Hull structure description</th>
<th>Maximum permissible sag value (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>Upper deck plating, double-bottom plating, bottom plating, side plating below the design waterline, upper and lower strakes of continuous longitudinal bulkheads and inner sides, deck plating and superstructures walls (in the middle part of the hull within 0.25 L forward of and abaft the midship), bilge strake of the outer shell and deck stringer (along the ship length)</td>
<td>5</td>
</tr>
<tr>
<td>IIa</td>
<td>Side plating above the design waterline, external walls of superstructures and wheelhouses, open decks, bulwark, enclosures of internal corridors, funnel casings and other structures to the appearance of which the strict requirements are applied</td>
<td>6</td>
</tr>
<tr>
<td>II</td>
<td>Structures of IA group situated in the hull extremities as well as main longitudinal and transverse bulkheads (except for the upper and lower strakes), lower deck platings, platform platings, internal enclosures and light bulkheads</td>
<td>7</td>
</tr>
<tr>
<td>III</td>
<td>Decks (cladded) not included in calculation of global strength and not referred to I and II groups; internal bulkheads and enclosures cladded from both sides; enclosures in store-rooms, holds, engine rooms, shower rooms and other structures to the appearance of which the special requirements are not applied</td>
<td>10</td>
</tr>
</tbody>
</table>
### Table A11.2

<table>
<thead>
<tr>
<th>Deformation description</th>
<th>Monitored framing description</th>
<th>Permissible sag or skewness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulge of flat parts of framing webs</td>
<td>Floors and keelsons of double bottom space</td>
<td>5</td>
</tr>
<tr>
<td>Stiffener's drop</td>
<td>Rest web framing</td>
<td>9</td>
</tr>
<tr>
<td>&quot;Box&quot; in framing web plane</td>
<td>Entire framing</td>
<td>2</td>
</tr>
<tr>
<td>&quot;Box&quot; at framing intersections from framing web plane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skewness between framing web and shell</td>
<td>Entire framing</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Skewness between strake and framing web at h (mm)</td>
<td></td>
<td>≤100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤200</td>
</tr>
</tbody>
</table>

Note: h — framing web height.

### Table A11.3

<table>
<thead>
<tr>
<th>Parameter to be checked</th>
<th>Tolerance permitted</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displacement of edges of jointing shell and plating plates</td>
<td>0.1 of plate thickness</td>
<td>Max. 3 mm</td>
</tr>
<tr>
<td>Deviation from straightness of jointing branches within the length of mounting spacing: vertical keel, stringers, carlings</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>longitudinal stiffeners</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Deviation from straightness of web frame branches jointed with floors and beams within total length up to 1 m</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>Misalignment of any hull members separated by a plate</td>
<td>0.5 of member web thickness</td>
<td>The minimum thickness is taken into account</td>
</tr>
<tr>
<td>Deviation of mounting spacing size</td>
<td>4 % of spacing size</td>
<td></td>
</tr>
<tr>
<td>Offset of bulkhead web relative to underlying framing web</td>
<td>0.5 of framing web thickness</td>
<td></td>
</tr>
<tr>
<td>Vertical deviation of bulkhead plane from station plane</td>
<td>2 mm for 1 m of bulkhead height</td>
<td>Max. 15 mm within the entire height</td>
</tr>
<tr>
<td>Offset of rudder stock axis relative to the centreline plane</td>
<td>&lt;3</td>
<td></td>
</tr>
<tr>
<td>Offset of opening centre in the sternframe from the main shaft axis</td>
<td>&lt;3</td>
<td></td>
</tr>
<tr>
<td>Offset of centre of rudder stock openings in the sternframe from vertical axis</td>
<td>&lt;5</td>
<td></td>
</tr>
<tr>
<td>Deviation of sternframe sole from the main plane</td>
<td>&lt;8</td>
<td></td>
</tr>
</tbody>
</table>
INSPECTION OF ENGINES FOR COMPLIANCE WITH MAXIMUM PERMISSIBLE HARMFUL SUBSTANCE EMISSION AND EXHAUST GASES OPACITY

1 Requirements to fuels and lubricants

1.1 While testing the engine shall operate on fuel and lubricants specified in technical documentation of the engine manufacturer. The specifications of fuel and lubricant used for testing shall be specified in the Test Report.

2 Atmospheric conditions during measurements

2.1 At the testing site, the following parameters shall be measured: atmospheric air temperature at the engine inlet $T_a$, $\text{K}$, atmospheric (barometric) air pressure $p_0$, kPa, considered as sum of partial pressures of dry air and water vapours in atmospheric air as well as relative and absolute air humidity used for calculation of partial pressure of dry atmospheric air.

2.2 Based on the measurement results the design coefficient (atmospheric factor) $F$ is calculated by the formulae:

for naturally aspirated engines, engines supercharged by a PTO supercharger or engines with combined supercharging:

$$F = \left(\frac{99}{p_{dry}}\right)^{0.7} \left(\frac{T_a}{298}\right)^{1.5}; \quad (A12.2.2-1)$$

for engines supercharged by free turbocharger:

$$F = \left(\frac{99}{p_{dry}}\right)^{0.5} \left(\frac{T_a}{298}\right)^{1.5} \quad (A12.2.2-2)$$

where $p_{dry}$ — partial pressure of dry atmospheric air, kPa, calculated by the formula:

$$p_{dry} = p_0 - p_{H_2O} \quad (A12.2.2-3)$$

$\rho_{H_2O}$ — partial pressure of water vapours in atmospheric air at $T_a$, kPa.

2.3 The testing results are considered reliable if during testing $F$ remains within the limits set for engines during:

- onboard testing $0.93 - 1.07$
- bench testing $0.98 - 1.02$

3 Measurement of exhaust gas composition

3.1 The exhaust gas composition is measured for engine operation modes specified in Table A12.3.1 depending on its application. The measurement shall be started with nominal power mode and then the load shall be gradually decreased to the minimum.

3.2 Before measurement the gas analyzers are heated and calibrated in accordance with the manufacturer instruction.

3.3 The gas analyzer indications are read for each mode three times with an interval of not less than 1 minute. The first reading is made not earlier than 2 minutes after the establishing the temperature condition of the engine in the test mode. The results of three sequential readings shall not differ more than by $\pm 3.5\%$. The measurement result is taken as arithmetic mean of three readings. If an event recorder is provided the measurement result is taken as arithmetic mean of continuous recording during 1 minute, if during the entire time of recording the deviations from initial value is not more than $\pm 3.5\%$. 
### Table A12.3.1

<table>
<thead>
<tr>
<th>Engine application</th>
<th>Mode designation</th>
<th>Mode No.</th>
<th>Mode</th>
<th>Relation of crankshaft revolution frequency $n$ to the crankshaft revolution frequency at the rated power $n_{\text{ra}}$</th>
<th>Relation of engine output $P_e$ to its rated value $P_{e\text{rat}}$</th>
<th>Torque (%)</th>
<th>Mode weight coefficient $W$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main engines (except for hydrofoil diesel engines) operating as per propeller characteristic</td>
<td>E3</td>
<td>1</td>
<td>1</td>
<td>1.000</td>
<td>1.00</td>
<td>—</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>0.908</td>
<td>0.75</td>
<td>—</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td>0.794</td>
<td>0.50</td>
<td>—</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>4</td>
<td>0.630</td>
<td>0.25</td>
<td>—</td>
<td>0.15</td>
</tr>
<tr>
<td>Main engines for ships with a length less than 24 m (except for tugboats and pushboats) operating as per propeller characteristic</td>
<td>E5</td>
<td>1</td>
<td>1</td>
<td>0.100</td>
<td>1.00</td>
<td>—</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>0.91</td>
<td>0.75</td>
<td>—</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td>0.80</td>
<td>0.50</td>
<td>—</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>4</td>
<td>0.63</td>
<td>0.25</td>
<td>—</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>5</td>
<td>Idle run</td>
<td>0</td>
<td>—</td>
<td>0.30</td>
</tr>
<tr>
<td>Auxiliary engines with variable load and constant revolution frequency (diesel generators)</td>
<td>D2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>100</td>
<td>100</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td>75</td>
<td>75</td>
<td>0.25</td>
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<tr>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td></td>
<td>50</td>
<td>50</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>4</td>
<td></td>
<td>25</td>
<td>25</td>
<td>0.30</td>
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<tr>
<td></td>
<td></td>
<td>5</td>
<td>5</td>
<td></td>
<td>10</td>
<td>10</td>
<td>0.10</td>
</tr>
<tr>
<td>Main engines operating as per propeller characteristic in mooring mode</td>
<td>—</td>
<td>1</td>
<td>1</td>
<td></td>
<td>100</td>
<td>100</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td>83</td>
<td>83</td>
<td>0.15</td>
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<tr>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td></td>
<td>63</td>
<td>63</td>
<td>0.15</td>
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<tr>
<td></td>
<td></td>
<td>4</td>
<td>4</td>
<td></td>
<td>39</td>
<td>39</td>
<td>0.15</td>
</tr>
</tbody>
</table>

#### 3.4 Simultaneously with measuring the exhaust gas composition the values of engine parameters required for determining the regulated parameters are recorded.

#### 3.5 Upon the engine testing results the Engine Test Report is drawn up in order to confirm the compliance of the engine to the technical regulations of harmful substances emissions and opacity in exhaust engine gases (TOCT P 52408).

#### 4 Processing of measurement results

**4.1** Hourly fuel mass flow is measured for each test mode by methods providing the accuracy of ±5%.

**4.2** The exhaust gas flow $V_{\text{exh}}$ is measured by any direct method followed by reducing to normal atmospheric conditions or is calculated according to the measured values of air and fuel flow for each test mode by the formula specified in 6.2.5 RPPS.

**5 Measurement of exhaust gas opacity by optical method**

**5.1** The exhaust gas opacity is measured in the engine operation modes which are the same for measurement of exhaust gas composition.

The installation diagram of the optical-type smoke density indicator is given in Fig. A12.5.1.

**5.2** Before measuring the smoke density indicator is heated and calibrated according to the reference light filter included in the device set in accordance with the manufacturer instruction.

**5.3** The opacity parameters are measured for each engine operation mode at least three times with an interval between the following measurements of at least 1 minute. After each measurement the zero position of the smoke density indicator arrow is checked and set to the zero position, if required. The measure-
5.4 The measurement results are included in the Test Report.

6 Measurement of exhaust gas opacity by filtration method

6.1 The installation diagram of filtration-type smoke density indicator is given in Fig. A12.6.1.

Before measuring the smoke density indicator is heated and calibrated according to the reflectance standard included in the device set in accordance with the manufacturer instruction.

6.2 A sample is collected in accordance with operation instruction developed by the manufacturer of the smoke density indicator. The sample is passed through a filter which then is removed from the smoke density indicator and replaced with a new one through which a new sample is passed in order to recheck the result and receive its mean value. No moistened or non-standard filters are permitted.

Fig. A12.6.1. Installation diagram of filtration-type smoke density indicator:
1 — straight section of exhaust engine pipeline; 2 — gas sampling probe; 3 — sampling line; 4 — cooler; 5 — smoke density indicator; EG — exhaust gases
6.3 The opacity for each engine operation mode is measured at least three times with an interval between two following measurements of at least 1 minute. After each measurement the zero position of the smoke density indicator arrow is checked and set to the zero position, if required. The measurements are considered valid, if deviations between two last readings as per scale FSN do not exceed \( \pm 0.2 \) FSN, and the results of three measurements do not form a steadily decreasing or increasing sequence. If these conditions are met, the measurement series can be continued until receiving three sequence parameters meeting the specified conditions. The measurement result is taken as arithmetic mean of three readings.

6.4 The measurement results are included in the Test Report.
GUIDELINES FOR TESTING OF TYPE SPECIMENS OF LIFE-SAVING APPLIANCES

1 Lifeboats

1.1 Testing of type specimens of lifeboats includes:
   .1 main dimensions checking;
   .2 lifeboat weight determining;
   .3 freeboard height determining;
   .4 lifeboat strength testing;
   .5 lifeboat tightness testing;
   .6 lifeboat stability testing;
   .7 accommodation capacity checking;
   .8 lifeboat floodability testing;
   .9 removable air boxes testing;
   .10 floodability testing of lifeboat buoyant material;
   .11 strength testing of lifeboat handling gear;
   .12 strength testing of plugging and fastening the handling gear (for plastic lifeboats);
   .13 checking of lifeboat engine operation;
   .14 fire testing (for lifeboats of oil tankers).

1.2 The main dimensions are checked and lifeboat weight is determined as follows:
   .1 in order to measure, a lifeboat is positioned horizontally on level in longitudinal and transverse directions.

   During measurement the following parameters are determined: compliance of thwart height and distance between transverse thwarts, dimensions $L$, $B$, $H$ of lifeboat hull and distance $A$ to the design documentation. Here:

   $L$ — distance between projections on the base plane of intersections of external shell surface and stem and sternframe (transom) at level of lower gunwale edge, m;

   $B$ — maximum width between the external shell surfaces;

   $H$ — side height in the middle of lifeboat from BL to the gunwale edge, m;

   $A$ — distance between axial lines of lifting hooks, m;

   .2 weight of lifeboat fully completed with ship equipment and outfit is determined by weighing. The weighing may be performed using dynamometers secured on the lifeboat hooks.

   1.3 The freeboard height is measured amidships on both sides of the lifeboat in light and fully loaded conditions on still water.

   The outfit and persons weight may be replaced by equivalent load weight. Weight of one person is taken equal to 75 kg, and position of centre of gravity — at a height of 0.3 m above a thwart.

   1.4 The lifeboat hull is subjected to strength testing taking into account the following guidelines:

   .1 lifeboat is hanged by handling gear and loaded with a load distributed at seats for persons with weight determined by the formula, kg,

   $$G_{load} = 0.25G_h + 1.25\left(G_p + G_o\right)$$

   where $G_h$ — weight of lifeboat hull, kg;

   $G_p$ — weight of people, kg;

   $G_o$ — weight of outfit, kg.

   At the same time the keel, keelsons, sheerstrake, bulwark are inspected. The lifeboat is deemed to have passed the testing, if it is free from cracks and other damages.
plastic lifeboat are additionally tested by impact and drop. The lifeboat with a load of weight equal to persons and outfit weight is hanged by lifeboat hooks on slings of 6 m long at a distance of 0.5 m from the lifeboat gunwale to the vertical surface (e.g. concrete walls). The lifeboat is deflected from the vertical surface by 2.5 m and suddenly release. The lifeboat in the same loading condition is dropped from a height of 2.5 m from the lower keel edge to the water surface. Water depth in the test site shall not be less than two side heights of the lifeboat amidships. The lifeboat is deemed to have passed the testing, if it is free from residual deformations, cracks and other damages. The lifeboat not having passed the testing, after eliminating the defects, is allowed to undergo the strength testing again.

1.5 The lifeboat having passed the strength testing is subjected to tightness testing using one of the following methods:

- on keel-blocks — by flooding the hull up to the level corresponding to the draught of the lifeboat fully completed with persons or ballast replacing them and outfit. The lifeboat is deemed to have passed the testing, if during 2 hours after flooding the external surface is free from leakages and drops;
- afloat — at draught corresponding to displacement of the lifeboat fully completed with persons and outfit. The lifeboat floating for 2 hours on even keel and in upright position shall be free from leakages. However, for wooden lifeboats the flooding up to the level of 20 mm from the lower keelson edge is permitted.

The lifeboat not having passed the tightness testing, after eliminating the leakages, is tested again.

In order to test the above water part, the lifeboat on keel-blocks or afloat is alternatively sloped on right and left side so that water achieves the gunwale level. The hold time on each side is 30 minutes. The lifeboat is deemed to have passed the testing, if the monitored surface is free from leakages.

1.6 Stability testing procedure

1.1 The testing is carried out afloat with a load corresponding to the weight of permitted number of persons and outfit. The load is arranged on the places for persons and outfit. Centre of gravity of the load simulating persons is positioned at a height of 0.3 m from thwarts and secured to prevent the offset at heel. The lifeboat shall not have a heel. In order to incline, the load with a weight of 4 to 5% of total water displacement is moved from side to side. When inclining the moment statically inclining the lifeboat by 10° from zero position is determined and compared with the specified in the design documentation.

1.3 The sufficiency of freeboard height is checked. It shall be at least 100 mm when the lifeboat is loaded with 50% of the number of persons permitted to accommodate seated to one side of the centreline.

1.7 Testing by accommodating persons is carried out on the site protected from current, waves and wind. The testing may be carried out at current of less than 0.1 km/h, ripple and wind up to 3 m/s (hereinafter referred to as the calm water).

Persons 75 kg each (in average) are taking seats in lifejackets. The number of persons shall correspond to the design capacity of the lifeboat. The testing results determine if the persons obstruct each other when paddling and if each person is capable to stand up and take the provided outfit.

1.8 During floodability testing the lifeboat with ballast simulating the persons, and outfit is flooded up to the upper gunwale edge. At the same time the freeboard height is measured (it shall be at least 20 mm) and the lifeboat is checked for a heel.

If the lifeboat has not passed the testing, the capacity of air boxes or floating material is increased or number of persons permitted to accommodate is reduced.

1.9 The tightness testing of removable air boxes is carried out using one of the following methods:
.1 An air box is weighted and fully submerged in water so that the water layer above its surface comprises at least 100 mm. After 2 hours the air box is recovered and weighted. If the box weight is not changed, it is deemed to have passed the testing;

.2 Air box is submerged into a tank containing hot water with a temperature of 60 to 70°C so that the water layer above its surface comprises at least 100 mm, and the box is turned over in the water for 10 to 15 minutes. If the box is untight, the heated air will expand and come out, and bubbles will show the defect point;

.3 Compressed air through a nipple soldered to one of the angles of the tested box is pressurized into the air box up to it reaches the excessive pressure of 0.0196 MPa. If pressure drop measured after 20 minutes does not exceed 1% of the specified (excessive) pressure, the box is deemed to have passed the test.

The box capacity is determined using one of the following methods:

- careful calculation performed according to the results of measuring the box dimensions
- filling the box with water the volume of which is measured in the calibrated vessel
- submerging the box into the tank fitted with fixed scale graduated in volume units

Before testing the load required for holding the box in fully submerged condition is lowered. According to the water level in the tank with lowered load a zero mark is installed. The box with the load is submerged into the tank to a depth of 100 mm from water level. The water level is marked as per scale and volume of the air box is determined.

1.10 The buoyancy testing of lifeboat buoyant material is carried out on a specimen. Before submerging the specimen, the weight which specimen is capable to support is determined. Then the specimen is submerged in water so that the water layer above the surface is at least 100 mm, and it is conditioned for 24 hours. After that, the weight which the specimen is capable to support is determined again.

The specimen is deemed to have passed the test, if the difference between load weights in the beginning and at the end of test does not exceed 10% of load weight in the beginning of test, and upon test completion the specimen is free from damages, shrinkage, blistering or other changes of mechanical properties.

1.11 Strength testing of lifeboat handling gear:

.1 Before installing on the lifeboat each lifeboat hook (or replacing device) as well as hangers and fastenings shall be tested with load of a weight equal to \( G_\mu \), kg, for 10 minutes

\[
G_p = 2 \left( G_h + G_p + G_o \right) / n
\]

where \( G_h \) — weight of lifeboat hull, kg;
\( G_p \) — weight of people, kg;
\( G_o \) — weight of outfit, kg;
\( n \) — number of hooks.

During testing the release of lifeboat with onboard handling gear is checked after its launching both in light and design loaded condition.

The handling gear is deemed to have passed the test, if after unloading the components are free from cracks, tears and residual deformations. The absence of deformations is determined by measuring the distance between three points marked on the component surface with a centre punch.

.2 The gear as a whole is tested simultaneously with strength testing of the lifeboat.

1.12 When checking the strength of plugging and fastening the handling gear the plastic lifeboat overloaded by 50% and hanged by hooks is lowered with speed of 0.6 m/s and then hard braked. The structure is inspected for integrity, and the lifeboat hull is inspected for cracks and deformations.

1.13 Check of engined lifeboat operation

.1 Lifeboat afloat is loaded with load corresponding to the weight of permitted number of persons and outfit. The engine start is checked (including manual start). The start time shall be not more than 2 minutes.

The lifeboat manoeuvrability is checked for 2 hours and within this time the fuel consumption is determined;
.2 the capability of engined lifeboat to tow a liferaft with the maximum capacity in loaded condition with speed of at least 3.7 km/h is checked;

.3 the lifeboat engine operation for at least 5 minutes when it is flooded up to the crankshaft axis is checked. As a result of this test the engine shall not be damaged.

1.14 The lifeboats of oil tankers are additionally tested by fire.

The water area with an extend exceeding the lifeboat dimensions in plan view is filled with kerosene which quantity when ignited is sufficient to cover the lifeboat with fire for 8 minutes. During the fire testing the temperature in several points inside the lifeboat is measured (it shall not exceed 60° C). At the same time, the space inside the lifeboat is checked for smoke and harmful gases in air by analyzing the collected samples.

After the fire testing, the lifeboat is subjected to tightness testing.

2 Liferafts

2.1 Testing of type specimens of liferafts includes:

.1 weighting;
.2 drop testing;
.3 jump testing;
.4 towing testing;
.5 afloat testing;
.6 accommodation capacity testing;
.7 stability testing;
.8 flooding testing;
.9 special testing of inflatable liferafts;
.10 testing of hydrostatic release device of liferaft.

2.2 The liferaft fully completed and packed in container or case is subjected to weighting.

2.3 During the drop testing the liferaft packed in case or container with outfit is dropped from a height of 10 m to water. A free end of painter is laid out simulating the real falling conditions. After dropping the liferaft is remained afloat for 20 minutes and checked for positive buoyancy. After lifting the liferaft is inspected. If the liferaft is inflat-

able, it is inflated up to the operating pressure in order to inspect it. The liferaft is deemed to have passed the test, if it and its outfit are free from damages which would result in deg-
radation in performance.

2.4 When testing by jumping the testers with a weight of not less than 75 kg and wearing shoes with flat sole jump at least 5 times from a height of at least 4.5 m to the liferaft full operational and afloat. The jump testing may be replaced by dropping a load with equal weight onto the liferaft.

The liferaft is deemed to have passed the test, if it is free from breaks and damages.

2.5 During towing testing the liferaft full operational in fully loaded condition is towed by a towing rope secured on the liferaft's towing eye to a distance of at least 100 m at a speed of 5.5 km/h on calm water.

The liferaft is deemed to have passed the test, if it and towing arrangements are free from damages.

2.6 Afloat testing

.1 liferaft with a load corresponding to the weight of design number of persons and outfit is brought to an anchor in water area. The liferaft is remained afloat for 3 days. If the liferaft is inflatable, it may be additionally pumped by hand-bellows once a day.

The liferaft shall maintain its form and be free from damages;

.2 the afloat testing defines that the lif-
eraft at design load is capable to move on calm water to a distance of at least 30 m by means of paddles included in the outfit.

2.7 Accommodation capacity testing

.1 design number of persons 75 kg each (in average) dressed in the lifejackets are ac-
accommodated on the liferaft.

The testing determines whether the lif-
eraft has enough place for all the persons tak-
ing into account a space overhead under the canopy and whether the persons are capable to use the outfit inside the liferaft.

During testing the possibility of ease and quick (for 1 minute) closing/opening entries
in canopy (from outside and inside) is checked.

If the canopy is removable two testers install the canopy for 5 minutes and check the possibility to open and close the entries;

.2 the liferaft with raised canopy is checked for possibility of water ingress into the under-canopy space when entries are closed. For this purpose, the entries are tested by divergent water jet directed perpendicularly to the entry surface for 5 minutes. As result, no significant water accumulation inside the liferaft shall be observed.

2.8 Stability testing

.1 The design number of persons are accommodated at one side of the operational liferaft situated on calm water. The testing determines whether the freeboard remains positive and whether there is a risk of downflooding the liferaft.

.2 In order to check the liferaft stability during boarding, two testers dressed in life-jackets climb onto the liferaft from water on their own. Then they raise from water the third person who simulating a loss of consciousness. The results show whether the liferaft is stable and whether there is a risk of its capsizing.

2.9 During flooding testing the operational liferaft situated on calm water and completed with outfit and design number of persons (or ballast simulating the design load) is completely flooded. It is determined whether the liferaft is afloat and whether there are significant hull deformations.

2.10 Special testing of inflatable liferaft design:

.1 the liferaft is inflated using the gas inflation system at ambient temperature from 18 to 20°C.

The liferaft is deemed to have passed the test, if the operating pressure is achieved for not more than one minute and the liferaft is free from joint deformation, cracking or any other damages;

.2 the liferaft packed and completed with outfit shall be conditioned for at least 24 hours in the cold chamber with a temperature of minus 30°C. After that, the liferaft is inflated using the gas inflation system.

The liferaft is deemed to have passed the test, if the operating pressure is achieved for not more than 3 minutes and the liferaft is free from joint deformation, cracking or any other damages;

.3 the liferaft packed and completed with outfit is conditioned for at least 8 hours in the chamber with a temperature of plus 50°C. After that, the liferaft is inflated using the gas inflation system.

The liferaft is deemed to have passed the test, if the operating pressure is achieved for not more than one minute and the liferaft is free from joint deformation, cracking or any other damages;

.4 the liferaft is tested by pressure. For this purpose, the inflatable compartment (buoyant chamber) of the liferaft is inflated with compressed air up to pressure two times higher than the operating pressure. The safety valves are in non-operation condition.

The liferaft is deemed to have passed the test, if within 10 min the pressure is not decreased more than by 5% and it is free from any damages;

.5 the liferaft is subjected to buoyancy testing. During buoyancy testing it is stated that the liferaft one buoyancy compartment of which is not inflated is capable to support the design number of persons 75 kg each (in average) sitting in normal position providing the positive freeboard along the entire perimeter.

2.11 Testing of hydrostatic release gear of liferaft:

.1 during temperature testing the hydrostatic release gears are placed into a chamber with a temperature of minus 30°C and conditioned for 8 hours. Then the gears are placed into a chamber with a temperature of plus 50°C for 8 hours. This procedure is repeated 10 times. At the end of testing one hydrostatic release gear shall be taken from the chamber with temperature of minus 30°C and activated in water with a temperature of 0°C. The other hydrostatic release gear shall be taken from
3 Life-saving buoyancy aids

3.1 Testing of type specimens of life-saving buoyancy aids includes:
   .1 dimensions and form determining;
   .2 strength testing;
   .3 tightness testing of metal aid case or air boxes;
   .4 stability testing;
   .5 buoyancy testing.

3.2 Dimensions $L$, $B$, $H$ and form of an aid are checked for compliance with the technical documentation. Here:

$L$ — design length of aid measured between its end points in the centreline, m;

$B$ — design width of aid measured between its end points in the midship plane, m;

$H$ — design height of aid measured between its end points in the centreline, m.

3.3 The strength of the aid shall be checked by dropping it from a height of 10 m into the water. The aid is deemed to have passed the test, if it is free from cracks, dents and breaks.

3.4 The casing of metal aid or air boxes are subjected to tightness testing using one of the following methods:

   sequential blowing of compressed air into each compartment up to the excessive pressure of 0.0196 MPa. If on the expiry of 30 minutes the pressure drop according to the installed pressure gauge does not exceed 1% of the excessive one, the compartment is considered tight;

   flooding each compartment up to a height of 3 m above its upper horizontal tangent to the compartment. For this purpose, a hose or tube fitted with a nozzle at the lower end for screwing into the compartment and with a glass tube at the upper end is vertically inserted into each compartment. If within 1 hour the water level in glass tube is not dropped, the compartment is considered tight.

3.5 During stability testing the steel or cast iron plumbs with a weight of 14.5 kg are hanged on one of the long aid sides on each sag of lifeline.
If the upper surface of the loaded aid is not covered with water, the aid is considered to be stable.

3.6 During buoyancy testing the aid subjected to strength and tightness testings is fully submerged in the water and conditioned for 24 hours. Upon expiry of the stated time, a load with a weight corresponding to the weight of design number of persons (14.5 kg per each person) is placed on the aid. The load shall be above the water. The aid is deemed to have passed the test, if it is afloat for 1 hour.

4 Lifebuoys

4.1 Testing of type specimens of lifebuoys includes:
.1 measuring and weighting;
.2 heat resistance testing;
.3 frost resistance testing;
.4 fire resistance testing;
.5 oil product resistance testing;
.6 strength testing;
.7 buoyancy testing.

4.2 When measuring, weighting and inspecting it is stated that internal diameter, weight of a lifebuoy and outfit provided comply with the requirements of technical documentation.

4.3 During heat resistance testing the lifebuoy is placed into a chamber with a temperature of plus 50°C and conditioned for 8 hours. The lifebuoy is deemed to have passed the test, if it is free from damages and form changes, and the linear contraction does not exceed 2% of initial dimensions.

4.4 During frost resistance testing the lifebuoy is placed into the cold chamber with a temperature of minus 30°C and conditioned for 8 hours. The lifebuoy is deemed to have passed the test, if it is free from damages and form changes, and the linear contraction does not exceed 2% of initial dimensions.

4.5 During fire resistance testing the fireproof vessel with a size of 300 × 350× 60 mm is filled with water up to the mark of 10 mm and with gasoline — up to the mark of 40 mm. The gasoline is ignited and left to burn for 30 seconds. After that, the lifebuoy is hanged at a height of 250 to 500 mm above the upper edge of the vessel and left for 2 seconds. The lifebuoy is deemed to have passed the test, if after removing from flame it does not burn or melt.

4.6 During oil product resistance testing the lifebuoy is fully submerged into diesel fuel to a depth of 100 mm for 24 hours at room temperature. After the testing the lifebuoy shall be free from any damages.

4.7 The lifebuoy is subjected to strength testing after the heat, frost and fire resistance testings:

*Strength testing*

.1 The lifebuoy is dropped 4 times from a height of 10 m onto the water or from a height of 5 m onto the concrete floor. The lifebuoy is deemed to have passed the test, if after the testing it is free from breaks on shell joints and cloths and there is no form changes, and for the lifebuoy with self-igniting buoy — degradation in performance of alarm device;

.2 The strength of lifebuoy subjected to strength testing by dropping as well as strength of fastening the ends and lifeline to the lifebuoy are checked by sequence hanging a load with a weight of 75 kg for 10 minutes to each section of the lifeline. The lifebuoy is deemed to have passed the test, if there is no sliding of the lifeline and offset of its bead, destruction of lifeline end fastenings as well as breaks of shell joints and cloth;

.3 The strength of lifebuoy is additionally tested by hanging it for 20 min with secured load with a weight of 90 kg. The lifebuoy and load are hanged on the opposite sides on tapes of 50 mm wide. The lifebuoy is deemed to have passed the test, if after the testing it is free from breaks, cracks or residual deformation.

4.8 The buoyancy testing is carried out after the strength testing. The lifebuoy with hinged load made of steel or cast iron with a
weight of 14.5 kg is submerged into the water for 24 hours. The load shall not be secured to the lifeline. The lifebuoy is deemed to have passed the test, if during this time it remains afloat. For the lifebuoy with self-igniting buoy, at the same time the alarm device is checked for capability to continuously flash for 2 hours with light intensity of at least 2 cd.

5 Lifejackets

5.1 Testing of type specimens of lifejackets includes:
   .1 heat and frost resistance testing;
   .2 fire resistance testing;
   .3 oil product resistance testing;
   .4 strength testing;
   .5 buoyancy testing;
   .6 stability and convenience testing of lifejacket for adult;
   .7 stability and convenience testing of infant life jacket;
   .8 additional testing of inflatable lifejacket.

5.2 The lifejacket is subjected to heat and frost resistance testings in accordance with 4.3 and 4.4. The lifejacket is deemed to have passed the tests, if the shell and inside buoyant material are free from damages (e.g. shrinkage, bulging and cracking).

5.3 The lifejacket is subjected to fire testing in accordance with 4.5. The lifejacket is deemed to have passed the test, if it does not sustain the combustion and does not melt after its removing from the flame.

5.4 The lifejacket is subjected to oil product resistance testing in accordance with 4.6. The lifejacket is deemed to have passed the test, if after the testing its shell and buoyant material are free from damages, bulging and cracking.

5.5 The strength testing of lifejacket is divided into two types: strength testing by applying a force to belt; and strength testing by applying a force along the lifejacket.

During strength testing by applying a force to belt, the lifejacket is submerged into the water for 2 minutes. Then, a force of at least 320 kg for adult lifejacket (Fig. A13.5.5-1) and 240 kg for infant lifejacket is applied to the lifejacket part which secures it on person's body or to the lifting eye for 30 minutes. The specified force is transferred to the adult lifejacket via cylinder of 125 mm in diameter, to the infant lifejacket — via cylinder of 50 mm in diameter.

![Fig. A13.5.5-1. Strength testing of lifejacket by applying a force to belt:](image)

- **a)** vest-type lifejacket;
- **b)** collar-type lifejacket;
- \( P \) — test load

During strength testing by applying a force along the lifejacket, it is submerged into the water for 2 minutes. After that, it is removed from water and fastened as if it is dressed on a person. Then, a force of at least 90 kg for adult lifejacket and 70 kg for infant lifejacket is applied to the lifejacket’s shoulder part for 30 minutes. The specified force is transferred to the adult lifejacket via cylinder of 125 mm in diameter, to the infant lifejacket — via cylinder of 50 mm in diameter (Fig. A13.5.5-2).

The lifejacket is deemed to have passed the test, if after testing it is free from damages.

5.6 During buoyancy testing the lifejacket subjected to strength testing is submerged into the water for 20 minutes. Then a load is placed on the lifejacket so that the lifejacket still could keep it afloat, and weight of this load is measured. After that, the lifejacket is conditioned in submerged condition for
24 hours so that the water layer above its surface is at least 100 mm. At the end of testing a weight of load, which the lifejacket can keep afloat after being conditioned under water, is determined again. The difference between weights of the load in the beginning and at the end of testing shall not exceed 5% of load weight in the beginning of testing.

Then the adult lifejacket is loaded with a load made of steel or cast iron with a weight of 20 kg, the infant lifejacket — with a weight of 9 kg, and submerged into the water. The lifejacket is deemed to have passed the test, if it is free from damages and remains afloat with the specified load for 15 minutes.

5.7 The stability and convenience testing of the adult lifejacket is carried out by at least 6 test persons (including 1 to 2 women) dressed in casual clothes with different height and weight stated in Table A13.5.6

<table>
<thead>
<tr>
<th>Height (m)</th>
<th>Quantity (persons)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4-1.6</td>
<td>1</td>
<td>less than 60 more than 60</td>
</tr>
<tr>
<td>1.6-1.8</td>
<td>1</td>
<td>less than 70 more than 70</td>
</tr>
<tr>
<td>Over 1.8</td>
<td>1</td>
<td>less than 80 more than 80</td>
</tr>
</tbody>
</table>

.2 Test person dressed in a lifejacket shall swim 25 m and board a liferaft or rigid platform extended by 300 mm above the water surface.

.3 Test person dressed in a lifejacket shall make at least three smooth breast strokes and then relax with head down and partially filled lungs simulating the unconscious condition. From this position the lifejacket shall turn the test person on his back at an angle to the vertical for not more than 5 seconds and support the person’s head above the water so that the mouth is at a distance of at least 120 mm from the water surface.

.4 The test person dressed in a lifejacket shall jump feet-first from a height of 4.5 m into the water. The lifejacket when entering into the water shall not move, cause injuries or pain.

5.8 As far as practical, the infant lifejackets shall be subjected to the stability and convenience testing similar to those used for the adult lifejackets. The infant lifejackets are tested using test persons (dummies). The test persons shall be selected so that fully cover all dimensions. At least 6 test persons are required for each height and weight interval.

During testing for turning in water the test person’s mouth shall be above the water after at least 5 seconds.

The average distance from the mouth to the water surface shall be at least 90 mm. The mouth of a separate test person with a height of at least 1.27 m and weight of less than 23 kg shall be above the water of at least 50 mm, and the mouth of test person with a height of more than 1.27 m and weight of more than 23 kg — at least 75 mm.

During testing it shall be determined that the lifejacket does not move, injure, hinder movements inside and outside the water.

5.9 Additional testing of inflatable lifejacket

.1 After testing described in 5.2 to 5.4 the inflatable lifejacket is put in operating condition using the automatic inflation system, manually or orally;
.2 the strength of buoyant chambers of the inflatable lifejacket is checked by inflating the chambers manually using the additional pressure 1.25 times higher than operating pressure when safety valves are closed.

The inflatable lifejacket is deemed to have passed the test, if after holding the pressure for 30 minutes it is free from any damages;

.3 the lifejacket one buoyant chamber of which is not inflated is subjected to buoyancy, stability and convenience testing.

6 Immersion suits

6.1 Testing of type specimens of immersion suits includes:

.1 heat and frost resistance testing
.2 fire resistance testing
.3 strength testing
.4 buoyancy testing
.5 watertightness testing
.6 convenience testing

6.2 An immersion suit is subjected to heat and frost resistance testing in accordance with the requirements of 4.3 and 4.4. The immersion suit is deemed to have passed the test, if it is free from any damages, cracking and bulging.

6.3 The immersion suit is subjected to fire resistance testing in accordance with the requirements of 4.5. The immersion suit is deemed to have passed the test, if it does not sustain the combustion and does not melt after its removing from the flame.

6.4 The immersion suit is subjected to strength testing in accordance with 5.5. However, the applied load shall be 1350 N (if required, during testing the immersion suit may be cut for special arrangements). The immersion suit is deemed to have passed the test, if after the testing it is free from damages.

6.5 The immersion suit not requiring the lifejacket is subjected to buoyancy testing in accordance with 5.5. The immersion suit is deemed to have passed the test, if its buoyancy is not decreased by more than 5% after submerging it into water for 24 hours.

6.6 Watertightness testing:

.1 before testing a weight of test person dressed in the wetted immersion suit is determined. After 1 hour in water, the test person dressed in the immersion suit is weighted again. The immersion suit is deemed to have passed the test, if the weight of ingress water for this time does not exceed 200 g;

.2 the method specified in .1 determines the water quantity in the immersion suit after the test person jump into the water from a height of 4.5 m. The immersion suit is deemed to have passed the test, if during jumping it is not shifted and damaged, and the weight of ingress water does not exceed (500±50) g.

6.7 In order to test the convenience, the test men are selected in accordance with 5.7.

If the immersion suit requires to put on a lifejacket, it shall be put over the immersion suit:

Testing procedure

.1 the test person shall correctly put on the immersion suit without assistance for not more than 2 minutes;

.2 the test person shall steadily swim on calm water faceup. His mouth shall be not lower than 120 mm above the water surface. Then, the test person relaxes and down the head simulating the unconscious condition. From this position the immersion suit design shall turn the person on back faceup for 5 seconds;

.3 the test person dressed in an immersion suit shall jump from a height of 4.5 m and remain in water with a temperature of plus 5°C. for 1 hour. After that, the temperature of test person's body is measured. It shall not be decreased by more than 2°C.

7 Thermal protection aids

7.1 Testing of type specimens of the thermal protection aids includes:

.1 watertightness testing of material and thermal resistance testing of thermal protection aid;

.2 heat and frost resistance testing;

.3 oil product resistance testing;

.4 convenience testing.
7.2 During watertightness testing of material it shall be determined that the material used for manufacturing the thermal protection aid is capable to maintain its watertightness when affected by water column of a height of 2 m.

The testing shall determine that heat transfer coefficient of the thermal protection aid is not more than 7800 W/(m²·K).

7.3 The thermal protection aid is subjected to heat and frost resistance testing in accordance with 4.3 and 4.4. The aid is deemed to have passed the test, if during inspection it is free from damages.

7.4 Oil product resistance testing:

The thermal protection aid after closing of all openings is subjected to the oil product resistance testing in accordance with 4.6. The aid is deemed to have passed the test, if after cleaning its surfaces, after testing and inspecting, it is free from damages and the heat transfer coefficient does not exceed 7800 W/(m²·K).

7.5 In order to carry out the convenience testing the test persons are selected in accordance with the stability and convenience testings of the adult lifejacket.

The test persons located in a life-saving mean afloat unpack the thermal protection aid and put it on over the lifejacket without assistance.

If the test persons being in water and dressed in the thermal protection aid take it off for not more than 2 minutes without assistance, the aid is deemed to have passed the test.

8 Launching and evacuation arrangements

8.1 Testing of type specimens of the launching and evacuation arrangements includes:

.1 performance and strength testing of launching arrangement;
.2 heat, frost and fire resistance testing of marine evacuation chute;
.3 strength testing of marine evacuation chute;
.4 convenience testing of marine evacuation chute.

8.2 Performance and strength testing of launching arrangement

.1 Lifeboat and liferaft davits and lifeboat launching arrangements are tested by the test static load 1.5 times higher than their maximum operating load. The lifeboat completely swung overboard is overbalanced by making an arc of approximately 5° on either side from vertical in the planned longitudinal plane. The testing is first carried out when the ship is in upright position, and then — imitating the heel of 15° to one and another side.

Upon completion of this testing there shall be no significant deformation of arrangements or any other damages;

.2 The test static load 1.5 times higher than the operating load is applied to the winch drums with maximum permissible number of hoses. Such a load shall be maintained using the brakes. Then, this load is decreased by at least one full lap of drum axis. The test load 1.1 times higher than the operating load is decreased with maximum speed to a distance of 3 m and hard braked using the manual brakes. As result of testing, the brakes shall operate properly;

.3 The winch operation is checked using the manual drive, if it is provided by the winch design;

.4 The launching time of lifeboat completed with design number of persons and outfit is checked. The launching arrangement is deemed to have passed the test, if the launching time including the time for preparation and swung overboard does not exceed 5 minutes.

8.3 The marine evacuation chute is subjected to heat, frost and fire resistance testing in accordance with the guidelines of 4.3 to 4.5. The marine evacuation chute is deemed to have passed the test, if when activating it after testing there are no hull cracking, joint deformations and other defects.

8.4 Strength testing of marine evacuation chute:

.1 Buoyancy chambers of the marine evacuation chute when safety valves are closed are inflated with compressed air up to the
pressure 2 times higher than the operating pressure. The marine evacuation chute is deemed to have passed the test, if the pressure in its buoyancy chambers does not fall by more than 5% for 10 minutes and there is no damages of the structure;

.2 Ends of the marine evacuation chute inflated up to the operating pressure are installed on a rigid base at low height. The middle part of the chute is loaded with the distributed load with a weight up to 150 kg (1.47 kN). The marine evacuation chute is deemed to have passed the test, if it is not folded and deformed.

8.5 In order to carry out the convenience testing of the marine evacuation chute, the test persons are selected in accordance with 5.7. Here:

.1 The marine evacuation chute packed in container or case is installed at a height of its installation on board the ship. One test person activates it. Another test person fastens the end of the marine evacuation chute to a life-saving appliance (lifeboat or liferaft). The slope angle of the marine evacuation chute relative to horizon is visually fixed. It shall be within 30° to 35°.

The marine evacuation chute is deemed to have passed the test, if the actuation time does not exceed 5 minutes;

.2 The marine evacuation chute is installed in order to lower persons dressed in the lifejackets. The marine evacuation chute is deemed to have passed the test, if the surface of launchway is free from damages. It shall be shown that the pressure loss in any buoyant chamber of the marine evacuation chute does not restrict its application as an evacuation mean.
GUIDELINES FOR PYROTECHNIC SIGNAL MEANS TYPE SPECIMEN TESTING

1 Thermal stability and cold resistance test

1.1 Two specimens of each pyrotechnic signal mean shall undergo tests in accordance with Guidelines for lifebuoys on thermal stability and cold resistance (see 4.2, 4.3 Appendix 13). Signal means are considered as having passed tests if there is no any damages, cracking and blistering, and they operate normally when commissioned right after tests.

2 Strength test

2.1 Two specimens of each pyrotechnic signal mean are thrown on the concrete floor from height of 2 m. Signal means are considered as passed the test if there is no any damage, and they operate normally when commissioned.

3 Water resistance test

3.1 Two specimens of each pyrotechnic signal mean are immersed in water to a depth of 100 mm for 24 hours. Signal means are considered as passed the test if they operate normally when commissioned, and all instructive signs and figures on the housing are readily visible.

4 Operational tests

4.1 The tester performs without assistance manual start of two specimens of each pyrotechnic signal mean barehanded and gloved.

4.2 When firing rocket parachute flares the tester shall confirm visually that the rocket actuates on the height of about 300 m without damaging the parachute and its fixtures. He also shall document:
   - rocket burning period that should be not less than 40 s;
   - rocket lowering time from the trajectory apex.

   Then the rocket lowering speed shall be determined; it shall be not more than 5 m/s.

4.3 When road flares are actuated, the tester shall note the burning period at ambient temperature of one of road flares. It should be not less than 1 min. The second road flare shall be immersed in water to a depth of 100 mm after 30 s of burning. The road flare shall continue burning for min. 10 s.

4.4 The working efficiency of each pyrotechnic signal mean with air flow rate not less than 30 m/s is tested through laboratory tests with using fan. Pyrotechnic signal mean are considered as passed the test if they do not extinguish at that air flow speed.
1 INSULATION RESISTANCE

1.1 Equipment and electric cables insulation resistance as related to ship’s hull and also between phases/poles, measured during tests that are carried out after the ship’s construction, shall be not less than designated in the Table A15.1.1-1:

<table>
<thead>
<tr>
<th>Insulation resistance</th>
<th>Electrical equipment</th>
<th>Minimal electrical insulation at ambient temperature (20±5 °C), MΩ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before testing</td>
<td>After testing</td>
</tr>
<tr>
<td>Electrical machinery</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Transformers</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Distribution boards</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Commutation, protection and control facilities (undisturbed)</td>
<td>10</td>
<td>—</td>
</tr>
<tr>
<td>Ship control, communication and signalization equipment</td>
<td>20</td>
<td>—</td>
</tr>
<tr>
<td>Space heaters</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Lamps/projectors</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Mounting installations</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Static frequency converters</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

DC voltage provided by a megohm meter during insulation resistance measuring shall be not less than specified in Table A15.1.1-2.

1.2 Every electric circuit can be divided in various number of sections using installed consumers circuit-breaker.

In fire hazardous premises insulation resistance measurement shall be performed after premises ventilation with 10 air changes.

1.3 Measurement of insulation resistance is to be performed immediately after waterproof testing:

1.4 Insulation resistance data from megohm meter shall be fixated after applied voltage become steady voltage.

2 INSULATION DIELECTRIC STRENGTH

2.1 Equipment insulation dielectric strength except for separate types listed in 2.2-2.4 is tested within 1 min by applying listed in Table A15.2.1, alternating sinusoidal voltage of frequency 50 Hz in normal weather conditions.
2.2 Electrical machines/electromagnetic couplings windings connection insulation shall be tested in machine/coupling no-load condition. Tests are performed on heat machine/coupling with temperature close to the maximum temperature during heating test. Test voltage shall be equal to 1.3 of rated voltage. Test time is 3 min (for turbine generator – 5 min.) unless particular cases are specified.

2.3 During transformer windings insulation testing windings should withstand test voltage listed in Table A15.2.3.

Table A15.2.3

<table>
<thead>
<tr>
<th>Transformer windings test voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage, V</td>
</tr>
<tr>
<td>Up to 1000</td>
</tr>
<tr>
<td>1001–3000</td>
</tr>
<tr>
<td>3001–6000</td>
</tr>
<tr>
<td>6001–10000</td>
</tr>
</tbody>
</table>

Transformer windings connection insulation shall be tested by applying to ends of one winding overfrequency doubled voltage with other windings open. The test time is at least 15 s.

For current transformers connecting insulation of secondary side shall withstand in open position test voltage that is induced in it during rated current flowing in primary for 1 minute.

Testing by throwing on an impact load (instantaneous rise and drop of voltage by disabling without an arc with vacuum circuit breaker) on rated voltage shall be provided by transformer actuation on rated voltage 5 times. Occurrences accompanying turn-to-turn short circuit (noise change, smoke appearance, winding insulation colour changing and other occurrences indicating transformer's non-satisfactory condition) shall not be found.

2.4 Test voltage for fuses designed for voltage lower than 500 V shall be 3000 V.

2.5 During cables testing every isolated conductor of precut cable shall withstand for 5 minutes without rupture applying single-phased alternating sinusoidal voltage with frequency of 50(60) Hz or DC voltage stated in Table A15.2.5. This test voltage for precut cable either after for water stored cable or without such storage, either with or without immersion in water.

Cable tests are considered as positive if no insulation rupture or surface flashovers are detected.

Table A15.2.5

<table>
<thead>
<tr>
<th>Cables</th>
<th>Test voltage at current</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>DC</td>
</tr>
<tr>
<td>power cables at rated voltage, V</td>
<td>up to 250</td>
</tr>
<tr>
<td></td>
<td>251–750</td>
</tr>
<tr>
<td></td>
<td>751–1000</td>
</tr>
<tr>
<td></td>
<td>1001 to 3000</td>
</tr>
<tr>
<td></td>
<td>3001 to 10000</td>
</tr>
<tr>
<td>cables of signalization and communication at rated voltage of 250 V</td>
<td>1500</td>
</tr>
</tbody>
</table>

Notes: 1. Tables requirements apply to cables with rubber, PVC and polyethylene insulation or PVC enclosure.

2. Test voltage for cables which nominated voltage is not indicated in the Table shall be determined in technical documentation.

3. For cables with shielded conductors if they exceed 50% of all conductors, tested voltage can be lowered on 25% in comparison with voltage designated in the Table.

3 FUNCTIONAL TESTS

3.1 Every equipment specimen is subject to functional tests prior to separate tests types.

For tests performance it should be determined that equipment complete set, spares and insulation resistance are in accordance with technical documentation.
3.2 Equipment tests shall be performed for the nominal ratings covered by technical documentation, and in normal weather conditions.

3.3 During the test needed measurements and calibration are performed. Characteristics are determined both with rated power voltage and frequency, and with prolonged (instantaneous) (see 2.2.1 Part VI RCCS) deviations:
- with prolonged voltage deviations on +6% and -10% and frequency deviations on ±5 %;
- with instantaneous voltage deviations on +15 and -30 % and frequency on ±10 %.
Instantaneous voltage deviation duration - not more than 1.5 s, instantaneous frequency deviation – 5 s.

3.4 Equipment intended for supplying from batteries shall be tested with voltage deviation from rated value within +30 to -25% (for equipment supplied from battery attached to charger) and +20 to -25 % (for equipment not attached to the charger during charging).

3.5 Measurements results and characteristics matching to values specified in the technical documentation, and equipment working efficiency in given parameters are tested.

For equipment operated at the load calibration performed on reaching steady state working temperature.

4 OVERSPEED AND OVERLOAD TESTS

4.1 Overspeed test shall be performed after short overcurrent test, and for electrical machinery tested for stop under load current - after stop under load current tests. The test is performed at electrical machinery parts temperature close to steady temperature reached by the end of heating tests. The test time for all electrical machinery except for starter is 2 min (for starters — 20 sec).

4.2 Electrical machinery with series excitation shall be tested at rotation speed exceeded the biggest stated in the datasheet data by 20%, but not exceeded rated rotation speed more than 50%. Starters shall be tested at 120% of idle speed.

4.3 Electrical machinery with regulated rotation speed and with several rated rotation frequency shall be tested at rotation frequency exceeded the biggest stated value on rating plate by 20%. All other electrical machinery is tested at rotation frequency exceeded rated frequency speed by 20%.

4.4 Alternating current generators overcurrent test is performed at load power factor of 0.6 (\(\cos \varphi = 0.6\)) with current of 150% of rated during 120 s. Direct current generators test is performed with current of 150% of rated during 15 s. The tests are considered as successful if generator’s voltage does not reduce more than by 10%.

5 SHORT-CIRCUIT SURGE CURRENT RESISTANCE TESTS

5.1 Electrical machinery short-circuit surge current resistance tests shall be performed if the following conditions have been fulfilled:
- Short circuit mode shall be created by sudden simultaneous short circuit of all 3 phases (poles) while machinery runs idle at voltage of 105% of rated, and with automated voltage control devices engaged.
- Electrical machinery power during the test shall be not less than rated power.
- Length of conductors from electrical machinery to closing appliance shall be minimal, cross sectional area shall be maximal of all provided in technical documentation for the generator; conductors material shall be copper.

Short-circuit mode parameters shall be oscillographed.

Test result evaluation shall be performed by its detailed examination, especially examination of stator winding face parts, welds and other mechanical joints condition and fastening, and also on the results of insulation electric strength test performed after short-circuit current resistance test.

5.2 Electrical machinery above 1000 kW/A test results evaluation shall be performed in accordance with readings obtained from strain-gauging (deformations value determination on parts surface), stresses in active steel
fasteners and their parts fronts insulation, and as a result of vibration measurement of these parts. Stress limits norms shall be stated upon agreement with the River Register.

6 VIBRATION RESISTANCE TESTS

6.1 Vibration resistance tests of disabled equipment are performed within band of 2–80 Hz (Table A15.6.1). Tests shall be performed in three mutually perpendicular planes; one of them shall be working plane.

6.2 Tests on resonant frequencies detection is performed in same sub-band and amplitude as were used during vibration resistance tests (Table 15.6.5) for all sub-bands. Equipment shall be rigidly (without shock absorbers) attached direct to the test bench platform.

<table>
<thead>
<tr>
<th>Frequency band, Hz</th>
<th>Test</th>
<th>Amplitude, mm</th>
<th>Time, h</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-8</td>
<td>continuous</td>
<td>1.4</td>
<td>36</td>
</tr>
<tr>
<td>8-16</td>
<td>transient</td>
<td>2.5</td>
<td>9.0</td>
</tr>
<tr>
<td>16-31.5</td>
<td></td>
<td>0.7</td>
<td>24</td>
</tr>
<tr>
<td>31.5-63</td>
<td></td>
<td>0.7</td>
<td>24</td>
</tr>
<tr>
<td>63-80</td>
<td></td>
<td>0.2</td>
<td>12</td>
</tr>
</tbody>
</table>

Resonant frequencies search shall be performed by smooth frequency shift within every range with constant amplitude. Smooth frequency shift time within the range shall be not less than 2 minutes. Detected resonant frequencies shall be recorded both for equipment in general and for separate assemblies or parts to take them into account in subsequent vibration resistance tests. Amplitude increasing under resonance greater than 5 times as compared to connection points vibration amplitude is unacceptable.

6.3 Equipment vibration resistance test is performed when equipment is disabled, in such range stated in Table A15.6.1 where resonance appears; if there is no resonance within the range of 16 to 31.5 Hz, use amplitude 0.35 mm. The method of fastening the equipment to the test bench platform shall be the same as used in operation. Tests are performed by short-term vibration.

Smooth frequency shift within the range shall be performed with constant amplitude within at least one minute. The test time shall be distributed evenly between test positions on the test bench, i.e. for every position shall be stated nearly same number of frequency shift cycles.

In case of unsatisfactory test results the tests on resonant frequencies detection and vibration resistance by vibration prolonged exposure shall be repeated.

Equipment is admitted for vibration resistance testing if no equipment part breaking or any other visible damages were detected during the tests.

6.4 Vibration resistance tests shall be performed when equipment is operable under electrical load (under voltage for equipment having no load). Load is stated in test load and method of each equipment. The method of fastening the equipment to the test bench platform shall be the same as used in operation.

6.5 Frequency bands and amplitudes during vibration resistance test are shown in Table A15.6.5. Test time is the time needed for checking in operation and appearance of resonance in all equipment and its parts, but not longer than 2 h on every resonating frequency (if any) or on a frequency where parameters stability are violated.

The test shall be performed by smooth frequency shift under constant amplitude within every range. Smooth frequency shift time within every range shall be not less than 2 minutes.

<table>
<thead>
<tr>
<th>Frequency band, Hz</th>
<th>Amplitude, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-8</td>
<td>1.0</td>
</tr>
<tr>
<td>8-16</td>
<td>0.5</td>
</tr>
<tr>
<td>16-31.5</td>
<td>0.25</td>
</tr>
<tr>
<td>31.5-63</td>
<td>0.12</td>
</tr>
<tr>
<td>63-80</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Note: For electrical equipment installed on engines and other elevated vibration sources test norms can be extended.
6.6 Equipment is considered to have passed the test if switch contact positions did not change, work instability was not detected, parameter values did not exceed permissible limits, no broken parts, conductive wires brake, moving parts jamming, fastenings loosening or insulation deterioration were detected.

Note: Tests required by this Section are for equipment of weight less than 200 kg. Equipment of weight more than 200 kg can be tested block by block.

7 IMPACT AND SHOCKPROOF TESTS

7.1 Impact tests are performed when equipment is disabled; shockproof tests are performed when equipment is operable in three mutually perpendicular planes; one of them shall be working plane. The method of fastening the equipment to the test bench platform shall be the same as used in operation.

7.2 Test parameters: impact test: min. 1000 impacts with 7g acceleration and frequency of 40 to 80 impacts per minute; shock-proof test: min. 20 impacts with 5g acceleration and frequency of 40 to 80 impacts per minute.

Equipment is considered to have passed the test if no mechanical damages and breakages, fastening and contacts loosening and other events disturbing apparatus, devices and equipment normal operation are detected.

7.3 Portable VHF equipment shall withstand additional impact tests performed by dropping it on the hard surface from height of 1 m.

The test surface shall consist of hard wood solid peace of thickness not less than 150 mm and weight of over 30 kg. The height of equipment lowest point relative to test surface at the moment of dropping shall be (1000+10) mm.

A set of six droppings to the test surface is performed: one dropping per each equipment side. Equipment operating check and inspection for the presence of external damages.

Equipment is considered to have passed the test if no remarks on equipment operation check or visible damages that can prevent its operation are detected.

Note: Tests required by p.p. 7.1 and 7.2 are for equipment of weight less than 200 kg. Equipment of weight more than 200 kg can be tested block by block.

8 TESTS ON ROLLING RESISTANCE AND LONG-TERM SLOPE RESISTANCE

8.1 Equipment is tested in two mutually transverse directions. The method of fastening the equipment to the test bench platform shall be the same as used in operation.

During roll resistance tests the limit tilt angle from the vertical line is $-22.5^\circ$, roll period is 4 s. Test time shall be sufficient for functional testing, but not more than 15 min in every position.

8.2 During long-term slope resistance tests equipment is kept sequentially in two mutually transverse directions with inclination at an angle of $\pm 22.5^\circ$, emergency equipment - at an angle of $\pm 30^\circ$. Test time shall be sufficient for functional testing, but not more than 15 min in every position.

8.3 Equipment is considered to have passed the test if no false alarms under the influence of rolling and long-term slopes or breakdowns were detected during operation check.

9 HEAT STABILITY TESTS

9.1 When equipment is enabled, the working temperature stated in 9.2, 9.3 is set in the chamber with temperature increase rate of $(3\pm0.5)$ °C/min. Relative humidity shall be not more than 20%. Working temperature shall be kept within 16 h. Then equipment operation check is performed at least three times (when heat balance is reached, at the end of test mode and after tests in cold state).

9.2 Equipment (except for electrical machinery and lamps), designed for installation in premises where ambient temperature does not exceed 40 °C shall be tested on heat stability with working ambient temperature of 40 °C.
9.3 Equipment installed on the open deck, in engine room and galley, and also radio and navigational equipment installed on the open deck and in the ship interior spaces, shall be tested on heat stability with working ambient temperature of 55 °C.

9.4 Check of equipment operation at limit voltage and frequency deviations shall be performed after heat stability tests at the end of holding regime.

Equipment is considered to have passed the test if no events disturbing its normal operation are detected, parameters did not exceed accepted values during the tests, and insulation dielectric strength tests and insulation resistance measurement on the hot item at the end of tests gave satisfactory results.

9.5 Heat stability test of electrical machinery and their components in steering control systems and power installation electrical control systems shall be performed on enabled (operated) electrical machinery. During the heat stability tests specimen temperature is raised to 55 °C within 30 minutes. After that this temperature is kept for 16 h. Then tests on equipment adequate operation are performed to confirm its datasheet specifications.

10 COLD RESISTANCE TESTS

10.1 Equipment intended for installation indoors shall be tested in chamber within 6 h at temperature of –10 °C; equipment intended for installation on the open deck shall be tested at the temperature of –40 °C. After that equipment shall be tested in operation at rated load.

10.2 Items check on limit voltage and frequency deviations are performed right after its switch to operation condition after cold chamber.

10.3 Temperature change speed shall be not more than (3±0,5) °C/min. Equipment is considered to have passed the test if no faults, breakages and parameters deviations are detected.

10.4 During cold resistance tests of electronic device in steering control systems and systems of power installation or its components control, the item should be shut down, cooled to –25 °C and kept on this temperature within 2 h. Then temperature shall be increased to –10 °C, and tests on equipment adequate operation are performed to confirm its datasheet specifications.

11 HUMIDITY RESISTANCE TESTS

11.1 Equipment intended for installation on ships shall be tested on humidity resistance at air relative humidity of (95±3) % and temperature of +25 °C for 5 days; equipment installed on ships navigated in tropical area - for 7 days. Equipment of all versions shall be tested fully assembled in regular casing, except for sealed equipment, which hatches shall be open during tests in chambers.

11.2 Equipment is considered to have passed the test if no insulation breakdowns or resistance drop below the value stated in Section 1 of this Appendix are detected, and item parameters deviations did not exceed accepted values when equipment was in test medium, or equipment was in operated mode not less than 2 h.

12 TESTS ON SALT (SEA FOG) INFLUENCE

12.1 All items installed on river-sea navigation ships shall be tested.

12.2 Equipment is tested in regular enclosure with covers and doors shut down, with plugged feed-through holes. All other holes (for example, ventilation holes) shall be open.

12.3 Tests are performed by cyclical spraying (15 minutes for each hour of testing) in chamber aqueous solution of salt (sea fog) at temperature of +(27±2) °C:

- solution composition (g/l): sodium chloride — 27, magnesium chloride — 6, calcium chloride — 1, potassium chloride — 1, distilled water — 1 l
- fog dispersity — 1 to 10 μm (up to 90 to 95 drops)
- solution water content — 2 to 3 g/m² (at the end of spraying).
12.4 Test time depending on installation location:
   - 7 days — for equipment installed on open decks;
   - 2 days — for equipment installed in the inside spaces.

12.5 Equipment operation shall be checked after tests. Equipment is considered to have passed the test if no corrosion, paint coatings softening and disruption, and events disturbing its normal operation are detected.

13 ENCLOSURE PROTECTION TESTS

13.1 Equipment shall be subject to bench tests depending on its enclosure protection type. These tests apply to items with voltage lower than 1000 V. Protection level testing methods for voltage over 1000 V are developed in accordance with Electrical Installations Code.

13.2 Equipment shall be checked for efficiency of protection from access to its dangerous parts or foreign solid bodies and water penetration inside the item. Equipment protection level depending on installation place is stated in 2.3.6 Part VI of RCCS, and designations and characteristics of equipment protection level are stated in Appendix 1 Part VI of RCCS.

13.3 This para determines method of equipment enclosures testing depending on equipment level of protection against foreign solid bodies penetration inside the enclosure. Protection level is designated with the first characteristic digit:

   .1 The IP protection level equipment has no protection for characteristic digit 0 and can be used on board ships if built in the enclosure with adequate protection level;

   .2 Equipment of type IP for protection level characteristic digit 1. Application of sphere with diameter of 50 mm to any holes in enclosure with force of 30 N for all items and 50 N for electrical machinery;

   .3 Equipment of type IP for protection level characteristic digit 2. Application of tracing probe in any possible position with force up to 30 N and application of sphere with diameter of 12.5 mm to any holes with same force;

   .4 Equipment of type IP for protection level characteristic digit 3. Application of test bar with diameter of 2.5 mm with force up to 3 N should not lead to penetration inside the enclosure through any hole;

   .5 Equipment of type IP for protection level characteristic digit 4. Application of test bar with diameter of 1.0 with force up to 1 N should not lead to penetration inside the enclosure through any hole;

   .6 Equipment of type IP for protection level characteristic digit 5. Inside the chamber shall be induced vacuum adequate for differential pressure $2 \times 10^3$ Pa. Equipment is blown with talc sifted through a sieve with square mesh clear spacing dimension of 75 μm, in an amount of 2 kg of talc for 1m$^3$ of chamber volume. The test is performed as long as it needs for pumping with vacuum pump air volume in chamber 80-120 times more than air volume in the enclosure, but not less than 2 h;

   .7 Equipment of type IP for protection level characteristic digit 6. Same as for characteristic digit 5.

13.4 Evaluation of test results of equipment with type IP on foreign solid bodies penetration inside the enclosure:

   .1 Results are considered as successful for first characteristic digits 1, 2, 3, 4 if probe fullest cross section does not penetrate through any of holes and does not contact with current-carrying and moving parts inside equipment enclosure.

   .2 Results are considered as successful for first characteristic digit 5 if amount of talc penetrated inside equipment enclosure did not affect on its satisfactory performance (equipment efficiency and parameters are checked).

   .3 Results are considered as successful for the first characteristic digit 6 if talc does not penetrate inside the equipment enclosure (full dust protection).

13.5 This para determines method of equipment enclosures testing depending on
equipment level of protection against water penetration inside the enclosure. Protection level is designated with the second characteristic digit:

.1 The IP protection level equipment has no protection for characteristic digit 0 and can be used on board ships if built in the enclosure with adequate protection level.

.2 Equipment of type IP for protection level characteristic digit 1 is tested on protection efficiency from simulated rainfall vertical falling drops penetration inside the equipment. Tested equipment is mounted in normal working position under the reservoir created uniform drops falling on all enclosure surface. Swivel table, where enclosure is mounted, shall have rotation speed of 1 RPM and maximum off-centre distance about 100 mm. Test time is 10 min.

.3 Equipment of type IP for protection level characteristic digit 2 is tested on protection efficiency from simulated rainfall drops penetration inside the equipment. Tested equipment is exposed to rain with intensity of 3 mm/min. Equipment is mounted in four fixed positions with 15° slope. Test time is 2.5 minutes in every position. Total test time is 10 min.

.4 Equipment of type IP for protection level characteristic digit 3 is tested on protection efficiency from spray penetration inside the equipment. Tested equipment is exposed to spray from all directions at an angle of ±60° to the vertical line, created by special device with water pressure in supply pipe not less than 0.1 MPa. Test time is 1 min per 1 m² of the calculated surface; minimum test time is 5 min.

.5 Equipment of type IP for protection level characteristic digit 4 is tested on protection efficiency from blanket spraying penetration inside the equipment. Tested equipment is exposed to spray from all directions at an angle of ±180° to the vertical line, created by special device with water pressure in supply pipe not less than 0.1 MPa. Test time is 1 min per 1 m² of the calculated surface; minimum test time is 5 min.

.6 Equipment of type IP for protection level characteristic digit 5 is tested on protection efficiency from water penetration inside the equipment. Tested equipment exposed to water jet spilling from all directions using hose with nozzle inner diameter 6.3 mm from the distance of 2.5-3.0 m. Water pressure shall be not less than 0.1 MPa to get water discharge 12.5 l/min. Test time is 3 min.

.7 Equipment of type IP for protection level characteristic digit 6 is tested on protection efficiency from water penetration inside the equipment. Tested equipment exposed to strong water jet spilling from all directions using hose with nozzle inner diameter 12.5 mm from the distance of 2.5-3.0 m. Water pressure is adjusted to get water discharge 100.5 l/min ±5%. Test time is 3 min.

.8 Equipment of type IP for protection level characteristic digit 7 is tested on protection efficiency from submergence. Equipment is fully immersed so that water height to the upper part is not less than 0.15 m. Test time is 30 min. Equipment is considered to have passed the test if no water penetrates the enclosure at the specified pressure and in specified time.

.9 Equipment of type IP for protection level characteristic digit 8 is tested on protection efficiency from submergence. Unless there is a standard for equipment, test conditions shall be tougher than conditions stated by previous para. It shall also be taken into account that in operating conditions enclosure will be immersed for indefinitely long time (upon agreement). Equipment is considered to have passed the test if no water penetrated equipment enclosure at noted pressure and time.

13.6 For evaluation of test results of equipment with type IP on water penetration inside the enclosure, the following shall be considered:

Water penetration inside the enclosure is acceptable:

for equipment of type IP with second characteristic digits 1, 2, 3, 4 in the form of separate merged together drops of size not more than 30 mm;

for equipment of type IP with second characteristic digits 5 and 6 - in the form of separate drops.
In any case, if definite quantity of water penetrate the enclosure, there must not be:
- equipment perturbation of the normal operation and safety;
- water storage on electrically insulating materials, where water may cause arc tracking;
- water ingestion on parts being under voltage;
- water storage close to cable inlets or water insertion inside cables.
For equipment of type IP with second characteristic digits 7 and 8 water penetration is not allowed.

Equipment is considered to have passed the test if technical characteristics and/or working efficiency and/or electrical safety correspond to given requirements.

13.7 Generally, equipment enclosure protection tests are performed without power supply. Separate types of electrical equipment (if specified by requirements or testing program) can be tested with power supply. Safety measures must be adopted during such tests.

14 ELECTROMAGNETIC COMPATIBILITY TESTS

14.1 General provisions

Check of stress level and field strengths of industrial radio interference created by equipment is performed in accordance with ГОСТ 30805.16.1.1 (СИСП16-1-1), using measuring receivers with quasi-peak detector.

For measuring the level of:
- radio interference voltage artificial network and measuring receiver with quasi-peak detector shall be used. Receiver's band width during measuring must be 200 Hz in frequency band of 10 to 150 kHz, and 9 kHz in frequency band of 150 kHz to 30 MHz;
- in case of intensive radio interference a receiver with the band width of 9 kHz in frequency bands of 150 kHz to 30 MHz and 156 to 165 MHz, and with the band width of 120 kHz in frequency bands of 30 to 156 MHz and 165 MHz to 2 GHz shall be used.

Equipment is divided on the following categories:
- portable;
- protected from direct effects of weather conditions;
- non-protected from direct effects of weather conditions;
- immersed or having constant contact with water;

Nomenclature of equipment electromagnetic compatibility tests is specified in Table A15.14.1.

### Table A15.14.1

<table>
<thead>
<tr>
<th>Equipment specimens electromagnetic compatibility testing types</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Items</strong></td>
</tr>
<tr>
<td>1. Generators</td>
</tr>
<tr>
<td>2. Electric motors</td>
</tr>
<tr>
<td>3. Converters</td>
</tr>
<tr>
<td>4. Distribution systems</td>
</tr>
<tr>
<td>5. Electrical apparatus (switching, protecting etc.)</td>
</tr>
<tr>
<td>6. Electric meters</td>
</tr>
<tr>
<td>7. Transformers</td>
</tr>
<tr>
<td>8. Electrical equipment for internal combustion engines with starter</td>
</tr>
<tr>
<td>9. Lamps and gas-discharge lamps control equipment</td>
</tr>
<tr>
<td>10. Ship control, communication and signalization equipment</td>
</tr>
<tr>
<td>11. Automation equipment</td>
</tr>
<tr>
<td>12. Radio interferences protection filters</td>
</tr>
<tr>
<td>13. Communication and navigation equipment and other electronic equipment</td>
</tr>
</tbody>
</table>

1For navigation lights commutators.  
2For gas-discharge lamps.  
3For motor telegraphs, blades and rudder blade position indicators, tachometers, telephone switchboards, light, signal and sound devices apparatus, closers.

14.2 Electromagnetic interferences measurement

14.2.1 During interferences measurement tested equipment shall operate in normal conditions, and position of control elements affected on interferences (both conducted and
radiated) must be as to determine maximum interference level created by tested equipment. If needed equipment has several power modes, for example, "operation", "availability" etc., then the mode creating the max level of interference must be determined, and all measurements shall be performed for this mode. Equipment antenna's terminals shall be connected to non-radiative dummy antenna.

Allowable levels of created electromagnetic interferences during tests are specified in Table 2.7.3-1, Part VI of RCCS.

14.2.2 Conducted interferences (all equipment categories except for portable).

During tests shall be measured any signals generated by equipment or appeared on its power supply connection ports (terminals), that can disturb normal operation of other equipment if being included in ship's power mains.

For interferences measurements measuring receiver with quasi-peak detector shall be used. During tests equipment shall be connected to a separate power supply using artificial network to provide specific impedance on power supply terminals for high frequencies and elimination of undesired effect of external interferences incoming from common power supply. Receiver's band width must be 200 Hz when measuring in frequency band of 10 to 150 kHz, and 9 kHz when measuring in frequency band of 150 kHz to 30 MHz.

Connection cables between tested equipment power supply terminals (AC and DC) and artificial network must be shielded, and their length shall not exceed 0.8 m. If tested equipment consists of several devices with individual ports for AC and DC, then power ports with similar voltage rate may be connected in parallel with artificial network.

During measurements performance all metering equipments and tested equipment shall be mounted on a grounded surface and connected to it. If grounded surface using is impossible, then equivalent earthing must be performed on tested equipment metal frame or enclosure.

Radio frequencies voltage on power supply terminals of tested equipment in the band of 10 kHz to 30 MHz shall not exceed limit values specified in Fig. A15.14.2.2

14.2.3 Interferences radiated by equipment enclosure port (all equipment categories except for submersible).

During the test any signals radiated by equipment are measured except for antenna radiations that threaten to disturb normal operation of other ship equipment, for example, radio receiving equipment.

Test methods

The receiver with quasi-peak detector shall be used for measurements. The receiver shall have the band width of 9 kHz in frequency bands of 150 kHz to 30 MHz and 156 to 165 MHz, and the band width of 120 kHz in frequency bands of 30 to 156 MHz and 165 MHz to 2 GHz.
For frequencies higher than 30 MHz electromagnetic field electric component strength $E$ shall be measured. Measuring antenna shall represent dipole radiator of resonant length or, as an alternative - shortened dipole or antenna with a big amplification factor. Measuring antenna sizes towards to tested equipment shall not exceed 20% of the distance to it. On frequencies higher than 80 MHz the possibility of change of antenna's centre position height relative to ground within 1 to 4 m shall be provided.

Premise for tests shall have metal grounded surface. Premise dimensions shall allow to take measurement from the distance of 3 m.

Tested equipment shall be presented as a complete package with all connecting interdevice cables and set on normal operative position.

If tested equipment consists of several devices, connecting cables (excluding antennas power supply) between main and other devices shall be of maximum length indicated in Manufacturer's specification, or not shorter than 20 m if there is no such data. Input and output connectors shall be connected to cable, which max length is determined by manufacturer, or not shorter than 20 m if there is no such data; connectors also shall be aligned to impedance of other equipment which they usually connected to.

Cables shall be gathered in coils settled at the distance of 30 to 40 cm from connectors that they are connected to. If this is impossible, explanatory inscription shall be made in protocol.

Measuring antenna shall be located at the distance of 3 m from tested equipment. Antenna's centre shall be higher than grounded surface for at least 1.5 m. To determine maximum interference level, the antenna measuring E-field shall be adjusted for height only. Also, it shall have rotation possibility for measuring horizontal and vertical polarization. The antenna shall stay parallel to the floor. It shall be possible to displace either antenna around testing equipment to determine maximum frequencies level, or rotation of equipment mounted in orthogonal planes of measuring antenna at the level of its midpoint to achieve the same effect.

For frequency band 156 to 165 MHz it is allowed to use a receiver with peak detector or spectrum analyzer.

Limit radiation standards in the band of 150 kHz to 2 GHz, measured at a distance of 3 m from tested equipment enclosure, are specified in Fig. A15.14.2.3.

**Fig. A15.14.2.3. Limiting levels of radiated interferences from equipment enclosure connectors:**

- $B^*$ — measuring receiver's band width

### 14.3 External electromagnetic interference stability tests

**14.3.1** For performance of these tests (unless other instructions are provided) tested equipment shall be submitted in its normal working package and shall operate under normal conditions.

Tests results are assessed by criteria A, B and C:

- A criteria — normal operation in accordance with established requirements;
- B criteria — temporary functional deterioration or temporary functional failure with subsequent recovery of normal operation without operator's intervention;
- C criteria — temporary functional deterioration or temporary functional failure which
requires operator's intervention or system reboot.

Conditions and types of electromagnetic interference stability tests are shown in Table 2.7.3-2 Part VI of RCCS, where is also shown radio and navigation equipment operating quality criteria.

If radio receiver is included in equipment composition, then conducted interferences stability tests shall exclude any narrow bands of received operating frequencies on which radio receiver responds (false responses).

Stability to conducted low frequency interferences (all equipment categories except for portable)

14.3.2 In this test harmonic components of the voltage in AC mains supply or voltage ripples in DC mains is imitated. These tests are not applied to battery-operated equipment.

Tests on voltage harmonic components stability is performed by overlaying of additional testing sinusoidal voltage within the band of 50 Hz to 10kHz on power supply voltage. Level of sinusoidal voltage applicable actual value contains:

10% of supply voltage within frequency band of 50 Hz to 750 Hz;
10% to 1% of supply voltage within frequency band of 750 Hz to 5 kHz;
1% of supply voltage within frequency band of 5 kHz to 10 kHz.

Tested equipment operation control is performed during and after tests.

Stability to conducted radio frequency interferences (all equipment categories except for portable)

14.3.3 In this test effect of disturbances, induced in supply circuit, control circuit and circuit of signal flow from supply source starting, engine ignition systems, operating echo sounders and ship transmitters on frequencies below 80 MHz are imitated.

Tested equipment is mounted on an insulating table situated on the height of 0.1 m over the surface. Additional equipment needed for tested equipment power supply, as well as signals needed for its normal operation and functionality check, shall be connected with cables. Cables shall be provided with relevant communication devices and isolating devices, situates at a distance of 0.1 - 0.3 m from tested equipment.

Tests are performed with using generator connected through communication and isolation circuits.

Vacant input terminals of generator's HF-signal for communication and isolation circuits are loaded with resistance of 50 Ohm. Test generator is adjusted for every communication and isolation circuit; additional equipment and tested equipment are shut off and replace with resistances of 15 Ohm each. Test generator signal level shall be adjusted so as to provide non-modulated voltage of needed level on tested equipment input terminals.

Tests are performed in cases of following test signal levels:

- active voltage value 3 V at variable frequency in the band of 150 kHz to 80 MHz (test severity level 2);
- active voltage value 10 V in points with frequencies of: 2; 3; 4; 6.2; 8.2; 12.6; 16.5; 18.8; 22; 25 MHz.

During tests amplitude modulation with frequency of 400 Hz ±10% at modulation depth of (80±10)%.

Frequency slew rate shall not exceed \(1.5 \times 10^{-3}\) dec/s to give an opportunity to detect any malfunctions of tested equipment.

The above said signals are superimposed on power lines, signal lines and control lines of tested equipment. Tested equipment operation control is performed during and after tests.

Immunity to conducted radiated radio frequency interferences (all equipment categories except for submersible)

14.3.4 In these tests the effect of the impact of radio transmitters operated on frequencies above 80 MHz (for example, ships' fixed and portable VHF radio transceivers) situated close to the equipment are imitated.

Tested equipment is mounted in suitable shielded room or anechoic chamber, which dimensions shall be comparable to tested
equipment dimensions. Tested equipment shall be mounted in uniform field area and be insulated from the floor by non-metal support.

If requirements to the cable type for tested equipment are not specified, then unshielded parallel conductors shall be used. These conductors expose to electromagnetic field at the distance of 1 m from tested equipment.

Tests are performed with radiating antenna arranged face towards all sides of tested equipment. If equipment can be used in various orientations (vertical and horizontal), tests shall be performed from various sides. At start tested equipment is arranged face, matching with calibration plane. Frequency variation rate shall be \(1.5 \times 10^{-3}\ \text{dec/s}\) — for frequency band of 80 MHz to 1 GHz and \(0.5 \times 10^{-3}\ \text{dec/s}\) — for frequency band of 1 to 2 GHz and be slow enough to allow detection of any malfunctions in tested equipment.

Tested equipment is placed in modulated electrical field of strength 10 V/m at frequency shift within the band of 80 MHz to 2 GHz. At modulation frequency of \((400 \pm 40)\,\text{Hz}\) modulation depth shall be \((80 \pm 10)\,\%\).

**Immunity to electrical fast transient from fast transient processes in AC power supply circuits (all categories of equipment except for portable)**

14.3.5 In these tests fast low-power transient process created by equipment which enabling is accompanied by arcing on contacts are imitated.

Pulsing voltage is applied to power circuits, control circuits and signals circuits with following parameters:
- rise time: 5 ns (at level 10% and 90% of amplitude);
- duration: 50 ns (at level 50% of amplitude);
- amplitude: 2 kV on AC power supply differential inputs;
- 1 kV on signal and control circuits inputs;
- repeat rate: 5 kHz;
- type: periodic short sequences of continuance 15 ms, repeated every 300 ms;
- duration: 3-5 min for every positive and negative polarity of impulses.

**Immunity to microsecond impulse interferences from fast transient processes in AC power supply circuits**

14.3.6 These tests shall imitate influence of high energy pulse spikes, created by thyristor switches in AC mains supply.

Tests shall be performed using combined test generator of microsecond impulse interferences, together with communication and isolation circuit.

Pulsing voltage is applied to tested equipment power circuits with following parameters:
- rise time: 1 ms (at a level of 10% and 90% of amplitude);
- duration: 50 ms (at level 50% of amplitude);
- amplitude: 1 kV line/earth, 0.5 kV line/line;
- repeat rate: 1 impulse per second;
- nature of the exposure: continuous;
- exposure duration: 5 min for every positive and negative polarity of impulses;
- number of fed pulses: not less than five of positive polarity and five of negative polarity for each event of interference.

**Immunity to short-term parameters variation in power circuit (all equipment categories except for portable)**

14.3.7 These tests imitate changes of voltage and frequency in power circuits due to big load changes. Changes are not applied to DC powered equipment.

Power circuit parameters changes shall be performed using programmable power supply.

Equipment shall stay serviceable at following power circuit parameters changes compared with rated values (tests are performed once per minute, five cycles within 10 minute):
- voltage: increase of relative rated value by \((20\pm1)\,\%\) for \((1.5\pm0.2)\,\text{s}\);
- frequency: increase of relative rated value by \((10\pm0.5)\,\%\) for \((5\pm0.5)\,\text{s}\), with overlaying of specified parameter changes;
voltage: decrease of relative rated value by \((20\pm1)\%\) for \((1.5\pm0.2)\ s\);

frequency: decrease of relative rated value by \((10\pm0.5)\%\) for \((5\pm0.5)\ s\), with overlaying of specified parameter changes.

Time of voltage and frequency rise and drop shall be \((0.2\pm0.1)\ s\) (at amplitude level of 10 to 90%).

**Immunity to power source malfunctions**

(All equipment categories except for portable)

14.3.8 These tests imitate short interruptions of ship's power supply due to change of one power supply on another or while activating current protection. These tests are not applied to batteries-operated equipment.

Equipment shall stay serviceable after each of three power supply voltage interruptions of duration 60 s. Software shall not be ruined, and operation data stored in system's digital memory shall not be lost.

**Immunity to electro-static discharge**

(All equipment categories except for submersible)

14.3.9 In these tests static electricity discharges are imitated, that can appear at human contact with equipment enclosure.

Tests shall be performed using electro-static discharge generator (with storage reservoir of capacity 150 pF and discharging resistance of 330 Ohm, connected to discharging generator ferrule). Tested equipment shall be mounted on an insulating plate laid over grounded metal plate. Grounded plate shall protrude beyond the equipment overall dimensions on at least 0.5 m for all sides. Discharges from generator shall be applied to equipment points and surfaces that are accessible for stuff during normal operation. During tests generator shall be placed perpendicular to the surface, and points of discharges application can be chosen so that 20 discharges per second were provided. Every position shall be subject to tests on 10 positive and 10 negative discharges with intervals between discharges at least 1 s to provide detection of any malfunction in equipment operation. Preferred method during tests performance is contact discharge. If contact discharge can not be used (in the presence of painted surfaces), air discharge shall be applied.

For discharges imitation on items located or mounted close to tested equipment shall be performed 10 positive and 10 negative single contact discharges applied to grounded plate from every side of equipment. Places of discharges application shall be at a distance of 0.1 m from tested equipment.

Following 10 discharges shall be applied to the centre of vertical edges of grounded coupling plane of size 0.5×0.5 m. These tests shall be performed for every side of equipment. Vertical coupling plane shall be located so that all four front sides of equipment are fully covered.

Equipment shall stay serviceable at discharge voltage test levels of 6 kV for contact discharge and 8 kV for air discharge.

**15 TEST ON SOLAR RADIATION EXPOSURE**

15.1 Tests shall be performed on equipment (item) that is intended for operation on the open deck and that will fully or partly be subject to continuous exposure of solar radiation during operation.

15.2 Tests shall be performed in special chamber at air temperature in the shade of \((55\pm2)\ °C\). Equipment shall be placed on a support and continually exposed to solar radiation imitator during 80 h in accordance with Table A17.1.

Radiation intensity with regard to reflections shall be \((1120\pm112)\ W/m^2\) for spectral distribution, stated in Table A15.15.2.

15.3 Equipment is considered to have passed the test if:

1. no deformation, cracking, layering, buckling, ungluing of parts made of plastic or other materials have occurred;

2. parameters and insulation resistance have remained normal;

3. no reduction of visibility or readability of inscriptions and signs on bars or other parts of the item have been detected.
### Spectral distribution of solar radiation distribution with permissible spread (guides for tests on immunity to solar radiation)

<table>
<thead>
<tr>
<th>Spectral area</th>
<th>Band, μm</th>
<th>Power flow density, W/m²</th>
<th>Tolerance, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>UV B*</td>
<td>0.28-0.32</td>
<td>5</td>
<td>&lt;35</td>
</tr>
<tr>
<td>UV A</td>
<td>0.32-0.40</td>
<td>63</td>
<td>&lt;25</td>
</tr>
<tr>
<td>Visible</td>
<td>0.40-0.52</td>
<td>200</td>
<td>&lt;10</td>
</tr>
<tr>
<td></td>
<td>0.52-0.64</td>
<td>186</td>
<td>&lt;10</td>
</tr>
<tr>
<td></td>
<td>0.64-0.78</td>
<td>174</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Infrared</td>
<td>0.78-3.0</td>
<td>492</td>
<td>&lt;20</td>
</tr>
</tbody>
</table>

* Radiation with wavelength less than 0.30 μm, reached the Earth surface, is negligible.

### 16 EQUIPMENT TESTS ON IMMUNITY TO OIL EXPOSURE

16.1 Tested equipment is immersed in mineral oil on 3 h at temperature of (19±5) °C. Oil shall have following parameters:
- aniline point: (120±5) °C;
- point of ignition: at least 240 °C;
- viscosity: 10-25 centistokes at 99 °C.

16.2 After tests equipment shall be cleared from oil, also, operation control and equipment check shall be performed. Equipment is considered to have passed the test if there are no remarks on operation check, no such damage criterion as cracking, swelling, coatings dissolution or no changes or changes in mechanical characteristics.

### 17 FALL INTO WATER

17.1 During the tests shall be performed series of three drops. Each drop is performed with equipment starting position different from previous position.

The height of equipment lowest point relative to water surface at the moment of dropping shall be (20±1) m.

17.2 Equipment operating check and inspection for the presence of external damages and pressurization leakage.

17.3 Equipment is considered to have passed the test if there are no remarks on operation check, external damages and pressurization leakage.
GUIDELINES FOR CABLE ITEMS TESTING ON FLAME RETARDENCE

1 Tests shall be performed for checking insulated cable on wires on flame retardence.

2 Specimens are cable or wire sections of length (600±25) mm each. Before tests specimens shall stand the temperature of (23±5) °C and relative humidity of (50±20)% for at least 16 h. If cable or wire is covered with paint or varnish, then specimen shall stand the temperature of (60±2) °C for 4 h before tests.

3 Testing chamber consists of metal crate of length (450±25) mm, width (300±25) and height (1200±25) mm without the front side. Testing chamber bottom shall be protected with mineral insulation layer. Testing chamber shall be placed in premise without draughts and with removal systems of toxic gases emitted during burning.

4 Before tests burner shall be placed on the horizontal surface so that its flame was directed straight up, and its total length shall be 125 mm, and length of inner blue flame - 40 mm. Burning operation is tested by inserting of copper wire of diameter (0.710±0.025) mm and length at least 100 mm transversely to the flame at a distance higher than end of flame inner blue part on 10 mm, so that wire length was over the nozzle edge. Flame temperature shall be so that copper wire melt not faster than in 4 s and no slower than in 6 s.

5 The specimen is attached to two horizontal bearings with copper wire (Fig. A16.5-1) so that the distance between lower edge of upper bearing and upper edge of lower bearing was (550±5) mm. The lower end of the specimen shall be situated at a distance of about 50 mm from the chamber's bottom. The burner arrangement shall be so that the blue flame inner cone end was touching the specimen surface at a distance of about 75 mm higher than lower grip; the burner nozzle axis together with specimen vertical axis shall create angle of 45° (Fig. A16.5-2). Flame inner blue part shall be located at a distance of about 10 mm from the specimen.

Fig. A16.5-1. Specimen arrangement in the testing chamber:
1 — metal chamber; 2 — bearing bar and copper wire attachment; 3 — specimen; A — distance from the chamber's bottom to lower end of the specimen (about 50 mm)
After the burning is fully over, the specimen shall be carefully wiped with fabric.

If the specimen surface has no damages, after the wiping presence of soot is permissible on the specimen surface. Softening or any deformation of non-metal material shall be ignored. The distance between lower edge of upper bearing and specimen carbonized part beginning shall be measured with accuracy of up to 1 mm.

Burning part beginning shall be determined as follows. Cable surface is pressed with sharp object, for example - knife blade. Place, where specimen pliant surface changed on fragile (crumbly) counts as burning part beginning.

A cable or wire is considered to have passed the test if the specimen does not ignite, or appeared specimen burning fades away by itself at the end of test flame exposure and traces of fire do not reach upper end of the specimen.

Besides, if burning spreads down to the point located at a distance of more than 540 mm from lower edge of upper bearing, cable or wire count as failed the test.

If the specimen failed the test, two more tests shall be performed. If after two additional tests satisfactory results were gained, cable or wire count as passed the test.

---

6 The specimen shall be continuously exposed to flame for the time specified in Table A16.6. At the end of test burner shall be removed and burner's flame extinguished.

Table A16.6

<table>
<thead>
<tr>
<th>Outer diameter D of the specimen (mm)</th>
<th>Flame exposure time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D \leq 25$</td>
<td>60</td>
</tr>
<tr>
<td>$25 &lt; D \leq 50$</td>
<td>120</td>
</tr>
<tr>
<td>$50 &lt; D \leq 75$</td>
<td>240</td>
</tr>
<tr>
<td>$D &lt; 75$</td>
<td>480</td>
</tr>
</tbody>
</table>

---

Fig. A16.5-2. Burner flame applying to the specimen:

1 — lower edge of upper bearing; 2 — specimen
VALUES OF PARAMETERS CHECKED DURING THE TEST ON BUILT SHIP ELECTRICAL PROPULSION SYSTEM

Parameters checked during ship electrical propulsion system testing, requirements to their values and measurement tolerances are shown in Table A17.1.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Accuracy of voltage maintenance by AC main unit automatic regulator, equal to the ratio of difference between idle voltage and voltage at rated load to sum of these voltages at load $\cos \varphi = (0.8\pm 5)%$ without changing voltage regulator setting knob</td>
<td>Tolerance 2.5%</td>
</tr>
<tr>
<td>2. Accuracy of voltage maintenance by AC emergency unit automatic regulator, equal to the ratio of difference between idle voltage and voltage at rated load to sum of these voltages at load $\cos \varphi = (0.8\pm 5)%$ without changing voltage regulator setting knob</td>
<td>Tolerance 3.5%</td>
</tr>
<tr>
<td>3. Operation of automated generator load and frequency regulation at sudden load change. Apply on generator operating in idle intermediate load containing 70% (another power level is permissible in accordance with 2.12.3.2 Part IV RCCS) of rated generator power, then make a pause of duration at least 10 s, after that make a load rise up to 100% of rated generator power. Make a pause again of duration at least 10 s, then make a load relief down to idle</td>
<td>Voltage shall not deviate from rated value more than on +15, –30 % and shall restore to previous value within 1.5 s with deviation not more than ±3 % of rated value. Frequency shall not deviate from rated value more than on 10 % and shall restore to previous value within 5 s with deviation not more than ±5 % of rated value max. 1%</td>
</tr>
<tr>
<td>4. Steady frequency oscillations (swing) of AC diesel-generator at loads from 25 to 100% of rated active power.</td>
<td>Not more than 20% from rated power of generator with greatest capacity, operating in parallel with other generators (meeting the requirements of 3.6.4, Part VI of RCCS shall be provided)</td>
</tr>
<tr>
<td>5. Non-uniformity of active load of generators, operated in parallel, that can be checked by watt-meters reading difference with maximum and minimum values of active power.</td>
<td></td>
</tr>
</tbody>
</table>
### Continuation of Table A17.1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Non-uniformity of reactive load of generators, operated in parallel,</td>
<td>Not more than 20% from rated current of generator with greatest</td>
</tr>
<tr>
<td>that can be checked by amperemeters reading difference with maximum</td>
<td>capacity, operating in parallel with other generators (meeting the</td>
</tr>
<tr>
<td>and minimum current rate.</td>
<td>requirements of 3.6.5, Part VI of RCCS shall be provided)</td>
</tr>
<tr>
<td></td>
<td>8–15% of generator rated active power. Actuation time (generator</td>
</tr>
<tr>
<td></td>
<td>circuit-breaker shutdown) shall be within 3–10 s.</td>
</tr>
<tr>
<td></td>
<td>Parallel operation shall not be accompanied by exchangeable</td>
</tr>
<tr>
<td></td>
<td>fluctuations of active or reactive power.</td>
</tr>
<tr>
<td>7. Actuating of protection against generators reverse-power (for</td>
<td>1-st stage: power — 100% of the rated generator power; time — 5 s.</td>
</tr>
<tr>
<td>generators intended for parallel operation)</td>
<td>2-nd stage at keeping 100% load, generator shutdown in 10 s.</td>
</tr>
<tr>
<td></td>
<td>max. 30 s</td>
</tr>
<tr>
<td>8. Stability of parallel work of all generators at generators total load</td>
<td>max. 20 s</td>
</tr>
<tr>
<td>about 80% of common rated power of generators, operated in parallel.</td>
<td>max. 30 s</td>
</tr>
<tr>
<td></td>
<td>At least 0.06 M for networks up to 100 V and 0.2 M for networks up</td>
</tr>
<tr>
<td></td>
<td>to 500 V</td>
</tr>
<tr>
<td></td>
<td>max. 10%</td>
</tr>
<tr>
<td></td>
<td>max. 5% of nominal voltage</td>
</tr>
<tr>
<td>9. Automatic discharge with two stages at 2 and more generators</td>
<td>At current overload over 110%</td>
</tr>
<tr>
<td>operating in parallel.</td>
<td>One phase interruption or asymmetric voltage distributions on phases</td>
</tr>
<tr>
<td></td>
<td>Minimum 75% of nominal voltage</td>
</tr>
<tr>
<td></td>
<td>Maximum 30% of temperature values in normal mode (in accordance with</td>
</tr>
<tr>
<td></td>
<td>the datasheet data)</td>
</tr>
<tr>
<td>10. Generation startup and activation time on buses under voltage (with</td>
<td></td>
</tr>
<tr>
<td>synchronization) with following acceptance of load of established</td>
<td></td>
</tr>
<tr>
<td>level (80–95% of generator rated power)</td>
<td></td>
</tr>
<tr>
<td>11. Time of startup and load acceptance by following generator in case</td>
<td></td>
</tr>
<tr>
<td>of voltage loss on main distribution switchboard buses</td>
<td></td>
</tr>
<tr>
<td>12. Time of startup and load acceptance of emergency diesel-generator</td>
<td></td>
</tr>
<tr>
<td>13. Insulation resistance of networks under voltage, measured using</td>
<td></td>
</tr>
<tr>
<td>standard megohm meter on main distribution switchboards or emergency</td>
<td></td>
</tr>
<tr>
<td>distribution switchboards</td>
<td></td>
</tr>
<tr>
<td>14. Nonlinear distortion factor</td>
<td></td>
</tr>
<tr>
<td>15. Actual value of odd harmonics in networks with powerful semiconductor</td>
<td></td>
</tr>
<tr>
<td>converters.</td>
<td></td>
</tr>
<tr>
<td>16. Power disconnection from an external electric power source in case</td>
<td></td>
</tr>
<tr>
<td>of overload</td>
<td></td>
</tr>
<tr>
<td>17. Power disconnection from an external electric power source in case</td>
<td></td>
</tr>
<tr>
<td>of phase interruption or asymmetric voltage distributions on phases</td>
<td></td>
</tr>
<tr>
<td>18. Power disconnection from an external electric power source in case</td>
<td></td>
</tr>
<tr>
<td>of voltage drop</td>
<td></td>
</tr>
<tr>
<td>19. Electric motors temperature exceeding after stop under load current</td>
<td></td>
</tr>
<tr>
<td>in comparison with temperature before beginning of the test (exceeding</td>
<td></td>
</tr>
<tr>
<td>is defined as difference between maximum temperature of stop under</td>
<td></td>
</tr>
<tr>
<td>load current mode end before its steady decline, and temperature</td>
<td></td>
</tr>
<tr>
<td>before beginning of the test:</td>
<td></td>
</tr>
<tr>
<td>steering gears with direct electrical drive — within 60 s,</td>
<td></td>
</tr>
<tr>
<td>Anchor machinery — minimum 30 s;</td>
<td></td>
</tr>
<tr>
<td>Mooring machinery — minimum 15 s;</td>
<td></td>
</tr>
<tr>
<td>If there are no integrated sensors in winding, temperature can be</td>
<td></td>
</tr>
<tr>
<td>changed directly on electric motor bed, for example, by connecting</td>
<td></td>
</tr>
<tr>
<td>pyrometer's thermocouple. Need of tests related to that Para on the</td>
<td></td>
</tr>
<tr>
<td>ship and their methods are approved by the River Register.</td>
<td></td>
</tr>
</tbody>
</table>
20. Steering gear engine initial starting torque with direct electrical drive. Need of tests related to that Para on the ship and their methods are approved by the River Register.
21. Number of starts with duration of 5 s from main or emergency diesel-generator, provided by starting system (of compressed air or accumulator starting battery)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>20. Steering gear engine initial starting torque with direct electrical</td>
<td>Minimum 200% of nominal torque</td>
</tr>
<tr>
<td>drive. Need of tests related to that Para on the ship and their methods</td>
<td>min. 6</td>
</tr>
<tr>
<td>are approved by the River Register.</td>
<td></td>
</tr>
<tr>
<td>21. Number of starts with duration of 5 s from main or emergency diesel</td>
<td></td>
</tr>
<tr>
<td>generator, provided by starting system (of compressed air or accumulator</td>
<td></td>
</tr>
<tr>
<td>starting battery)</td>
<td></td>
</tr>
</tbody>
</table>
METHOD OF ON BOARD TESTING OF SYSTEMS, EQUIPMENT AND DEVICES FOR PREVENTION OF ENVIRONMENT POLLUTION

1 General requirements

1.1 Performance checking of ecological safety equipment shall be made during the mooring and/or running tests according to the program approved by the River Register.

1.2 Testing shall be held using authorised equipment and devices. Measuring means used for tests shall be supplied with the documents testifying its periodical checking if required.

1.3 The survey units are admitted to tests provided that its assembling has been checked by the Surveyor and no remarks have been made which may obstruct the testing procedure.

2 Filtering equipment

2.1 Tests shall be carried out at the design capacity of the equipment.

2.2 Before tests equipment shall be filled with clean water until its appearance from the sampling; at that standard purge pump output is measured (in case of filtering equipment supply and installation without standard purge pump, the output of used ship pump shall not exceed rated flow capacity of equipment more than by half as much). Then oil products shall be pumped through the equipment filled with water for 5 minutes in order to pollute it by oil together with connected pipes.

2.3 On the next stage the oil-water mixture with oil concentration of 5,000 to 10,000 ppm\(^{-1}\) shall be charged into the equipment until the stabilised mode is established. The mode is considered as stabilised when a volume of oil-water mixture has been pumped through the equipment which is not less than the doubled capacity of tested equipment.

The minimal rated time \(t\) needed to pump the indicated quantity of oil-water mixture is calculated by the formula, in hours

\[
 t = \frac{2(V_s + V_f)}{Q}, \tag{A18.2.3}
\]

where \(V_s\) — separator (filter) volume, \(m^3\);

\(V_f\) — filter volume, \(m^3\);

\(Q\) — pump capacity, \(m^3/h\).

2.4 The tests mentioned in 2.3 shall be carried out for 30 min. Samples shall be taken both at the inlet and outlet of the equipment on the 10th, 20th and 30th minutes of the stabilised mode; the last sampling at the outlet on the 30th minute shall be accompanied by air grasp by opening the cock at the pump suction and gradually closing the oil and water valves.

2.5 Sampling procedure and the analysis of the samples shall be carried out in accordance with the test program agreed with the River Register.

2.6 Oil contents in the discharge shall not exceed the admissible normative values (see Appendix 2).

2.7 In order to check the operation of oil gauge and the presence of oil in the oil collector as well as automatic drain valve sensors...
pure oil products shall be pumped to tested equipment until the devices are actuated.

The checking may be performed by means of submerging sensitive elements of the gauges dismantled from the oil collector into the capacity containing pure oil products.

2.8 The following shall be checked during the tests:
   .1 joint tightness during operation of the equipment;
   .2 automatic operating mode;
   .3 manually controlled operating mode;
   .4 operation of pump units and service systems;
   .5 operation of automation, alarm and control means.

Checking may be carried out by means of inducing extreme parameter values directly near the system sensors.

3 Alarm device. Device for automatic interruption of oil-containing water discharge

3.1 Tests are performed on oil-containing water and clean water as per 2.2.

3.2 Performance tests shall be carried out in conjunction with tests of filtering equipment; sampling shall be made as per 2.4. The pressure in a sampling point for test conditions shall be the same as for working conditions.

3.3 Results of sample analysis shall not exceed the device error which shall be within limits of ±10% of the actual oil concentration.

Readings of the alarm device for excessive oil concentration in the discharge shall comply with data of Appendix 2 of RPPS.

3.4 The following shall be tested:
   .1 calibration of the oil contents-measuring device according to the manufacturer instructions;
   .2 operation of the alarm device. It shall be actuated automatically when exceeding the given value of oil contents or by other way specified in its Registration Certificate, and send visual and audible signals simultaneously with actuation of the adjusting elements to interrupt overboard discharge. The alarm device shall be actuated automatically in the event of any malfunction of the device;
   .3 operation of the discharge controlling device. The overboard discharge of oil-containing water shall be interrupted if the normative value is exceeded. The discharge shall be interrupted in the event of any malfunction of the system or switching off the system;
   .4 availability of a local indicator of position of the system overboard valve;
   .5 operation of manual control of the discharge.

4 Automatic monitoring and control systems for ballast and washing water discharge

4.1 Tests are carried out in the water. The following shall be tested:
   .1 operation of pumps, absence of leakage in the sampling system;
   .2 operation of remotely controlled sampling valves;
   .3 the flow intensity or pressure drop whatever is used, and the adequacy of working flow parameters of the system. This test is to be carried out separately for each sampling point and checked by measuring;
   .4 operation of the alarm in the event of malfunctions caused by conditions external to the discharge control system, e.g. absence of the medium in the sampling system, absence of the flowmeter signal, power supply break etc.;
   .5 indication of adequacy of values and synchronisation of simulated (imitated) input signals by means of its manual measuring when the discharge control system operates on water. For discharge control systems of category A the evidence shall be got that the discharge control device is in operation and the data are recorded;
   .6 the possibility of restoration the normal operation conditions after the instantaneous intensity of the discharge has been reduced lower than 30 litres per mile;
.7 availability of recording after override to manual control. For discharge control systems of category A the evidence shall be got that the discharge control device is in operation;

.8 impossibility of overboard discharge control when the system has been switched off – for control systems of category A;

.9 position of zero point and calibration of the measuring device according to the operating manual and manufacturer’s instructions when the system is in operation;

.10 the accuracy of any installed flowmeter, e.g. by means of pumping water in closed contour where the flow rate may be calculated on the basis of the level changing in the tank. The checking is held at flow rate corresponding to 50 % of the nominal flow rate;

.11 the system actuation time from the moment of changing oil concentration in the discharge till the moment of actuation of the signal for the discharge interruption which shall not exceed 20 sec.

4.2 The following shall be tested during the tests of automatic oil measuring device in the discharge:

.1 the flow rate, pressure drop or other equivalent parameter whatever is used;

.2 incorporated alarm devices;

.3 adequacy of readings for several oil concentrations (checking method shall be approved by the River Register).

4.3 The following shall be tested during tests of the oil discharge control section:

.1 all signals;

.2 adequacy of operation of signal processing device and a recorder;

.3 actuation of the device when the oil discharge rate or the total amount of discharged oil exceeds the stated norms;

.4 actuation of signal of overboard discharge interruption in conditions when the alarm has been actuated.

5 Detectors of the oil-water phase division boundary in settling tanks

5.1 For testing purposes the tank shall be filled with oily mixture.

5.2 The following shall be tested:

.1 the accuracy of the detection of oil-water phase division boundary by means of comparison of the device readings with the position of phase boundary known or measured by any other method. The device accuracy shall provide for the indication of oil-water phase division boundary within limits of ±25 mm from the actual;

.2 actuation time of the device.

6 Pumping, delivery and discharge systems for sewage

6.1 During tests of pumping and collection systems the operation of the remote control of an oil amount in the oil-containing mixture and the level alarm in the cargo, settling and collecting tanks shall be checked. An oil amount in the oil-containing mixture may be simulated according to method agreed by the Inspection-office.

6.2 The following shall be tested during tests of the delivery system:

.1 operation of manual start and stop devices of pumping means;

.2 conditions of remote stop of pumping means from the place of the discharge observation or effective telephone or radio communication between the place of observation and the control station of pumping means;

.3 delivery of oil-containing water and oil residues from collecting tanks to reception facilities;

.4 adequate operation of visual and audible warning alarm when the upper limit level in the cargo, settling and collecting tanks is reached.

7 Sewage treatment plant

7.1 Prior to testing the sewage treatment plant in operation the availability of valid resolution of the federal sanitary supervision body shall be checked.

When the resolution in addition to tests (see 7.2 of this Appendix) is not available, the installation shall be tested for sanitary workability. The procedure of those tests shall be
determined by a representative of the federal sanitary supervision body.

The resolution of the federal sanitary supervision body shall be attached to the documents issued by the River Register.

7.2 The plant tests shall be performed on water and check:
   .1 free flow to the installation;
   .2 operation of a grinder (macerator) for solid impurities, if any;
   .3 adequate operation of pump and air-blowing units;
   .4 conditions of actuation of level sensors located in the installation chambers;
   .5 operation of batchers for flocculant (coagulant) and disinfecting agent;
   .6 operation in manual and/or automatic operating mode;
   .7 operation of automation, alarm and control means (may be made by simulation method);
   .8 operation of electric drives and auxiliary facilities (by external examination);
   .9 operation of submersible pumps, if any;
   .10 operation of ventilation system of a separate space containing the installation, if any.

8 Sewage collecting tanks

8.1 Tests may be carried out on the outboard water.

8.2 The following shall be tested:
   .1 free flow of sewage;
   .2 the possibility of washing from the water fire main and steaming if steam-heating system is available;
   .3 draining by a pump or ejector with overboard discharge of water;
   .4 adequate operation of visual and audible warning alarm when the upper limit level in the sewage collecting tanks is reached.

9 Pumping, delivery and discharge systems for sewage

9.1 Performance tests are carried out in conjunction with the tests mentioned in 7 and 8 of the present Appendix proceeding from the contents of the ecological safety equipment installed in a ship.

9.2 The following shall be tested:
   .1 adequate operation of means for manual start-up of pumping equipment (pumps or ejectors);
   .2 delivery of sewage from collecting tanks to reception facilities.

10 Incinerators

10.1 Tests are carried out on the kinds of refuse stated in the documentation for the incinerator.

10.2 Water contents in oil residues and/or sewage slime, when the incinerator is intended for its burning, shall be not lower than listed in the documentation.

10.3 Tests are carried out at operating modes specified in the documentation for the incinerator. The sequence of modes, the period of operation at each mode and test sequence are determined by the program approved by the River Register.

10.4 During testing the following shall be checked:
   .1 adequate operation of ventilation system of a separate space containing the installation, if any;
   .2 conditions of blocking the feeding hopper lids, if any, to prevent from its simultaneous opening during loading;
   .3 conditions of blocking the fuel nozzle when it is in working position and air for burning is supplied into the furnace;
   .4 adequate operation of automatic shut-off devices for fuel supply to the burner in the event of stop of the air supply, flame failure or cut-off of electric power supply;
   .5 adequate operation of the incinerator in manual and automatic operating modes;
   .6 adequate operation of automation, alarm and control means;
   .7 condition of the space during the operation of the incinerator;
.8 absence of sparking from gas-discharging system to the ambient atmosphere.

11 Garbage treatment plants

11.1 Adequate operation of the following items shall be tested:
.1 ventilation system of a separate space containing the installation, if any;
.2 loading mechanisms;
.3 grinders for refuse. The size of grinded particles shall not exceed 25 mm;
.4 compacting devices for refuse which shall reduce its initial volume by 5;
.5 automation, alarm and control systems.

12 Hoses designed to pump the oil and oil-containing water

12.1 Hoses included into ship supply and used for pumping oil, oil-containing or sewage water are subjected to hydraulic tests by testing pressure equal to 1.5 of work pressure.
RUSSIAN RIVER REGISTER

RULES
FOR CLASSIFICATION
AND CONSTRUCTION OF SHIPS
(RCCS)

MOSCOW 2015
The Rules for Classification and Construction of Ships (RCCS) have been approved by the Order of Federal Autonomous Institution “Russian River Register” No. 35-п dated 09.09.2015 and brought into force since 19.07.2016 by the Order of Federal Autonomous Institution “Russian River Register” No. 27-п dated 11.07.2016.

The present re-edition of the Rules for Classification and Construction of Ships (RCCS) includes amendments and additions approved by the following Orders of the Federal Autonomous Institution “Russian River Register”:
- Order No. 32-п dated 20.07.2016, came into force since 23.07.2016;
- Order No. 42-п dated 09.08.2016;
- Order No. 50-п dated 09.09.2016 (Notice No. 1);
- Order No. 78-п dated 07.11.2016;
- Order No. 100-п dated 27.12.2016;
- Order No. 24-п dated 09.03.2017 (Notice No. 2), came into force since 15.03.2017;
- Order No. 38-п dated 11.04.2017 (Notice No. 3), came into force since 17.04.2017;
- Order No. 65-п dated 14.08.2017 (Notice No. 4), came into force since 20.08.2017;

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Part 0

CLASSIFICATION
1.1 The present Part of the Rules for the Classification and Construction of Inland and Combined (River-Sea) Navigation Ships (here and in all other Parts — Rules) defines the basic terms and definitions applicable for all Parts of the Rules, general procedure of ship's class adjudication and composing of class formula, as well as contains information on the documents issued by Russian River Register (hereinafter — River Register) and on the areas and seasons of operation of the ships with the River Register class.

1.2 When performing its classification and survey activities the River Register is governed by the requirements of applicable international agreements of Russian Federation, Regulations on Classification and Survey of Ships, as well as the Rules specified in Clause 2 of Article 35 of Inland Water Transport Code of Russian Federation which contain the requirements for the ships and their components specified in 1.4, in regard to their designing, manufacturing, modernization, refitting and repair, as well as the requirements for products and materials intended for use onboard the ship.

1.3 The purpose of classification and survey of the ships is the performance of works (rendering services) on evaluation of compliance of ships, materials and products intended for installation onboard the ships, organizations, which design, manufacture, modernize, refit and repair the ships as well as products and materials for ships, with the Rules.

1.4 The requirements of the present Rules are applicable to the ships subject to official registration as well as to the products and materials for the ships except for small craft used for non-for-profit purposes. The requirements of the present Rules are applicable to passenger ships, tankers, pushboats, tugboats, ice breakers and industrial ships of overall length less than 20 m.

The requirements of the present Rules are not applicable to small craft, pleasure ships, sports sailing ships, military and border-security ships, ships with nuclear power units, floating drill rigs and other floating facilities. However, the River Register develops and issues corresponding regulations and other standards being part of the Rules for particular types of ships (small craft used for commercial purposes, pleasure and sports sailing ships, ekranoplans etc.) and other floating facilities (pontoon bridges etc.).

1.5 In order to verify the compliance with the requirements of the Rules the River Register approves the technical documentation on construction, repair, modernization and refitting of ships, manufacturing of products and materials for installation onboard the ships.

Ships, materials and products, which technical documentation is submitted to the River Register for approval after the Rules or amendments thereto have come into force, are to meet the requirements of those Rules and amendments. To ships under construction, materials and products, which technical documentation had been approved by River Register before the Rules came into force, the Rules’ version is applied which was in force at the moment of its approval unless otherwise stated in the Rules.

1.6 If the technical documentation contains equivalents to the Rules’ requirements, the organization developer of such technical
documentation shall provide to the River Register a list of the equivalents with their detailed description and technical evaluation.

1.7 If the ship with the River Register class does not comply with the requirements of the Rules, then the corresponding documents shall not be issued (confirmed, renewed or restored) for such ship or the already issued documents shall be withdrawn or suspended by the River Register as specified in 2.16 of the Rules for Supervision of Ships in Operation.
2 BASIC TERMS

2.1 The following terms and abbreviations related to the classification activity are used in the present Rules:

.1 River Register — FAI “Russian River Register” as organization in general or its particular structural subdivision (Head Office, Branch Offices) if otherwise specified;

.2 Head Office of River Register (Head Office) — part of River Register located at the legal (actual) address of River Register and executing inter alia such functions as arrangement and coordination of Branch Offices’ activity;

.3 Branch Office — standalone subdivision of the River Register specified in its Statute and executing part of River Register’s functions on the basis of the guidelines approved by the River Register and within the specified scope of activity;

.4 Expert — authorized person of River Register executing one or more of the following functions in accordance with the Rules:
   - consideration and approval of technical documentation;
   - technical supervision over construction, modernization, refitting, repair of ships and their components, manufacturing of materials and products intended for installation onboard the ships;
   - survey of the ships in service and the organizations which carry out works (render services) or manufacture products in accordance with the requirements of Rules;
   - issuance of the documents of the River Register;

.5 Regulations on Classification and Survey of Ships — regulatory legal act of the Ministry of Transport of Russian Federation which specifies the procedure of ships classification by organizations authorized to carry out classification and survey of ships;

.6 Rules of the River Register (Rules) — an integrated technical standard document(s) of the River Register. The Rules specify the requirements for ships, materials and products to be used on board the ships when designing and manufacturing (construction); the requirements for the procedures of technical supervision over construction, modernization, refitting and repair of ships, manufacturing, mounting, testing of materials and products to be installed onboard the ships as well as the requirements for the survey procedures applied to ships, their components and facilities in service.

2.2 The following terms and definitions are used in the Rules.

.1 Withdrawal of class — cancellation of the documents issued by the River Register for a ship and removal of this ship from the Register book of ships;

.2 Tugboat — self-propelled ship equipped with a towing gear and intended for towing of other ships and floating facilities;

.3 Light-ship displacement — ship displacement in tons without cargo, fuel, lubrication oil, ballast, fresh and boiler waters in the tanks, waste waters, ship’s stores, passengers, crew members and their belongings, but with water, fuel and oil in boilers, engines and pipelines;

.4 Renewal of class — issuance of Classification Certificate for a ship, which had a class before but its validity period has expired;
.5 Restoration of class — restoration of Classification Certificate for a ship the class of which was suspended;

.6 Random inspection — one of the River Register’s methods of technical supervision or survey. During the random inspection when performing the technical supervision the object’s compliance with the requirements of the Rules is examined on the basis of control inspection of particular parameters, dimensions, properties or characteristics of the object or on the basis of inspection of one or more samples from a batch as well as particular manufacturing operations, conditions or other parameters. During the random inspection when performing the technical supervision of a ship the compliance of ship’s components and ship’s technical facilities with the requirements of the Rules is examined on the basis of the random inspection of particular dimensions, properties, parameters and characteristics;

.7 High-speed ship — a ship capable to move at a maximum speed \( v \), \( \text{m/s} \), equal or more than \( v \geq 3.7V^{0.1667} \), where \( V \) — volume displacement of the ship at the design waterline draught, \( \text{m}^3 \). The definition is applicable for ships with \( V \geq 150 \text{ m}^3 \);

.8 Wave height — a characteristic of waves specified as height of wind waves the probability of which complies with that approved for water basins and sea areas of the given type;

.9 Skimming boat (skimmer) — a ship the basic mode of motion of which is skimming the water surface, when the supporting force is mainly composed of water reaction and the influence of buoyancy is negligible;

.10 Type ship — a ship of single construction or first ship in production batch built from a new project.

First ship built from the same project but by other organization is considered as first but not type ship;

.11 Cargo ship — a ship designed for transportation of cargos (dry cargo ship, tank ship, combined ship, refrigerating cargo ship etc.);

.12 Date of ship construction — the date of issuance of the River Register documents for the ship when the results of initial survey of the ship after construction are positive. For the ships built not under technical supervision of the River Register the date of ship construction is the date of issuance of the documents by a classification society which carried out technical supervision over ship construction. If such supervision was not carried out at all the date of ship construction is the date of issuance of the documents by the organization manufacturer of the ship;

.13 Deadweight — difference between ship displacement at freeboard mark drought and light-ship displacement;

.14 Flammable liquids — oil, oil products and other liquids equivalent to them (hereinafter – oil products) capable to create explosive and inflammable concentrations of vapor and with vapor flash point specified according to national standards;

.15 Products — ship’s technical facilities (engines, generators, compressors, pumps, deck machinery, steering engines etc.), boilers, components of ship facilities, electrical, radio, navigational and other equipment, components of ship’s technical facilities, boilers and equipment, appliances, consumables, fixtures and other objects which are subject to the requirements of the Rules;

.16 Domestic voyage — any voyage of the ship which is not international;

.17 Product quality — a combination of product’s properties specifying product’s capability to meet the requirements of the Rules in accordance with product’s designation;

.18 Classification — activities of the River Register including development and publication of the Rules, consideration and approval of technical documentation for construction, refitting, modernization and repair of ships, manufacturing of materials and products, survey of ships and organizations, technical supervision over manufacturing of

1 ГОСТ Р 53717, ГОСТ 26098, ГОСТ 4333, ГОСТ 12.1.044
materials and products, repair of products, construction, repair, modernization and refitting of ships with class assigning (issuance of corresponding documents), as well as confirmation, suspension, renewal, restoration and withdrawal of class on the basis of ship survey results in accordance with the Rules;

.19 Ship’s class — a combination of symbols assigned to the ship during classification which specifies the design features and conditions of operation of the ship in accordance with the Rules and safety requirements;

.20 Combined cargo ship — a ship designed for alternate bulk transportation of liquid cargos or bulk and/or other hard cargos. A separate cargo space is provided for each cargo type;

.21 Container carrier ship — special ship designed and equipped for transportation of cargos in containers;

.22 Icebreaker — special ship designed for breaking the ice cover and supporting the navigation;

.23 Small craft — a ship the overall length of which does not exceed 20 m and the total number of persons onboard does not exceed 12 persons;

.24 Engine room — a room or a number of rooms where the main an auxiliary components of the power plant as well as repair bays and workshops are located. The room is longitudinally limited by the transverse tight bulkheads, in transverse direction — by ship's sides and vertically — by ship's deck and bottom;

.25 Machinery spaces — spaces within the engine room where main and auxiliary engines as well as boilers, compressors, their systems and auxiliaries, pumps of ship's systems, electric power sources, distributing devices, electrical devices, power converters, fuel receiving stations, technical facilities and equipment of refrigerating installations, ventilation and air conditioning systems are located as well as other similar spaces and trunks leading to such spaces;

.26 International voyage — a voyage from the state under the flag of which the ship is sailing to the port outside the flag state or from the port of foreign state to the port of the flag state of the ship.

.27 Shelter area — a natural or artificial protected water area which may be used by a ship as a shelter when there is a danger to ship's safety;

.28 Multihull ship — a ship the supporting force of which is provided by at least two hulls joint with a special structure;

.29 Ship modernization — a combination of operations on changing the design of the ship or ship's component aimed at improvement of technical and operational characteristics of the ship and living and working conditions as well as fulfilment of the requirements of international agreements and treaties of Russian Federation in the area of inland water transport and merchant marine;

.30 Superstructure — a closed structure on the freeboard deck which extends from side to side of the ship or whose side walls are not set inboard of the ship's sides by more than 4% of the breadth (B);

.31 Liquid cargo ship — a ship designed for transportation of liquid cargos in bulk;

.32 Floating bridge — a bridge with floating piers;

.33 Dangerous goods — substances, materials and products containing such substances and materials with properties which may create a threat to life and health of people, cause damage to the environment, damage or destroy material values during transportation;

.34 Organization — legal body (irrespective of legal organizational form, property form and departmental identity) or individual businessman which is carrying out design, construction, repair, modernization and refitting of ships, manufacturing and repair of products and manufacturing of materials for installation onboard the ships as well as test laboratories which have recognition certificate confirming that the organization manufactures its products, performs works and/or renders services in accordance with the Rules. The results of organization’s activities are used by the River Register during classification process;
.35 Survey of ships — part of classification process consisting of the following:
check of availability of approved technical
documentation, certificates (specified by the
Rules) or conformity documents for materials
and component parts used or installed on-
board the ship during the period of time since
the last survey, documents of organization's
technical control service, ship owner's docu-
ments, certificates of previous surveys;

visual inspection, measurements, checks
during operation and test of the ship and its
components;

issuance of the documents specified in the
Rules;

.36 Survey of organizations —
part of classification process aimed at confir-
mation that the organization manufactures
products, performs works and/or renders services
which meet the requirements of the Rules;

.37 Ferry — a self-propelled or non-
self-propelled transport ship intended for
transportation of land vehicles, people and
cargoes from one cost to another;

.38 Passenger — an individual which
concluded a passenger carriage contract, or an
individual for transportation of which a con-
tract of affreightment is concluded;

.39 Passenger capacity — maxi-
mum number of passengers allowed for trans-
portation by the given passenger ship or crew
boat according to its specification and the
River Register documents;

.40 Passenger ship — a ship inten-
ted for transportation of more than 12
passengers;

.41 Reclassification of ship —
a procedure of assignment of a new class to a
ship on the basis of initial survey in the course
of which an evaluation of compliance of all
ship components and technical documenta-
tion (approved by the River Register) with the
requirements of the Rules (applicable to the
new class) is performed. After reclassification
the ship receives a new class as well as new
conditions and areas of navigation are as-
signed. Apart from that the freeboard and the
dates of the next regular and annual surveys
are specified;

.42 Refitting of ship — a com-
Bination of operations on changing ship's struc-
ture in order to change its functional purpose;

.43 Floating crane — a crane on a
floating platform intended for load handling;

.44 Confirmation of class — an
averment made on the basis of annual or
regular survey of the ship which confirms that
the ship with the River Register class fully or
to the extent considered by the River Register
as sufficient complies with those requirements
of the Rules which are applicable to the ship
in accordance with its employment, condi-
tions of operation and class formula. On the
basis of the above the ship is recognized as
able for navigation in the areas specified in
the Classification Certificate;

.45 Pontoon — a floating structure
intended for keeping afloat various facilities
using its own buoyancy. The pontoons may be
used as supports for floating cranes, floating
docks, traveling ship elevators etc.;

.46 Control stations — spaces
where the main navigational instruments, ship
control equipment, radio sets, broadcasting
centers and central fire-fighting stations are
located, accumulator rooms and plant rooms
for radio sets or for emergency lighting as well
as spaces for emergency power sources;

.47 Suspension of class — sus-
pension of validity of ship documents;
after damage of the ship without elimina-
tion of which the operation safety can not be
provided;
in case of presentation of the ship for sur-
vey within specified time limit;
when performing works on structural
changes of the ship without preliminary ap-
proval of the River Register;
when violating the navigation conditions
specified in the ship documents;
when failing to fulfill the requirements of
the Rules and the River Register.

.48 Pleasure ship — a ship in-
tended for recreation on water with total
number of people onboard not exceeding 18
persons including not more than 12 passengers;

.49 Crew boat — a ship intended for
transportation of not more than 12 crew
members and which is not a passenger, small or pleasure ship;

**.50 Deckhouse** — a decked structure on the freeboard deck or a superstructure deck whose side walls are set inboard of the ship's sides by more than 4% of the breadth (B). The deckhouse has doors, windows and other openings in the outside bulkheads. The deckhouses may be arranged in one or more tiers;

**.51 Fishing ship** — a ship intended and specially equipped for fishing and/or fish handling as well as for transportation of fish products;

**.52 Convoy** — self-propelled and non-self-propelled ships coupled with each other or floating structures towed or pushed by a ship (ships) forming part of the convoy;

**.53 Rapid ship** — a ship capable of sailing at a speed greater than km/h;

**.54 Sailing sport ship** — a ship built or refitted for sports activities and used for noncommercial purposes, the primary motive force of which is the wind force;

**.55 (shall be considered to have lost force);**

**.56 Ship** — a self-propelled or non-self-propelled floating facility used for navigation such as combined (river-sea) navigation ship, ferry, dredger, floating crane and other technical facilities alike;

**.57 Ship under construction** — a ship under construction from the moment of keel laying-down until the moment of obtaining of ship's documents issued by the River Register, which confirm ship's compliance with the Rules.

The moment (date) of keel laying-down is the moment of the beginning of construction, which can be specified as related to the present ship, or when the mass of assembled part of the hull is not less than 1 % from calculated mass of all the ship materials;

**.58 Ship in operation** — a ship, which is not a ship under construction;

**.59 Air-cushion ship (ACS)** — a ship, the mass (in whole or significant part) of which is maintained above the water (ground, ice etc.) in motion or at standstill by the excess air pressure forces created by the air constantly inflated under the hull into the cavity called air cushion;

**.60 Hydrofoil ship** — a ship, which is maintained above the water surface by hydrodynamic forces created by the hydrofoil wings when moving under operating conditions;

**.61 Bulk oil-carrying ship** — a cargo ship designed for oil and oil products storage and transportation in bulk. Oil stations (oil transfer, bunker and pollution control stations, as well as oil-containing water gathering and treatment stations) and oil-gathering ships are to be considered as bulk oil-carrying ship as regards to the Rules application;

**.62 Ship with dynamic principle of supporting** — a ship, the mass (or major part of the mass) of which is counterbalanced by non-bouyant forces under one of the operating conditions; or which is capable to operate at such speed when the ratio (speed coefficient) of maximal speed of the ship to the square root of product of free fall acceleration and ship length (at construction waterline) is not less than 0.9 (ACS, hydrofoil ship, air cavern ship, skimmer, ekranoplan etc.);

**.63 Combined navigation (river – sea) ship** — a ship, which is capable (according to technical characteristics) and allowed (according to established procedure) for operation at sea and on inland water ways;

**.64 Industrial ship** — a ship designed for maintenance of ships and water ways, port facilities, underwater mining etc. (dredgers, sludge carriers, multicats, bouy tenders and crew boats designed for navigation support, ecological monitoring and analysis of water environment, bottom soil and ambient air);

**.65 Ship owner** — a legal body or an individual which operates the ship on behalf of itself whether he owns the ship or uses her on other legal grounds;

**.66 Navigation** — an activity related to the use of ships on inland water ways for transportation of goods, passengers and their belongings, as well as postal items, towing of ships and other floating objects, exploration and extraction of minerals, construction activities, trackworks, hydraulic works, underwater technical operations and other similar works, piloting, icebreaker assistance, rescue operations, water objects protection activities, contamination and pollution prevention, lift-
ing of sunken property, monitoring activities, scientific activities, educational, training, sports activities, as well as for cultural and other purposes;

.67 Dry cargo ship — a ship designed for transportation of dry cargoes (general cargoes, containers, timber, cargoes in bulk, vehicles without passengers etc.);

.68 Tanker — a liquid cargo ship built or refitted for transportation of liquid or semiliquid cargoes, mainly crude oil and oil products;

.69 Technical documentation — design and technological documentation, as well as technical documentation for objects of technical supervision, which contains data required for checking the compliance with the Rules;

.70 Technical supervision — part of classification process, which includes step-by-step checks of Rules execution as well as attendance at the tests in the course of ships (or their components) construction, refitting, modernization and repair, manufacturing and repair of ship technical facilities and materials intended for installation onboard the ship. The list of objects, type and volume of technical supervision are specified by the Rules;

.71 Type technological process — a technological process intended for specified conditions and field of application without any reference to particular ship or other object of technical supervision;

.72 Pushboat — a ship designed for propelling other ships or other floating facilities by means of pushing;

.73 Requirements of River Register — requirements of the Rules and other regulatory documents of the River Register, as well as the requirements specified in written form including the documents issued by the River Register;

.74 Area with sea navigation conditions — an area of water ways of Russian Federation within which the navigation-hydrographic conditions of navigation safety provisions comply with the requirements of merchant navigation, and the matters arising from navigation safety are subject to the Merchant Shipping Code of Russian Federation;

.75 Ship class formula — a sequence of symbols and words specifying ship's class, which is specified by the Regulations on Classification and Survey of Ships and the Rules (see 2.2.19);

.76 Ship crew — command personnel, ship's company, as well as servicing staff onboard the passenger ship. Command personnel consists of the captain, dredger officer, their mates and assistants, engineers, electrical engineers, their assistants, radio engineers and medical officers. Ship's company consists of persons (which are not part of command personnel or servicing staff) who provide the following: ship navigation, maintenance, survivability and safety of operation, as well as maintenance of ship's technical facilities, systems and equipment;

.77 Floating object — a non-self-propelled floating facility, which is not a ship, including landing stage, floating (located on water surface) house, hotel, restaurant, pontoon, raft, pontoon bridge, floating pier and other similar technical facility;

.78 Special personnel — persons onboard the ship which are not passengers or ship crew.

Special personnel include:

.1 officers performing official duties within the scope of their official powers in the field of border monitoring, customs inspection, sanitary, transport, port control or any other state control or supervision;

.2 persons participating in the following activities: exploration and extraction of mineral resources, building, roadway, hydraulic or underwater works and similar, rescue operations, security of water objects, weighing of sunken property, investigation of transport accidents, scientific researches, pilotage and icebreaker assistance.

.3 persons which are transported to other ships in order to change the crew.

.79 Special purpose ship — a ship allowed for operation in sea areas with more than 12 persons of special personnel onboard.
3 SHIP’S CLASS AND CLASS FORMULA

3.1 The ship’s class is assigned to the ship during the initial survey. The class may be confirmed, suspended, renewed and restored for a period of time (specified by the River Register) or withdrawn during other types of surveys. Assignment, renewal and restoration of class are certified by issuance of Classification Certificate or by confirmation of Certificate’s validity period.

3.2 The ship’s class assignment is performed in accordance with ship’s design features and classification of water basins where the ship shall be operated.

3.3 Inland water basins are classed on categories "Ë", "Ð", "Î" and "Ì" due to their wind-and-wave conditions on the basis of the following:

- in the basins of "Ë", "Ð" and "Î" categories the waves of 1 percent probability with 0.6; 1.2 и 2.0 m height respectively have a total reoccurrence (probability) for not more than 4 percent of navigation time;
- in the basins of "Ì" category the waves of 3 percent probability with 3.0 m height have a total reoccurrence (probability) for not more than 4 percent of navigation time.

The sea areas are classed on "Î-ÏÐ", "Ì-ÏÐ" and "Ì-ÑÏ" categories depending on their wind-and-wave conditions and availability of shelter areas.

The list of inland water basins and sea areas where the ships are operated according to their categories, as well as the operating conditions of the ships are established by a federal body of executive power in the field of transport. These lists are given in Appendices 1 and 2 for reference.

3.4 The assignment of a class to the ship is certified by issuance of Classification Certificate where (as in other ship documents) the class formula is specified for the ship on the basis of initial survey results.

3.5 The main symbols in the class formula of inland navigation ships are letters "Ì", "P", "O" and "M", which determine the design features of a ship and the water basin category where the ship is allowed for operation.

The main symbols in the class formula for the ships operating in the sea areas are letter combinations "O-ÎP", "M-ÎP" and "M-ÇP", which determine the design features of the ship and her operating conditions in the sea areas.

3.6 Proceeding from the design features of the ship the main class symbol is added by the following supplementary symbols:

- the symbol ‡ for the ships built under technical supervision of the River Register or other Classification Society recognized by the River Register and authorized to perform classification and survey of ships, which is put in front of the main symbol, e.g. ‡Î.

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the permissive wave height in meters with the accuracy to within nearest decimal point is put directly after the main class symbol, e.g. "‡Î2.0".

For high-speed ships: skimmers, ACS, hydrofoil ships, air cavern ships and ekranoplan the wave height restrictions are given as a fraction with a numerator being the wave height at displacement mode, and a denominator being the wave height in service mode followed by the ship type according to the movement principle, e.g. "‡Ð1.2/0.8 skimmer", «‡Î2.0/1.2 ACS», «‡Î2.0/1.5 hydrofoil ship», «‡Ð1.2/0.4 ekranoplan»;

for ships fitted with special ice strengthenings the wave height value is followed by the word "ëåä" (ice) in brackets and the value of thickness of finely broken winter ice, in cm, specified by the River Register when approving the ship design, e.g. "‡Î2.0 (ëåä 20)". Class formula of icebreakers includes the word "ледокол" (icebreaker);

for ships fitted with automation means according to the Rules the letter "A" is put after all symbols mentioned in para. 1 – 3 of the present Clause, e.g. "‡Î2.0 (лед 20) А".

3.7 The River Register may withdraw or change any symbol in the class formula in the event of change or violation of conditions being the basis for entering that symbol into the class formula.

3.8 Upon ship owner's application the River Register may perform ship re-classification. On the basis of such re-classification the main class symbol in the class formula of the ship, as well as ship's type and/or purpose, may be changed.

3.9 The works connected with preparing the ship for re-classification for higher class assignment and/or changing the ship's type and purpose shall be performed according to the technical documentation approved by the River Register and under the technical supervision of the latter. Calculations and tests shall be made according to the Rules' version, which was in force at the moment of development of the technical documentation for re-classification, and shall be directed towards the new operating conditions due to changes of external stresses, technical characteristics (draught, water displacement, freeboard etc.), the type of goods carried etc.

The works connected with preparing the ship for re-classification for lower class assignment shall be performed according to the technical documentation approved by the River Register and under the technical supervision of the latter provided that the type and purpose of the ship shall not changed. The volume of documentation shall be sufficient for confirmation of ship's components compliance with the Rules' requirements applied for the new class of the ship.

3.10 The River Register may assign a class to a ship which is built not under the technical supervision of the latter or built under technical supervision of other organization authorized to perform classification and survey of ships. In this case the River Register shall consider the technical documentation for the ship and perform the analysis of ship design compliance with the Rules' requirements, requests elimination of discrepancies detected and survey of defects for all components of the ship including component-by-component survey of hull structure. Upon completion of the above the River Register shall assign a class to the ship on the basis of initial survey.

3.11 A ship entry shall be made in the Ship Registry Book after assignment of the River Register's class.
4 DOCUMENTS OF THE RIVER REGISTER

4.1 When performing classification the River Register issues documents specified by the laws of Russian Federation and the Rules.

5 REQUIREMENTS FOR SHIPS

5.1 The requirements for ships (and their components) intended for operation in “I”, “II”, “III” water basins and “O-II”, “M-II”, ”M-CII” sea areas are given in the Parts I – XI of the Rules and Appendices 1 – 3.
6 List of Inland Water Basins According to their Category for Determination of Areas and Conditions of ... 31

6.1 Category "JI" is assigned to the following basins:

1. reservoirs:
   Voronezhskoe;
   Sayano-Shushenskoe — from Verkhny Enisey River to Shagonar City;

2. rivers:
   Aldan — from the upper reaches to the village of Ust-Maya;
   Amur — from the source to 978th km of Sredny Amur (Blagoveshensk City);
   Belaya — from the source to Yamalinsky Yar (1776th km of Belaya River);
   Volga — from the source to 278.3rd km of Volga River (river port of Tver City);
   Don — from the source to 2689th km of Don River and from the dam Tzymliansk Hydroelectric Power Station to Rostov-on-Don City — 3121st km of Don River (mouth of Aksay River);
   Don — from 3121st km of Don River (mouth of Aksay River) to Rostov-on-Don City — 3151st km of Don River (mouth of Koysug River);
   Enisey — from the source to Ust-Abakan village;
   Indigirka — from the source Druzhin village;
   Irtysh — from the source to Omsk village (mouth of Om River, 1833.5th km of Irtysh River);
   Iya — from the source to 180th km;
   Kama — from the source to Berezniki City;
   Kolyma — from the source to Zyryanka village;
   Lena — from the source to the mouth of Vitim River;
   Manych — from the dam of Veselovskoe reservoir to the mouth;
   Mezen — from the source to Mezen City;
   Ob — from the source to Kamen-on-Ob City;
   Oka (tributary of Angara River) — from the source to 330th km;

* N o t e : the symbol * marks the areas of inland waterways of Russian Federation where the navigating conditions and hydrographic characteristics of ships operation and safety navigation comply with the requirements of merchant shipping and are regulated by the Federal Law No. 81-ФЗ dated 30 April 1999 «Merchant Shipping Code of the Russian Federation» (Collection of Legislative Acts of the Russian Federation, 1999, No. 18, art. 2207; 2001, No. 22, art. 2125; 2003, No. 27, art. 2700; 2004, No. 15, art. 1519, No. 45, art. 4377; 2005, No. 52 (Part 1), art. 5581; 2006, No. 50, art. 5279; 2007, No. 46, art. 5557, No. 50, art. 6246; 2008, No. 29 (Part 1), art. 3418, No. 30 (Part 2), art. 3616, No. 49, art. 5748; 2009, No. 1, art. 30, No. 29, art. 3625; 2010, No. 27, art. 3425, No. 48, art. 6246; 2011, No. 23, art. 3253, No. 25, art. 3534, No. 30 (Part 1), art. 4590, 4596, No. 45, art. 6335, No. 48, art. 6728; 2012, No. 18, art. 2128, No. 25, art. 3268, No. 31, art. 4321; 2013, No. 30 (Part 1), art. 4058; 2014, No. 6, art. 566, No. 42, art. 5615, No. 48, art. 6659; 2015, No. 1 (Part 1), art. 89, No. 13, art. 1810, No. 29 (Part 1), art. 4339, 4356).
Oka (tributary of Volga River) – from the source to the mouth;
Olenyok – from the source to Ust-Olenyok village;
Petchora – from the source to Ust-Tsylma village;
Northern Dvina – from the source to the mouth of Pinega River;
Yana – from the source to Yansky village;
3 lakes, canals and rivers not specified in Items 6.2 – 6.4.

6.2 The «P» category is assigned to the following basins:
1 lakes:
Beloe;
Ilmen;
Kubenskoe;
Pskovskoe;
Teletske (from Artybash village to Azhin Cape);
Chudske;
Onega (during navigation period from May to September inclusively): within the water areas of Petrozavodskaya Guba bay, Kondopozhskaya Guba bay and Velikaya Guba bay, Kizhi skerries; Gulf of Bolshoe Onega to the north of parallel 62°10'00,0'' N including Gorskaya Guba bay, Bolshaya Lzhemskaya Guba bay, Unitskaya Guba bay, Zaonezhsy Gulf to the north of parallel 62°15' N, Povenetsky Gulf;
2 reservoirs:
Boguchanskoe;
Bureyskoe;
Veselovskoe;
Gorkovskoe;
Zeyskoe – from the dam to 65th km and upstream of 180th km;
Irktuskoe;
Krasnodarskoe;
Krasnoyarskoe – along Enisey River from the village of Ust-Abakan to the pier of Chernogorsk; along Derbino River from 30th km to the mouth; along Ezagash River from 20th km to the mouth; along Sisim River from 20th km to the mouth; along Syda River from 25th km to the mouth; along Tuba River from the village of Gorodok (22nd km) to the village of Nikolo-Petrovka (15th km);
Novosibirsk Reservoir – from the city of Kamen-na-Obi (497th km from the confluence of Biya and Katun River s) to the village of Maloyino (530th km from the confluence of Biya and Katun River s), from the upper approach channel of Novosibirsk lock to the 3rd km of Berd River;
Rybinsk Reservoir – from the city of Cherepovets (540th km of Nizhnyya Sheksna River) to the village of Vichelo;
Saratov Reservoir – from Syzransky bridge to the dam of Saratov Hydroelectric Power Station;
Sayano-Shushenskoe – from the city of Shagonsar to the dam of Sayano-Shushenskaya Hydroelectric Power Station;
Ust-Ilmenskoe;
Cheboksary Reservoir;
Sheksninskoe;
3 rivers:
Aldan — from the village of Ust-Maya to the mouth;
Amur – from 978th km of Sredny Amur (Blagoveschensk City) to the line connecting the mouth of Polovinka River and the Cape Kuklya (Nikolayevsk-on-Amur);
Anadyr — from the source to the zero kilometer, Cape Amerikanskaya Koshka;
Anadyr – from the zero kilometer, Cape Amerikanskaya Koshka, along the ship channel of Onemen Gulf to the line connecting Zaselelniya Cape and Alyumka isle and then going to the stream Promyslovya*;
Angara – from the dam of Irkutsk Hydroelectric Power Station to the village of Nizhnaya Barkhatovo; from the dam of Boguchanskaya Hydroelectric Power Station to the mouth;
Belaya – from Yamalinsky Yar (1776th km of Belaya River) to the mouth;
Velikaya (Bolshaya) – from the source to the influx into Anadyr River;
Volga – from the 278.3th km of the Volga River (river station of Tver City) to Koprino village (including Ivankovskoe and Uglich Reservoirs), from the dam of Rybinsk Hydroelectric Power Station to the mouth of
6 List of Inland Water Basins According to their Category for Determination of Areas and Conditions of ... 33

- Elnat River, from the dam of Gorkovskaya Hydroelectric Power Station to the mouth of Sura River, from the dam of Cheboksarskaya Hydroelectric Power Station to the village of Kamskoe Ustye, from the dam of Kuibyshevskaya Hydroelectric Power Station to Syzranksy bridge, from the dam of Saratov Hydroelectric Power Station to Uveksky bridge, from the dam of Volgogradskaya (Volzhskaya) Hydroelectric Power Station to the village of Streletskoe;
  - Volga – from the village of Streletskoe to the village of Krasnye Barrikady (0 km of Volga-Caspian canal)*;
  - Don – from Rostov-on-Don City (3151 km of Don River, mouth of Koysug River) to the meridian 039°12'00,0'' E including Azov-Donskoy maritime canal, outer roads No. 6 and the Kalancha arm to the halting point Dugino*;
  - Enisey – from the dam of Krasnoyarsk Hydroelectric Power Station to the city of Igarka;
  - Indigirka — from the village of Druzhina to Nemkov isle;
  - Irtysh – from Omsk City (mouth of Om River, 1833.5 km of Irtysh River) to the mouth;
  - Iya – from 180th to 45th km;
  - Kama – from the dam of Kama Hydroelectric Power Station to Chastye pier, from the dam of Vohtinsk Hydroelectric Power Station to the town of Ust-Belsk (1756 km of Kama River), from the dam of Nizhnekamsk Hydroelectric Power Station to the city of Chistopol;
  - Kanchalan – from the source to the influx into Anadyr River;
  - Kolyma – from the village of Zyryanka to the village of Chersky;
  - Kolyma – from the village of Chersky to the village of Mikhalkino*;
  - Lena – from the mouth of Vitim River to the village of Zhigansk;
  - Mezen – from Mezen City to the mouth of Bolshaya Chetsa River *;
  - Neva – from the source to the border of inland waterways: along Bolshaya Neva River – Blagoveshchensky bridge; along Malaya Neva River – along the lower border of Tuchkov bridge, along Malaya Nevka River along the lower border of Bolshoy Petrovsky bridge, along Bolshaya Nevka and Srednyya Nevka River s – to meridian 030°13'00,0'' E;
  - Ob – from the dam of Novosibirsk Hydroelectric Power Station to Yamsal bar along the Khamanelskaya Ob River and along the branch of Bolshaya Narechinskaya Ob to Nachalny isle;
  - Oka (Tributary of Angara River) — from 330th km to the village of Toporok;
  - Pechora – from the village of Ust-Tsylma to the city of Naryan-Mar;
  - Pechora – from Naryan-Mar City to Alekseevskiy isle including Vasilkovo Gulf *;
  - Svir;
  - Northern Dvina — from the mouth of Pinega River to the mouth of Uyma River;
  - Northern Dvina – from the mouth of Uyma River:
    - To Lapominka village along Korabelny arm including Maymaks and Kuznechikha Rivers*;
    - To Cape Knevaty along Murmansk arm*;
  - To the entrance into the branch between Nikolsky isle and Ugol isle along Nikolsky arm including the branch of Korytka and the water area of Severodvinsk City within the limits of Yagra isle shore in the north, mainland shore in the south, reinforced-concrete mole in the west and Bolshoy Chayachy isle and reinforced-concrete bridge across the branch of Korytka in the east*;
    - The mouth reach of Northern Dvina River:
      - Konetskdvorka branch (from Onishevka branch to Svinets isle),
      - Onishevka branch (from Kiselev isle to the front edge of Khop isle),
      - Rybolovka branch (front edge of Kego isle to Onishevka branch),
      - Perednya branch (from Onishevka branch to Chubola village),
      - Khabarka branch (front edge of Khabarka isle to Pustosh village),
      - Podborka branch (from Maymaks arm to Lapaminka village);
  - Selenga;
Tazovskaya Guba bay – from the mouth of Taz River to the parallel 68°00'00.0" N; 
Khatanga (with tributaries) – upstream of Novorybnaya village; 
Yana – from the village of Yansky to Udey village; 
.4 canals: 
Belomorsky entrance canal to the point 64°34'48.0" N, 035°14'00.0" E*; 
Volga-Baltic – from the Lake Onega to the dam of Sheksninskaya Hydroelectric Power Station including Sizminsky expansion; 
Volga-Don – from Volgograd City (lower approach canal of lock No. 1, 2588.6 km of the Volga River) to the lower border of oil-loading Pyatizhianskie roads (2701.6 km of the Volga River); 
Volga-Caspian canal – from the village of Krasnye Barrikady (0 km of the canal) to 146th km of the canal*; 
Moscow Canal – from the pier of Bolshaya Volga to the lock No. 7; 
.5 gulfs: 
Kaliningradsky (Vistula Lagoon) Gulf including the sea port and canal of Kaliningrad (except for the remote sea terminal Pionersky) to the line connecting the ends of the northern and southern moles of the port of Baltiysk*; 
Kanchalan*; 
Kurshsky Gulf to the line connecting the ends of the northern and southern moles of the entrance gate to the port of Klaipeda*; 
Onemen*. 
.6 The harbour of Vyborg merchant port*; 
.7 Yeysky firth to the east of the line connecting the northern edge of Yeyskaya spit and the southern edge of Yeyskaya Kosa isle; eastern edge of Yeyskaya Kosa isle with the basis of Glafirovskaya spit on the parallel 46°46'18.0" N*; 
.8 Nevskaya Guba – from the border of inland waterways to the dam along the line connecting Gorskaya village – Kronstadt City – Lomonosov City*. 

Notes. 1. The passenger ships operating in the Gorkovskoe Reservoir from the city of Yuryevets to the dam are to be of «O» class. 
2. The covers onboard the ships of «P» class navigating the Bureyskoe Reservoir, Amur River from the city of Khabarovsk to the city of Nikolsyevsk-on-Amur, in Onemen Gulf, Anadyr River throat, Kanchalan bay and Saratov Reservoir from the dam of Saratov Hydroelectric Power Station to Syzransky bridge shall meet the requirements specified for the «O» class ships. 
The open ships of «P» class are allowed to navigate the abovementioned part of Saratov Reservoir at the wind speed not exceeding 8 m/s. 
3. The ships of «P» class are allowed to navigate the Angara (100 – 145 km, 205 – 245 km, 260 – 290 km) and Ilim (50 – 110 km) directions of Ust-Ilimskoe Reservoir at the wave height \( h_{1\%} = 1.2 \) m and being fitted with the equipment according to the requirements specified in the Rules for the «O» class ships. 
4. The ships of «P» class are allowed to navigate the Sayano-Shushenskoe Reservoir from the city of Shagonar to the mouth of Bedelig River if they are fitted with the equipment required for the «O» class ships. 

6.3 The «O» category is assigned to the following basins: 
.1 lakes: 
Vygozero; 
Lake Ladoga during the navigation period from May to September inclusively; west area – to the west of the line connecting Cape Pesotsky Nos, western edge of Konevets isle and Cape Kurkiniemi, north area – to the north of the line connecting Zayachy isle, Nikonovsky isle and north-west edge of Valaam isle to Pitkyaranta City including 2 mile coastal area around the Valaam isle; south area – to the south of the line connecting Cape Moryn Nos, point with coordinates 032°30'00.0" E, 60°40'00.0" N and along the parallel 60°40'00.0" N to the shoreline; 
Note. The navigation in the Lake Ladoga in the «O» category areas is allowed to the ships with «O.2,0» class, in the west, north and south areas from May to September inclusively at the wave height \( h_{1\%} \leq 1.5 \) m. 
The ships navigating in Ladoga and Onega Lakes shall be fitted with collective life-saving equipment in accordance with the standards specified for the ships of «M» class.
Lake Onega during the navigation period from May to September inclusively:
areas to the west and north of the line connecting the mouth of Vytegra River and the crossing point of the line, connecting the mouth of Vytegra River and the south edge of Suysari isle, and the parallel 61°45'00,0'' N and then going across to the south edge of Rechnoy isle to the shoreline;
5 mile coastal area along the isles Bolshoy Klimentsky and Rechnoy and Peninsula Zaonezhye to the parallel 62°15'00,0'' N;
Teletskoe (from Cape Azhyn to the mouth of Chulysman River);
.2 reservoirs:
Bratsk Reservoir — along Angara River from N. Barkhatovo village to dam of Bratsk Hydroelectric Power Station;
along Oka River from the village of Toporok to the mouth; along Iya River from the 45th km to the mouth;
Volgograd Reservoir — from Uveksky bridge to the dam of Volgogradskaya (Volzhskaya) Hydroelectric Power Station;
Votkinsk Reservoir — from the pier Chastye to the dam of Votkinsk Hydroelectric Power Station;
Zeya Reservoir — from 65th to 180th km of the reservoir;
Kama Reservoir — from the city of Berezniki to the dam of Kama Hydroelectric Power Station;
Krasnoyarskoe — along Enisey River from the pier Chernogorsk to the dam of Krasnoyarsk Hydroelectric Power Station; along Tuba River from the village of Nikolayevsk-on-Amur City; along Mezen from the mouth of Bolshaya Chetsa River to the line crossing the perpendicular axis of the navigation pass in the point with coordinates 66°10'30,0'' N 043°58'31,8'' E;
Pechora — from Alekseevsky isle to the line connecting Cape Bolvansky Nos and the north edge of Lovetskaya isle;
Northern Dvina — along Korabelny arm from Lapominka village to the south edge of Mudugsky isle; along Murmansky arm from Cape Knevaty to Kumbysh isle; along Nikolai river from the south-east edge of Uglimin isle to the north edge of Yagra isle;
Nadymskaya Ob — from the village of Salmal to Obskaya Guba bay and Obskaya Guba bay to the line Novy Port – village of Yamburg;

Novosibirsk Reservoir — from the village of Maletino to the dam of Novosibirsk Hydroelectric Power Station;
Rybinsk Reservoir excluding its northern part from the city of Cherepovets (540th km of Nizhnyya Sheksna River) to the village of Vichelo;
Tsimlyansk Reservoir — from the lower border of oil-loading Pyatizbianskie roads (2701.6th km of the Volga River) to the dam of Tsimlyansk Hydroelectric Power Station;
.3 rivers:
Amur — from the line connecting the mouth of Polovinka River and Cape Kuklya (Nikolayevsk-on-Amur City) to the line connecting Astrakhanovka village and Subbotino village (Nikolayevsk-on-Amur City)*;
Anadyr — from the line connecting Cape Zaseleniya and Alyumka isle and then going along the stream Promyslovy along the ship channel to Nikolaya spit*;
Enisey — from Igarka City to Ust-Port*;
Kilyma — from Mikhalitino village to Cape Medvezhy*;
Len — from Zhigansk village to Cape Bykov;
Len — from Cape Bykov to the sea port of Tiksi City*;
Mezen — from the mouth of Bolshaya Chetsa River to the line crossing the perpendicular axis of the navigation pass in the point with coordinates 66°10’30,0’’ N 043°58’31,8’’ E*;
Pechora — from Alekseevsky isle to the line connecting Cape Bolvansky Nos and the north edge of Lovetskaya isle*;
Northern Dvina — along Korabelny arm from Lapominka village to the south edge of Mudugsky isle; along Murmansky arm from Cape Knevaty to Kumbysh isle; along Nikolai river from the south-east edge of Uglimin isle to the north edge of Yagra isle*;
Tazovskaya Guba bay – from parallel 68°00'00,0'' N to the line connecting Cape Povorotny and Antipayuta village;

Anabar – from Yuryung-Khaya to Cape Khorgo*;

river bars: Indigirka from Nemkov isle, Olenyok from the village of Ust-Olenyok, Yana from the village of Udey – to 5 m depth isobath curve;

Note. The ships of «Î» class are allowed to navigate the bars of Indigirka, Olenyok and Yana at the wave height $h_{3%} \leq 1.5$ m.

Taganrog Bay – area from meridian 039°12'00,0'' E to meridian 038°52'00,0'' E*;

transloading roads of the mouths (bars) of Indigirka, Olenyok and Yana Rivers*;

Sevastopol bay including all other bays being part of it – to the line connecting the northern and southern protecting moles*;

Balaklava bay – to the line connecting the eastern and western entrance capes*;

Donuzlav Lake *.

6.4 The «M» category is assigned to the following basins:

.1 lakes:

Baikal;

Ladoga (except for areas specified in the subparagraph 1 of paragraph 3 of the present Annex);

Onega (except for areas specified in the subparagraph 1 of paragraph 2 and subparagraph 1 of paragraph 3 of the present Annex);

.2 rivers:

Enisey – from Ust-Port to the northern edge of Brekhovskie isles*;

Obskaya Guba bay – from the line Novy Port – village of Yamburg to the line consequently connecting the point with coordinates 68°26'00,0'' N, 073°35'00,0'' E (Cape Kamenny); 68°25'00,0'' N, 073°48'00,0'' E; 69°04'00,0'' N, 073°52'00,0'' E (Cape Trek-lobugorny);

Tazovskaya Guba bay – from the line connecting Cape Povorotny and Antipayuta village to Obskaya Guba bay;

Khatanga Gulf – from the line connecting Cape Povorotny and Cape Bolshaya Korga to Cape Kosisty*.
7 LIST OF SEA NAVIGATION AREAS FOR DETERMINATION OF AREAS AND CONDITIONS OF NAVIGATIONS OF THE SHIPS WITH THE CLASS OF RUSSIAN RIVER REGISTER

7.1 In the present Section the navigation conditions shall be understood as operating restrictions specified for ships according to areas and seasons of navigation, as well as 3% probability wave height.

7.2 Constant operation in the sea areas is allowed for the cargo self-propelled and non-self-propelled ships, tugboats, passenger displacement self-propelled ships according to their class and limitations specified in the Table given below.

7.3 The navigation conditions for tugboats, ice-breakers, industrial ships, non-self-propelled passenger ships and ships with dynamic principle of supporting are specified as agreed upon with the River Register.

7.4 The passenger displacement self-propelled ships are allowed for operation in the sea when the value of 3% probability wave height in the class formula is equal to the specified one complying with the main class symbol.

For such ships the permissible distance between the shelter areas, which provide entrance and mooring at the wind of all directions, shall not exceed the distance passed by the ship within 12 hours at still water and sailing rate – 70% of the rated one.

The ship is allowed to leave the shelter area (port) and return to the route of navigation when the weather forecast for the next 12 hours specifies that the 3% probability wave height does not exceed the $h_{3\%}$ value reduced by 0.5 m. For the displacement ships of 30 m length and less the predicted wave height, irrespective of the class, can not exceed $0.2L^{0.75}$ value, where $L$ – overall length of the ship in meters.

7.5 The following abbreviations are used in the Table given below:
- ГС – for cargo self-propelled ships only;
- КН – except for cargo non-self-propelled towed ships and tugboats;
- КП – except for passenger self-propelled displacement ships;
- НБ – for cargo non-self-propelled towed ships and tugboats;
- ПБУ/БС – for floating drilling outfits/ships;
- ССН – for special purpose ships;
- СТФ – for industrial ships;
- РС – fishing ships;
- ТР – Technical Regulations on the safety of inland water transport objects of Russian Federation.

7.6 The «М-СП» class ships may be operated in the areas specified for operation of «М-ПП» and «О-ПП» class ships, the «М-ПП» class ships – in the areas specified for operation of «О-ПП» class ships.

7.7 The areas and seasons of navigation for roads (harbour) and port navigation are specified on the basis of special studies carried out by an organization having the Recognition Certificate of the River Register. Such studies shall be based on the update of long-term characteristics of sea in the area under consideration or evaluation of the maximal possible waves in protected water area taking into account the ice conditions.
7.8 The lists of water basins are given in the following Tables: for "M-СI" category - Table 7.8.1, for "M-II" category - Table 7.8.2, for "O-II" category - Table 7.8.3.

7.9 The areas and conditions of operation for the "M-СI 4.5" class training sailing ships and the "M-СI 4.5" class special purpose sailing ships are specified by the decision of the Head Office after consideration of justifications provided by an organization having the Recognition Certificate of the River Register or taking into account the areas and conditions of navigation specified by a classification organization recognized by the River Register and having an agreement on cooperation and mutual substitution concluded with the River Register.

**Table 7.8.1**

<table>
<thead>
<tr>
<th>Sea</th>
<th>Geographical borders of navigation area</th>
<th>Additional restrictions acc. to wave height $h_{max}$, m</th>
<th>Navigation season</th>
<th>Ship type restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Azov Sea</td>
<td>No restrictions</td>
<td>3.5 All year around</td>
<td>—</td>
<td>ПБУ/БС; ССН; СТФ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 All year around</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>2. Black Sea</td>
<td>20-mile coastal zone except for the coastal zone of eastern and southern coasts from Tuapse port to Bosphorus strait</td>
<td>3.5 All year around</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20-mile coastal zone along the eastern coast from Tuapse port to Batumi port</td>
<td>3.5 All year around</td>
<td>ГС; РС</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100-mile coastal zone at the distance from the shelter areas up to 100 n. miles</td>
<td>4.5 All year around</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coastal zone between the lines connecting the point with the following coordinates 45°05'30,0'' N, 36°35'30,0'' E with Panagiya Cape and Zhelezny Rog Cape</td>
<td>2.0 March, November</td>
<td>—</td>
<td>ГС</td>
</tr>
<tr>
<td>3. Caspian Sea</td>
<td>Kerch Strait to the north of the line passing through the end of Tuzla Spit</td>
<td>— March – November</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kerch Strait from the line passing through the end of Tuzla Spit to the line consequently connecting Takil Cape, anchorage with coordinates 45°05'30,0'' N, 36°33'30,0'' E, 45°05'30,0'' N, 36°35'30,0'' E and Panagiya Cape</td>
<td>— April – 20 November</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No restrictions including Gulf of Bothnia, Gulf of Finland and Gulf of Riga; Oresund Strait, Great and Little Belt Straits, Kattegat to the south of 57°45'00,0'' N</td>
<td>2.0 March, 21–30 November</td>
<td>ГС</td>
<td></td>
</tr>
<tr>
<td>4. Baltic Sea</td>
<td></td>
<td>3.5 All year around</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>5. White Sea</td>
<td>The Gulfs of Onega, Dvina and Kandalaksha; 20-mile coastal zone to the south of 66°45'00,0'' N</td>
<td>3.5 May – October</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>To the north of 66°45'00,0'' N to the line connecting Lumbovsky Gulf and the Cape Kanin Nos</td>
<td>2.5 June – August</td>
<td>КП</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0 September</td>
<td>КП</td>
<td></td>
</tr>
<tr>
<td>Sea</td>
<td>Geographical borders of navigation area</td>
<td>Additional restrictions acc. to wave height $h_{w} \leq m$</td>
<td>Navigation season</td>
<td>Ship type restrictions</td>
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<tr>
<td>6. Barents Sea</td>
<td>10-mile coastal zone from Cape Kanin Nos along the coast of Kanin Peninsula, and to the south of 68°00'00.0'' N</td>
<td>2.0 September</td>
<td>KI</td>
<td></td>
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<tr>
<td></td>
<td>2.5 June – August</td>
<td></td>
<td>KI</td>
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<td>3.5</td>
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<tr>
<td></td>
<td>20-mile coastal zone along the south coast from Cape Svyatoy Nos (Timansky) to Pechorskaya Guba bay including entrance into the harbour Ramenka on the south coast of Kolguev isle</td>
<td>3.5 June – September</td>
<td>KI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20-mile coastal zone along the south coast from Pechorskaya Guba bay to Yugorsky Shar strait; Pechorskaya Guba bay; Khaypudyrskaya Guba bay</td>
<td>3.5 June – October</td>
<td>KI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coastal zone along Kola peninsula within the specified borders of ship routes from the line connecting Lumbovsky Gulf and Cape Kanin Nos to Kola bay</td>
<td>3.5 May – September</td>
<td>TC objects of regulation by TP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kola bay</td>
<td>3.5 May – September</td>
<td>KI</td>
<td></td>
</tr>
<tr>
<td>7. Kara Sea</td>
<td>10-mile coastal zone from Yugorsky Shar strait to Kharasavey village; Baydaratskaya Guba bay</td>
<td>3.5 July – October</td>
<td>KI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The south-west part of the sea to the south of the line connecting Kharasavey village and the crossing point of 70°00'00.0'' N parallel with the eastern coast of Vaygach isle</td>
<td>3.5 July – September</td>
<td>KI</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20-mile coastal zone along the western and northern coasts Yamal peninsula from Kharasavey village to Obskaya Guba bay through Malygina strait</td>
<td>3.5 August – October</td>
<td>KH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20-mile coastal zone from Dikson isle to the mouth of Pyasina River</td>
<td>3.5 August – September</td>
<td>KI</td>
<td></td>
</tr>
<tr>
<td>8. East Siberian Sea</td>
<td>Coastal zone along the southern coast within the limits up to 15-meter isobath curve from the mouth of Kolyma River to the sea port of Pevek with permissible distance from the coast up to 7 miles near Letyatkina Cape, Bolshoy Baranov Cape, Malaya Baranikh Cape, mouth of Milkera River and the north-west coast of Ayon isle</td>
<td>3.5 August – September</td>
<td>KH</td>
<td></td>
</tr>
<tr>
<td>9. Sea of Japan</td>
<td>Tataryska strait and Amursky firth to the north of the line connecting the Sovetskaya Gavan sea port and Uglegorsk City to the line connecting Cape Menshikova and Cape Tamlano</td>
<td>3.5 June – October</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20-mile coastal zone along the western coast from the sea port of Vladivostok City to Preobrazhenya harbour</td>
<td>3.5 All year around</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>
### Table 7.8.1

<table>
<thead>
<tr>
<th>Sea</th>
<th>Geographical borders of navigation area</th>
<th>Additional restrictions acc. to wave height ( h_{\text{acc}} ), m</th>
<th>Navigation season</th>
<th>Ship type restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Laptev Sea</td>
<td>Khatanga Gulf; Vostochny and Severny straits; 20-mile coastal zone along the northern and eastern coasts of Bolshoy Begichev isle and from Nordvik peninsula to Cape Terpyay Tumsa; Anabarsky strait; Olenyoksky Gulf limited by the line 5 miles distant to the north from the line connecting Cape Terpyay Tumsa and the northern edge Aerosemki isles; 5-mile zone around Aerosemki isles; 25-mile coastal zone from Aerosemki isles to the sea port of Tiksi City</td>
<td>3.5</td>
<td>20 July – September</td>
<td>KH, KП</td>
</tr>
<tr>
<td>11. East Siberian Sea and Laptev Sea</td>
<td>20-mile coastal zone along the southern and western coast of Bolshoy Lyakhovsky isle from Cape Shalaurov to Cape Vagin; 20-mile coastal zone around Maly Lyakhovsky isle and along the southern and western coast of Kotelný isle from Malygintseva harbour to Stantsiya lagoon; Sea area between the northern coast of Bolshoy Lyakhovsky isle and south-western coast of Kotelný isle, and between 140°00'00,0'' E and western edge of Kotelný isle</td>
<td>3.5</td>
<td>20 July – September</td>
<td>KH, KП</td>
</tr>
</tbody>
</table>

### Table 7.8.2

<table>
<thead>
<tr>
<th>Sea</th>
<th>Geographical borders of navigation area</th>
<th>Additional restrictions acc. to wave height ( h_{\text{acc}} ), m</th>
<th>Navigation season</th>
<th>Ship type restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Azov Sea</td>
<td>No restrictions¹</td>
<td>—</td>
<td>March – November</td>
<td>—</td>
</tr>
<tr>
<td>2. Black Sea</td>
<td>10-mile coastal zone from Kerch Strait to the sea port of Novorossiysk City; 10-mile coastal zone around Crimean Peninsula from Kerch Strait to the crossing of 45°00’00,0” N on the western coast of Crimean Peninsula; 20-mile coastal zone in the north-west part to the north of 45°00’00,0” N from the Gulf of Kalamita to the port of Chornomorsk (Ilyichyovsk); 10-mile coastal zone from port of Chornomorsk (Ilyichyovsk) to Dunayskaya Prova</td>
<td>—</td>
<td>April – October</td>
<td>—</td>
</tr>
<tr>
<td>Sea</td>
<td>Geographical borders of navigation area</td>
<td>Additional restrictions acc. to wave height $h_{max}$, m</td>
<td>Navigation season</td>
<td>Ship type restrictions</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
<td>---------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>3. Azov Sea and Black Sea</td>
<td>Kerch Strait to the north of the line passing through the ends of Tuzla Spit</td>
<td>—</td>
<td>March – November</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Kerch Strait from the line passing through the ends of Tuzla Spit to the line consequently connecting Takil Cape, anchorage with coordinates 45°06′00.0″ N, 036°33′00.0″ E and Panagiya Cape</td>
<td>—</td>
<td>April – 20 November</td>
<td>—</td>
</tr>
<tr>
<td>4. Caspian Sea</td>
<td>To the north of 44°30′00.0″ N</td>
<td>—</td>
<td>March – November</td>
<td>КП¹</td>
</tr>
<tr>
<td>5. Baltic Sea¹</td>
<td>Gulf of Finland to the east of the line consequently connecting the Cape Pytytenina, Vigrund Isle, Moschny Isle, Somers Isle, southern edge of Cape Krestovyi, Gulf of Riga</td>
<td>—</td>
<td>April – November</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>10-mile coastal zone along the southern coast of the Gulf of Finland from the Cape Pytytenina to the Gulf of Riga</td>
<td>2.0</td>
<td>April – November</td>
<td>КН КП</td>
</tr>
<tr>
<td>6. Barents Sea</td>
<td>Pechorskaya Guba bay to the line consequently connecting the Chernaya village, Gulyaevskie Koshki Isles, Cape Russky Zavorot, Khaypudyanskaya Guba bay to the south of 68°45′00.0″ N</td>
<td>—</td>
<td>July – September</td>
<td>—</td>
</tr>
<tr>
<td>7. White Sea</td>
<td>Gulf of Onega to the south of the line consequently connecting Kem village, northern edge of Solovetskie Isles, Zhizhginisky Isle</td>
<td>—</td>
<td>May – October</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Dvina Bay to the south of the line connecting Zhizhginisky Isle and the northern edge of Mudyugsky Isle</td>
<td>—</td>
<td>May – October</td>
<td>КН</td>
</tr>
<tr>
<td></td>
<td>4-mile coastal zone around Zhizhginisky Isle</td>
<td>2.0</td>
<td>May – October</td>
<td>КП НБ</td>
</tr>
<tr>
<td>8. Kara Sea</td>
<td>Obskaya Guba bay to the north of the line consequently connecting the point with the following coordinates: 68°26′00.0″ N, 073°35′00.0″ E (Cape Kamenyy); 68°25′00.0″ N, 073°48′00.0″ E; 69°04′00.0″ N, 073°52′00.0″ E (Cape Trekhbugornyi)</td>
<td>—</td>
<td>July – October</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Gydansky and Enisey Gulfs to the south of the line consequently connecting the northern edge of Shokalsky Isle, northern edge of Sibiryakova Isle, Dikson Isle; 3-mile coastal zone around Shokalsky Isle</td>
<td>—</td>
<td>July – September</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>5-mile coastal zone around the northern coast of Yamal Peninsula from Cape Poelovo to Cape Khasalya; Malygina Strait between the line connecting Cape Khasalya and Cape Shuberta and the line connecting Cape Golovina and Cape Malygina</td>
<td>—</td>
<td>July – October</td>
<td>КП</td>
</tr>
</tbody>
</table>
### Table 7.8.2

<table>
<thead>
<tr>
<th>Sea</th>
<th>Geographical borders of navigation area</th>
<th>Additional restrictions acc. to wave height ( h_{\text{max}} ), m</th>
<th>Navigation season</th>
<th>Ship type restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Laptev Sea and East Siberian Sea</td>
<td>From the sea port of Tiksi City to the mouth of Yana River and 20-mile coastal zone along the southern coast from the mouth of Yana River to the mouth of Kolyma River</td>
<td>—</td>
<td>20 July – September</td>
<td>—</td>
</tr>
<tr>
<td>10. Sea of Okhotsk and Sea of Japan</td>
<td>Tatarsky Strait to the north of the line connecting Chikhacheva Bay and Cape Uandi, and Amursky Firth to the south of the line connecting Cape Men-skikova and Cape Tamlavo</td>
<td>—</td>
<td>June – October</td>
<td>—</td>
</tr>
<tr>
<td>11. Sea of Okhotsk</td>
<td>20-mile coastal zone along the southern coast from the mouth of Kolyma River to the mouth of Tiksi City</td>
<td>—</td>
<td>June – October</td>
<td>—</td>
</tr>
</tbody>
</table>

1. The navigation areas in Taganrog Bay at the lines Azov – Taganrog – Yeysk are assigned to the passenger self-propelled displacement ships designed for navigation on inland waterways and re-classed for higher class, or built using components of other inland water ships which were previously in operation.

2. The operation of the passenger self-propelled displacement ships is allowed only when they are used for accommodation of special personnel in protected water areas.

3. Except for the passenger self-propelled displacement ships designed for navigation on inland waterways and re-classed for higher class, or built using components of other inland water ships which were previously in operation.

### Table 7.8.3

<table>
<thead>
<tr>
<th>Sea</th>
<th>Geographical borders of navigation area</th>
<th>Additional restrictions acc. to wave height ( h_{\text{max}} ), m</th>
<th>Navigation season</th>
<th>Ship type restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Azov Sea 1</td>
<td>Taganrog Bay to the line consequently connecting Dolgaya Spit, Berdianskaya Spit, port of Berdiansk City and 20-mile coastal zone along the eastern coast to 45°21′00′′0″ N</td>
<td>—</td>
<td>March – November</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>20-mile coastal zone along the north-western coast from the port of Berdiansk City to the port of Gen-ichesky City</td>
<td>—</td>
<td>March – November</td>
<td>—</td>
</tr>
<tr>
<td>2. Black Sea</td>
<td>5-mile coastal zone along the northern coast from the port of Skadovsk City to the port of Odessa City</td>
<td>—</td>
<td>March – November</td>
<td>—</td>
</tr>
<tr>
<td>3. Caspian Sea 2</td>
<td>To the north of the line consequently connecting Cape Suyutkina Kosa, southern edge of Tyuleny Isle, point with coordinates 45°00′00′′0″ N, 048°35′00′′0″ E and passing along the parallel 45°00′00′′0″ N to the coast line; Mangyshlaksky Bay to the north of 44°45′00′′0″ N</td>
<td>—</td>
<td>April – November</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>To the east of the line connecting the point with coordinates 45°30′00′′0″ N, 049°30′00′′0″ E and the point with coordinates 44°30′00′′0″ N, 050°15′00′′0″ E</td>
<td>—</td>
<td>1.5</td>
<td>April – November</td>
</tr>
<tr>
<td>4. Baltic Sea 3</td>
<td>5-mile coastal zone of the Gulf of Riga from the mouth of Daugava (Western Dvina) River to the mouth of Gauja River</td>
<td>1.5</td>
<td>April – October</td>
<td>—</td>
</tr>
</tbody>
</table>
### 7. List of Sea Navigation Areas for Determination of Areas and Conditions of Navigations of the Ships...

<table>
<thead>
<tr>
<th>Sea</th>
<th>Geographical borders of navigation area</th>
<th>Additional restrictions acc. to wave height $h_{w_{cc}}$, m</th>
<th>Navigation season</th>
<th>Ship type restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gulf of Finland to the east of the line connecting Kotlin Isle and Zelenogorsk City, Kronstadt ship channel and 10-mile coastal zone along the northern coast from Zelenogorsk City to the sea port of Bybor City</td>
<td>—</td>
<td>May – October</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Mezen Bay: 5-mile coastal zone from the mouth of Mezen River to the mouth of Kolyo River; Onega Bay: 5-mile coastal zone from Belomorsk City to Kem City; Dvina Bay: 5-mile coastal zone from the mouth of Northern Dvina River to Severodvinsk City</td>
<td>1.5</td>
<td>June – September</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Olenyoksky Gulf: 10-mile coastal zone from Olenyokskaya arm to the mouth of Olenyok River</td>
<td>1.5</td>
<td>August – September</td>
<td>KII</td>
<td></td>
</tr>
<tr>
<td>Sakhalin Gulf from the line connecting Cape Menshikova and Cape Tamlavo within Nevelsky and Sakhalinsky ship channels, to the south of the point with coordinates 53°29'30,0'' N, 141°22'48,0'' E and coastal zone limited with the line connecting the point with coordinates 53°29'30,0'' N, 141°22'48,0'' E and the entrance ship channel of Baykal Gulf</td>
<td>1.5</td>
<td>June – September</td>
<td>KII</td>
<td></td>
</tr>
<tr>
<td>Amursky Firth to the south of the line connecting Cape Menshikova and Cape Tamlavo and to the north of the line connecting Cape Yuzhny and Cape Tyk</td>
<td>—</td>
<td>June – September</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Tatarsky Strait: 10-mile coastal zone along the western coast from Cape Yuzhny to Chikhacheva Bay</td>
<td>1.5</td>
<td>June – September</td>
<td>KII</td>
<td></td>
</tr>
<tr>
<td>Kerch Strait to the north of the line passing through the ends of Tuzla Spit</td>
<td>—</td>
<td>March – November</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Kerch Strait from the line passing through the ends of Tuzla Spit to the line consecutively connecting Cape Takal, anchorage with coordinates 45°06'00,0'' N, 036°33'00,0'' E and Cape Panagiy</td>
<td>1.5</td>
<td>April – 20 November</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

1. The navigation areas in Taganrog Bay at the lines Azov – Taganrog – Yeysk are assigned to the passenger self-propelled displacement ships designed for navigation on inland waterways and re-classed for higher class, or built using components of other inland water ships which were previously in operation.

2. The operation of the passenger self-propelled displacement ships is allowed only when they are used for accommodation of special personnel in protected water areas.

3. Except for the passenger self-propelled displacement ships designed for navigation on inland waterways and re-classed for higher class, or built using components of other inland water ships which were previously in operation.
Part I

HULL AND HULL EQUIPMENT
1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION

1.1.1 The present part of the Rules applies to single-hull displacement ships and catamarans, hydrofoils craft and hovercraft classed by the Russian River Register (hereinafter referred to as the River Register) and establishes requirements to the structure and designing of hull, global and local strength, vibration strength, buckling strength of hull structural components, equipment of spaces, railings and handrails designed for crew and passengers protection, gangways, companionways, scuttles.

The requirements of the present part of the Rules apply to the designed ships and ships under construction if otherwise is stated in the corresponding clauses and chapters of the present part of the Rules.

1.1.2 The requirements of this part of the Rules apply to ship’s hulls made of steel, aluminum alloys, reinforced concrete and glass reinforced plastics.

1.1.3 Materials used for fabrication of hull structural components shall comply with requirements of Part X of the Rules.

1.2 TERMS AND DEFINITIONS

1.2.1 Terms related to the Rules general terminology and their definitions are stated in 2.1 and 2.2 Part 0 of the Rules.

1.2.2 The following terms are used in these Rules:

.1 Freeboard means the distance between the upper edge of the deck line and the upper edge of the maximum draught line measured vertically on the side amidships (for the definition of deck line, see 1.2.24 Part II of the Rules);

.2 Main ship dimensions:

- \( L \) — design waterline length, m;
- \( B \) — maximum design waterline breadth, m;
- \( H \) — depth, i.e. vertical distance measured in the midship plane from the base plane to the intersection line of moulded surfaces of the side and upper deck (or their extensions in case or rounded deck-to-side joint), m;
- \( T \) — moulded draught / draught to design waterline, m;
- \( D \) — ship displacement at the moulded draught, kN;
- \( V \) — volume displacement at the moulded draught, m³;
- \( \delta \) — block coefficient.

.3 Design waterline (DWL) means a waterline chosen as the basis for lines drawing, which corresponds to the full displacement of the ship obtained by preliminary calculation;

.4 Aft perpendicular means the intersection line of centre plane and vertical transverse plane passing through the aftmost point of the design waterline;

.5 Engine room — see 2.2.24 Part 0 of the Rules;

.6 Machinery spaces — see 2.2.25 Part 0 of the Rules;

.7 Fore perpendicular means the intersection line of centre plane and vertical transverse plane passing through the foremost point of the design waterline;

.8 Draught means the vertical distance between base plane and specified load waterline amidships;
.9 Compartment means a part of inner space of the hull limited by the bottom or inner bottom, sides or longitudinal bulkheads, deck (if available) or the upper edge of the side (when there is no deck), and two adjacent transverse watertight bulkheads or a peak bulkhead and an extremity;

.10 Bulkhead deck means the uppermost deck, up to which the transverse watertight bulkheads extend;

.11 Ship length parts:
   ship’s middle part is a part $0.5L$ long taking $0.25L$ forward of and abaft the midship;
   fore extremity is a part $0.15L$ long measured from the fore perpendicular towards the midship;
   aft extremity of a self-propelled ship means a part between the aft perpendicular and the aft bulkhead of the engine room or a part $0.15L$ long from the aft perpendicular towards the midship, whichever is less;
   aft extremity of a non-self-propelled ship means a part $0.15L$ long from the aft perpendicular towards the midship;
   transition areas mean parts between the middle part and extremities.

1.2.3 Definitions and explanations relating to the catamaran and hovercraft hulls are given in 4.1.2 and 6.1.7 to 6.1.9.
2 STRUCTURE AND STRENGTH OF STEEL HULL

2.1 GENERAL REQUIREMENTS

2.1.1 The present Section establishes requirements to strength and dimensions of main structural components of steel welded hulls.

2.1.2 This Section establishes requirement to ships operating in М-ПР, М, О-ПР, М, О, Р and Л water basins at the design wave heights shown in Table 2.1.2.

Table 2.1.2

<table>
<thead>
<tr>
<th>Design wave heights</th>
<th>Ship class</th>
<th>Design wave height, m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>М-СП 4.5</td>
<td>4.5</td>
</tr>
<tr>
<td></td>
<td>М-СП 3.5</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>М, М-ПР</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>О, О-ПР</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Л</td>
<td>0.6</td>
</tr>
</tbody>
</table>

2.1.3 The requirements of 2.1.5 to 2.6 apply to ships with main dimensions ratios within the limits prescribed by Tables 2.1.3-1 and 2.1.3-2.

The requirements of this Section apply to ships given in Table 2.1.3-2 if their forward draught is not less than given in Table 2.1.3-3.

2.1.4 The requirements of this Section apply to the following ship types with length not exceeding 140 m:

1. self-propelled aft-engined one-decked ships with holds;
2. self-propelled aft-engined tankers;
3. non-self-propelled one-decked dry-cargo ships with holds;
4. non-self-propelled tankers;
5. self-propelled flush deck aft-engined ships and non-self-propelled flush deck ships;
6. passenger ships;
7. tugboats and pushboats;
8. industrial ships;
9. fishing vessels;
10. crew boats,
as well as ships of М-СП, М-ПР and О-ПР classes up to 140 m long, types of which are
Table 2.1.3-2
Maximum main dimension ratio for M-CII class ships

<table>
<thead>
<tr>
<th>Types of ships</th>
<th>Maximum main dimension ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L/H</td>
</tr>
<tr>
<td>Dry cargo ships and tankers</td>
<td>24</td>
</tr>
<tr>
<td>Passenger ships</td>
<td>25</td>
</tr>
<tr>
<td>Tugboats</td>
<td>18</td>
</tr>
<tr>
<td>Icebreakers</td>
<td>18</td>
</tr>
</tbody>
</table>

Notes. 1. The requirements of this Section apply to dry cargo ships and tankers of M-CII class with L/H ≤ 23.
2. In case of tankers with longitudinal built-in cargo tanks or a trunk deck included into the hull girder, the height H shall be taken as H1, i.e. the height from the base plane to the upper edge of the tank or trunk.

Table 2.1.3-3
Requirements to draught of M-CIII, M-III and O-III class ships

<table>
<thead>
<tr>
<th>Minimum permissible forward draught*, Tc, m, of ship class</th>
<th>M-CIII</th>
<th>M-III</th>
<th>O-III</th>
</tr>
</thead>
<tbody>
<tr>
<td>with ship length L, m</td>
<td>≤25</td>
<td>≥60</td>
<td>≤25</td>
</tr>
<tr>
<td></td>
<td>0.90</td>
<td>1.70</td>
<td>0.75</td>
</tr>
</tbody>
</table>

* The minimum permissible forward draught for intermediate ship lengths shall be determined by linear interpolation.

given in Table 2.1.3-2 (except for passenger ships and icebreakers of M-CIII class).

2.1.6 Where main dimension ratios are outside the limits prescribed by Tables 2.1.3-1 to 2.1.3-2 and where types of ships are not covered by 2.1.4, structures and scantlings shall be chosen according to the results of additional calculations, on the basis of which the applicability of the Rules or their equivalents may be proved.

The structural elements of hulls shall comply with the requirements of 2.2, the scantlings of the hull elements of all ships to the requirements of 2.3 to 2.6. Scantlings of ships with a length exceeding 50 m, moreover, shall be verified by calculation in accordance with the requirements of 2.2. Designer can also specify the scantlings of the hull elements based on the results of direct strength calculation and buckling strength verification of structural hull elements with due regard to their specified service life according to 2.2.83 and requirements to ships in service stipulated by the Rules.

2.1.7 The Instruction on Loading and Unloading proved by necessary strength, stability and trim calculations made for the most unfavorable loading cases during loading/unloading shall be prepared for all dry-cargo ships and tankers.

The Instruction on Loading and Unloading shall contain the following data:

.1 ship’s loading conditions in which her navigation may be allowed, including partial loading and permissible overloading under certain circumstances, with the indication of corresponding draught marks;
.2 conditions of ship’s loading, i.e. availability of ballast and possibility of simultaneous loading, unloading and ballasting, as well as monitoring methods;
.3 permissibility of performing cargo handling operations in wavy open water areas and the category of the respective water area basin permitted for cargo handling operations and the permissible wave height;
.4 procedure in case of emergency i.e. flooding of some holds or compartments of the ship;
.5 measures aimed at provision of goods safety in accordance with the rules and regulations on carriage of bulk cargoes;
.6 permissible longitudinal and transverse non-uniformity of the ship loading between holds and inside each hold;
.7 permissible values of specific loads both at uniform cargo distribution with due regard to non-uniformity as per .6 and also when carrying concentrated cargoes and heavyweights;
.8 permissible number of cargo layers and the order of loading and unloading operations;
.9 recommended cargo stowing and securing methods;
.10 distinctive features of loading and unloading of tankers: the order of tanks filling, permissible capacity of the cargo systems
with due regard to electrostatic sparking safety provisions, methods for monitoring cargo tank levels and ship draught, permissible cargo level differences between the tanks, drop of filling capacity at the initial stage and before the loading is finished, etc.;

1 the information on the possibility and procedure of accelerated loading and unloading depending on the type and the maximum capacity of the equipment and cargo systems, number of transverse and longitudinal bulkheads, etc.

2.1.8 Materials used for fabrication of hull structural components covered by the present Section of the Rules shall comply with requirements of Part X of the Rules.

2.1.9 High normal strength steels (see 2.2 Part X of the Rules) with yield point of 235 MPa and higher strength steels with yield point up to 390 MPa inclusively may be used.

Note: Rolled steel is used under the following conditions:

- steel of grades D, E, D27S, E27S, D32, E32, D36, E36, D40, D40S, E40, E40S (see 2.2 Part X of the Rules) of any thickness may be used without restrictions;
- steel of grades B, A27S, A32, A36, A40, A40S (see 2.2 Part X of the Rules) may be used for ships of all classes excepting the ice belt;
- steel of grade A may be used for:
  - ships of all classes with a length of 25 m and more excepting the ice belt, pushing and coupling arrangements, and structures participating in the global strength;
  - ships of all classes with a length less than 25 m excepting the ice belt and pushing and coupling arrangements.

2.1.10 Values of the cross-section moduli of hull framing girders calculated according to formulae given in 2.4 correspond to steel with \( R_{th} = 235 \) MPa. Where steel with higher strength is used for hull structures, the section moduli shall be reduced in proportion to the ratio 235/(\( k_{th} R_{th} \)), where \( k_{th} \) is coefficient determined by formula (2.2.67-3) and \( R_{th} \) — yield point of the used steel with higher strength.

2.1.11 When using tables of the present Section, intermediate values of parameters shall be determined by linear interpolation.

2.2 STRENGTH AND BUCKLING CALCULATIONS

Design loads at global bending

2.2.1 In order to calculate bending moments \( M_w \) and shear forces \( N_w \) on still water\(^1\), a load curve shall be integrated over not less than 21 equidistant ordinates. For ships of all types and purposes, the most unfavorable loading cases shall be considered.

2.2.2 Design loading conditions for dry cargo ships and tankers are as follows:

- lightship condition without ballast, with 10% and 100% of stores and fuel;
- lightship condition with ballast, with 10% and 100% of stores and fuel;
- fully loaded with cargo distributed in accordance with the Instruction of Loading and Unloading;
- in other unfavorable loading conditions, namely carriage of heavyweights, partial utilization of ship’s cargo capacity, etc.;
- during loading and unloading.

2.2.3 Design loading conditions for tugboats and pushboats are as follows:

- with 10% of stores and fuel with and without ballast;
- with 100% of stores and fuel with and without ballast.

2.2.4 Design loading conditions for passenger ships are as follows:

- lightship condition without cargo and passengers, with 10% and 100% of stores and fuel;
- fully loaded and with passengers, with 10% and 100% of stores and fuel;

2.2.5 Design loading cases for industrial ships:

- with 10% and 100% of stores and fuel, with and without ballast, in cruising condition;

---

\(^1\) Still water means the water area with current velocity less than 0.1 km/h and still surface (ripple is permissible) at wind speed up to 3 m/s.
2.2.6 Design loading conditions for other ships not stated in 2.2.2 to 2.2.5 are specified in technical documentation approved by the River Register with due regard to their purposes and design features.

2.2.7 Loading conditions (other than the loading condition as per 2.2.2.5), at which flooding of some spaces (see 4.2 and 4.3 Part II of the Rules) results in increase of bending moments, shall be considered.

2.2.8 For dry cargo ships, $M_{sw}$ and $F_{sw}$ shall be determined for the loading condition as in 2.2.2.3 with an assumption that 5% (7.5% is recommended for ships intended for local carriages of mineral building materials) of the total cargo taken on a ship have been carried from holds/cargo deck in the middle part of ship to holds/cargo deck in extremities (Figs. 2.2.1.8-1 and 2.2.1.8-2) or vice versa.

2.2.9 $M_{sw}$ and $F_{sw}$ at still water may be determined with due regard to hull flexibility. In this case calculations shall be made using a method approved by the River Register. Area moments of inertia of the ship hull corresponding to the design thickness, which are determined regardless of reduction of the hull girders, shall be used as rigidity factors.

2.2.10 Additional wave bending moment at the midship of the M, O, P and Λ ship classes shall be calculated as follows, kN·m:

![Cargo distribution according to the Instruction of Loading and Unloading](image1)

![Cargo distribution according to the Instruction of Loading and Unloading](image2)
where $M_w$ — bending moment due to waves

$k_p$ — coefficient considering the influence of wave vibration;

$M_i$ — bending moment due to the impact of waves to the fore extremity (impact bending moment), kN-m.

Wave bending moment is determined by the following formula, kN-m:

$$M_w = 0.255s k_\delta k_t k_w B L^2 h,$$

(2.2.10-2)

where $h$ — wave height obtained from Table 2.1.2, m;

$\varepsilon$ — coefficient obtained from Table 2.2.10-1;

### Parameters for determining components of additional wave moment

<table>
<thead>
<tr>
<th>Basin class</th>
<th>$\varepsilon$</th>
<th>$\eta$</th>
<th>$v_1$, (m/s)</th>
<th>$v_2$, (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>0.920</td>
<td>1.000</td>
<td>1.18</td>
<td>5.42</td>
</tr>
<tr>
<td>O</td>
<td>0.805</td>
<td>0.874</td>
<td>1.64</td>
<td>4.14</td>
</tr>
<tr>
<td>P</td>
<td>0.848</td>
<td>0.874</td>
<td>2.22</td>
<td>3.21</td>
</tr>
<tr>
<td>L</td>
<td>0.874</td>
<td>0.874</td>
<td>3.28</td>
<td>2.26</td>
</tr>
</tbody>
</table>

Coefficients $k_\delta$, $k_t$, $k_w$ are calculated by the formulae:

$$k_\delta = \exp\left[-1.6\left(1 - \delta\right)\right];$$  

(2.2.10-3)

$$k_t = \exp\left[-1.14T\delta\left[\eta h(2\delta + 1)\right]\right];$$  

(2.2.10-4)

$$k_w = \left[1 - \exp\left[-0.198B/(\eta h)\right]\right] \eta h/(0.198B);$$  

(2.2.10-5)

$\delta$ — block coefficient;

$\eta$ — coefficient obtained from Table 2.2.10-1.

The aforementioned coefficients may be obtained also from Tables 2.2.10-2 – 2.2.10-4, where $a$ and $b$ are calculated as follows:

$$a = 3T\delta/(2\delta + 1);$$  

(2.2.10-6)

$$b = \delta B.$$  

(2.2.10-7)

Values of $L$, $B$, $T$ and $\delta$ shall be determined at the ship’s trim corresponding to the design loading case used for calculating a bending moment on still water $M_{sw}$.

### Coefficient $k_\delta$ depending on $\delta$

<table>
<thead>
<tr>
<th>$\delta$</th>
<th>$k_\delta$</th>
<th>$\delta$</th>
<th>$k_\delta$</th>
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<tbody>
<tr>
<td>0.55</td>
<td>0.487</td>
<td>0.80</td>
<td>0.726</td>
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<tr>
<td>0.60</td>
<td>0.527</td>
<td>0.85</td>
<td>0.787</td>
</tr>
<tr>
<td>0.65</td>
<td>0.571</td>
<td>0.90</td>
<td>0.852</td>
</tr>
<tr>
<td>0.70</td>
<td>0.619</td>
<td>0.95</td>
<td>0.923</td>
</tr>
<tr>
<td>0.75</td>
<td>0.670</td>
<td>1.00</td>
<td>1.000</td>
</tr>
</tbody>
</table>

### Coefficient $k_i$ depending on basin category and parameter $a$

<table>
<thead>
<tr>
<th>$a$, m</th>
<th>$k_i$ for basin category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
</tr>
<tr>
<td>0.0</td>
<td>1.000</td>
</tr>
<tr>
<td>0.5</td>
<td>0.939</td>
</tr>
<tr>
<td>1.0</td>
<td>0.881</td>
</tr>
<tr>
<td>1.5</td>
<td>0.827</td>
</tr>
<tr>
<td>2.0</td>
<td>0.776</td>
</tr>
<tr>
<td>2.5</td>
<td>0.729</td>
</tr>
<tr>
<td>3.0</td>
<td>0.684</td>
</tr>
<tr>
<td>3.5</td>
<td>0.642</td>
</tr>
<tr>
<td>4.0</td>
<td>0.603</td>
</tr>
<tr>
<td>4.5</td>
<td>0.566</td>
</tr>
</tbody>
</table>

### Coefficient $k_w$ depending on basin category and parameter $b$

<table>
<thead>
<tr>
<th>$b$, m</th>
<th>$k_w$ for basin category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
</tr>
<tr>
<td>3.0</td>
<td>0.911</td>
</tr>
<tr>
<td>6.0</td>
<td>0.832</td>
</tr>
<tr>
<td>9.0</td>
<td>0.762</td>
</tr>
<tr>
<td>12.0</td>
<td>0.700</td>
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<tr>
<td>15.0</td>
<td>0.646</td>
</tr>
<tr>
<td>18.0</td>
<td>0.597</td>
</tr>
<tr>
<td>21.0</td>
<td>0.553</td>
</tr>
<tr>
<td>24.0</td>
<td>0.514</td>
</tr>
<tr>
<td>27.0</td>
<td>0.479</td>
</tr>
<tr>
<td>30.0</td>
<td>0.448</td>
</tr>
</tbody>
</table>

Coefficient $k_p$ shall be calculated by the formula:

$$k_p = \psi\left[1 + \omega_{th}^2/\left(\sigma^2\left[1-\omega_{th}^2/\sigma^2\right]^2 + \left(2k_p\omega_{th}/\sigma\right)^2\right]\right],$$

(2.2.10-8)

where $\omega_{th}$ — wave frequency observing from moving ship, s⁻¹;

$$\omega_{th} = \omega_{av} + 1.92 k_v v_{av}/L$$

(2.2.10-9)

$\omega_{av}$ — wave frequency, s⁻¹ determined as per Table 2.2.10-1;
\[ \sigma = k_s \sqrt{I/[1.2 + B/(3T)] DL^3}] ; \]  
(2.2.10-10)

\[ k_s = 0.0612 (1 - 0.047\sigma - 0.0077\sigma^2) \geq 0 \]  
(2.2.10-11)

(coefficient \( k_s \) shall be not less than zero);

\[ k_v = \text{coefficient determined by the formula:} \]
\[ k_v = 1 - 19.9h/L + 143(h/L)^2, \]  
(2.2.10-12)

\[ v_{sw} = \text{ship’s speed in still water for design loading case, km/h;} \]
\[ k_s = \text{coefficient equal, for the following ships, to:} \]
- cargo ships \( 123 \times 10^4 \)  
- passenger ships \( 117 \times 10^4 \)  
- tugboats and pushboats \( 104 \times 10^4 \)

\( I \) — area moment of inertia of the hull girder amidships, \( m^4 \) calculated using the design thicknesses and girder reduction coefficients equal to 1;

\( D \) — ship’s displacement corresponding to design loading condition, kN;

\( \psi \) — coefficient determined by the formulae:
- if \( 0 \leq \omega_{dh}/\sigma \leq 1.0 \)  
  \[ \psi = \cos \left[ 1.3 \left( \omega_{dh}/\sigma \right)^2 \right] \]  
  (2.2.10-13)
- if \( 1.0 < \omega_{dh}/\sigma \leq 1.4 \)  
  \[ \psi = 2.167 \omega_{dh}/\sigma - 1.9 \]  
  (2.2.10-14)

The impact bending moment is determined by the formula, kN-m:
\[ M_i = k_i \varphi_1 DL, \]  
(2.2.10-15)

where
\[ k_i = 5.3 \times 10^{-4} \varphi_0 \sigma v_0 \]  
(2.2.10-16)

\( \varphi_1 \) — coefficient equal to:
- \( \varphi_1 = 1 \) if \( T_f \leq T_f^0 \);
- \( \varphi_1 = 3 - 2T_f/T_f^0 \) if \( T_f^0 < T_f < 1.5T_f^0 \);
- \( \varphi_1 = 0 \) if \( T_f \geq 1.5T_f^0 \);

\( T_f \) — forward draught for design loading case, m;

\( T_f^0 \) — “threshold” forward draught, m, equal to:
\[ T_f^0 = \left( 0.68 + 0.21k_v v_{sw}/\sqrt{L} \right) \eta h \]  
(2.2.10-17)

\( \varphi_0 \) — coefficient equal to
\[ \varphi_0 = 1 - 1.03b_0 + b_0^2 - 0.417b_0^3 \]  
(2.2.10-18)

\[ b_0 = 4.32\sqrt{8(B/L)(T/L)} \]  
(2.2.10-19)

the value of \( v_0 \) is obtained by the formula
\[ v_0 = \left( 0.336 + 0.104 k_v v_{sw}/\sqrt{L} \right) v_1 + 0.024k_v v_{sw} \]  
(2.2.10-20)

the value of \( v_1 \) is taken from Table 2.2.10-1.

The value of the additional wave bending moment for the ships of P and L classes shall be taken constant within \( 0.5L \) in the middle part of the hull and shall go down linearly towards the ship’s extremities down to zero (see Fig. 2.2.10). For ships of M and O classes, boundaries of constant section of the distribution diagram shall be not less than \( 0.15L \) forward of and abaft the midship.

![Fig. 2.2.10 Distribution diagrams of additional wave moment and shear force](image)

The maximum value of the additional wave shear force \( N_{sw} \) is determined by the formula, kN:
\[ N_{sw} = 4M_{sw} / L. \]  
(2.2.10-21)

Distribution diagram of additional wave shear forces shall be taken in accordance with Fig. 2.2.10.

### 2.2.11 Additional wave bending moment

Additional wave bending moment of ships of Ì-ÑÏ, Ì-ÏÐ and Î-ÏÐ classes shall be determined using the following formula, kN-m:
\[ M_{aw} = 9.81k_0 k_1 k_2 k_3 \delta B L^2 h \]  
(2.2.11-1)

where \( k_0 \) — coefficient calculated by the formula:
\[ k_0 = 1.24 - 1.7B/L \leq 1.0 \]  
(2.2.11-2)
$k_1$ — coefficient depending on ship length $L$ determined as per Table 2.2.11;

<table>
<thead>
<tr>
<th>Ship class</th>
<th>Coefficient $k_1$, values* for ship length, m</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-CHI</td>
<td>0.0147 0.0147 0.0147 0.0137</td>
</tr>
<tr>
<td>M-PIT</td>
<td>0.0143 0.0147 0.0137 0.0120</td>
</tr>
<tr>
<td>O-PIT</td>
<td>0.0154 0.0154 0.0114 0.0089</td>
</tr>
</tbody>
</table>

* $k_1$ values for intermediate ship lengths shall be determined by linear interpolation.

$k_2$ — coefficient depending on ship length $L$ and forward draught $T_f$ determined by the formula:

$$k_2 = 2 - 20 T_f / L \geq 1.0; \quad (2.2.11-3)$$

$k_3$ — coefficient taken, for ships of M-CHI 4.5 class, equal to 1.114 for ships 25 and 60 m long; 1.277 for ships 100 m long; 1.367 for ships 140 m long. The values of $k_3$ for intermediate lengths of ship shall be determined by linear interpolation. For ships of all other classes, $k_3 = 1.0$ regardless of their length.

$\delta$ — block coefficient;
$h$ — design wave height taken from Table 2.1.2.
$L$, $T_f$ and $\delta$ values shall be taken with due regard to the design loading case used for determining a bending moment on still water.

Additional wave bending moment is taken as constant within 0.3$L$ in the middle part of the hull and linearly reducing towards the fore and aft extremities down to zero (see Fig. 2.2.10).

2.2.12 Design bending moments for sagging and hogging, $kN\cdot m$ in the hull section under consideration shall be calculated by algebraical summing the values of bending moments in still water and the additional wave bending moment in this section:

$$M = M_{sw} + M_{aw} \quad (2.2.12-1)$$

For passenger ships of M-CHI class with length of 50 m and more, the bending moments in still water $M_{sw}$, $kN\cdot m$ shall be calculated as per 2.2.4 and taken, by the absolute value, not less than that determined by the formula:

$$M_{sw} = \pm k_{sw} \delta BL^2, \quad (2.2.12-2)$$

where $\delta$ — block coefficient;

$k_{sw}$ — coefficient determined by the formula:

$$k_{sw} = k_\sigma k_1 k_2 - 34.34 k_0 k_1 k_2 \geq 0; \quad (2.2.12-3)$$

$k_\sigma$ — coefficient taken from Table 2.2.12-1;

<table>
<thead>
<tr>
<th>Characteristic of hull members</th>
<th>$k_\sigma$ at $R_{sw}$, MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>235</td>
</tr>
<tr>
<td></td>
<td>315</td>
</tr>
<tr>
<td></td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>390</td>
</tr>
<tr>
<td>Participating in</td>
<td></td>
</tr>
<tr>
<td>global bending</td>
<td></td>
</tr>
<tr>
<td>not bearing local load</td>
<td>1.645</td>
</tr>
<tr>
<td>bearing local load</td>
<td>1.410</td>
</tr>
<tr>
<td></td>
<td>1.572</td>
</tr>
<tr>
<td></td>
<td>1.585</td>
</tr>
<tr>
<td></td>
<td>1.598</td>
</tr>
<tr>
<td></td>
<td>1.534</td>
</tr>
<tr>
<td></td>
<td>1.591</td>
</tr>
</tbody>
</table>

$k_1$ — coefficient determined by the equation:

$$k_1 = \left( 0.171 - 2.516 \cdot 10^{-3} L + 2.446 \cdot 10^{-5} L^2 \right) / \left( 1 - 1.768 \cdot 10^{-3} L + 1.888 \cdot 10^{-4} L^2 \right) \quad (2.2.12-4)$$

or taken from Table 2.2.12-2;

<table>
<thead>
<tr>
<th>$L$</th>
<th>$k_1$</th>
<th>$L$</th>
<th>$k_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0.257</td>
<td>110</td>
<td>0.381</td>
</tr>
<tr>
<td>65</td>
<td>0.315</td>
<td>125</td>
<td>0.370</td>
</tr>
<tr>
<td>80</td>
<td>0.366</td>
<td>140</td>
<td>0.351</td>
</tr>
<tr>
<td>95</td>
<td>0.392</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$k_1$ — coefficient taken from Table 2.2.11.

2.2.13 Design shear forces for sagging and hogging, $kN$ in at the hull section under consideration shall be calculated by summing the absolute values of shear force on still water and the additional wave shear force in this section:

$$N = | N_{sw} | + | N_{aw} | \quad (2.2.13)$$

2.2.14 Maximum design bending moments and shear forces shall be determined according to 2.2.12 and 2.2.13 in design loading cases as per 2.2.2 – 2.2.7.

2.2.15 For the design condition as per 2.2.2.5, if loading and unloading at waves are not required by design documentation approved by the River Register, $M_{sw}$ and $N_{sw}$ in
formulae (2.2.12) and (2.2.13) shall not be taken not less than 0.7 of the respective values determined as per 2.2.10 for the ship of I class. If the design documentation approved by the River Register requires cargo operations in non-sheltered waters, $M_{aw}$ and $N_{aw}$ are determined by the formulae (2.2.10-1) and (2.2.10-21) for ships operating in basin category comprising the water area in question.

Values of $M_{aw}$ and $N_{aw}$ during loading and unloading operations shall be calculated with due regard to the cargo distribution over the ship’s length as per 2.2.8.

Design local loads

2.2.16 Local load shall be calculated for the following loading cases of the ship:

.1 in fully loaded condition;
.2 in lightship condition or with ballast;
.3 during loading and unloading (for cargo ships);
.4 during water-tightness and gas-tightness tests of the hull;
.5 in case of flooding compartments according to 4.2 and 4.3 Part II of the Rules;
.6 in other unfavorable operational conditions of the ship.

2.2.17 Local strength of structures shall be verified for the loads that produce maximal stresses.

The strength of longitudinal girders is verified against summary stresses produced by global longitudinal bending of the ship and the local load.

2.2.18 The design local load shall be specified in the form of a pressure taken equal to the greatest value from those obtained by the formulae in 2.2.19 to 2.2.29 according to ship type, permissible loading conditions, and hull form. These formulae use the following symbols:

- $T_b$ — draught of a ship with ballast in the section under consideration, m;
- $h_b$ — height of a ballast tank up to the top of the air pipe, m;
- $h_{tr}$ — height of expansion trunk of tanker’s cargo tank, m;
- $h_{aw}$ — water head corresponding to over-pressure, for which the breathing valve in the gas outlet pipe is designed and calculated, m;
- $r$ — wave half-height, m (wave height is taken from Table 2.1.2 regardless of permissible wave height limit set to the ship). For ships of M-CTI 4.5 class, the design wave half-height in common case shall be equal to $r = 2.35$ m. If the specified design wave half-height exceeds this value, it is required also to calculate the modulus of cross-section of the girder by the formulae stated in 2.4;
- $p_c$ — cargo/fuel pressure calculated regardless of non-uniformity of its distribution, kPa;
- $H_{sec}$ — height of the ship’s hold in the section under consideration measured from the base plane, m;
- $\gamma_c$ — specific gravity of bulk or liquid cargo, kN/m³;
- $h_{db}$ — double bottom height, m.

2.2.19 Cargo pressure $p_c$ is calculated by the following formulae with due regard to non-uniformity of its distribution, kPa:

.1 for dry cargo ships

$$p_{ma} = k_{nu} \cdot p_c$$

(2.2.19.1)

where $k_{nu}$ — coefficient of cargo pressure non-uniformity, taken equal to 1.25 to calculate web framing and 1.50 to calculate ordinary framing and plates (except for ships carrying cargo loaded in heaps or stockpiles);

.2 for tankers

$$p_{ma} = p_c \pm \Delta p_{nu}$$

(2.2.19.2)

where $\Delta p_{nu}$ — permissible design non-uniformity of cargo pressure by holds for the loading cases provided in the Instruction on Loading and Unloading;

.3 for dry cargo ships carrying cargo loaded in heaps when calculating ordinary members and plates
\[ p_{nu} = \gamma_c \left[ \frac{(H_{\text{heap}} - h)}{(1.13 + 0.480 + 0.150^2) + h} \right], \]  

(2.2.19.3-1)

where \( H_{\text{heap}} \) — height of a heap, m, determined from the mass of cargo in a heap increased by 10% (by 15% for ships carrying mineral building materials on local voyages) in order to take the non-uniformity of loading into account;

\( \theta \) — natural slope angle of the bulk cargo, rad;

\( h \) — reduced height of a heap, m, calculated by the formula:

\[ h = H_{\text{heap}} - \tan \theta \left( L_{\text{heap}} + B_{\text{heap}} + \sqrt{L_{\text{heap}}^2 + R_{\text{heap}}^2} \right) / \delta. \]  

(2.2.19.3-2)

Here \( L_{\text{heap}}, B_{\text{heap}} \) — length and breadth of a section of the deck plating occupied by one heap of cargo, correspondingly, m.

If calculation according to formula (2.2.19.3-2) results in \( h < 0 \), then \( h \) shall be taken equal to zero.

.4 for dry cargo ships carrying bulk cargoes in stockpiles, when calculating ordinary framing and plates

\[ p_{nu} = \gamma_c \left[ \frac{(H_{\text{st}} - h_{\text{st}})}{(1.07 + 0.330) + h_{\text{st}}} \right], \]  

(2.2.19.4)

where \( h_{\text{st}} \) — height of the rectangular part of stockpile’s cross-section, in m;

\( H_{\text{st}} \) — overall height of the stockpile determined from the cargo mass increased by 10% to take the non-uniformity of loading into account (15% for ships carrying mineral building materials on local voyages), m;

.5 for dry cargo ships carrying bulk cargoes in heaps, when calculating web framing, the cargo pressure is considered non-uniformly distributed throughout the deck plating area. Inside a circle with its centre in the heap’s centre and with radius

\[ r_1 = (0.12 + 0.390) R_1, \]  

(2.2.19.5-1)

where \( R_1 \) — radius of the flared part of the heap, m, determined by the formula:

\[ R_1 = (H_{\text{heap}} - h) \cot \theta, \]  

(2.2.19.5-2)

the pressure is constant and equal to \( p_{nu} \) as calculated by formula (2.2.19.3-1).

Inside the ring \( r_1 \leq r_M \leq R_1 \) the pressure varies along the radius linearly

\[ p_M = p_p + (p_{nu} - p_p)(R_1 - r_M)/(R_1 - r_1), \]  

(2.2.19.5-3)

where \( r_M \) — distance between point \( M \), at which pressure \( p_M \) is calculated, and the centre of the heap, m;

\( p_p \) — constituent equal to

\[ p_p = \gamma_c h. \]  

(2.2.19.5-4)

At points of bearing rectangle with a radius-vector \( r_M > R_1 \), the pressure is determined by the formula

\[ p_M = p_p. \]  

(2.2.19.5-5)

.6 for dry cargo ships carrying bulk cargoes in stockpiles, when calculating web framing, the cargo pressure is considered uniformly distributed over the stockpile length and non-uniformly distributed in the transverse direction. In the middle part of plating under the stockpile, the pressure shall be considered constant and equal to \( p_{nu} \) as calculated by the formula (2.2.19.4).

The middle part is considered as an area where

\[ y_M \leq (0.037 + 0.1650) B_{\text{st}}, \]  

(2.2.19.6-1)

\( B_{\text{st}} \) — breadth of stockpile, m;

\( y_{\text{st}} \) — distance between the point where pressure is determined and longitudinal axis of the stockpile on the deck plating, m.

At the stockpile’s edges, pressure shall be considered distributed in the transverse direction linearly

\[ p_M = p_{nu} - (p_{nu} - \gamma c h_2) \times \]  

\[ \times \left[ 2y_M/B_{\text{st}} - (0.074 + 0.3290)/(0.926 - 0.3290) \right]; \]  

(2.2.19.6-2)

.7 for dry cargo ships carrying bulk cargoes in heaps, when calculating the web framing, the cargo pressure may be considered uniformly distributed throughout the deck plating, provided that the breadth of the heap is not less than the breadth of the cargo bunker. In this case, the pressure shall be calculated by formula (2.2.19.1), where non-uniformity coefficient shall be calculated as follows
\[ k_{nu} = \left(1.6 + 0.2 \frac{L_{hoop}}{B_{hoop}}\right) \left[1 - 0.77 \left(\frac{L_{hoop}}{B_{hoop}}\right)^{0.7}\right] \left[1.5 - (1.1 - \gamma_t h_t / p_t) + \gamma_t h_t / p_t\right], \]  
(2.2.19.7-1)

where \( K_r \) — coefficient:

\[ K_r = n_{tg} \frac{L_{hoop}}{B_{hoop}}^{\frac{1}{3}} \left[n_{i} I_{t}\right]; \]  
(2.2.19.7-2)

\( n_{tg} \) — number of girders of main direction (transverse girders) per heap;

\( n_{i} \) — number of intersecting members (longitudinal girders) in the grillage;

\( I_{t}, I_{i} \) — area moments of inertia, with respect to neutral axis, of girders of main direction and intersecting members, respectively;

\( h \) — reduced height calculated by formula (2.2.19.3-2).

The non-uniformity coefficient shall be not less than 1.25.

.8 for dry cargo ships carrying bulk cargoes in stockpiles, when calculating the web framing, the cargo pressure may be considered uniformly distributed throughout the deck plating, provided that the stockpile’s breadth is not less than the cargo bunker’s breadth. In this case, the pressure shall be calculated by formula (2.2.19.1), where non-uniformity coefficient shall be calculated as follows

\[ k_{nu} = 1.46 - 0.33 \gamma_t h_t / p_c, \]  
(2.2.19.8)

where \( h_t \) — height of the rectangular part of cross-section of the stockpile.

The non-uniformity coefficient shall be not less than 1.25.

2.2.20 Design load at the fore extremity of a ship is considered to be uniformly distributed on the bottom (according to rectangle law) and on the sides (according to a triangle or trapeze law) over the side’s height. For the bottom, the design load is taken as, kPa:

.1 for a wedge bow

\[ p = 9.81 \left(T_{\text{load}} + 2r\right); \]  
(2.2.20.1)

.2 for a spoon-shaped bow

\[ p = 9.81 \left(T_{\text{load}} + 2.5r\right); \]  
(2.2.20.2)

.3 for a sledge-shaped bow

\[ p = 9.81 \left(T_{\text{load}} + 3r\right). \]  
(2.2.20.3)

2.2.21 Design load in the aft extremity is considered to be uniformly distributed as stated in 2.2.20 for fore extremity, and the design load for the bottom is taken to be equal to, kPa:

\[ p = 9.81 \left(T_{\text{load}} + r\right). \]  
(2.2.21)

2.2.22 Pressure at the bottom in the ballast tanks area shall be taken equal to, kPa

\[ p = 9.81 \left(h_b - T_{\text{load}} + r\right), \]  
(2.2.22-1)

but not exceeding

\[ p = 9.81 h_b. \]  
(2.2.22-2)

2.2.23 Design load on the bottom and inner bottom, except for extremities, shall be determined by the formula, kPa:

.1 for ordinary framing and bottom plating of all compartments, provided that there is no counter-pressure from cargo or ballast, and under the following conditions:

in loaded condition \( p = 9.81 \left(T_{\text{load}} + r\right); \)  
(2.2.23.1-1)

in lightship condition \( p = 9.81 \left(T_{\text{light}} + r\right); \)  
(2.2.23.1-2)

with ballast \( p = 9.81 \left(h_b - T_{\text{load}} + r\right); \)  
(2.2.23.1-3)

.2 for web framing of cargo holds of dry cargo ships in full-loaded condition:

\( p = 9.81 \left(T_{\text{load}} - r\right); \)  
(2.2.23.2-1)

for web framing of spaces not subject to counter-pressure of cargo (flush deck ships, compartments of engine room, accommodation spaces of passenger ships and tugboats)

\( p = 9.81 \left(T_{\text{load}} + r\right); \)  
(2.2.23.2-2)

in lightship condition with ballast in the double bottom

\( p = 9.81 \left(T_{\text{load}} - r - h_{db}\right), \)  
(2.2.23.2-3)

where \( h_{db} \) — double bottom height, m;

in lightship condition with ballast outside the double bottom

\[ p = 9.81 (T_b + r); \]  
(2.2.23.2-4)

in lightship condition without ballast

\[ p = 9.81 (T_{\text{light}} + r); \]  
(2.2.23.2-5)
3 for the ordinary framing and the bottom of the shell plating of cargo tanks of tanker in loaded condition:

if there is no double bottom and the compartment is fully loaded

\[ p = \gamma_c \left( H_h + h_r \right) - 9.81 \left( T_{\text{load}} - h_s - r \right) ; \]
(2.2.23.3-1)

with not fully loaded compartment

\[ p = p_{\text{au}} - 9.81 ( T_{\text{load}} - r - h_s ) ; \]
(2.2.23.3-2)

if there is a double bottom, \( p \) is determined according to formula (2.2.23.2-2);

in lightship condition with ballast in the double bottom, the design load is determined according to formulae (2.2.22-1) and (2.2.22-2); in lightship condition without ballast, the design load is determined according to formula (2.2.23.2-5).

4 for ordinary framing and double bottom plating of dry cargo ships:

in fully loaded condition

\[ p = p_{\text{au}} ; \]
(2.2.23.4-1)

in lightship condition with ballast in the double bottom

\[ p = 9.81 ( h_b - h_{\text{db}} ) , \]
(2.2.23.4-2)

where \( h_{\text{db}} \) is taken as per 2.2.23.2.

5 for ordinary framing and double bottom plating of tanker in fully loaded condition:

with fully loaded compartment

\[ p = \gamma_c \left( H_{\text{heap}} - h_{\text{db}} + h_r \right) + 9.81 h_s ; \]
(2.2.23.5-1)

with not fully loaded compartment

\[ p = p_{\text{au}} + 9.81 h_s ; \]
(2.2.23.5-2)

6 for web framing of cargo compartments of tanker in fully loaded condition, the loading is determined by formula (2.2.23.3-1).

2.2.24 When calculating the web and ordinary framing, as well as the side shell plating, the load on the sides is considered to be distributed over the side’s height according to triangle or trapeze law.

Pressure on the sides and outer sides of double-sided ships at the bottom level (except for extremities) shall be taken equal to:

for all ships, except the ballast compartments area and the area of cargo compartments of tankers, according to formula (2.2.23.2-2);

in the area of cargo compartments of tankers, according to formula (2.2.23.3-1) or (2.2.23.3-2);

in the area of ballast compartments, according to formulae (2.2.22-1) and (2.2.22-2).

Pressure on the inner sides of double-sided ships at the level of double bottom shall be taken equal to, kPa:

for tankers, according to formula (2.2.23.5-1) or (2.2.23.5-2),

for dry cargo ships

\[ p = 9.81 ( H_{\text{sec}} - h_{\text{db}} ) , \]
(2.2.24-1)

for ships taking ballast into between-hull space,

\[ p = 9.81 ( H_b - h_{\text{db}} ) , \]
(2.2.24-2)

but not less than the value calculated by formula (2.2.24-1).

2.2.25 Design load on strong watertight bulkheads is considered to be distributed according to the triangle or trapeze law and at the bottom level it is considered equal to, kPa:

1 for the forepeak bulkhead of ships of all types and classes, for all bulkheads of passenger ships of М–СП, М–ПР, О–ПР, М and О classes, for the afterpeak bulkhead of pushed vessels of all classes

\[ p = 9.81 H_{\text{sec}} ; \]
(2.2.25.1)

2 for bulkheads enclosing compartments or tanks of ships of all types and classes (excepting bulkheads of cargo compartments of tankers)

\[ p = p_{\text{au}} , \]
(2.2.25.2)

where \( p_{\text{au}} \) is taken as per 2.2.19;

3 for the rest bulkheads of ships of all types and classes

\[ p = 5.9 H_{\text{sec}} . \]
(2.2.25.3)
Design load on the deck grillage is considered equal to, kPa:

1. for the cargo deck of dry cargo ships
   \[ p = p_{\text{nu}} \], (2.2.26.1)

2. for decks of tankers in the area of cargo compartments
   \[ p = 9.81 \left( h_{\text{tr}} + h_{\text{v}} \right) \], (2.2.26.2)

3. for open parts of the decks not intended for cargo stowage of the hulls of ships of all classes other than tankers:
   \[ p = 5; \] (2.2.26.3)

4. for enclosed parts of hull decks, superstructures and wheelhouses intended for passengers and crew accommodation
   \[ p = 3.5; \] (2.2.26.4)

5. for upper decks of superstructures and wheelhouses not accessible for passengers and not intended for cargoes
   \[ p = 1. \] (2.2.26.5)

2.2.27 When carrying out water-tightness and gas-tightness tests of ship hull, the load shall be taken with due regard to the agreed test schedule in accordance with instructions given in Appendix 10 RTSC.

Local loads during loading and unloading shall be determined according to 2.2.19 – 2.2.24 using the draught values in the given section at the particular cargo handling stage instead of \( T_{\text{fload}}, T_{\text{light}} \) and \( T_{\text{b}} \) and the level of the liquid inside the ballast tank or cargo tank for a current stage of the loading instead of \( H_{\text{icw}}, h_{\text{b}} \) and \( H_{\text{tr}} \) respectively.

Design wave half-height is taken as 0.2 m, if loading and unloading are not required for the ship. If the ship is required to carry out cargo handling operations in non-sheltered waters, the wave half-height shall be taken from Table 2.1.2 for ship operating in basin category comprising this water area.

2.2.28 Design local load on walls and decks of superstructures and wheelhouses of ship of M-CII class shall be set in the form of the design pressure determined:
   - on side walls, from Table 2.2.28-1;
   - on open decks not intended for cargo stowage, from Table 2.2.28-2;
   - on end walls, from Table 2.2.28-3.

For the ships of M-CII 4.5 class, the design pressures specified in Tables 2.2.28-1, 2.2.28-2 and 2.2.28-3 shall be increased proportionally to coefficient \( k_{p} \) determined by the formula:

\[ k_{p} = 0.57r, \] (2.2.28)

where \( r \) – see 2.2.18.

Values \( x/L \) — 0.5 and \( x/L = -0.5 \) in Tables 2.2.28-1 to 2.2.28-3 correspond to the cross-sections in the fore and aft perpendiculars at the design waterline draught, and \( x/L = 0 \) corresponds to the midship section.

For enclosed decks intended for accommodation of passengers, crew and equipment, the design pressure shall be not less than 5.0 kPa.

Proceeding from the ship’s design features, other combinations of local loads bringing to maximum local stresses shall be also taken into consideration. This requirement applies to the ships of all classes.

### Table 2.2.28-1

<table>
<thead>
<tr>
<th>Deck</th>
<th>Design pressure at deck level, kPa, for relative distance ( x/L ) of the design cross-section under consideration from the midship</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( -0.5 )</td>
</tr>
<tr>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Upper</td>
<td>5.9</td>
</tr>
<tr>
<td>Tier 1</td>
<td>4.7</td>
</tr>
<tr>
<td>Tier 2 and higher</td>
<td>4.7</td>
</tr>
</tbody>
</table>

* If the ship length differs from the values specified in the table, the design pressure shall be determined by linear interpolation of the tabulated data.
Table 2.2.28-2

Design pressures on open deck of M-CII class ships not intended for cargo stowage

<table>
<thead>
<tr>
<th>Deck</th>
<th>Design pressure on deck, kPa, for relative distance x/L of the design cross-section under consideration from the midship</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-0.5</td>
</tr>
<tr>
<td></td>
<td>for ship length*, m</td>
</tr>
<tr>
<td>Upper</td>
<td>6.1 6.5 9.8 12.9 16.5 6.0 6.0 6.0 8.1 10.1 8.3 12.0 16.0 19.8 27.4</td>
</tr>
<tr>
<td>Tier 1</td>
<td>3.6 3.6 3.7 7.5 9.8 3.6 3.6 3.7 4.7 6.0 4.6 7.5 9.9 12.7 19.2</td>
</tr>
</tbody>
</table>
* If the ship length differs from the values specified in the table, the design pressure shall be determined by linear interpolation of the tabulated data.

Note: For open unloaded decks of second and further tiers of superstructures and wheelhouses, the design pressure shall be not less than 1.5 kPa.

Table 2.2.28-3

Design pressures on end walls of M-CII class ships

<table>
<thead>
<tr>
<th>Deck</th>
<th>Design pressure on wall at the deck level, kPa</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>rear (aft)</td>
<td>front (bow)</td>
</tr>
<tr>
<td></td>
<td>for relative distance x/L of the superstructure wall under consideration from the midship</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>-0.5</td>
<td>-0.2 ≤ x/L &lt; 0</td>
</tr>
<tr>
<td></td>
<td>for ship length*, m</td>
<td></td>
</tr>
<tr>
<td>Upper</td>
<td>5.8 6.0 9.2 14.3 15.6 5.8 6.0 6.1 8.0 14.3 11.6 11.9 21.0 39.0 70.0 12.6 16.0 33.0 55.0 98.0</td>
<td></td>
</tr>
<tr>
<td>Tier 1</td>
<td>5.8 6.0 6.1 5.8 6.0 6.1 6.2 6.2 5.8 6.0 6.1 6.2 6.2 5.8 6.0 6.1 19.0 44.0</td>
<td></td>
</tr>
<tr>
<td>Tier 2</td>
<td>5.8 6.0 6.1 6.2 5.8 6.0 6.1 6.2 6.2 5.8 6.0 6.1 6.2 6.2 5.8 6.0 6.1 19.0 44.0</td>
<td></td>
</tr>
<tr>
<td>Tier 3</td>
<td>5.8 6.0 6.1 6.2 5.8 6.0 6.1 6.2 6.2 5.8 6.0 6.1 6.2 6.2 5.8 6.0 6.1 6.2 6.2</td>
<td></td>
</tr>
</tbody>
</table>

1 If the ship length differs from the values specified in the table, the design pressure shall be determined by linear interpolation of the tabulated data.

2 Numerator represents design pressures for the next lower tier of superstructure (wheelhouse), denominator for the next upper tier.

2.2.29 When cars and other motor vehicles with pneumatic tires are carried or when forklifts are used, the wheel pressure is considered as uniformly distributed over its footprint and equal to pressure in tires. The footprint of a vehicle wheel is considered to be rectangular-shaped with sides l₁ and l₂ (l₁ refers to the wheel width). The sides of the footprint shall be obtained from the equations, cm, as follows:

for a bias tire

\[
l_1 = \sqrt{(10K_dQ/p_t) b_t/ d_t},
\]

(2.2.29-1)

\[
l_2 = \sqrt{(10K_dQ/p_t) d_t/ b_t},
\]

(2.2.29-2)

for a radial tire (marked with symbols R or "Radial")

\[
l_1 = 0.7 b_t,
\]

(2.2.29-3)

\[
l_2 = 10K_dQ/(p_t l_1),
\]

(2.2.29-4)

where \(p_t\) — pressure in the tire, MPa;

\(Q\) — load applied to the tire, kN;

\(b_t\) — width of the tire, cm;

\(d_t\) — diameter of the tire, cm;

\(K_d\) — dynamic coefficient equal to \(K_d = 1\) for forklift and \(K_d = 1.1\) for the cars.

Where it is unknown at the design stage what tires will be used in the wheel vehicle, \(l_1\) and \(l_2\) shall be taken for a wheel with the minimal square of the footprint.

As regards the forklift, it is assumed that the whole load (weight of the forklift plus cargo) is transferred via its front axis only.

Global strength calculations

2.2.30 Global bending stress shall be determined for two cases: sagging, i.e. when the
deck is compressed, and hogging, i.e. when the bottom is compressed.

Calculation shall be made for those hull cross-sections where maximal summary stresses may be expected, for instance, at the weakest section of the middle part of ship, where main longitudinal members terminate, at cross-sections where different framing systems are joined or where hull material changes to another one.

2.2.31 The hull girder comprises all the longitudinal members in the cross-section under consideration, which are continuously extended to the length exceeding the doubled depth, provided that these members are so connected with the hull that they participate in the global bending (see also 2.4.43).

2.2.32 Where the cutout breadth $b_0$ (see Fig. 2.2.32) in the deck does not exceed 0.05 of the breadth $B_0$ of the continuous part of the deck in the given place, this cutout is not taken into consideration when calculating modulus of the cross-section. If the cutout breadth $b_0$ is equal to or more than 0.05 of the breadth of the continuous part of the deck in the given place, only the members outside the cutout (across the deck) shall be included in the hull girder. Here, a part of the members outside the cutout (along the deck) shall not be included in the hull girder.

2.2.33 Intercostal members in the areas where they terminate shall be included in the hull girder in accordance with Figs. 2.2.32 and 2.2.33 (the shaded areas shall not be included in the hull girder).

2.2.34 Single-tier superstructures (wheelhouses) or superstructures of the first tier supported by at least three transverse bulkheads shall be included in the hull girder in accordance with Fig. 2.2.33.

At end parts of longitudinal walls of superstructures (wheelhouses) there shall be no densely arranged windows or other cutouts whose breadth exceeds the distance between the cutouts.

2.2.35 Railings of cargo decks of flush deck ships and fenders of all ships are not included in the hull girder.

Special measures aimed at exclusion of the fenders and railings of flush deck ships from participation in global bending shall not cause excessive stress concentration.

2.2.36 Elements of the hull girder and normal stresses therein shall be calculated following the approximation method with respective reduction of flexible members like shell, inner bottom, platforms, decks, sides and longitudinal bulkheads.

Approximation step, at which the difference of normal stresses from global bending of the ship between the final and previous approximation steps does not exceed 5% for each extreme edge of the hull girder, shall be taken as the final approximation step.

2.2.37 The following is not subject to reduction:
.1 plate sections adjacent to longitudinal members at breadth equal to 0.25 of the short side of bearing contour from each side of the member (Figs. 2.2.37-1 and 2.2.37-2) but not more than 25-fold plate thickness;

.2 bilge plate throughout the length of the bilge curve;

.3 plates of the extended zone of the hull girder in case of the longitudinal framing system.

2.2.38 In case of the longitudinal framing system, the reduction coefficients for compressed plates shall be obtained from the formula

$$\varphi = \frac{\sigma_c}{\sigma_t},$$

(4.3.20)

where $|\sigma_c|$ — absolute value of the compressive stress in the rigid members at the level of plate's centre of gravity as obtained from calculation of the hull girder at the corresponding approximation step, MPa;

$\sigma_c$ — critical stress in the compressed plate calculated as per 2.2.72, MPa.

The reduction coefficient shall not exceed 1.

2.2.39 In case of the transverse framing system, the reduction coefficients of plates shall be specified in accordance with Table 2.2.39. When determining these coefficients, the local transverse load on the plate is to be specified according to instructions of 2.2.19 to 2.2.28, and the design value of sagging $h_0$ shall be taken not less than calculated by the formula, m:

$$h_0 = a \left(0.0015/t + 0.4\right)/55,$$

(2.2.39-1)

where $a$ — length of the shorter side of the plate, m;

$t$ — plate thickness, m.

<table>
<thead>
<tr>
<th>Type of deformation</th>
<th>Reduction coefficient $\varphi$ at the plate thickness, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension</td>
<td>0.07 0.18 0.33 0.56</td>
</tr>
<tr>
<td>Compression</td>
<td>0.03 0.07 0.12 0.28</td>
</tr>
</tbody>
</table>

Table 2.2.39

Reduction coefficients for transverse plates

For cargo deck plating and double bottom of the ships loaded with clamshells, the value of sagging $h_0$ calculated by formula (2.2.39-1) shall be doubled; initial sagging shall be considered cosine-shaped, and the strip girder to be considered rigidly fixed regardless of the fact whether the plating is under transverse load or not.

The reduction coefficient at compression $\varphi_c$ shall not exceed the value obtained from the equation:

$$\varphi = \left(19/|\sigma_t|\right)\left(100/t\right)^2 \left(1 + a^2/b^2\right)^2,$$

(2.2.39-2)

where $|\sigma_t|$ see 2.2.38;

$a$ — see 2.2.39-1;

$b$ — length of the larger side of the plate, m.

2.2.40 At global bending of the hull, the following stresses in the hull members shall be determined:

normal stresses, MPa,

$$\sigma_i = M_{\rho} C_i \cdot 10^{-3} / I;$$

(2.2.40-1)
tangent stresses, MPa, at the level of characteristic horizontal cross-sections along the hull girder height:

\[ \tau = \frac{M}{I \sum t}, \]  

(2.2.40-2)

where

\( M \) — the greatest design bending moment in the cross-section, kN\(m \);

\( I \) — area moment of inertia of the hull girder, m\(^4\);

\( z_i \) — distance between \( i \)th member and the neutral axis of the hull girder (with symbol plus when above the neutral axis and symbol minus when below the neutral axis), m;

\( N_r \) — the greatest design shear force in the cross-section, kN;

\( S \) — static moment, relative to the axis, of the part of hull girder cross-section situated either above or below the given horizontal cross-section, in which tangent stresses are calculated, m\(^3\);

\( \sum t \) — the sum of thicknesses of the sides, longitudinal coaming plates and longitudinal bulkheads in the given horizontal section, in which tangent stresses are calculated, mm.

### Local strength calculations

**2.2.41** The local strength calculations shall be performed for ships of all classes regardless of ship length.

When calculating the local strength, the following shall be assumed:

1. Web framing members — floors, web side frames and beams — shall be considered as rigid bearing for longitudinal bottom, side and deck girders (stiffeners); keelsons, side stringers and carlings, similarly, for ordinary bottom and side frames and beams; web stays and bulkhead shelves, similarly, for ordinary horizontal and vertical stiffeners;

2. Variability of rigidity characteristics of the web member sections resulting from knees shall not be taken into account when expanding static indeterminacy of the system;

3. Spans of members constituting a frame ring shall be taken as overall dimensions (hull depth, hull breadth, distance between longitudinal bulkheads);

4. When calculating stresses in bearing cross-sections of the frame girders, knees shall be taken into account when calculating the modulus of cross-section of the girder (by inclusion of the knee cross-section) and when calculating bending moment acting at knees’ edge;

5. Where the height of girders (floors, side web frames, bulkhead web stays, etc.) varies, it is allowed to use scantling of the mid girder span for calculation purposes;

6. Tangent stresses near cutouts in webs of web members shall be obtained by dividing the shear force by the area of the web cross-section minus the area of the cutout cross-section.

**2.2.24** When calculating the web frames, the following provisions shall be considered:

1. Sagging of beams and bilge curve radius shall not be accounted; members constituting the frame shall be considered rectilinear, and their length shall be taken in accordance with directions of 2.2.41.3;

2. Pillars supporting web frames shall be considered as only equalizing sags of bottom and deck branches and as loaded with point forces. When expanding static indeterminacy in calculations, the change of pillar length or influence of knee rigidity shall not be considered.

The pillars, whose rigidity is close to the rigidity of ring frame branches, shall be calculated as the frame ring elements loaded with end moments, in addition to axial force;

3. Where the web frames are relieved by longitudinal girders (that may be seen from preliminary calculation of the grillage), their relieving action shall be accounted as concentrated reaction forces. If there is no deck loading, frame rings with no pillars may be calculated as open frame rings, whose side branches rest freely on hard bearings in the deck junction;

4. Multi-tiered frame rings may be calculated as one-tiered ones, provided that the deck is not loaded;

5. Bracket floors in each span between keelsons may be calculated as girders loaded by water pressure from below and by cargo pressure from above. The top and bottom girders of bracket floors interconnected by a
vertical stay amidst the span may be calculated assuming that sags of the girders are equal at the points where the girders are connected with the stay.

2.2.43 When calculating the strength of the grillages, the restraint coefficient of the main direction girder ends shall be obtained from the calculation of the frame ring. If the frame ring is not calculated, restraint coefficients of floors at the bilge and of beams at the sides shall be determined by the formula

\[ k = \frac{1}{[1 + \zeta(H/B_i)]}, \]  

(2.2.43)

where \( \zeta \) — coefficient to be obtained from Table 2.2.43 depending on the number of longitudinal bulkheads, the loading conditions and ratio \( H/(B_i) \);

\( l \) — span of the side frame, m;

\( B_i \) — span of the beam or floor, m;

\( I \) — area moment of inertia of the beam or floor, m^4;

\( i \) — area moment of inertia of the side frame, m^4.

### Table 2.2.43

<table>
<thead>
<tr>
<th>Number of longitudinal bulkheads</th>
<th>Ratio ( H/(B_i) )</th>
<th>Value of ( \zeta ) for ship in:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>fully loaded condition</td>
</tr>
<tr>
<td>0</td>
<td>—</td>
<td>0.50</td>
</tr>
<tr>
<td>1</td>
<td>&lt;1</td>
<td>0.50</td>
</tr>
<tr>
<td>≥1</td>
<td>≥1</td>
<td>0.50</td>
</tr>
</tbody>
</table>

2.2.44 Restraint coefficients \( k \) of the floors and beams shall be determined in the following way depending on availability of longitudinal bulkheads or trusses:

- where distances between adjacent longitudinal bulkheads/trusses or between a longitudinal bulkhead/truss and the side differ from each other by less than 20%, then \( k = 1 \);
- ditto, by more than 20%:
  - for smaller spans of girders \( k = 1 \);
  - for greater spans of girders \( k = 0.75 \).

2.2.45 Restraint coefficients \( k \) of intersecting members in the grillages shall be obtained as follows:

- where lengths of adjacent compartments differ from each other by less than 20%, \( k = 1 \);
- where lengths of adjacent compartments differ from each other by more than 20%, \( k \) is calculated by the formula:

\[ k = \left[ 1 + 0.5q\left(\frac{L'_{gr}}{L_{gr}}\right)^2 / q \right] / \left(1 + 0.5\frac{L'_{l}}{L_{l}}\right). \]

(2.2.45)

where \( q' \) — average arithmetical value of loads of the adjacent compartments, kPa;

\( q \) — load on the grillage under consideration, kPa;

\( L'_{l} \) — average arithmetical value of lengths of adjacent grillages, m;

\( L_{l} \) — length of the grillage under consideration, m.

2.2.46 Keelsons and carlings, floors and beams connected by pillars at each web frame may be calculated as a grillage by considering them to be a girder of summed rigidity and separating reaction forces in junctions proportionally to rigidities of keelsons and carlings.

For bottom grillages, it is necessary to verify tangent stresses in webs of girder bearing sections.

2.2.47 Trusses shall be considered as rigid bearings for web framing.

2.2.48 Ordinary frames and beams shall be calculated as multi-spanned girders assuming that longitudinal web members (keelsons, carlings and side stringers) are rigid non-shifting bearings for the ordinary frames and beams, and particular parts of the latter are in bending.

For the connection of the side ordinary frame and floor with a knee, the bottom end of the frame is be considered as rigidly attached.

For the connection of the side ordinary frame and floor with a knee, the bottom end of the frame is be considered rigidly attached.

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For the connection of the side ordinary frame and floor with a knee, the bottom end of the frame is be considered as rigidly attached.

For the connection of the side ordinary frame and floor with a knee, the bottom end of the frame is be considered rigidly attached.

Ends of ordinary frames and beams in the deck-to-side junction, as well as ends of half-beams adjoining to the coaming, shall be considered as freely resting.
2.2.49 Longitudinal girders (stiffeners) in the longitudinal framing system shall be calculated based on the requirements of:

.1 local strength as:
- girders rigidly attached to the web transverse members (floors, frames or beams) under symmetrical load;
- multi-spanned continuous girders under non-symmetrical load;
.2 buckling strength as girders freely resting on the transverse web members.

2.2.50 Side stringers shall be calculated within the structure of the side grillage.
If cross-connected, stringers of outer and inner sides shall be calculated as a system of girders with cross-members.

2.2.51 Bulkhead framing consisting of web stays and shelves, provided that shelves support these stays, shall be calculated as a grillage.
Where there is no shelves, ordinary vertical stays shall be calculated as single-spanned girders, and where there are shelves, as continuous multi-spanned girders.
Where there are no web stays, ordinary horizontal stiffeners shall be calculated as single-spanned girders, and where there are web stays, as girders rigidly attached on web stays, if distances between the latter are equal. Otherwise, the restraint coefficients of ordinary horizontal stiffeners shall comply with the requirements of 2.2.44.

2.2.52 Calculation of strength of the shell plates and plating shall be made under the assumption that all the plates carrying local load are plates of finite rigidity firmly fixed on long edges of the bearing contour.
Where bearing contour side ratio exceeds two, the plates shall be considered as bending over a cylindrical surface and be calculated as strip girders.

2.2.53 When calculating frame scantlings, width of the effective flange shall be specified as follows:

.1 when calculating longitudinal girders of deck, bottom and double bottom (with the longitudinal framing system), or ordinary beams and frames (with the transverse framing system), as well as ordinary girders, width of the effective flange shall be determined by the formula:

\[ c_i = 0.5a, \]  

where \( a \) — distance between the same-name ordinary girders (i.e. spacing), m.
Effective flange shall not be taken wider than its 50-fold thickness;

.2 when calculating the web members perpendicular to ordinary girders (beams, frames, floors in case of the longitudinal framing system, and carlings, keelsons and side stringers in case of the transverse framing system), the width of the effective flange for these members shall be obtained from the equation, m:

\[ c_2 = c_1 + (b - c_1)\phi, \]

where \( c_1 \) — width of the effective flange as per 2.2.53.1, m;
\( b \) — distance between the same-name web members arranged perpendicular to ordinary girders, m;
\( \phi \) — reduction coefficient obtained from Table 2.2.39.
If reduction coefficient is calculated (see 2.1.6) instead of obtaining from Table 2.2.39, the stress in rigid members being a part of the cubic equation shall be taken equal to normal stress in the web member under consideration with a respective sign;

.3 when calculating the web members co-directional to ordinary framing (carlings and floors in case of the transverse framing system, web frames in case of the longitudinal framing system, etc.), the cross-sections within the flange of ordinary framing stiffeners shall be added to design values of the effective flange area, and the width of the effective flange is calculated as follows, m:

\[ c_3 = 0.5d \left[ 1 + 0.45(100r/a)^2 \right], \]

where \( d \) — distance between same-name web members parallel to ordinary girders, m;
\( a \) — distance between the same-name ordinary girders (i.e. spacing), m.
In all cases, the following condition shall be met: \( c_2 \leq d; \)

.4 in all cases, the width of the effective flange of the framing girders shall not exceed...
1/6 of length of the design span of the girder under consideration;

5 for the web members located across corrugations and connected directly with a corrugated plate throughout its length, the width of the effective flange shall be taken equal to 12-fold thickness of the corrugated plate;

6 for the web members located across corrugations and having no direct connections with a corrugated plate throughout its length, the width of the effective flange shall be taken equal to zero;

7 for members running on the longitudinal girders (attached framing system), the width of the effective flange shall be taken equal to zero.

2.2.54 Design load on deck junction of truss or deck end of a separate pillar shall be determined by the formula, kN:

\[ P = f f + P_u, \]  

(2.2.54-1)

where \( f \) — area of the deck or a platform supported by the pillar, including cargo hatches in the area under consideration, m²;

\( p \) — design load on the area \( f \) to be obtained as per 2.2.26, kPa;

\( P_u \) — design load on the pillar from the upper pillar, kN.

Design load on bottom junction of truss or bottom end of a separate pillar shall be determined by the formula, kN:

\[ P_b = 9.81 f_b (T + r) \geq 0, \]  

(2.2.54-2)

where \( f_b \) — bottom area supported by the bottom junction of truss or a separate pillar, m²;

\( T \) — draught in considered ship loading case in vicinity of the truss or separate pillars, m;

\( r \) — design wave half-height, m.

The value of \( P_b \) shall not be less than zero. Forces in pillars and braces shall be determined based on calculation of truss loaded by forces \( P \) and \( P_b \). Truss span shall be considered equal to:

for transversal trusses, the distance between side and longitudinal bulkhead or between longitudinal bulkheads.

The loading on transversal trusses shall also include reaction forces resulting from interaction with longitudinal trusses.

Forces in separate pillars shall be determined from joint calculation of bottom and deck grillages. The force compressing a separate pillar may be taken as the greater of the forces \( P \) and \( P_b \).

When determining forces in braces and pillars, two cases shall be considered:

when the maximum permissible load acts on the deck in considered ship area. In this case, the minus is used in formula (2.2.54-2);

when there is no load on deck in the considered ship area. In this case, the plus is used in formula (2.2.54-2).

2.2.55 The cross-section area of the pillar or brace \( F \), m² shall be not less than

\[ F = 2 \cdot 10^{-3} |P|/\sigma_c, \]  

(2.2.55-1)

where \(|P|\) — absolute value of design force in pillar/brace determined taking into account the load on deck and bottom junctions (see 2.2.54) and truss structure, kN;

\( \sigma_c \) — critical stresses calculated according to 2.2.71 from the Euler stresses, MPa;

\[ \sigma_E = 2 \cdot 10^5 I / (l^2 F), \]  

(2.2.55-2)

where \( I \) — the minimum area moment of inertia of the pillar/brace, m⁴;

\( l \) — design length of the pillar/brace, m, taken equal to:

for pillar, the actual length of the pillar;

for brace, reduced length \( l_{\text{red}} \) determined by the formula:

\[ l_{\text{red}} = kl_{\text{p}}/\cos \alpha, \]  

(2.2.55-3)

where \( k \) is a coefficient taken equal to:

1, for trusses shown on Fig. 2.2.55 a) and 2.2.55 b);

0.66, for trusses shown on Fig. 2.2.55 c);

\( l_{\text{p}} \) — overall length of the brace, m;

\( \alpha \) — angle between longitudinal axis of the pillar and longitudinal axis of the brace.
Transverse strength of double-sided cargo ships with large deck openings is estimated by calculation of cargo bunker bottom grillage together with frame rings of the double sides, under assumption that all the junctions of these frame rings are fixed and both outer and inner sides act as a rigid bearing for floors, provided that the following inequality is met:

\[
(I_f I_e I_i) + (f_0 f_i f_e) \geq 2.7
\]

(2.2.56-1)

where \(l_h\) — length of the longest hold, m;
\(B_i\) — floor length (distance between the inner sides at the double bottom level), m;
\(d_i\) — distance between the floors, m;
\(k_{av}\) — average restraint coefficient of the floors:

\[
k_{av} = (k_{f_i} n_i + k_{hb} n_b)/(n_i + n_b)
\]

(2.2.56-2)

\(n_i\) — number of floors in the hold positioned in the frame ring planes;
\(n_b\) — number of floors in the hold positioned in the planes of half-bulkheads;
\(k_{av}\) — restraint coefficient of floor ends in frame rings:

\[
k_{av} = 1/\left(1 + I_f/B_i \left[ I_s/H + I_d/(b_h \alpha_s) \right]\right)
\]

(2.2.56-3)

\(H\) — side depth, m;
\(\alpha_s\) — shift coefficient:

\[
\alpha_s = 1 + 7.8I_d/(b_h^2 f_d);
\]

(2.2.56-4)

\(f_i, f_e, f_i\) — area moments of inertia of the floor in the cargo bunker area, the double bottom floor, and the inner side frame with effective flange, m^4;
\(f_0\) — cross-sectional area of inner side frame’s web, m^2;
\(b_h\) — double bottom width at the level of bottom deck, m;
\(k_{hb}\) — restraint coefficient of floors in half-bulkheads:

\[
k_{hb} = 1/[1 + 6I_f/(t_{hb}^2 B_f)]
\]

(2.2.56-5)

but not less than \(k_{fr}\);
\(t_{hb}\) — thickness of the half-bulkhead plate in its lower part, m;
\(h_d\) — double bottom height, m;
\(i_i\) — relative moment of inertia of the double side in case of constrained torsion:

\[
i_i = b_d^2 (t_d H + t_b h_d)/(12I_f)
\]

(2.2.56-6)

\(b_d\) — double bottom width at the level of deck, m;
\(i_b\) — relative moment of inertia of the double side in case of free torsion:

\[
i_b = Ht_d b_d^2 [1 + b_d t_d/(H h_d)]/I_n
\]

(2.2.56-7)

\(t_d, t_s\) — average deck plating thickness and side plating thickness (inner and outer sides), respectively, m;
\(b_d\) — double bottom width at the level of side half-depth.

If inequality (2.2.56-1) is not complied with, calculation of joint deformation of double sides and bottom grillage in still water under local loads as stipulated by this Part of the Rules shall be submitted.

For ships with large deck opening area, where inequality (2.2.56-1) is not complied with, additional (i.e. caused by waving) shear forces and bending moments in the centre plane cross-section of floor and inner side cross-section of floor shall be calculated and summed up with the same forces and moments in still water.

For ships of M-СП, M-ΠР, M and O classes, the maximum values of forces and
moments may be obtained from the following equations:

shear force in the inner side cross-section, kN,
\[
V_{def} = \pm 6.52hB; d_i e^{-kT} \left(1 - e^{-0.5kB}\right) / (kB);
\] (2.2.58-1)
bending moment in the inner side cross-section, kN·m,
\[
M_{def} = \pm h d_i \left[4.88\beta T \left(1 - e^{-kT}\right) + 0.710B_i^2 \times \left(k - k_i, \beta\right)e^{-kT} \left(1 - e^{-0.5kB}\right) / B\right] / k;
\] (2.2.58-2)
bending moment in the centre plane cross-section, kN·m,
\[
M_{ul} = \pm h d_i \left[3.96\beta T \left(1 - e^{-kT}\right) + 0.641B_i^2 \times \left(1.5 - k + k_i, \beta\right)e^{-kT} \left(1 - e^{-0.5kB}\right) / B\right] / k;
\] (2.2.58-3)

where \( h \) — wave height obtained from Table 2.1.2, m;
\( k \) — provisional wave number; for ships of O-ΠP and O classes it shall be taken equal to 0.140 m\(^{-1}\), for ships of M-ΙΠ, M-ΠP and M classes 0.0838 m\(^{-1}\);
\( T \) — draught in the middle of the hold, m;
\( B \) — ship breadth, m;
\[
\beta = k / \left( B; d_i \left[97.4(H/l_0)^2 i_1 + 3.80l_1\right] / l_0^2 + k_i; \right);
\] (2.2.58-4)
\( l_0 \) is be taken equal to the hold length, m for \( l_0 \leq 65 \) m, and equal to 65 m for \( l_0 > 65 \) m;
For \( B; d_1, i_1, l_2, k_i; \) see 2.2.56.

When calculating bending moments acting in sections of the floor placed in the frame ring plane, it shall be assumed that \( k = k_0; \) when calculating bending moments acting in sections of the floor located in the half-bulkhead plane, that \( k = k_{rb}; \)

2.2.59 When carrying vehicles and using forklifts, strength of the plating shall be determined through the value of the residual sag \( W_{res} \) caused by load from a wheel or a group of wheels. The sag shall comply with the following inequality:
\[
W_{res} / b \leq 0.01 ,
\] (2.2.59-1)
where \( b \) — minimum size of the plate in plan view (i.e. the distance between stiffeners, see Fig. 2.2.59), m.

Fig. 2.2.59 Arrangement of load spot on deck

Parameter \( W_{res} / b \) is calculated by the formula:
\[
W_{res} / b = 10^{-2} k_1 k_2 k_3 k_4 k_5 \sqrt{(\rho_i / \rho_y - 1)^3} ,
\] (2.2.59-2)
where \( k_1 \) is a coefficient equal to 1.40 for steel with \( R_{st} = 235 \) MPa and equal to 1.00 for higher strength steels;
\[
k_2 = 6.0 / (b / t_{min}) - 15 ;
\] (2.2.59-3)
\[
k_3 = 0.45 b_0 / b + 0.75 ;
\] (2.2.59-4)
\[
k_4 = 0.20 a_0 / b + 0.80 ;
\] (2.2.59-5)
\[
k_5 = 1.9 \left(\sigma_c \cdot 10^3 / E \right)^2 + 0.74 ;
\] (2.2.59-6)
\( \rho_i \) — pressure in the load spot (see Fig. 2.2.59) equal to the tire inner pressure, MPa;
\( \rho_y \) — pressure resulting in fiber yield:
\[
p_y = t_{min}^2 (R_{st} - \sigma_0) / (k_\sigma a_0 b_0) ;
\] (2.2.59-7)
\( t_{min} \) — thickness of the plating at the end of ship’s service life without renewal repair as calculated by formula (2.2.59-11), m;
\( \sigma_c \) — absolute value of maximal compressive stresses in the rigid members at the plating level: in case of the transverse framing system, in the effective flange of a carling or keelson at global hull bending; in case of the longitudinal framing system, in the effective flange of a beam or floor at the grillage bend-
ing; when calculating effect of vehicle wheels during the voyage, it shall be found with due regard to waves; when calculating effect of forklift wheels, with due regard to loads acting during cargo handling operations, MPa;

\[ \sigma_0 = \text{stresses equal to } \sigma_c \text{ or } \sigma_E, \text{ whichever is less}; \]

\[ \sigma_E = 19 \left(100 \frac{\sigma_{\min}}{b}\right)^2; \quad (2.2.59-8) \]

\( a_0 \) — size of the load spot along the longer side of the plate, m;

\( b_0 \) — ditto, along the shorter side, m;

\( R_{eh} \) — yield point of the plating material, MPa;

\( E \) — Young’s modulus, MPa;

\( k_\sigma \) — stress coefficient in the plate, as obtained from Table 2.2.59.

| Table 2.2.59 Coefficient \( k_\sigma \) depending on ratios \( b_0/b \) and \( a_0/b \) |
|----------------------------------|----------|--------|--------|--------|
| \( b_0/b \)                        | 0.3      | 0.6    | 1.2    | 1.8    | 2.4    |
|----------------------------------|----------|--------|--------|--------|
| 0.2                               | 1.056    | 0.904  | 0.652  | 0.492  | 0.387  |
| 0.4                               | 0.896    | 0.766  | 0.550  | 0.409  | 0.316  |
| 0.6                               | 0.734    | 0.630  | 0.456  | 0.342  | 0.266  |
| 0.8                               | 0.602    | 0.518  | 0.376  | 0.284  | 0.222  |
| 1.0                               | 0.494    | 0.424  | 0.309  | 0.233  | 0.183  |

Sizes of the load spot \( a_0 \) and \( b_0 \) are considered to be equal to \( l_1 \) and \( l_2 \) with due regard to the wheel orientation. Values of \( l_1 \) and \( l_2 \) are determined as per 2.2.29.

For twin wheels \( l_1 \) is replaced with \( l_1^* \)

\[ l_1^* = l_1 + b_t + \Delta , \quad (2.2.59-9) \]

where \( b_t \) is referred to in 2.2.29, and pressure in the tire \( p \) is replace by the reduced pressure \( p^* \)

\[ p^* = 2p l_1/l_1^* , \quad (2.2.59-10) \]

where \( \Delta \) — distance between tires of a twin wheel.

If \( b_0 > b \), \( b_0 = b \). If \( p < p_t \), residual sag \( W_{ns} = 0 \).

Formula (2.2.59-2) is applicable when:

\[ 30 \leq b/t_{\min} \leq 170 ; \]

\[ 0.15 \leq a_0/b \leq 2.10 ; \]

\[ 0.20 \leq b_0/b \leq 1.00 ; \]

\[ 0.11 \leq 100 R_{eh}/E \leq 0.17 ; \]

\[ 0 \leq \sigma_c \cdot 10^4 /E \leq 8,0 . \]

Plating thickness at the end of ship’s service life without renewal repair is determined as:

\[ t_{\min} = t - \Delta t , \quad (2.2.59-11) \]

where \( t \) — design thickness of the plating, which shall be not less than specified in 2.4.1, m;

\( \Delta t \) — wear over the service life, m:

\[ \Delta t = 8 \cdot 10^{-5} \tau , \quad (2.2.59-12) \]

\( \tau \) — ship service life without renewal repair, years.

2.2.60 The following stresses shall be determined in the area of cutouts in webs of web members where the greatest shear force occurs, MPa:

normal stresses

\[ \sigma = \left[ \frac{Mz/I + V_{sh} (0.5 l_{cut} - x)}{z_{br}/I_{br}} \right] \cdot 10^{-3} ; \quad (2.2.60-1) \]

tangent stresses

\[ \tau = 10^{-3} V/F_w , \quad (2.2.60-2) \]

where \( M \) — bending moment on the girder in the cross-section in the middle of the cutout, kN-m;

\( I \) — central area moment of inertia of the girder in the cutout area, m\(^4\);

\( z \) — distance between the point where the stress is determined and the girder’s neutral axis, m;

\( \Delta t \) — distance between the point where the stress is determined and the girder’s neutral axis, m;

\( l_{cut} \) — cutout length, m;

\( x \) — distance between the design cross-section and the left edge of the cutout, m;

\( I_{br} \) — area moment of inertia of the girder cutout bridges above or below the cutout, relative to their own neutral axes, m\(^4\);

\( z_{br} \) — distance between the point under consideration and the neutral axis of the web bridge, m;

\( V, F_w \) — shear force, kN and the weakest cross-section area of the girder web, m\(^2\), correspondingly.
**Summation of stresses**

2.2.61 Design stresses in hull members caused by global bending and local loads shall be determined depending on the values, positions and directions of acting external loads.

The greatest normal and tangent stresses, which shall not exceed those permitted by the Rules, shall be considered design stresses in the hull member under consideration.

2.2.62 Strength of longitudinal hull members participating in global bending shall be verified by stresses resulting from algebraic summation of stresses caused by longitudinal global bending stresses and stresses caused by local load.

2.2.63 For ships not carrying cargo on deck, summary stresses shall be determined only in bottom members. Global bending stresses are considered to be design stresses in deck members for those ships. However, if in those ships some load is transmitted by pillars from the bottom to the deck and causes bending in deck members, total stresses in deck members shall be calculated as regards that load (for instance, total stresses in deck members of flush deck ships in lightship condition).

2.2.64 For all ships carrying cargo on deck, summary stresses in deck members shall be calculated as regards the local load on the deck.

2.2.65 Stresses are determined and summed up for design both sagging and hogging moments.

Local load stresses to be summed up with global bending stresses, which are determined for each of the aforementioned moments, shall be calculated at the respective local load.

2.2.66 Total stresses caused by global bending and grillage bending shall be determined for outer and inner edges of its members on the bearing and in the span.

**Permissible stresses**

2.2.67 When calculating stresses caused by global bending and local load, as well as when calculating total stresses, the following stresses to be taken as unsafe normal and tangent stresses:

\[
\sigma_0 = k_n R_{sh} \quad \text{and} \quad \tau_0 = 0.57 \sigma_0 ,
\]

(2.2.67-1)

where \( R_{sh} \) — yield point of the material;

\[
k_n = 1 - 0.089 \left( \frac{R_{sh}}{235} - 1 \right) - 0.129 \left( \frac{R_{sh}}{235} - 1 \right)^2.
\]

(2.2.67-2)

2.2.68 Values of permissible stresses are given in Table 2.2.68.

**Table 2.2.68**

<table>
<thead>
<tr>
<th>Regulated permissible stresses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name and characteristic of the hull members</strong></td>
</tr>
<tr>
<td>1. Rigid members of the hull girder participating only in global bending and not carrying local load (longitudinal continuous coamings, members of unloaded decks, etc.)</td>
</tr>
<tr>
<td>2. Rigid members of the hull girder participating only in global bending and not carrying local load (bottom members of all ships, members of loaded decks and loaded longitudinal continuous coamings, excepting coamings of double-sided ships of О-П, О, П and І classes)</td>
</tr>
<tr>
<td>3. Longitudinal continuous coamings and carlings of ships carrying cargo on cargo hatches and on the deck, as well as keelhons of ships of all types</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
### Buckling strength calculations

**2.2.69** Verification calculations of buckling shall be made for the following hull members:

1. deck grillages, bottom grillages of ships without double bottom, longitudinal deck stiffeners, bottom, double bottom, sides, longitudinal bulkheads – for maximum compressive stresses due to global bending;

2. pillars (single pillars and pillars within trusses) and braces – for maximum compressive stresses;

3. side shell and plates of longitudinal bulkheads – for maximum tangent stresses due to global bending.

**2.2.70** Buckling shall be checked with due regard to deviations from Hooke’s law of critical stresses (revised Euler stresses) $\sigma_{cr}$.  

---

<table>
<thead>
<tr>
<th>Name and characteristic of the hull members</th>
<th>Characteristic of design stresses due to loads</th>
<th>Regulated permissible stresses as percentage of the unsafe stresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Longitudinal girders (continuous stiffeners)</td>
<td>Total normal stresses due to global and local bending:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.95</td>
</tr>
<tr>
<td>5. Hull’s shell and deck plating in case of the transverse framing system</td>
<td>Normal stresses due to local load:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.95</td>
</tr>
<tr>
<td>6. Shell and deck plating in case of the longitudinal framing system</td>
<td>Normal stresses due to local load:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>Tangent stresses</td>
<td>0.60</td>
</tr>
<tr>
<td>7. Hull members under shear force at global bending (the side shell plating and the plating of longitudinal bulkheads)</td>
<td>Normal stresses due to local load:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.85</td>
</tr>
<tr>
<td>8. Transverse web members: floors, web frames and beams</td>
<td>Normal stresses due to local load:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.95</td>
</tr>
<tr>
<td>9. Transverse ordinary members: bottom and side frames, beams and inner bottom members, in case of the transverse framing system</td>
<td>Normal stresses due to local load:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.95</td>
</tr>
<tr>
<td>10. Longitudinal and transverse bulkheads (including tank walls):</td>
<td>Normal stresses due to local load:</td>
<td></td>
</tr>
<tr>
<td>web stays and shelves</td>
<td>in a span</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.90</td>
</tr>
<tr>
<td>ordinary stays (stiffeners)</td>
<td>in a span</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.95</td>
</tr>
<tr>
<td>plates of bulkheads</td>
<td>in a span</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.95</td>
</tr>
<tr>
<td>11. Webs of web girders</td>
<td>Tangent stresses in solid sections</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>Normal stresses in cutout areas</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>Tangent stresses in cutout areas</td>
<td>0.80</td>
</tr>
</tbody>
</table>

**Notes.** 1. In calculations of the hull strength for ship lifting and launching, for carrying out watertightness and gas-tightness tests, as well as in case of a flooded compartment, the regulated permissible stresses (due to global bending and local load) shall be taken equal to 0.95 of the yield point of the member material.

2. For separately working members (pillars and braces) to be checked for buckling, the regulated permissible stresses at compression shall be taken equal to 0.50 and for intersecting braces equal to 0.75 of the critical stress, but not more than 0.50 of the yield point of the member material.
Critical stresses shall be determined depending on Euler stresses \( \sigma_E \) calculated under assumption that the hull material is subject to Hooke’s law at the moment when loss of buckling occurs.

**2.2.71** For compressed steel members, critical stress \( \sigma_{cr} \), MPa shall be obtained by the formulae:

\[
\begin{align*}
\sigma_{cr} &= \sigma_E \quad \text{when } \sigma_E \leq 0.6 R_{eH}, \\
\sigma_{cr} &= (1.12 - 0.312 R_{eH}/\sigma_E) R_{eH} \quad \text{when } 0.6 R_{eH} < \sigma_E < 2.6 R_{eH}, \\
\sigma_{cr} &= R_{eH} \quad \text{when } \sigma_E \geq 2.6 R_{eH},
\end{align*}
\]

(2.2.71)

where \( R_{eH} \) — yield point of the material.

**2.2.72** Critical stresses of plates, MPa compressed along the longer edge shall be calculated by the formulae:

\[
\begin{align*}
\sigma_{cr} &= \sigma_E \quad \text{when } \sigma_E \leq 0.6 R_{eH}, \\
\sigma_{cr} &= (1.63 - 0.8 \sqrt{R_{eH}/\sigma_E}) R_{eH} \quad \text{when } 0.6 R_{eH} < \sigma_E < 1.6 R_{eH}, \\
\sigma_{cr} &= R_{eH} \quad \text{when } \sigma_E \geq 1.6 R_{eH},
\end{align*}
\]

(2.2.72-1)

where \( \sigma_E \) — Euler stresses, MPa:

\[
\sigma_E = 78.5 \left(100 t/a\right)^2, 
\]

(2.2.72-2)

\( t \) — plate thickness, cm;
\( a \) — length of the shorter edge, cm;
\( R_{eH} \) — yield point of the material, MPa.

**2.2.73** Critical stresses at compression of the bottom and deck grillages, as well as the longitudinal stiffeners shall not be less than the yield stress of the material.

In case of the transverse framing system, rigidity of bottom ordinary frames and ordinary beams shall not be less than the critical one. Critical stresses of bottom and deck grillages, as well as longitudinal stiffeners may be decreased down to values, at which the following condition is met:

\[ \sigma_{cr} \geq K_s \sigma_c, \]

(2.2.73-1)

\( \sigma_c \) — maximum compression stress in the grillage or longitudinal stiffener at global bending due to design loads, MPa;
\( K_s \) — stability coefficient determined by the formula:

\[
K_s = K_{cl} \left(0.75 + 0.25 R_{eH}/235\right),
\]

(2.2.73-2)

where \( R_{eH} \) — see 2.2.71, MPa;
\( K_{cl} \) — stability coefficient for ship classes: 
M-CH, M-CHP and M - 1.43
Others - 1.33

**2.2.74** At buckling calculations, ordinary longitudinal stiffeners are considered freely resting on the respective transverse members (floors, web frames and beams). Euler stresses at compression in longitudinal stiffeners, MPa are as follows:

\[
\sigma_{cr} = \pi^2 E I \left[b^2 \left(f + a t\right)\right],
\]

(2.2.74)

where \( E \) — Young’s modulus, MPa;
\( I \) — area moment of inertia of the stiffener with effective flange, whose dimensions are determined as per 2.2.53.1, m^4;
\( b \) — stiffener span, m;
\( f \) — cross-sectional area of the stiffener without the effective flange, m^2;
\( a \) — distance between stiffeners (length of the shorter side of the plate), m;
\( t \) — plate thickness, m.

**2.2.75** Tangent stresses of plates of sides and bulkheads at global bending as determined by formula (2.2.40-2) shall not exceed 0.95 of critical tangent stresses determined by the formula, MPa:

\[
\begin{align*}
\tau_{cr} &= \tau_s \quad \text{when } \tau_E \leq 0.5 R_{eH}/\sqrt{3}, \\
\tau_{cr} &= R_{eH} \left[1 - R_{eH}/(4 \tau_E \sqrt{3})\right]/\sqrt{3} \quad \text{when } \tau_E > 0.5 R_{eH}/\sqrt{3},
\end{align*}
\]

(2.2.75-1)

where \( R_{eH} \) — see 2.2.71,
\( \tau_E \) — Euler’s tangent stresses determined by the formula:

\[
\tau_E = 19k \left(100 t/a\right)^2, 
\]

(2.2.75-2)

where \( k \) — coefficient obtained from Table 2.2.75 depending on plate side ratio \( b/a \) (\( b \) — length of the longer side of the plate, m);
\( t, a \) — see 2.2.74.

**Calculation of ultimate global strength**

**2.2.76** In all cases the hull’s global strength shall be verified by ultimate moments.
The ultimate moment is a bending moment inducing normal global bending stresses equal, in absolute values, to the unsafe stresses in at least one longitudinal members included into the hull girder; in this case stresses in all the other members shall not exceed the unsafe stresses. For members not subject to local load the unsafe stresses are taken as
\[
\sigma = \frac{\varphi}{R} k_n n, \quad (2.2.76-1)
\]
and for the members subject to local load
\[
\sigma = 0.9 k_n R, \quad (2.2.76-2)
\]
where \( R \) is yield point of material of the member under consideration;
\( k_n \) is calculated by formula (2.2.67-3).

If for ships of Ì-ÑÏ class the requirement of 2.5.2 is met, the calculations of global strength of ships with a length less than 50 m (except passenger ships) may be omitted.

2.2.77 The two ultimate moments \( M_\alpha \) shall be determined: one moment at sagging and the other at hogging of the hull, kN·m:
\[
M_\alpha = W_\alpha \sigma_o \cdot 10^3, \quad (2.2.77)
\]
where \( W_\alpha \) — section modulus of the hull girder relative to the member where the stresses are equal to the unsafe ones, m³;
\( \sigma_o \) — unsafe stress in the member under consideration, MPa.

2.2.78 When calculating the section modulus \( W_\alpha \), the reduction coefficients in case of the longitudinal framing system shall be set in accordance with requirements of 2.2.38, and in case of the transverse framing system as per Table 2.2.78.

2.2.79 The compressed "rigid" hull members (longitudinal girders of decks, platforms, sheerstrake, bottom, double bottom plating) having critical stresses \( \sigma_{cr} \) calculated as per 2.2.71 and 2.2.74 less than stresses in rigid members \( \sigma_i \) caused by ultimate moment, are also subject to reduction. The reduction coefficient of these members is obtained from the equation
\[
\phi = \frac{\sigma_{cr}}{\|\sigma_i\|} \leq 1. \quad (2.2.79)
\]

2.2.80 In order to ensure hull strength by ultimate moment, the following condition shall be met:
\[
[M_\alpha] \geq k [M_\alpha], \quad (2.2.80)
\]
where \( k \) — safety coefficient with regard to ultimate moment;
\( M_\alpha \) — design bending moment at sagging and hogging, kN·m.

2.2.81 Values of the coefficient \( k \) regardless of the steel grade is taken as 1.35 for ships of all classes.

2.2.82 For cargo ships, the hull strength by ultimate moment shall be additionally verified using the expression:
\[
M_\alpha \geq k \alpha D L, \quad (2.2.82)
\]
where \( k_\alpha \) — coefficient of the ultimate moment to be defined as per Table 2.2.82;
\( D \) — displacement of the ship in fully loaded condition, kN.

2.2.75 Table 2.2.75 Coefficient \( k \) depending on ratio \( b/a \)

<table>
<thead>
<tr>
<th>( b/a )</th>
<th>( k )</th>
<th>( b/a )</th>
<th>( k )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>9.34</td>
<td>1.8</td>
<td>6.70</td>
</tr>
<tr>
<td>1.1</td>
<td>8.56</td>
<td>2.0</td>
<td>6.56</td>
</tr>
<tr>
<td>1.2</td>
<td>8.00</td>
<td>2.5</td>
<td>6.07</td>
</tr>
<tr>
<td>1.3</td>
<td>7.60</td>
<td>3.0</td>
<td>5.86</td>
</tr>
<tr>
<td>1.4</td>
<td>7.30</td>
<td>3.5</td>
<td>5.35</td>
</tr>
</tbody>
</table>

2.2.78 Table 2.2.78 Reduction coefficients for transverse plates for determining \( W_\alpha \)

<table>
<thead>
<tr>
<th>Type of deformation</th>
<th>Reduction coefficients ( \phi ) at plate thickness, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension</td>
<td>Compression</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>0.08</td>
<td>0.24</td>
</tr>
<tr>
<td>0.03</td>
<td>0.07</td>
</tr>
</tbody>
</table>

2.2.82 Table 2.2.82 Ultimate moment coefficient \( k_\alpha \) depending on type and length of ship

<table>
<thead>
<tr>
<th>Type of ship</th>
<th>Coefficient ( k_\alpha ) at ship length ( L ), m</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>Self-propelled cargo ships</td>
<td>0.068</td>
</tr>
<tr>
<td>Non-self-propelled cargo ships</td>
<td>0.056</td>
</tr>
<tr>
<td>Tanker</td>
<td>0.048</td>
</tr>
</tbody>
</table>
Calculation of hull global strength at the end of the ship’s service life

Estimation of service life for particular hull members

2.2.83 For ships with a length of 50 m and more, the hull global strength for a planned period of service without the hull renewal repair shall be verified. This period is specified by shipowner (design customer) or designer.

For all ships, the service life of particular hull members shall be estimated as regards the residual thickness values permissible for operation.

The calculations shall be made for the operating conditions stated in the design specification (operation basin category, tonnage, types of cargo to be carried, conditions of cargo handling operations), which influence the hull strength, and designed scantlings.

The calculations shall be made as per 2.2.84 to 2.2.97.

2.2.84 Global strength at the end of the service life is verified by the ultimate moments.

The two ultimate moments shall be determined: one moment at sagging and the other at hogging of the hull, kN-m:

\[ M_{ul,w} = \sigma_u W_{ul,w} \cdot 10^3, \] (2.2.84)

where \( W_{ul,w} \) — section modulus of the hull girder cross-section calculated taking into account wear and local residual deformations of the hull members relative to the member where the stresses are equal to the unsafe ones, m³;

\( \sigma_u \) — unsafe stress in the member under consideration, MPa; it is specified as per 2.2.76.

2.2.85 When determining the section modulus \( W_{ul,w} \), hull flexible members shall be reduced on the assumption that in one of these members the normal global bending stresses are equal, in absolute values, to the unsafe stresses, and with due regard to simultaneous wear of the hull members as per 2.2.86 to 2.2.88 and their local deformations as per 2.2.89 to 2.2.92. Wear and deformations shall be determined at the ship’s age equal to the planned service life minus 5 years.

2.2.86 Service life of particular hull members \( T \) is to be calculated by the formula:

\[ T = \left( t_d - [t] \right) / c_p + 5, \] (2.2.86-1)

where \( t_d \) — thickness of the member under consideration specified in the design, mm;

\( [t] \) — permissible residual thickness, which shall be taken for shell and deck plating from Table 2.2.86 and calculated for the girders by the formula:

\[ [t] = \alpha t_d, \] (2.2.86-2)

where \( \alpha \) — coefficient equal to 0.6 for longitudinal deck and bottom girders, and 0.5 for other girders.

When using the data in Table 2.2.86, the following shall be considered:

1. If spacing is taken more than 550 mm, the hull member thicknesses stated in the table (except for 5.1) shall be increased by correction value \( \Delta t = \left( a/a_0 - 1 \right) \cdot [t] \), where: \( a \) — actual spacing, mm; \( a_0 \) — normal spacing taken equal to 550 mm; \( [t] \) — tabular permissible residual thickness of an individual hull member;

2. If spacing is taken less than \( a_0 \) and/or hull members are made of higher strength steel, than the member thicknesses specified in the table (except for 5.1) are to be decreased by correction value

\[ \Delta t = \left( 1 - 15.3 a / a_0 \sqrt{R_{yH}} \right) \cdot [t], \] where \( a \), \( a_0 \), \( [t] \) — see above (if \( a > a_0 \), \( a = a_0 \)); \( R_{yH} \) — yield point of the member material, MPa.

Permissible residual thicknesses obtained after application of correction \( \Delta t \) to the tabular values \([t] \) shall not be taken less than thicknesses regulated by 3.5.5.2 of RSSS;

3. For ships of М-СП, М-ПР, М, О-ПР and О classes with a length over 50 m, in case of the transverse framing system in the middle part of ship, residual thickness specified by the table is to be increased: by the value of \( 1.2 \left( L - 50 \right) / 90 \) for bottom plating (see 1.1); by the value of \( 0.7 \left( L - 50 \right) / 90 \) for double bottom plating (see 3.1) and lower plates of inner sides of tankers within the cargo tank area (see 4.6);
## Permissible residual thicknesses of shell and deck plating

<table>
<thead>
<tr>
<th>Name of member</th>
<th>Minimum residual thickness, mm, for ship classes at length, m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M-CP</td>
</tr>
<tr>
<td></td>
<td>60</td>
</tr>
<tr>
<td>1 Outer shell plating</td>
<td></td>
</tr>
<tr>
<td>1.1 Outer shell plating (for cases other than mentioned in 1.2 to 1.7)</td>
<td>4.0</td>
</tr>
<tr>
<td>1.2 Outer shell plating bounding ballast and fuel tanks</td>
<td>4.5</td>
</tr>
<tr>
<td>1.3 Bilge strake of the outer shell</td>
<td>4.5</td>
</tr>
<tr>
<td>1.4 Sheer strake in the middle part of ship</td>
<td>5.0</td>
</tr>
<tr>
<td>1.5 Bottom plating of single-bottomed tankers and side plating of single-sided tankers in the cargo tank area</td>
<td>5.0</td>
</tr>
<tr>
<td>1.6 Bottom plating at the fore extremity at the height up to 0.04B from the base plane</td>
<td>5.0</td>
</tr>
<tr>
<td>1.7 Side plating at the fore extremity</td>
<td>4.5</td>
</tr>
<tr>
<td>2 Plating of decks and platforms</td>
<td></td>
</tr>
<tr>
<td>2.1 Deck plating (except for cases mentioned in 2.2 to 2.8)</td>
<td>4.5</td>
</tr>
<tr>
<td>2.2 Deck stringer in the middle part of ship</td>
<td>5.0</td>
</tr>
<tr>
<td>2.3 Upper deck plating in the extremities, plating of partitions between hatches, plating of poop and superstructure decks (not participating in global bending of the hull) in areas not protected by superstructures. Forecastle deck plating</td>
<td>4.5</td>
</tr>
<tr>
<td>2.4 Upper deck plating beyond the middle part, plating of poop deck and superstructure decks (not participating in global bending of the hull) in areas protected by superstructures. Platform plating</td>
<td>3.5</td>
</tr>
<tr>
<td>2.5 Deck plating of tankers in cargo tank area</td>
<td>5.0</td>
</tr>
<tr>
<td>2.6 Deck plating at the extremities of pushed ships</td>
<td>——</td>
</tr>
<tr>
<td>2.7 Plating of deck of superstructure participating in global bending of the hull in the middle part of ship and in areas not protected by superstructures</td>
<td>——</td>
</tr>
<tr>
<td>2.8 Plating of deck of superstructure participating in global bending of the hull beyond the middle part of ship in areas protected by superstructures</td>
<td>——</td>
</tr>
<tr>
<td>3 Inner bottom plating of cargo ships</td>
<td></td>
</tr>
<tr>
<td>3.1 Double bottom plating of cargo ships (except for cases mentioned in 3.2 and 3.3)</td>
<td>4.0</td>
</tr>
<tr>
<td>3.2 Double bottom plating of dry cargo ships under the cargo hatches if loading/unloading is carried out by clamshells, and deck plating of flush deck ships within the cargo area</td>
<td>6.5</td>
</tr>
<tr>
<td>3.3 Double bottom plating of tankers within the cargo tank area</td>
<td>5.0</td>
</tr>
</tbody>
</table>
### End of Table 2.2.86

| Name of member | Minimum residual thickness, mm, for ship classes |  
|----------------|-------------------------------------------------|---|
|                | M-CPI M-IPP and M O-IIP and O P and I |  
|                | at length, m | 60 | 140 | 25 | 80 | 140 | 25 | 80 | 140 | 25 | 80 |  
| 4 Bulkheads and inner sides |  
| 4.1 Plating of watertight bulkheads and inner sides (for cases other than mentioned in 4.2 to 4.9) | 3.5 | 3.5 | 2.5 | 3.5 | 3.5 | 2.5 | 3.5 | 2.5 | 3.0 | 2.5 | 3.0 |  
| 4.2 Forepeak bulkhead plating | 4.0 | 4.0 | 3.0 | 4.0 | 4.0 | 2.5 | 3.5 | 4.0 | 2.5 | 3.5 |  
| 4.3 Plating of inner sides and lower plates of watertight bulkheads of dry cargo ships within the cargo hold area Plating of inner sides and transverse bulkheads, which separate loaded and unloaded compartments of cargo tank area of tankers (with the exception of the lower strake) | 4.0 | 4.5 | 3.0 | 4.0 | 4.5 | 3.0 | 3.5 | 4.0 | 2.5 | 3.5 |  
| 4.4 Plating of watertight bulkheads of dry cargo ships within the cargo hold area (with the exception of the lower plates) | 4.0 | 4.0 | 2.5 | 3.5 | 4.0 | 2.5 | 3.0 | 3.5 | 2.5 | 3.0 |  
| 4.5 Inner side plating of ships with fully opening cargo holds, lower plates of inner sides of ships with partial opening of cargo holds, and transverse bulkheads within the cargo hold area, if loading/unloading is carried out by clamshells | 5.0 | 5.0 | 4.0 | 4.5 | 5.0 | 4.0 | 4.5 | 5.0 | 3.0 | 4.0 |  
| 4.6 Lower plates of inner sides and transverse bulkheads, which separate loaded and unloaded compartments of cargo tank area of tankers | 5.0 | 5.5 | 4.5 | 5.0 | 5.5 | 4.5 | 5.0 | 5.5 | 4.0 | 4.5 |  
| 4.7 Plating of transverse bulkheads, which separate loaded compartments on tankers | 3.5 | 4.0 | 2.5 | 3.5 | 3.5 | 2.5 | 3.0 | 3.5 | 2.5 | 3.0 |  
| 4.8 Upper strake of bulkheads of flush deck ships within the cargo area | 5.5 | 5.5 | 3.0 | 5.0 | 5.0 | 3.0 | 5.0 | 5.0 | 3.0 | 4.5 |  
| 5 Other members |  
| 5.1 Plate structures and webs of web girders under the deck plating of flush deck ships and under the inner bottom plating under the cargo hatches of dry cargo ships, if loading/unloading is carried out by clamshells | 5.5 | 5.5 | 3.0 | 5.0 | 5.0 | 3.0 | 5.0 | 5.0 | 3.0 | 4.5 |  
| 5.2 Continuous longitudinal coamings of cargo hatches | 6.0 | 7.5 | 4.5 | 6.0 | 7.5 | 3.5 | 5.5 | 6.5 | 3.5 | 4.5 |  
| 5.3 Transverse coamings of cargo hatches | 5.0 | 6.0 | 2.5 | 4.5 | 5.0 | 2.5 | 4.5 | 5.0 | 2.5 | 3.5 |  
| 5.4 Plates of trunks of engine rooms and capes of engine rooms, walls of superstructures not participating in global bending of the hull | 3.0 | 3.0 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |  
| 5.5 Wall plating of superstructures participating in global bending of the hull | — | — | 3.0 | 4.0 | 4.5 | 3.0 | 3.5 | 4.5 | 2.5 | 3.0 |  

Notes. 1. Member plate thicknesses are specified in the table assuming the spacing is equal to 550 mm. 2. The residual thickness of individual shell and deck plating of ships less than 25 m long shall be taken according to the requirements to average residual thicknesses of appropriate member group set forth in Table 3.6.2 of RSSS for ship group II. 3. For ships with a sledge-shaped fore extremity, the provision of 1.6 applies to the hull part extending above the flush part of the bottom in the bow raising area by 4% of the ship’s breadth. 4. Instructions of 1.6 of the table on residual thickness of bottom plating at the fore extremity for ships of M-CPI class are applied to hull section located within 0.2L from the
fore perpendicular. For ships of M-CII class that may operate at sea with wave height limited to 3.5 m, for hull section located within 0.15\(L\) to 0.20\(L\) from the fore perpendicular, the residual thickness is to be reduced down to the values required for the middle part of ship; 

.5 the residual thickness of individual plates of the ice strake for ships with ice reinforcement notation shall be not less than 0.8 of the thickness required by the Rules for respective hull area for ice reinforcement category specified for the ship;

.6 residual thickness of individual plates of the ice strake of ice breakers shall be not less than 0.8 of the design thickness;

.7 regardless of values in the table, residual thicknesses of outer shell and deck plating of tugboats, pushboats, icebreakers (beyond the ice strake), floating cranes, plating of transverse bulkheads of tugboats, pushboats, icebreakers (for sheets adjoining to the side), plating of longitudinal and transverse bulkheads of floating cranes, shall not be less than required average residual thicknesses of respective member group as specified in Table 2.2.86 of RSSS for ship group II;

.8 Bottom plating thickness required by 1.6 for ships of M-CII, M-IIIP and M classes is to be reduced by 0.5 mm in the hull sections where the bottom framing consists of ordinary longitudinal girders and transverse web girders at each spacing;

.9 For ships of M-CII 4.5 class, the hull member thicknesses stated in 1.1, 1.6, 2.1 and 2.3 of Table 2.2.86 shall be increased by value \(\Delta t_{\text{max}}\) determined by the formula:

\[
\Delta t_{\text{min}} = (\sqrt{k_p} - 1) t,
\]

where \(t\) — member permissible residual thickness specified in Table 2.2.86 for ship of M-CII class;

\(k_p\) — coefficient determined according to 2.2.28.

Calculated values of the service life of particular members shall not be less than the planned service life of the ship as specified in the design.

2.2.87 Designed wear rate is calculated by the formula:

\[
e_p = (1 + k_q v)c, \tag{2.2.87-1}
\]

where \(v\) — coefficient of variation of the wear rate:

\[
v = 0.51 - 1.06c; \tag{2.2.87-2}
\]

\(k_q\) — coefficient taken equal to:

0 when verifying the hull global strength using the ultimate moment at the end of the service life;

1.65 when estimating the service life of a particular member;

\(c\) — recommended mean wear rate assigned from Table 2.2.87, mm/year.

When using the data from Table 2.2.87, the following shall be considered:

.1 For inland navigation ships intended for operation in basins of northern and eastern rivers, mean wear rates of the hull members, which are not in contact with carried cargoes, may be halved. In this case, the navigation areas, for which the design mean wear rates of members were reduced because of specific navigation conditions, shall be mentioned in the specification as the areas allowed for navigation;

.2 For river-sea ships of all classes intended for operation in Arctic Ocean seas, mean wear rates of the hull members can be taken as for ships of M, O, P and J classes;

.3 For ships of M-CII class intended for operation in the Baltic and White seas, mean wear rates can be taken as for ships of M-IIIP class;

.4 For ships intended for operation in the Black, Marmara, Ionian, Aegean, Mediterranean, Caspian and Arabian seas (regardless of the main class notation), the recommended mean wear rates of the inner and outer side members shall be taken according to the requirements to ships of M-CII class. For other members, recommended mean wear rates shall be taken not less than those required for ships of M-IIIP class;

.5 If while verifying the strength at the end of service life of ship, mean wear rates were reduced under requirements of 2.2.87.2 and 2.2.87.3, navigation area of the ships subjected to such a reduction shall be mentioned in specification as allowed for navigation.
Table 2.2.87
Recommended mean wear rates for various hull members

<table>
<thead>
<tr>
<th>Name of member</th>
<th>Recommended mean wear rate, mm/year, for ship class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M-SP</td>
</tr>
<tr>
<td>1 Deck plating</td>
<td></td>
</tr>
<tr>
<td>1.1 in vicinity of ballast compartments</td>
<td>0.07</td>
</tr>
<tr>
<td>1.2 of flush deck ships carrying bulk cargoes</td>
<td>0.15</td>
</tr>
<tr>
<td>1.3 in vicinity of cargo tanks of tankers</td>
<td>0.15</td>
</tr>
<tr>
<td>1.4 in vicinity of cargo tanks of tankers carrying crude oil</td>
<td>0.21</td>
</tr>
<tr>
<td>1.5 in areas other than 1.1 to 1.4</td>
<td>0.06</td>
</tr>
<tr>
<td>2 Side plating</td>
<td></td>
</tr>
<tr>
<td>2.1 Side of single-sided ships:</td>
<td></td>
</tr>
<tr>
<td>2.1.1 freeboard</td>
<td>0.08</td>
</tr>
<tr>
<td>2.1.2 below waterline in fully loaded condition</td>
<td>0.10</td>
</tr>
<tr>
<td>2.2 Side of double-sided ships (double side compartments are intended for cargo, fuel or ballast):</td>
<td></td>
</tr>
<tr>
<td>2.2.1 freeboard</td>
<td></td>
</tr>
<tr>
<td>tanks filled with fuel</td>
<td>0.13</td>
</tr>
<tr>
<td>tanks filled with ballast</td>
<td>0.12</td>
</tr>
<tr>
<td>2.2.2 below waterline in fully loaded condition</td>
<td></td>
</tr>
<tr>
<td>tanks filled with fuel</td>
<td>0.15</td>
</tr>
<tr>
<td>tanks filled with ballast</td>
<td>0.13</td>
</tr>
<tr>
<td>3 Bottom plating</td>
<td></td>
</tr>
<tr>
<td>3.1 bilge strake and adjacent strake of the bottom plating</td>
<td>0.12</td>
</tr>
<tr>
<td>3.2 other strakes of the bottom plating</td>
<td>0.09</td>
</tr>
<tr>
<td>3.3 in vicinity of fuel tanks</td>
<td>0.14</td>
</tr>
<tr>
<td>3.4 in vicinity of ballast compartments</td>
<td>0.12</td>
</tr>
<tr>
<td>3.5 in vicinity of cargo tanks</td>
<td>0.14</td>
</tr>
<tr>
<td>4 Inner bottom plating</td>
<td></td>
</tr>
<tr>
<td>4.1 in vicinity of fuel tanks</td>
<td>0.14</td>
</tr>
<tr>
<td>4.2 in vicinity of ballast compartments</td>
<td>0.10</td>
</tr>
<tr>
<td>4.3 in holds, if cargo handling operations are to be carried out by clamshells</td>
<td>0.17</td>
</tr>
<tr>
<td>5 Inner side plating</td>
<td></td>
</tr>
<tr>
<td>5.1 Inner side plating of cargo ships</td>
<td></td>
</tr>
<tr>
<td>5.1.1 top and middle strakes</td>
<td>0.06</td>
</tr>
<tr>
<td>5.1.2 lower strake</td>
<td>0.13</td>
</tr>
<tr>
<td>5.1.3 in vicinity of fuel tanks</td>
<td>0.14</td>
</tr>
<tr>
<td>5.1.4 in vicinity of ballast compartments</td>
<td>0.10</td>
</tr>
<tr>
<td>5.2 Inner side plating of ships carrying bulk cargoes, among other kinds of cargo</td>
<td></td>
</tr>
<tr>
<td>5.2.1 top and middle strakes</td>
<td>0.12</td>
</tr>
<tr>
<td>5.2.3 lower strake</td>
<td>0.17</td>
</tr>
<tr>
<td>6 Plating of longitudinal and transverse bulkheads</td>
<td></td>
</tr>
<tr>
<td>6.1 Watertight bulkheads</td>
<td></td>
</tr>
<tr>
<td>6.1.1 top and middle strakes</td>
<td>0.06</td>
</tr>
<tr>
<td>6.1.2 lower strake</td>
<td>0.10</td>
</tr>
<tr>
<td>6.2 Bulkheads separating holds for bulk cargoes</td>
<td></td>
</tr>
<tr>
<td>6.2.1 top and middle strakes</td>
<td>0.11</td>
</tr>
<tr>
<td>6.2.2 lower strake</td>
<td>0.17</td>
</tr>
<tr>
<td>6.3 Bulkheads separating cargo tanks</td>
<td></td>
</tr>
<tr>
<td>6.3.1 top strake</td>
<td>0.16</td>
</tr>
<tr>
<td>6.3.2 middle strake</td>
<td>0.12</td>
</tr>
<tr>
<td>6.3.3 lower strake</td>
<td>0.15</td>
</tr>
</tbody>
</table>
### Table 2.2.87

<table>
<thead>
<tr>
<th>Name of member</th>
<th>Recommended mean wear rate, mm/year, for ship class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M-CP</td>
</tr>
<tr>
<td>6.4 Bulkheads separating cargo tanks of crude oil tankers</td>
<td></td>
</tr>
<tr>
<td>6.4.1 top strake</td>
<td>0.22</td>
</tr>
<tr>
<td>6.4.2 middle strake</td>
<td>0.16</td>
</tr>
<tr>
<td>6.4.3 lower strake</td>
<td>0.21</td>
</tr>
</tbody>
</table>

### 7 Deck framing

7.1 Longitudinal underdeck girders, beams and carlings that border:

- 7.1.1 cargo holds of dry cargo ships and areas of ship spaces: 0.06 0.04 0.04 0.03
- 7.1.2 cargo tanks: 0.16 0.13 0.13 0.12
- 7.1.3 cargo tanks of crude oil tankers: 0.22 0.19 0.19 0.18
- 7.1.4 fuel tanks: 0.16 0.13 0.13 0.12
- 7.1.5 ballast compartments: 0.12 0.08 0.07 0.06
- 7.2 Coamings of cargo hatches: 0.06 0.04 0.04 0.03

### 8 Side and bulkhead framing

8.1 Longitudinal girders, main and web frames, vertical stays and horizontal frames of sides and bulkheads that border:

- 8.1.1 cargo holds of dry cargo ships and areas of ship spaces: 0.08 0.05 0.05 0.04
- 8.1.2 cargo tanks: 0.16 0.13 0.13 0.12
- 8.1.3 cargo tanks of crude oil tankers: 0.22 0.19 0.19 0.18
- 8.1.4 fuel tanks: 0.16 0.13 0.13 0.12
- 8.1.5 ballast compartments: 0.17 0.11 0.10 0.08

### 9 Bottom and inner bottom framing

9.1 Vertical keel, bottom stringers, floors and longitudinal bottom girders of single-bottom ships:

- 9.1.1 in vicinity of cargo holds: 0.10 0.07 0.06 0.05
- 9.1.2 in ballast compartments: 0.12 0.08 0.07 0.06
- 9.1.3 in compartments not intended for flooding, including flush deck ships: 0.10 0.07 0.06 0.05
- 9.2 Vertical keel, bottom stringers, floors, bottom and inner bottom longitudinal girders in the double bottom compartments:
  - 9.2.1 not intended for filling: 0.1 0.07 0.06 0.05
  - 9.2.2 in fuel tanks: 0.16 0.13 0.13 0.12
  - 9.2.3 in ballast compartments: 0.12 0.08 0.07 0.06

**Notes:**

1. If no fender guards are provided, the mean wear rate of the outer shell plating shall be doubled.
2. The mean wear rate of the bottom plating of ships intended for operation mostly on shallow waters shall be taken as 0.10 mm/year.

**2.2.88** Local residual deformations (dents) of longitudinal girders together with shell or plating shall be taken into account for the deck of flush deck ships, inner bottom plating and inclined walls of the cargo bunker or inner sides of dry cargo ships.

**2.2.89** Summary width of dents is taken to be equal to the breadth of the structure within the limits of the cargo zone. Camber of an individual dent in a cross-section shall be taken as harmonically distributed between longitudinal web members.

**2.2.90** Maximum camber $h$ at the midpoint between longitudinal web members is calculated by the formula, mm:

$$h = 501 k_s k_p k_k b (\tau - 5)^{0.73} \sqrt{R_{ch} W_b}$$

(2.2.90-1)

where $k_s$ — coefficient taken equal to:

- in case of cross-members between ordinary 0.5 longitudinal stiffeners of the inner bottom plating and the bottom plating fitted in mid of span
- in other cases 1.0

$k_p$ — coefficient taken equal to:
where cargo handling operations by load cranes of lifting capacity 200 kN or more is stipulated

\[ k_k = \text{coefficient taken equal to:} \]

- for cargo decks of flush deck ships \( 1.0 \)
- for inner deck plating of dry cargo ships \( 0.7 \)
- for walls of the cargo bunker and inner sides \( 0.7 \cos \alpha \)

Here, \( \alpha \) — angle of slope of the bunker wall and inner sides with respect to the base plane;

\( b \) — girder length, cm, equal to the distance between transverse web members, on which the girder rests;

\( \tau \) — planned service life of the ship, years;

\( R_{eh} \) — yield point of the girder material, MPa;

\( W_0 \) — stiffener cross-section modulus, cm³:

\[ W_0 = f_\delta (y_0 + 0.05 t_d), \quad (2.2.90-2) \]

where \( f_\delta \) — design cross-sectional area of the girder without effective flange, cm²;

\( y_0 \) — distance between the centre of gravity of the girder cross-section without effective flange and the plating, cm;

\( t_d \) — design width of the effective flange, mm.

2.2.91 Distorted longitudinal girders with effective flanges, whose width is equal to half of the distance between the girders, shall be included into the hull girder with reduction coefficients \( \varphi \), obtained depending on the following parameters:

\( h \) — sag of the deformed girder as per 2.2.90, cm;

\( a \) — distance between girders, cm;

\( \Gamma, k \) — cross-sectional area, cm² and moment of inertia of this area relative to the neutral axis, cm⁴, respectively, of the deformed and worn-off girder with effective flange having width equal to \( a \);

\( z_{max} \) — distance between the extreme flange fiber and the neutral axis of the aforementioned cross-section, cm;

\( \rho \) — radius of inertia, cm:

\[ \rho = \sqrt{F_p / F_p}; \quad (2.2.91-1) \]

\[ E, R_{eh} \] — Young’s modulus and the yield point, respectively, of the girder material, MPa;

\( b \) — girder length, cm, equal to the distance between transverse web members, on which the girder rests;

\( \sigma_k \) — Euler stress in the girder material, MPa:

\[ \sigma_k = \pi^2 E \frac{I_p}{b^4}; \quad (2.2.91-2) \]

\( \sigma_r \) — stress in rigid members at the level of the gravity centre of the cross-sectional area of the girder with effective flange, MPa:

- at tension \( \sigma_r > 0 \)
- at compression \( \sigma_r < 0 \)

\( n \) — relative stress:

\[ n = \sigma_r / R_{eh}; \quad (2.2.91-3) \]

\( p \) — cargo pressure on the plating supported by the girder as per 2.2.19 to 2.2.23.

For girders supporting a shell or plating not under pressure of cargo it shall be taken \( p = 0 \);

\( H_p \) — girder height, cm.

Reduction coefficient \( \varphi_p \) is to be calculated by the formulae:

\[ \varphi_p = \varphi_0 Y k_p \]

\[ \varphi_p = \varphi_0 k_p \]

\[ \varphi_p = \varphi_0 \]

\[ \varphi_p = \varphi_0 X_1 \]

where \( \varphi_0 \) — coefficient obtained from Table 2.2.91;

\[ Y = \frac{a}{b}, \quad X_1 = \frac{a}{b}, \quad k_p = \text{coefficient taken equal to:} \]

- for deck girders of flush deck ships and inner bottom girders \( 1.0 \)
- in other cases \( 0.85 \)

\( n_1, n_2 \) — number obtained by the formula:

\[ \frac{h_i / \rho}{h_i / \rho} \text{ for } \frac{\sigma_k}{\sigma_k} \text{ equal to } \frac{h_i / \rho}{h_i / \rho} \text{ for } \frac{\sigma_k}{\sigma_k} \text{ equal to } \]

<table>
<thead>
<tr>
<th>( h_i / \rho )</th>
<th>( \varphi_0 ) for ( \sigma_k / \sigma_k ) equal to</th>
<th>( h_i / \rho )</th>
<th>( \varphi_0 ) for ( \sigma_k / \sigma_k ) equal to</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0.916</td>
<td>0.889</td>
<td>0.848</td>
</tr>
<tr>
<td>2</td>
<td>0.719</td>
<td>0.667</td>
<td>0.609</td>
</tr>
<tr>
<td>3</td>
<td>0.516</td>
<td>0.471</td>
<td>0.428</td>
</tr>
<tr>
<td>4</td>
<td>0.363</td>
<td>0.333</td>
<td>0.307</td>
</tr>
<tr>
<td>5</td>
<td>0.260</td>
<td>0.242</td>
<td>0.227</td>
</tr>
</tbody>
</table>

\[ k_p \] — coefficient taken equal to:

- for deck girders of flush deck ships and inner bottom girders \( 1.0 \)
- in other cases \( 0.85 \)

\( n_1, n_2 \) — number obtained by the formula.
\[ n_{1,2} = \pm \left( 1.056 + 0.021 h_0^2 / \rho^2 - 0.145 h_0 / \rho - 0.131 z_{\text{max}} / \rho \right). \quad (2.2.91-5) \]

where number \( n_1 \) is negative, \( n_2 \) is positive; \( X, X_1, Y \) — values calculated by the formulæ:

\[ X = 1 + n \left[ -0.402 + 1.60 h_0 / b - 0.015 \sigma_E / R_{\text{H}} - 0.982 n - 45.2 h_0^2 / b^2 + 0.614 h_0 \sigma_E / (b R_{\text{H}}) - 0.00142 \sigma_E^2 / R_{\text{H}}^2 - 0.362 n^2 \right]; \quad (2.2.91-6) \]

\[ X_1 = 1 + n \left[ 0.400 - 2.90 h_0 / b + 0.0137 \sigma_E / R_{\text{H}} - 0.896 n + 50.1 h_0^2 / b^2 - 0.522 h_0 \sigma_E / (b R_{\text{H}}) + 0.00123 \sigma_E^2 / R_{\text{H}}^2 + 0.329 n^2 \right]; \quad (2.2.91-7) \]

\[ Y = 1 - 1 \cdot 10^{-3} p a b^2 H_p \times \left( 0.0271 + 0.169 h_0 / b - 0.00292 \sigma_E / R_{\text{H}} / (I_p R_{\text{H}}) \right) / (I_p R_{\text{H}}). \quad (2.2.91-8) \]

When any coefficient is calculated by formulæ (2.2.91-6) to (2.2.91-8) as negative, it shall be taken equal to zero, and when as positive, it shall be taken equal to one.

2.2.92 Reduction coefficients of plates in vicinity of dents, in case of the longitudinal framing system, shall not be taken higher than reduction coefficient of deformed longitudinal girders included into the bearing contour of those plates, as determined as per 2.2.91.

Reduction coefficients of plates in vicinity of dents, in case of the transverse framing system, except for cargo decks of flush deck ships and inner bottom plating of dry cargo ships, shall be taken from Table 2.2.98. Reduced parts of plates of cargo decks of flush deck ships and inner bottom plating of dry cargo ships, in case of the transverse framing system, are not included into the hull girder.

2.2.93 To ensure the global strength by ultimate moment \( M_{\text{ul,w}} \) with due regard to wear and local residual deformations of the hull members, the following condition shall be met:

\[ |M_{\text{ul,w}}| > K_w |M_d|, \quad (2.2.93) \]

where \( K_w \) — safety coefficient by ultimate moment taking into account wears and local residual deformations of the hull members; \( M_d \) — design bending moment at sagging and hogging, kN·m.

2.2.94 Coefficient \( K_w \) in the strength condition (2.2.93) is taken equal to coefficient \( K_s \) as stipulated in 3.3 Appendix 1 to RSSS.

2.2.95 For cargo ships, it is necessary to verify additionally the global strength by ultimate moment \( M_{\text{ul,w}} \) taking into account wear and local residual deformations of the hull members, using the following equation:

\[ |M_{\text{ul,w}}| > k_{\text{ul,w}} DL, \quad (2.2.95) \]

where \( k_{\text{ul,w}} \) — ultimate moment coefficient taking into account wear and local residual deformations of the hull members.

2.2.96 Values of the coefficient \( k_{\text{ul,w}} \) at the end of ship’s service life shall be taken from Table 2.2.96.

<table>
<thead>
<tr>
<th>Type of ship</th>
<th>Coefficient ( k_{\text{ul,w}} ) at ship length, m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-propelled cargo ships</td>
<td>0.055 0.045 0.033 0.027 0.023</td>
</tr>
<tr>
<td>Non-self-propelled cargo ships</td>
<td>0.045 0.035 0.023 0.018 0.015</td>
</tr>
<tr>
<td>Tanker</td>
<td>0.036 0.024 0.016 0.013 0.010</td>
</tr>
</tbody>
</table>

2.2.97 Requirements of 2.2.93 to 2.2.95 shall be met during the entire planned service life of the ship.

2.3 DESIGNING OF THE HULL

General requirements

2.3.1 When designing the hull, a principle of alignment of members in the same plane shall be complied with in order to compose closed structures like: carling — transverse bulkhead web stay — keelson; deck/platform longitudinal girder — transverse bulkhead ordinary stay — double bottom/platform longitudinal girder; floor — frame — beam; side
stringer – transverse bulkhead shelf – longitudinal bulkhead shelf, etc.

2.3.2 Thickness, height, cross-section and shape of hull members shall have smooth transitions.

A difference of thickness of adjacent plates shall not exceed 30% of the thickest of the joined plates or 5 mm, whichever is less. The said does not concern plates forming seams, as well as thickened plates placed at ends of superstructures, under anchor hawsepipes or under the ship machinery. The thicker edge shall be beveled down to thickness of the thinner plate according to applicable national standards^1^.

2.3.3 Transition of heights of webs of girders and stiffeners from higher to lower or vice versa shall be arranged over a part whose length shall be at least five-fold difference in web heights for keelson and carling webs in the middle part of ship, and at least two-fold difference in web height for other members.

Girder flanges shall have similarly smooth transition between each other.

2.3.4 It is necessary to ensure the continuity of most possible number of main longitudinal members.

2.3.5 Transition from one framing system to another shall be smooth. Not more than 1/3 of ordinary longitudinal girders and not more than two longitudinal web members placed on the bottom or under the deck may be interrupted in the same cross-section of the hull. Sections where longitudinal members are interrupted shall be at least two spacings apart from each other.

2.3.6 Longitudinal members shall not be terminated in areas weakened by cutouts or in stress concentration areas, e.g. in way of rounded corners or rectangular cutouts, ends of superstructures, or longitudinal coamings.

2.3.7 At the ends of decks, platforms, double bottom plating or longitudinal bulkheads, knees or other structures shall be fitted to relief stress concentration (Fig. 2.3.7).

---

^1^ GOST 8713, GOST 52640, GOST 14771

Fig. 2.3.7 Design of ends of decks, platforms, inner bottom plating, longitudinal bulkheads

2.3.8 Ends of stiffeners shall extend to a transverse member and reinforced by knees.

The ends of the following members may be mitered:

- .1 counter-vibration stiffeners;
- .2 stiffeners supporting webs of members;
- .3 ordinary stays of transverse bulkheads in ships with the transverse framing system, except for peak bulkheads and engine room bulkheads;
- .4 ordinary stays of longitudinal bulkheads in ships with the longitudinal framing system.

Stiffeners shall not be mitered at the ends near a cutout with non-reinforced edge, including cutouts for ordinary girders.

^Note^: End mitering means machining the ends of ordinary members (stays), stiffeners, and flanges of web members, knees and brackets as shown in Fig. 2.3.8.
2.3.9 Longitudinal web girders shall be terminated at transverse bulkheads or transverse web members.

At the opposite side, a knee shall be fitted with a length of at least 1.5 height of the terminated girder; this knee shall extend to a transverse web girder and be welded to it. The knee height shall be equal to the height of the terminated girder with the decrease at the end down to 1/4 of that height. Web thickness and flange dimensions of the knee shall be the same as for the terminated girder. The flange shall be mitered (Fig. 2.3.9, a and b). When the terminated web girder is transiting to an ordinary longitudinal girder, the knee may not be extended to a transverse girder (Fig. 2.3.9, c).

2.3.10 In case of the longitudinal framing system of deck, bottom or platform, ends of ordinary frames shall be reinforced with knees to be extended to nearest longitudinal girders.

In case of the combined framing system of sides (see 2.4.33), where ordinary frames attach to side stringers or platforms, knees shall be fitted in the frame planes.

In case of the combined or longitudinal framing systems of sides, knees shall be provided between web frames at the bilge and at the side-to-deck connection; those knees shall be placed in the plane of each actual frame and be extended to the nearest longitudinal girders.

2.3.11 Structural measures shall be taken in order to increase strength and rigidity of hull structures, which in operation are subject to local concentrated or impact loads not taken into consideration in the strength calculations, for instance, deck (in vicinity of bearing drum), sides and bottom of floating cranes; extremities of pushboats and pushed ships; decks of flush deck ships; inner bottom and inner sides of dry cargo ships, etc.

Designing of framing girders

2.3.12 Girders whose webs are in the same plane (beam and frame, frame and floor, etc.), shall be connected by knees fitted in the plane of their webs, and the web girders themselves shall be welded to each other. Ordinary transverse girders may be connected by overlapping knees.

When connecting web girders, knees shall overlap the members for at least the height of the smaller girder, and for ordinary girders – for at least twice height of the smaller girder (for overlapping knees, the overlap is measured from the girder flange). Thickness of the knees connecting web and ordinary girders shall be not less than thickness of the web of the smaller connected girder. Thickness of
knees connecting ordinary girders may be reduced: for non-flanged knees – by 1 mm for girder web thickness of 7 to 9 mm inclusive and by 2 mm for girder web thickness of 10 mm and more; for flanged knees and knees with welded strip — by 1 mm for girder web thickness of 6 to 8 mm and by 2 mm for girder web thickness of 9 mm and more.

2.3.13 Knees fitted in web girder connections shall have a mitered flange/strip at their free edge. For the rest cases, the free edge shall be reinforced if the length of a welded side of the knee/bracket exceeds 35-fold thickness of the knee/bracket. The thickness of strip welded to knee shall be not less than the knee web thickness, and its width shall be not less than 8-fold thickness of the strip but not less than 40 mm at one side from the welding line. The flange thickness shall be not less than 8-fold thickness of the knee but not less than 40 mm. Maximal width of the flange measured from the knee web shall not exceed 10-fold its thickness. The cross-sectional area of the knee flange in the web girder junction shall be not less than 0.8 of cross-sectional area of flange of the smaller connected girder.

2.3.14 In the places of intersection of web girders with bulkheads, the former shall be supported from both sides by knees overlapping them at a length at least equal to their height. Webs and flanges of girders shall be welded to the bulkhead plating. For bulkheads of the engine room and the extremities, as well as bulkheads taking alternating loads, girder flanges shall be mitered.

2.3.15 Ordinary members shall go through cutouts in non-tight web members or non-tight bulkheads. Web of an ordinary girder shall be welded to web of a non-tight web member or non-tight bulkhead, or the members shall be connected by means of knees, plates (Fig. 2.3.15-1), stiffeners or by combination of the said methods.

The knee thickness shall be taken according to 2.3.12, the thickness of plate and/or stiffener shall be not less than the thickness of web of the web girder or bulkhead.
knee shall have a bent flange regardless of the thickness and dimensions of the knee sides (Fig. 2.3.16).

![Fig. 2.3.16. Intersection between ordinary girder and watertight web member](image)

Legs of the knee shall be at least 1.5 of the height of ordinary girder, and stiffener height shall be at least 0.6 of height of this girder. Requirements for stiffeners stated in 2.3.20 shall also be met. Misalignment of knee or stiffener from the plane of unsymmetrical profile web shall not exceed the weld leg plus 1 mm.

In case of attached framing structure, the ordinary girders made of angle bars may be connected with web girders by means of welding the flanges by two welds. When using bulb profiles as ordinary members, the connection shall be made with knees.

For attached (two-tier) framing, finished rolled or welded I-beams or channel beams, as well as bent channels with same-width flanges may be used as web girders.

2.3.17 In order to form drain openings near the transverse members, the bottom and deck longitudinal girders may be not extended to the webs of respective members. The distance between the web end and member's web shall not exceed 10-fold thickness of the bottom plating but not exceed 100 mm, whichever is less. Longitudinal ordinary girders shall be connected according to 2.3.16.

2.3.18 Ends of ordinary members, which interrupt at bulkheads or web members, shall not be welded to non-reinforced plates via knees. There shall be a stiffener in the plane of knee (Fig. 2.3.18-1) or a stiffener made of a flat or a rolled profile shall be placed at the end of one of the knees; this stiffener shall extend to the nearest girders (Fig. 2.3.18-2). The stiffener ends may be mitered.

The knee supporting the end of ordinary girder at the transverse web girder shall be extended to the flange of the latter. A process gap of 10 to 20 mm may be provided (Fig. 2.3.18-3).

![Fig. 2.3.18-1. Eliminating dead point at the ends of knees using vertical stiffener](image)

![Fig. 2.3.18-2. Eliminating dead point at the ends of knees using horizontal stiffener](image)
The side of the knee or bracket to be welded to the flange of web girder shall not be extended to the free edge of the flange by 10 to 20 mm.

Where reaching the outer plating, the flanges of web members shall be mitered, and a gap of 10 to 20 mm shall be provided between the end of the flange and the plating.

2.3.19 Where three mutually perpendicular structures (e.g. a platform, longitudinal bulkhead and transverse bulkheads) intersect, knees or stiffeners shall be fitted in order to spread loads arising in the intersection point (Fig. 2.3.19).

2.3.20 Webs of web members, where ratio of height $h$, cm, to thickness $t$, cm, exceeds $80\sqrt{235/R_{eh}}$ (where $R_{eh}$ — yield point of the girder material), shall be reinforced by stiffeners fitted perpendicular or parallel to flanges of the web members so that the following conditions are met:

1. distance between the supporting stiffeners $S$, cm, fitted perpendicular to web member flanges shall not exceed:

$$S = (0.24 \frac{h}{t} - 9.5) \frac{h\sqrt{R_{eh}/235}}{(h/t - 75\sqrt{235/R_{eh}})};$$

(2.3.20.1)

2. area moment of inertia of the stiffeners fitted perpendicularly to the web member flanges, including effective flange, cm$^4$, shall be not less than:

$$i = 0.1St^3 \frac{KS}{h},$$

(2.3.20.2)

where $K$ — coefficient taken from Table 2.3.20.2;

<table>
<thead>
<tr>
<th>$h/\sqrt{R_{eh}/235}$</th>
<th>$K$</th>
<th>$i/\sqrt{R_{eh}/235}$</th>
<th>$K$</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>0</td>
<td>105</td>
<td>7.89</td>
</tr>
<tr>
<td>85</td>
<td>1.05</td>
<td>110</td>
<td>9.23</td>
</tr>
<tr>
<td>90</td>
<td>3.53</td>
<td>115</td>
<td>10.31</td>
</tr>
<tr>
<td>95</td>
<td>5.04</td>
<td>120</td>
<td>12.00</td>
</tr>
<tr>
<td>100</td>
<td>6.65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. area moment of inertia of the stiffeners fitted in parallel to the web member flanges, including effective flange, cm$^4$, shall be not less than:

$$i = 5.1 \cdot 10^{-7} R_{eh} \left( f + at \right)^2,$$

(2.3.20.3)

where $R_{eh}$ — yield point of the stiffener material, MPa;

$f$ — cross-section area of the stiffener (excluding effective flange), cm$^2$;

$a$ — distance between supporting stiffeners, cm;

$l$ — length of supported part of the web, cm.

The stiffeners may be made of flat if their height to thickness ratio does not exceed 10; here, web height shall be not less than 50 mm and the thickness not less than 0.8 of the thickness of the web to be supported.

The $h/t$ ratio for webs of web members subject to high local loads (side framing of all ships; deck framing of flush deck ships to be
2.3.21 Web member web thickness shall be not less than stated in Table 2.3.21-1 depending on the adjacent plating thickness.

<table>
<thead>
<tr>
<th>Table 2.3.21-1</th>
<th>Web member web thickness depending on adjacent plating thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness, mm</td>
<td>Plating</td>
</tr>
<tr>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>4.5</td>
<td>4.0</td>
</tr>
<tr>
<td>5.0</td>
<td>4.5</td>
</tr>
<tr>
<td>5.5</td>
<td>5.0</td>
</tr>
<tr>
<td>6.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

When the plating thickness is 12 mm and more, the web thickness may be made 4 mm less than the plating thickness.

The web thickness of web members adjacent to the deck stringer or coaming of open ships may be reduced by more than stated above but not less than one-half of the thickness of said adjacent plates.

Thickness of webs of web members of cargo ships with a length of 50 m and more shall be taken not less than stated in Table 2.3.21-2.

<table>
<thead>
<tr>
<th>Table 2.3.21-2</th>
<th>Web member web thickness for cargo ships with a length of 50 m and above</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of member</td>
<td>Minimum web girder web thickness, mm</td>
</tr>
<tr>
<td></td>
<td>at hull length, m</td>
</tr>
<tr>
<td>Web members:</td>
<td>6</td>
</tr>
<tr>
<td>side web members in the middle and aft part of ship</td>
<td>7</td>
</tr>
<tr>
<td>sides in the fore extremity</td>
<td>6</td>
</tr>
</tbody>
</table>

2.3.22 Thickness of girder’s welded flange shall not exceed the doubled web thickness. Width of symmetrical flange shall not exceed 24-fold its thickness, and width of single-sided flange shall not exceed 12-fold thickness. Thickness of bent flange shall be taken within 8- to 12-fold its thickness.

For L-shaped profiles, the flange width to flange thickness ratio shall not exceed 30. Width of additional small flange shall be not less than 30 mm.

2.3.23 When calculating the section modulus and the area moment of inertia of unsymmetrical girder with bent flange, flange area \(f_f\) shall be multiplied by coefficient \(\varphi\) determined by the formula:

\[
\varphi = \left(1 + \frac{3}{1 + 12\left[\frac{h}{\left(10\eta\beta\right)}\right]^4 \left(\frac{f_w}{f_f}\right)^2 \left(t/f\right)}\right)^{-1},
\]

where \(l\) — span of the beam, cm; 
\(\eta\) — coefficient depending on end attachment method and taken equal to:
- for both ends constrained 1.5
- with one end is constrained and the other one is freely resting 1.25
- for both ends freely resting 1
\(h\) — web height, cm; 
\(f_w\) — cross-sectional area of the web, cm\(^2\); 
\(f_f\) — cross-sectional area of the flange, cm\(^2\); 
\(t\) — flange thickness, cm; 
\(b\) — flange width, cm.

Cutouts in hull structures

2.3.24 Rectangular cutouts in longitudinal members shall be rounded in their corners with a radius of not less than 0.1 of the cutout width. Radii of rounding of cargo hatch cutouts in main decks enclosed by continuous longitudinal coamings may be reduced down to 0.5 m.

2.3.25 Cutouts in longitudinal members shall be arranged with the longer side lengthways the ship.

2.3.26 Members in way of cutouts shall be ended at a specially fitted member and welded to the it (Fig. 2.3.26). Where there are several cutouts, they shall be arranged on the same line along the ship so far as practicable and not in the same cross section.
2.3.27 Cutouts in girder webs are not allowed in vicinity of supports and knees. The cutouts shall be at least 50% clear of the girder depth from the knee end.

2.3.28 Summary height of cutouts in webs of web girders for passing ordinary girders shall not exceed 0.5 of the web member depth. Where webs of girder are connected by welding and cutout is reinforced by a plate, the height of such a cutout may be increased up to 0.6 of depth of the web member. In way of double sides, height of cutout may be taken equal to 0.6 of depth of the web half-beam. The total height of cutouts for passing ordinary members through webs of continuous floors and keelsons of the double bottom and continuous web frames of “diaphragms” and double side platforms shall not exceed 0.4 of the depth (width) of the said members.

The height of lightening cutouts and access cutouts shall not exceed 50% and width shall be not exceed 75% of the web member depth in the given place.

The distance from edges of all cutouts in web members to edges of cutouts for passing ordinary girders shall not be less than the depth of those girders.

2.3.29 The height of drainage openings in members shall not exceed 20% of the girder depth, and the length shall not exceed 15-fold thickness of the shell or plating.

2.3.30 Web member web weakened by a cutouts shall be reinforced by stiffeners fitted in parallel to girder flanges with area moment of inertia, including effective flange, not less than that defined by formula (2.3.20.3).

2.3.31 Stiffeners provided in 2.3.30 for girders with cutouts may be omitted, if the cutouts are of a circle shape, their diameter does not exceed 20% of web girder depth, and they are located at a distance at least than double girder depth from each other or from other cutouts.

2.3.32 Web member web section adjacent to the inner side, transverse or longitudinal bulkheads shall be reinforced by sloping stiffeners (Fig. 2.3.32); the cutout shall be made in the middle of the web to be supported. The sloping stiffeners shall have a cross-sectional area $f$ (without effective flange) not less than, $cm^2$:

$$f = \left(12.7V - F_w \tau_0 \right)/\left(2R_{el} \sin \alpha\right)$$

and area moment of inertia $i$ of stiffeners, including effective flange, not less than, $cm^4$:

$$i = 5.1 \cdot 10^{-7} R_{el} \left[ f + h t / (6 \sin \alpha) \right] h^2 / \sin^2 \alpha,$$

where $V$, $F_w$ — shear force, kN, and the weakest cross-section of the girder web, $cm^2$, correspondingly;

$\tau_0$ — dangerous tangent stress of web material according to (2.2.67-2), MPa;

$R_{el}$ — yield point of the stiffener material, MPa;

$h$, $t$ — depth and thickness of the web, correspondingly, cm;

$\alpha$ — angle of slopping of the stiffeners regarding to neutral axis of the web, deg.

2.3.33 Corrugated structures may be used for watertight and permeable bulkheads of the hull and subordinate structures not participat-
ing in global bending, i.e. enclosures, walls and roofs of wheelhouses.

2.3.34 A strength of corrugated structures shall not be less than the strength of relevant flat structures.

2.3.35 Corrugates of hull watertight bulkheads shall be continuous of trapeze (Fig. 2.3.35, a) or wavy (Fig. 2.3.35, b) cross section.

Corrugates of transverse bulkheads shall be located vertically and corrugates of longitudinal bulkheads shall be located either horizontally or vertically. Where corrugates of a longitudinal bulkhead are vertically, the bulkhead is not included in the hull girder.

2.3.36 At the ends of knees of girders adjacent to corrugated platings, transverse stiffeners shall be provided (extended to the nearest edges of the corrugates), shelves or other structures to distribute concentrated load from the knee corners (Fig. 2.3.36).

Welding joints

2.3.37 Butts of the outer shell and deck plating shall not be located directly in places of increased stress concentration, i.e. in corners of large cutouts, e.g. in the vicinity of the ends of foundations.

2.3.38 Welds shall not be congested, i.e. intersect at acute angles, or failure to comply with requirements of 2.3.39.

2.3.39 The distance between parallel intersection butt and fillet welds shall be at least $10t$ for plate thickness $t = 3$ to $10$ mm and $100$ mm for $t > 10$ mm.

The distance between parallel butt and fillet welds inside a section shall be at least $30$ mm.

Fig. 2.3.35. Types of corrugate cross-sections of watertight bulkheads:

a) trapeze; b) wavy

Fig. 2.3.36. Example of distribution of the concentrated load at the knee ends
2.3.40 The angle between two butt welds shall be over 60°.

2.3.41 Assembling joints of deck plating and outer shell of sections and blocks shall be in the same plane.

2.3.42 Where hull elements are butt welded, the welds shall be fused through entire thickness of the connected parts.

2.3.43 For T-joint welds loaded by tensile load and subject to vibration, variable or impact loads, continuous double-sided welds shall be applied with full fusion of the abutting web.

2.3.44 Types of T-welds in hull structures are stated in Table 2.3.44-1.

Table 2.3.44-1

<table>
<thead>
<tr>
<th>Weld type and sketch</th>
<th>Weld symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Double-sided continuous</td>
<td>ДК</td>
</tr>
<tr>
<td>2. Single-sided continuous</td>
<td>ОК</td>
</tr>
<tr>
<td>3. Single-sided intermittent</td>
<td>К-a/t</td>
</tr>
<tr>
<td>4. Staggered intermittent</td>
<td>К-аZt¹</td>
</tr>
<tr>
<td>5. Single-sided dotted</td>
<td>Т-б/t</td>
</tr>
</tbody>
</table>

Note. Д — double-sided; О — single-sided; Т — dotted; К — weld leg, mm; а — welded length, mm; t — pitch, mm; b — dot width, mm.

2.3.45 Welds shown in Table 2.3.44-2 may be replaced by welds of equal strength of other type with different dimensions of design features in accordance with national standards¹.

2.3.46 Numbers of T-welds for hulls of ships intended for operation in various water basin categories are to be specified according to Table 2.3.46.

2.3.47 On tug-and-push boats and pushed ships, the framing shall be welded by continuous welds to the outer shell and the deck in area of coupling arrangements.

2.3.48 For T-joints loaded by tensile load, weld No. 1 shall be used to ensure strength (both shear and tensile) equal to the abutting web.

1 GOST 2.312, GOST 14771, GOST 5264

2.3.49 Free ends of webs of ordinary girders and free ends of stiffeners, in case of one side welding, shall be continuously welded around, and the weld shall pass over to the other side for at least double depth of the girder/stiffener.

In case of one side welding, ordinary girder webs in way of cutouts and cutouts in bulkheads shall be continuously welded around, and weld shall pass over to the other side for at least double height of profile.
<table>
<thead>
<tr>
<th>Thickness of the thinnest connected plate, mm</th>
<th>Particulars of T-weld number</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 and 3.5</td>
<td>/3</td>
</tr>
<tr>
<td>4.0 and 4.5</td>
<td>/3</td>
</tr>
<tr>
<td>5.0 and 5.5</td>
<td>/3</td>
</tr>
<tr>
<td>6 and 7</td>
<td>/5</td>
</tr>
<tr>
<td>8 and 9</td>
<td>/6</td>
</tr>
<tr>
<td>10</td>
<td>/7</td>
</tr>
<tr>
<td>12</td>
<td>/9</td>
</tr>
</tbody>
</table>

Particulars of non-beveled T-welds in hull structures

Particulars of T-weld number

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>with strength coefficient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.75</td>
<td>0.50</td>
<td>0.35</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3.50/100 or T-10/40</td>
<td>3.50/100 or T-10/50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4.75/200 or T-10/50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Weld legs of 5 mm and more made by automatic or semi-automatic submerged arc welding or carbon dioxide welding may be reduced by 1 mm.

Numbers of T-welds for ship hull elements

Hull elements to be welded

<table>
<thead>
<tr>
<th>Hull elements to be welded</th>
<th>Weld number from Table 2.3.44-2 for ships of classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-CHP, M-HP, O-HP, M, O, P and J</td>
<td></td>
</tr>
</tbody>
</table>

Bottom framing

1. Webs of keelsons and floors to outer shell, excepting those mentioned in 3 and 5 |
2. Webs of keelsons and floors to their flanges or to double bottom plating, excepting those mentioned in 3 to 5 |
3. Webs of keelsons and floors to their flanges, double bottom plating, or outer shell in engine rooms in way of foundations |
4. Webs of keelsons and floors to double bottom plating of dry cargo ships to be loaded/unloaded with clamshells |
5. Webs of watertight floors and keelsons to outer shell and double bottom plating |
6. Webs of floors and keelsons to each other and to bulkheads |
7. Ordinary members to outer shell in the engine room and within 0.2 length of the ship in extremities |
8. Ordinary members to outer shell in all the areas other than mentioned in 7 |
9. Ordinary members to double bottom plating in dry cargo ships to be loaded/unloaded with clamshells |
10. Ordinary members to double bottom plating for ships other than mentioned in 9 |
11. Double bottom plating to outer shell and to inner sides |

Side framing

12. Webs of web frames and side stringers to their flanges, to outer shell and inner side plating |
13. Side stringer webs, web frame webs, and ordinary members to double bottom plating in ships to be loaded/unloaded with clamshells |
14. Webs of web frames and side stringers to each other and to bulkheads |
15. Ordinary members to outer shell and inner side plating |

Deck and platform framing

16. Deck members to deck plating in way of bearing drums in floating cranes |
17. Deck members to deck plating in flush deck ships |
18. Deck members to deck plating in ships other than those mentioned in 17 |
19. Webs of web members to their flanges |
20. Webs of web beams and carlings to each other, to side shell plating and to bulkheads |
21. Hatch coamings to decks and beams
TABLE 2.3.46

<table>
<thead>
<tr>
<th>Hull elements to be welded</th>
<th>Weld number from Table 2.3.44-2 for ships of classes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M-СП, М-ПР, О-ПР, М, О</td>
</tr>
<tr>
<td></td>
<td>P and L</td>
</tr>
<tr>
<td><strong>Bulkheads</strong></td>
<td></td>
</tr>
<tr>
<td>22. Forepeak and afterpeak bulkheads and bulkheads of water and oil tanks to outer shell and to deck</td>
<td>2 2</td>
</tr>
<tr>
<td>23. Watertight bulkheads other than those mentioned in 22 to outer shell, double bottom plating and deck plating</td>
<td>2 2</td>
</tr>
<tr>
<td>24. Webs of web members to their flanges and to bulkhead plates</td>
<td>4 4</td>
</tr>
<tr>
<td>25. Webs of bulkhead web members to each other and to the bottom, side and deck framing members</td>
<td>2 2</td>
</tr>
<tr>
<td>26. Longitudinal bulkheads to transverse bulkheads</td>
<td>2 2</td>
</tr>
<tr>
<td>27. Bulkhead ordinary members to their bulkhead plates</td>
<td>5 5</td>
</tr>
<tr>
<td><strong>Decks, platforms and superstructures</strong></td>
<td></td>
</tr>
<tr>
<td>28. Deck stringers of designed upper decks to outer shell</td>
<td>1 1</td>
</tr>
<tr>
<td>29. Deck stringers of decks other than mentioned in 28 and platforms to outer shell</td>
<td>2 2</td>
</tr>
<tr>
<td>30. Pillars to flanges of web members and to double bottom plating</td>
<td>2 2</td>
</tr>
<tr>
<td>31. Outer walls of wheelhouses and superstructures to deck</td>
<td>3 3</td>
</tr>
<tr>
<td>32. Framing of superstructures and wheelhouses to their walls</td>
<td>5 5</td>
</tr>
<tr>
<td>33. Superstructure and wheelhouse bulkheads to deck</td>
<td>4 4</td>
</tr>
<tr>
<td><strong>Knees and web member reinforcements</strong></td>
<td></td>
</tr>
<tr>
<td>34. Knees to members and plates of structures</td>
<td>2 2</td>
</tr>
<tr>
<td>35. Knee flanges to knee webs</td>
<td>2 3</td>
</tr>
<tr>
<td>36. Reinforcing stiffeners and strips around cutouts to webs of web members</td>
<td>4 5</td>
</tr>
<tr>
<td><strong>Foundations</strong></td>
<td></td>
</tr>
<tr>
<td>37. Webs, brackets and knees of foundations of internal combustion engines to each other, to outer shell, to double bottom plating and to bearing flanges</td>
<td>1 1</td>
</tr>
<tr>
<td>38. Webs, brackets and knees of foundations other than mentioned in 37, to outer shell, to double bottom plating and to bearing flanges</td>
<td>2 2</td>
</tr>
<tr>
<td>39. Flanges of brackets and knees to their webs</td>
<td>2 3</td>
</tr>
</tbody>
</table>

2.3.50 Cutouts shall be provided in webs of web members in places of their intersection with plating welds, if these platings are to be welded after installation of the members.

2.3.51 Dotted welds as per Table 2.3.44-2 are not allowed in the underwater part of the hull, as well as in way of local vibration and impact loads (in vicinity of engine room, propellers, ice strengthening, fore extremity).

2.3.52 Weld No. 2 shall be used to connect ordinary members to webs of web members, permeable bulkheads, enclosures and platforms, where the ordinary members pass through cutouts and no knees (plates, stiffeners) are provided.

2.3.53 Ends of web girders (i.e. webs and free flanges) not supported by knees shall be connected by weld No. 2 over a length equal to the girder profile depth.

For intercostal web girders (floors, beams, keelsons, carlings, stringers), the ends are understood as sections adjacent to intersecting members (sides, bulkheads, trusses) being the rigid supports for the girders.

Ends of ordinary girders not supported by knees shall be connected by weld No. 2 over a length equal to double girder profile depth.

2.3.54 At the girder areas supported by knees (within distances a and a’ from support to the outer edge of the knee, Fig. 2.3.54), girder webs shall be connected to flanges and
plates by welds whose numbers are specified equal to the numbers of welds of the knees.

2.3.55 T-welds of coupling arrangements and stops shall be double-side continuous.

2.3.56 Welded joints shall be made in accordance with the requirements of 7 Part X of the Rules.

2.3.57 Flanges of the deck and bulkhead penetrations shall be welded to watertight bulkheads and decks at both sides by continuous welds.

### 2.4 ARRANGEMENT, SCANTLING AND CONSTRUCTION OF INDIVIDUAL HULL MEMBERS

#### Thickness of plates and spacing

2.4.1 Thickness of members shall be not less than that specified in Tables 2.4.1-1 to 2.4.1-4.

For ships of M-ΠΠ, O-ΠΠ, M and O classes with a length over 50 m, in case of the transverse framing system in the middle part of ship, minimal thickness specified by the Table 2.4.1-1 shall be increased: by 1.2 (L – 50)/90 for bottom plating (see 1.1, Table 2.4.1-1); by 0.7 (L – 50)/90 for double bottom plating (see 3.1, Table 2.4.1-1) and lower plates of inner sides of tankers within the cargo tanks area (see 4.10, Table 2.4.1-1).

Bottom plating thicknesses required by 1.5 in Tables 2.4.1-1 and 2.4.1-2 for ships of M-СΠП, M-ΠΠ and М classes may be reduced by 0.5 mm in the hull areas where the bottom framing consists of longitudinal girders and transverse girders at each spacing.

Requirements to minimum thickness of outer shell in the fore extremity for ships of M-СΠΠ class (1.5 and 1.6, Table 2.4.1-2) apply to the ships that may operate at sea with minimum draught $T_f < 0.035L$. In case of larger minimum draught, the outer shell thickness in the fore extremity shall be taken according to the requirements of Table 2.4.1-1 for ships of M-ΠΠ and М classes.

![Fig. 2.3.54 Girder areas](image-url)

#### Table 2.4.1-1

Minimum hull member thicknesses

<table>
<thead>
<tr>
<th>Name of member</th>
<th>Minimum thicknesses of hull members, mm, for ships of class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M-ΠΠ and M</td>
</tr>
<tr>
<td></td>
<td>at ship length, m</td>
</tr>
<tr>
<td>25</td>
<td>80</td>
</tr>
</tbody>
</table>

**1 Outer shell plating**

- 1.1 Outer shell plating (for cases other than mentioned in 1.2 to 1.6) | 4.0 | 6.0 | 8.0 | 4.0 | 6.0 | 7.0 | 3.0 | 5.0 |
- 1.2 Outer shell plating bounding ballast and fuel tanks | 4.5 | 7.0 | 9.0 | 4.5 | 7.0 | 8.0 | 3.5 | 6.0 |
- 1.3 Bilge strake of the outer shell | 5.0 | 7.0 | 9.0 | 5.0 | 7.0 | 8.0 | 4.0 | 6.0 |
- 1.4 Sheer strake in the middle part of ship | 5.0 | 8.0 | 10.0 | 5.0 | 7.0 | 8.5 | 4.0 | 6.0 |
- 1.5. Bottom plating at the fore extremity at the height up to 0.04B from the base plane | 5.0 | 8.0 | 9.0 | 4.5 | 7.0 | 8.0 | 4.0 | 6.0 |
- 1.6 Side plating at the fore extremity | 4.5 | 7.0 | 9.0 | 4.5 | 7.0 | 8.0 | 4.0 | 6.0 |

**2 Plating of decks and platforms**

- 2.1 Deck plating (for cases other than mentioned in 2.2 to 2.8) | 4.0 | 6.5 | 8.0 | 4.0 | 6.0 | 7.0 | 3.5 | 5.5 |
- 2.2 Deck stringer in the middle part of ship | 5.0 | 8.0 | 10.0 | 5.0 | 7.0 | 8.5 | 4.0 | 6.0 |
### Minimum thicknesses of hull members, mm, for ships of class M-HP and M, O-HP and O, P and L at ship length, m

<table>
<thead>
<tr>
<th>Name of member</th>
<th>M-HP and M</th>
<th>O-HP and O</th>
<th>P and L</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3 Upper deck plating in the extremities, plating of partitions between hatches, plating of poop and superstructure decks (not participating in global bending of the hull) in areas not protected by superstructures. Forecastle deck plating</td>
<td>4.0 5.0 5.5</td>
<td>4.0 5.0 5.5</td>
<td>3.0 4.0 4.0</td>
</tr>
<tr>
<td>2.4 Upper deck plating beyond the middle part, plating of poop deck and superstructure decks (not participating in global bending of the hull) in areas protected by superstructures. Platform plating</td>
<td>3.0 4.0 4.0</td>
<td>3.0 4.0 4.0</td>
<td>3.0 4.0 4.0</td>
</tr>
<tr>
<td>2.5 Deck plating of tankers in cargo tank area</td>
<td>5.0 7.0 9.5</td>
<td>5.0 7.0 8.5</td>
<td>4.0 7.0 8.0</td>
</tr>
<tr>
<td>2.6 Deck plating at the extremities of pushed ships</td>
<td>4.0 7.0 8.0</td>
<td>4.0 7.0 8.0</td>
<td>4.0 7.0 8.0</td>
</tr>
<tr>
<td>2.7 Plating of deck of superstructure participating in global bending of the hull in the middle part of ship and in areas not protected by superstructures</td>
<td>4.0 5.0 5.5</td>
<td>4.0 5.0 5.5</td>
<td>3.0 4.0 4.0</td>
</tr>
<tr>
<td>2.8 Plating of deck of superstructure participating in global bending of the hull beyond the middle part of ship in areas protected by superstructures</td>
<td>3.0 4.0 4.0</td>
<td>3.0 4.0 4.0</td>
<td>3.0 4.0 4.0</td>
</tr>
</tbody>
</table>

### 3 Inner bottom plating of cargo ships

<table>
<thead>
<tr>
<th>Name of plating</th>
<th>M-HP and M</th>
<th>O-HP and O</th>
<th>P and L</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Double bottom plating of cargo ships (except for cases mentioned in 3.2 and 3.3)</td>
<td>4.5 6.0 7.0</td>
<td>4.0 5.5 6.5</td>
<td>3.0 5.0 6.0</td>
</tr>
<tr>
<td>3.2 Double bottom plating of dry cargo ships under the cargo hatches if loading/unloading is carried out by clamshells, and deck plating of flush deck ships within the cargo area</td>
<td>7.0 10.0 10.5</td>
<td>9.5 10.0 10.0</td>
<td>7.0 9.0 9.0</td>
</tr>
<tr>
<td>3.3 Double bottom plating of tankers within the cargo tank area</td>
<td>6.0 7.5 8.0</td>
<td>5.5 7.0 8.0</td>
<td>6.0 5.0 6.0</td>
</tr>
</tbody>
</table>

### 4 Bulkheads and inner sides

<table>
<thead>
<tr>
<th>Name of plating</th>
<th>M-HP and M</th>
<th>O-HP and O</th>
<th>P and L</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Plating of watertight bulkheads and inner sides (for cases other than mentioned in 4.2 to 4.12)</td>
<td>3.0 5.0 5.0</td>
<td>3.0 4.0 4.0</td>
<td>3.0 4.0 4.0</td>
</tr>
<tr>
<td>4.2 Forepeak bulkhead plating</td>
<td>3.5 5.5 5.5</td>
<td>4.5 5.5 5.5</td>
<td>3.0 4.5 4.5</td>
</tr>
<tr>
<td>4.3 Plating of inner sides of dry cargo ships within the cargo hold area</td>
<td>4.5 6.0 7.0</td>
<td>4.0 5.5 6.5</td>
<td>3.0 4.5 4.5</td>
</tr>
<tr>
<td>4.4 Plating of watertight bulkheads of dry cargo ships within the cargo hold area (with the exception of the lower plates)</td>
<td>3.5 5.5 6.0</td>
<td>3.5 5.0 5.5</td>
<td>3.0 4.4 4.0</td>
</tr>
<tr>
<td>4.5 Lower plates of watertight bulkheads of dry cargo ships within the cargo hold area</td>
<td>4.0 6.0 6.5</td>
<td>4.0 5.5 6.0</td>
<td>3.5 4.5 4.5</td>
</tr>
<tr>
<td>4.6 Inner side plating of ships with fully opening cargo holds, lower plates of inner sides of ships with partial opening of cargo holds, and lower plates of transverse bulkheads within the cargo hold area, if loading/unloading is carried out by clamshells</td>
<td>5.0 7.0 8.0</td>
<td>5.0 7.0 8.0</td>
<td>4.5 6.0 6.0</td>
</tr>
<tr>
<td>4.7 Upper strake of bulkheads of flush deck ships within the cargo area</td>
<td>5.0 8.0 8.0</td>
<td>8.0 8.0 8.0</td>
<td>5.0 7.0 7.0</td>
</tr>
<tr>
<td>4.8 Plating of inner sides and transverse bulkheads separating loaded and empty cargo compartments within the cargo tanks area of tankers (with the exception of the lower and upper strakes)</td>
<td>5.0 6.5 7.5</td>
<td>4.5 6.0 7.0</td>
<td>3.5 5.5 5.5</td>
</tr>
<tr>
<td>4.9 Upper strake of inner sides and transverse bulkheads separating loaded and empty cargo compartments within the cargo tanks area of tankers</td>
<td>5.5 7.0 8.0</td>
<td>5.0 6.5 7.5</td>
<td>4.0 6.0 6.0</td>
</tr>
</tbody>
</table>
### Table 2.4.1-2: Minimum hull member thicknesses for ships of M-CII class

<table>
<thead>
<tr>
<th>Name of member</th>
<th>Ship length, m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
</tr>
<tr>
<td><strong>1 Outer shell plating</strong></td>
<td></td>
</tr>
<tr>
<td>1.1 Outer shell plating (for cases other than mentioned in 1.2 to 1.6)</td>
<td>5.0</td>
</tr>
<tr>
<td>1.2 Outer shell plating bounding ballast and fuel tanks</td>
<td>6.0</td>
</tr>
<tr>
<td>1.3 Bilge strake</td>
<td>6.0</td>
</tr>
<tr>
<td>1.4 Sheer strake in the middle part of ship</td>
<td>5.5</td>
</tr>
<tr>
<td>1.5 Bottom plating in area within 0.2L abait the fore perpendicular and 0.04B from the base plane</td>
<td>5.5</td>
</tr>
<tr>
<td>1.6 Side plating at the fore extremity</td>
<td>5.5</td>
</tr>
<tr>
<td><strong>2 Plating of decks and platforms</strong></td>
<td></td>
</tr>
<tr>
<td>2.1 Deck plating (for cases other than mentioned in 2.2 to 2.3)</td>
<td>5.0</td>
</tr>
<tr>
<td>2.2 Deck stringer in the middle part of ship</td>
<td>5.5</td>
</tr>
<tr>
<td>2.3 Upper deck plating in the extremities, plating of partitions between hatches, plating of poop and superstructure decks (not participating in global bending of the hull) in areas not protected by superstructures. Forecastle deck plating</td>
<td>5.0</td>
</tr>
<tr>
<td>Name of member</td>
<td>Ship length, m</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>2.4 Upper deck plating beyond the middle part, plating of poop deck and superstructure decks (not participating in global bending of the hull) in areas protected by superstructures. Platform plating</td>
<td>4.5 5.0 5.0</td>
</tr>
<tr>
<td>2.5 Deck plating of tankers in cargo tank area</td>
<td>5.5 9.0 10.0</td>
</tr>
<tr>
<td><strong>3 Inner bottom plating of cargo ships</strong></td>
<td></td>
</tr>
<tr>
<td>3.1 Double bottom plating of cargo ships (except for cases mentioned in 3.2 and 3.3)</td>
<td>5.0 7.0 7.0</td>
</tr>
<tr>
<td>3.2 Double bottom plating of dry cargo ships under the cargo hatches if loading/unloading is carried out by clamshells, and deck plating of flush deck ships within the cargo area</td>
<td>8.0 12.0 12.0</td>
</tr>
<tr>
<td>3.3 Double bottom plating of tankers within the cargo tank area</td>
<td>6.5 8.0 8.5</td>
</tr>
<tr>
<td><strong>4 Bulkheads and inner sides</strong></td>
<td></td>
</tr>
<tr>
<td>4.1 Plating of watertight bulkheads and inner sides (for cases other than mentioned in 4.2 to 4.12)</td>
<td>4.0 5.0 5.0</td>
</tr>
<tr>
<td>4.2 Forepeak bulkhead plating</td>
<td>4.5 5.5 5.5</td>
</tr>
<tr>
<td>4.3 Plating of inner sides of dry cargo ships within the cargo hold area</td>
<td>5.0 6.5 7.0</td>
</tr>
<tr>
<td>4.4 Plating of watertight bulkheads of dry cargo ships within the cargo hold area (with the exception of the lower plates)</td>
<td>4.5 6.5 6.5</td>
</tr>
<tr>
<td>4.5 Lower plates of watertight bulkheads of dry cargo ships within the cargo hold area</td>
<td>5.0 6.5 7.0</td>
</tr>
<tr>
<td>4.6 Inner side plating of ships with fully opening cargo holds, lower plates of inner sides of ships with partial opening of cargo holds, and transverse bulkheads within the cargo hold area, if loading/unloading is carried out by clamshells</td>
<td>7.0 10.0 10.0</td>
</tr>
<tr>
<td>4.7 Upper strake of bulkheads of flush deck ships within the cargo area</td>
<td>5.5 9.0 9.0</td>
</tr>
<tr>
<td>4.8 Plating of inner sides and transverse bulkheads separating loaded and empty cargo compartments within the cargo tanks area of tankers (with the exception of the lower and upper strakes)</td>
<td>5.5 7.0 7.5</td>
</tr>
<tr>
<td>4.9 Upper strake of inner sides and transverse bulkheads separating loaded and empty cargo compartments within the cargo tanks area of tankers</td>
<td>6.0 8.5 9.0</td>
</tr>
<tr>
<td>4.10 Lower strake of inner sides and transverse bulkheads separating loaded and empty cargo compartments within the cargo tanks area of tankers</td>
<td>7.0 8.0 8.5</td>
</tr>
<tr>
<td>4.11 Plating of transverse bulkheads separating loaded compartments on tankers (with the exception of the upper strake)</td>
<td>5.0 6.5 7.0</td>
</tr>
<tr>
<td>4.12 Upper strake of the plating of transverse bulkheads separating loaded compartments on tankers</td>
<td>5.5 8.5 9.0</td>
</tr>
<tr>
<td><strong>5 Other members</strong></td>
<td></td>
</tr>
<tr>
<td>5.1 Plate structures and webs of web girders under the deck plating of flush deck ships and under the inner bottom plating under the cargo hatches of dry cargo ships, if loading/unloading is carried out by clamshells</td>
<td>6.0 9.0 9.0</td>
</tr>
<tr>
<td>5.2 Plate structures and girders inside ballast tanks</td>
<td>5.5 7.0 7.0</td>
</tr>
<tr>
<td>5.3 Underdeck framing and bulkhead framing inside cargo and fuel tanks</td>
<td>6.0 8.0 8.0</td>
</tr>
<tr>
<td>5.4 Continuous longitudinal coamings of cargo hatches</td>
<td>7.5 10.0 12.0</td>
</tr>
<tr>
<td>5.5 Transverse coamings of cargo hatches</td>
<td>5.5 8.0 10.0</td>
</tr>
<tr>
<td>5.6 Plates of trunks of engine room and capes of engine room, walls of superstructures not participating in global bending of the hull</td>
<td>4.0 4.5 5.0</td>
</tr>
</tbody>
</table>

**Notes.**

1. For ships with a sledge-shaped fore extremity, the provision of 1.5 applies to the hull part extending above the flush part of the bottom in the bow raising area by 4% of the ship’s breadth.
2. The minimum values of Member plate thickness comply with spacing of 550 mm and are to be adjusted taking into account the actual spacing in accordance with the requirements of 2.4.3 and 2.4.4.
3. The rounding rule is stated in Note 2 to Table 2.4.1-1.
### Table 2.4.1-3

<table>
<thead>
<tr>
<th>Name of superstructure/wheelhouse structure</th>
<th>Minimum plate thicknesses, mm, at ship length, m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Side walls</td>
<td></td>
</tr>
<tr>
<td>Lower tier of superstructure participating in global bending of the hull</td>
<td>4.2</td>
</tr>
<tr>
<td>Lower tier of superstructure not participating in global bending of the hull; outer shell plating of forecastle and poop</td>
<td>4.1</td>
</tr>
<tr>
<td>Upper tiers of superstructure/wheelhouse</td>
<td>4.0</td>
</tr>
<tr>
<td>End walls</td>
<td></td>
</tr>
<tr>
<td>Lower tier of superstructure</td>
<td>4.1</td>
</tr>
<tr>
<td>Upper tiers of superstructure/wheelhouse</td>
<td>4.0</td>
</tr>
<tr>
<td>Decks</td>
<td></td>
</tr>
<tr>
<td>Lower tier of superstructure participating in global bending of the hull</td>
<td>4.7</td>
</tr>
<tr>
<td>Lower tier of superstructure not participating in global bending of the hull; forecastle and poop decks of displacement passenger ships</td>
<td>4.1</td>
</tr>
<tr>
<td>Forecastle and poop deck of tugboats and ice breakers</td>
<td>5.0</td>
</tr>
<tr>
<td>Upper tiers of superstructure/wheelhouse</td>
<td>4.0</td>
</tr>
</tbody>
</table>

**Notes.** 1. The plate thicknesses are given for structures made of steel.
2. The rounding rule is stated in Note 2 to Table 2.4.1-1.
3. In case of ship length does not coincide with values specified in the table, the minimum plate thicknesses are determined by linear interpolation of the tabulated data.

### Table 2.4.1-4

<table>
<thead>
<tr>
<th>Name of members</th>
<th>Minimum thicknesses of member plates, mm, at ship length, m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
</tr>
<tr>
<td>1. Outer shell plating in the middle part of ship and aft extremity</td>
<td>5.0</td>
</tr>
<tr>
<td>2. Sheer strake and deck stringer in the middle part of ship</td>
<td>6.0</td>
</tr>
<tr>
<td>3. Outer shell plating of forepeak</td>
<td>6.0</td>
</tr>
<tr>
<td>4. Outer shell plating from forepeak to the section located 0.25L abaft from the fore perpendicular</td>
<td>6.0</td>
</tr>
<tr>
<td>5. Bilge strake of the outer shell plating in the middle part of ship and aft extremity</td>
<td>6.0</td>
</tr>
<tr>
<td>6. Upper deck plating in fore and aft extremities within 0.15L from the fore and aft perpendiculars</td>
<td>5.5</td>
</tr>
<tr>
<td>7. Platform plating</td>
<td>4.5</td>
</tr>
<tr>
<td>8. Watertight bulkhead plating</td>
<td>5.0</td>
</tr>
</tbody>
</table>

**Notes.** 1. Values of minimum thicknesses of member plates correspond to spacing of 550 mm and shall be corrected for the actual spacing according to the requirements of 2.4.3 and 2.4.4.
2. The rounding rule is stated in Note 2 to Table 2.4.1-1.
3. In case of ship length does not coincide with values specified in table, the minimum thicknesses of the member plates are determined by linear interpolation of the tabulated data.

Thickness of deck and shell plating of superstructures stated in Table 2.4.1-3 in area of their interconnection shall be increased by 1 mm over a width not less than 300 mm.

Thickness of upper deck plating stated in Table 2.4.1-4 except for areas in extremities (6, Table 2.4.1-4) at spacing equal to 550 mm shall be taken not less than 5.5 mm for any ship length.

For ships of M-CII 4.5 class, the hull member thicknesses stated in 1.1, 1.5, 2.1 and
2.3 of Table 2.4.1-2 shall be increased on the value $\Delta t_{\text{min}}$ determined by the formula:

$$\Delta t_{\text{min}} = \left( \sqrt{R_p} - 1 \right) t,$$  \hspace{1cm} (2.4.1-1)

where $t$ — permissible residual thickness of member as specified in Table 2.2.86 for ship of M-CP class;

$k$ — coefficient determined according to 2.2.28.

For tankers of M-CP class with longitudinal cylindrical built-in cargo tanks, minimum thicknesses of outer plating in the middle part of ship, sheer strake and deck stringer in the middle part of ship shall be taken according to Table 2.4.1-2 as for ships with conventional length $L_1 = LH/H_1$, where $H_1$ — height of hull girder. Vertical distance between the upper edge of the cylindrical tank and the deck in the centreline plane shall not exceed $1.2R$.

Plate thicknesses of walls and decks of superstructures and wheelhouses of the M-CP class ships regardless of calculation results and steel grade shall not be less than those specified in Table 2.4.1-3. Here:

1. if spacing is taken more than 550 mm, the minimum thicknesses of grillage plates stated in Table 2.4.1-3 shall be increased proportionally to the increase of spacing compared with 550 mm;

2. if spacing is taken less than 550 mm, the minimum thicknesses of grillage plates stated in Table 2.4.1-3 may be decreased proportionally to the decrease of spacing compared with 550 mm. Thicknesses may not be decreased by more than 10%;

3. if the structure is made of light alloys, the minimum thicknesses of its plates shall be taken not less than it is required for correspondent structure made of steel.

Plate thicknesses of hull members of tugboats and ice breakers of the M-CP class regardless of calculation results and steel grade shall be not less than those specified in Table 2.4.1-4.

The requirements of 2.5.15 to 2.5.22 apply to the tugboats of the M-CP class. The plate thickness of hull members in any cases shall not be less than specified in Table 2.4.1-4, and additional increase by 1 mm of thickness of watertight bulkheads as regulated by 2.5.20 is not required.

For tugboats of the M-CP 4.5 class, member thicknesses specified in 1, 4 and 6 of Table 2.4.1-4 shall be increased by $\Delta t_{\text{min}}$ as determined by formula (2.4.1-1).

2.4.2 Spacing means a distance between longitudinal or transverse girders; it shall not exceed 650 mm. Recommended spacing is 550 mm.

2.4.3 Where spacing is taken more than $a_0$, than the thicknesses of the hull members specified in Table 2.4.1-2 (other than stated in 4.9, 4.12, 5.1 to 5.3) shall be increased by $\Delta t$ as determined by the formula, mm:

$$\Delta t = \left( a/a_0 - 1 \right) [t],$$  \hspace{1cm} (2.4.3)

where $a$ — actual spacing, mm;

$a_0$ — standard spacing taken equal to 550 mm;

$[t]$ — permissible residual thickness of a particular hull member as specified in Table 2.2.86 (without corrections set forth by Notes 2 and 3 of the said table), mm.

2.4.4 Where spacing is taken less than $a_0$ and/or the members are made of higher strength steel, than the thickness of the hull members specified in Table 2.4.1-2 (other than stated in 4.9, 4.12, 5.1 to 5.3) may be reduced by $\Delta t$ as determined by the formula, mm:

$$\Delta t = \left[ 1 - 15.3a/a_0 \sqrt{R_{\text{st}}} \right] [t],$$  \hspace{1cm} (2.4.4)

where $a, a_0, [t]$ — see above (if $a > a_0$, $a = a_0$);

$R_{\text{st}}$ — yield point of the member material, MPa.

2.4.5 Width of the thickened strakes of bulkheads (see 4.5, 4.7, 4.9, 4.12 of Table 2.4.1-1) shall not be less than 0.6 m.

2.4.6 Thicknesses specified in 1.4 and 2.2 of Table 2.4.1-1 are related to ships with side depth $H \geq 2.5$ m. Width of the sheer strake shall not be less than $0.2H$, and width of the deck stringer not less than 0.6 m.

When $H < 2.5$ m, the width of the sheer strake may be taken equal to the thickness of the outer shell.
2.4.7 Thicknesses of plate structures subject to specific wear and damages (i.e. increased mechanical wear, increased wear of deck plat- ing and framing in way of tanks of tankers carrying sulfide oil products, high corrosion wear due to carriage of corrosive cargoes) shall be increased as compared with Tables 2.4.1-1 and 2.4.1-2 depending on the actual wear rates.

2.4.8 Thicknesses of the bottom shell plat- ing and the bilge strake of ships intended for operation in shallow waters shall be increased by 1 mm in respect to those specified in 1.1 to 1.3 and 1.5 of Table 2.4.1-1.

2.4.9 Plate thickness change in the transition areas shall be smooth (see 2.3.2).

Bottom framing in single-bottom ships and single-bottom compartments

2.4.10 The distance between the floors, m, shall be aliquot to the spacing and shall not exceed:

for flush deck ships 1.8
for passenger ships and tankers 2.4
for ships of other types 2

2.4.11 Section modulus of floor including effective flange W, cm³, shall not be less than:

\[ W = 7k_1k_2dB_1^2(T + r), \] (2.4.11-1)

and for ships of Ι class, in addition, not less than

\[ W = 7k_1k_2dB_1^2(0.6T + 0.72), \] (2.4.11-2)

where \( k_1, k_2 \) — coefficients taken from Tables 2.4.11-1 and 2.4.11-2;

\( d \) — distance between the floors, m;

\( B_1 \) — value to be taken equal to the greatest distance between longitudinal bulkheads (trusses) or between them and ship side, m.

For three or four longitudinal bulkheads (trusses), value \( B_1 \) shall be taken not less than B/3, for five or more longitudinal bulkheads (trusses) not less than B/4. Where longitudinal bulkheads (trusses) are not available, \( B_1 \) is taken equal to B;

2.4.12 In case of the transverse framing system of the bottom with floors not at each spacing, bottom ordinary frames shall be installed between them.

The section modulus of the bottom ordinary frame, cm³, including effective flange, shall not be less than:

---

1 Water area where the depth to ship draught ratio does not exceed 3.
and the moment of inertia, cm\(^4\), not less than:
\[
I = 3\left[2 - a/(d - a)\right](t/a)^3 \times c^4, \tag{2.4.12-2}
\]
where:
- \(a\) — spacing, m;
- \(c\) — maximum distance between keelsons or between keelson and longitudinal bulkhead (or side), m;
- \(t\) — bottom plating thickness according to 2.4.1, cm;
- \(T, r, d\) — taken according to 2.4.11.

2.4.13 A continuous central keelson shall be fitted in all ships. Instead of the central keelson, two keelsons may be fitted, one from each side of the centre line. Here, coefficient \(k_1\) in formulae (2.4.11-1) and (2.4.11-2) shall be taken same as when the central keelson is fitted. A distance between keelsons and between keelsons and the side or longitudinal bulkhead shall not exceed 2.5 m. The keelsons shall be extended as far as possible forwards and abaft. Section modulus of the central and side keelsons shall be not less than section modulus required for floors.

2.4.14 In case of the longitudinal framing system, bottom stiffener section modulus, cm\(^3\), including effective flange, shall be not less than:
\[
W = 10a_1d^2 \times (T + r), \tag{2.4.14-1}
\]
and the moment of inertia, cm\(^4\), shall be not less than
\[
I = 2.8d^2 \times (f + 100a_1t), \tag{2.4.14-2}
\]
where:
- \(a_1\) — distance between the stiffeners, m;
- \(f\) — cross-section area of the stiffener without effective flange, cm\(^2\);
- \(d, T, r\) — see 2.4.11, \(t\) — see 2.4.12.

2.4.15 In ships with deadrise, a depth of floors amidships within \(0.125B\) from side shall be not less than a half of its depth in the centre line.

2.4.16 In ships with deadrise, floors in way of bilge shall rise smoothly towards the side starting at least \(0.05B\) from the side, in order to get a connection with a ordinary side frame. The depth of such a rising measured over the side (from the floor upper edge line extended to side) shall be not less than three-fold depth of the ordinary side frame. If this rising of floors is arranged using knees, their thickness shall be equal to the floor thickness; in addition, free edge of the knee shall be fitted with the same strip as the floor, or a flange shall be bent out.

### Bottom framing in double bottom compartments

2.4.17 The distance, m, between floors shall be aliquot to the spacing and shall not exceed:
- for dry cargo ships within cargo holds 1.8
- for passenger ships and tankers 2.4
- for dry cargo ships outside the cargo holds area and for the rest types of ships 2.4

2.4.18 The height of the double bottom space, m, shall be not less than the following for ships with a length:
- \(120\) m and less 0.8
- over \(120\) m 0.9

2.4.19 In double bottom compartments of all ships, continuous centre keelsons, and — if it is provided by the Rules — side keelsons shall be fitted.

A distance between keelsons and between keelsons and the side or longitudinal bulkhead shall not exceed 3 m. The keelsons shall be extended as far as possible forwards and abaft.

2.4.20 Minimum thickness of the floor plates shall correspond to 5.1 and 5.2 of Tables 2.4.1-1 and 2.4.1-2.

2.4.21 In case of the transverse framing system with floors not at each spacing, bracket floors shall be fitted between them.

2.4.22 The bracket floors shall consist of upper and lower continuous girders interconnected by brackets in way of keelsons (longitudinal bulkheads) and at the bilge.

2.4.23 Edges of brackets shall have welded or bent flanges. Thickness of the brackets shall be not less than the floor thickness.

2.4.24 Ends of the upper and lower girders of the bracket floors shall overlap the brackets...
over at least double depth of the corresponding girder (Fig. 2.4.24).

**2.4.25** Width of the brackets at both sides of the vertical keel and at the bilge shall be at least 0.5 height of the double bottom space. Width of the brackets near keels shall be at least 0.3 height of the double bottom space. The use of intercostal girders at the bracket floors is allowed, which are cut in way of kee. In this case, brackets shall be fitted at each side of the keels, width of the brackets shall be not less than 0.3 height of the double bottom space.

**2.4.26** Cross-members may be installed between the brackets to connect the upper and lower girders of the bracket floor and divide the span of bracket floor girder in two halves. Cross-sectional area of the cross-member shall be not less than the cross-sectional area of the smaller bracket floor girder.

**2.4.27** Section modulus of the lower girder of bracket floor, cm$^3$, including effective flange, shall be at least

\[ W = 5.5K_0a_1s_1^2(T + r), \]  

(2.4.27-1)

Section modulus of the upper girder of bracket floor, cm$^3$, including effective flange, shall be at least

\[ W = 4K_0a_1^2H_c, \]  

(2.4.27-2)

and for cargo ships at least

\[ W = 0.4K_0a_1^2p \]  

(2.4.27-3)

In the above formulae:
- \( s_1 \) — the greatest distance between inner edges of the brackets, m;
- \( H_c \) — depth of the ship’s side in the section under consideration, m;
- \( p \) — cargo pressure on the double bottom plating to be taken according to 2.2.23.4, kPa;
- \( a \) — see 2.4.12,
- \( T, r \) — see 2.4.11.

**2.4.28** In case of the longitudinal framing system of the bottom, section modulus of bottom longitudinal girders, including effective flange, cm$^3$, shall be not less than

\[ W = 10K_0a_1d^2(T + r), \]  

(2.4.28-1)

and the moment of inertia, cm$^4$, shall be not less than

\[ I = 2.8d^2(f + 100a_1t), \]  

(2.4.28-2)

Section modulus of double bottom longitudinal girders, including effective flange, cm$^3$, shall be not less than:

\[ W = 7K_0a_1d^2H_c, \]  

(2.4.28-3)

and for cargo ships, in addition, not less than

\[ W = 0.7K_0d^2p \]  

(2.4.28-4)

In the above formulae:
- \( K_0, H_c, p \) — taken as per 2.4.27;
- \( a_1, f \) — see 2.4.14;
- \( d, T, r \) — see 2.4.11;
- \( t \) — see 2.4.12.

**2.4.29** Cross-sectional area of a cross-member fitted between the bottom and the double bottom longitudinal girders shall be not less than a cross-sectional area of the smaller of the girders being so connected.

---

![Fig. 2.4.24. Design of bracket floor](image-url)
2.4.30 In ships intended for carriage of bulk cargoes and loaded/unloaded with clamsheells, the section modulus of the upper girder of bracket floors \( W_1 \) and double bottom longitudinal girders \( W_2 \) including effective flange, cm³, within the cargo hatches shall be not less than

\[
W_1 = 91ka_s, \quad (2.4.30-1)
\]

where \( a, s \) are taken according to 2.4.27;

\[
W_2 = 91ka_d, \quad (2.4.30-2)
\]

where \( a_1, d \) are taken according to 2.4.28;

\( k \) — coefficient taken, for cranes with the following lifting capacity, kN, equal to:

<table>
<thead>
<tr>
<th>Lifting Capacity</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0.5</td>
</tr>
<tr>
<td>100 and 160</td>
<td>1.0</td>
</tr>
<tr>
<td>200</td>
<td>1.5</td>
</tr>
</tbody>
</table>

In case of cross-members as per 2.4.26, the values of \( W_1 \) and \( W_2 \) may be reduced by 30%.

2.4.31 Where the double bottom terminates at the inner side, the floor depth in double bottom space near the inner side shall be equal to the double bottom height. A smooth transition shall be provided from the inner bottom plating to free flange of that floor by means of scalloped or attached knees fitted in the plane of the floor flange. Width of the scalloped knee or the total width of the flange and attached knees (where they are connected to the inner side) shall be at least 0.25 of the distance between the floors. The knee thickness shall be taken equal to the double bottom plating thickness. The knee thickness may be reduced by 2 mm if the double bottom plating is thickened for loading/unloading with clamsheells.

2.4.32 In case of the longitudinal framing system of the bottom and the double bottom extended to the outer side, at the section between floors in the plane of each actual frame, bilge brackets shall be provided and extended to the nearest longitudinal girders of the bottom and the double bottom. The thickness of the brackets shall be taken equal to the thickness of the floors.

### Side framing

2.4.33 The side framing shall be made according to the following framing systems: transverse framing system where web frames alternate with ordinary frames; uniform transverse framing system with web frames; combined framing system, i.e. longitudinal framing system in the upper and the lower areas of the side and transverse system in the middle area of the side).

2.4.34 Web frames shall be installed in the floor planes.

The distance between the web frames shall not exceed values specified for floors.

2.4.35 Web frame web depth in single-bottom compartments shall be not less than 0.65 of the floor depth. Cross-sectional area of web frame's free flange in single-bottom compartments shall be not less than 0.65 of cross-sectional area of the floor's free flange.

2.4.36 Section modulus of a web frame including effective flange, cm³, shall be not less than

\[
W = 10kH_{sec}d, \quad (2.4.36-1)
\]

where \( k \) — coefficient determined by the formulae:

\[
k = \sqrt{2+0.085L}, \quad (2.4.36-2)
\]

for all types of ships other than tankers

\[
k = \sqrt{2+0.050L}, \quad (2.4.36-3)
\]

for tankers

where \( H_{sec} \) — depth of the ship’s side in the section under consideration, m;

\( d \) — distance between web frames, m.

2.4.37 Section modulus of ordinary frame including effective flange, cm³, shall be not less than

\[
W = 12kla, \quad (2.4.37)
\]

where \( k \) — coefficient taken according to 2.4.36;

\( l \) — the greatest distance measured over a side between the bottom (double bottom plat- ing) and a side stringer, between side stringers, or between a side stringer and the deck, m;

\( a \) — spacing, m.
2.4.38 In case of uniform transverse side framing system, the section modulus of a frame including effective flange, \( \text{cm}^3 \), shall be at least
\[
W = 14kH_e a, \tag{2.4.38}
\]
where \( k \) — coefficient taken according to 2.4.36.

2.4.39 At the ends of frames, beam and bilge knees shall be installed.

A beam knee of an ordinary frame or a frame, in case of the uniform transverse side framing system, shall overlap the bilge rounding. The height of a bilge knee shall be such as a frame overlaps the knee over a length of its double depth.

If the section modulus of bottom ordinary frames is not less than that required for side ordinary frames, then the bottom frames may be extended upwards along the bilge and side and no bilge knees may be installed.

2.4.40 In ships with double bottom and single sides, web and uniform frames shall be terminated at the inner bottom by means of knees with dimensions corresponding to requirements of 2.3.12. Knees fitted in the girder web plane may be replaced by attached or scalloped knees located in the girder flange plane. The total width of attached knees plus flange or width of scalloped knee shall be at least three-fold flange width. In the plane of these knees below the inner bottom plating, either stiffeners or brackets shall be installed.

2.4.41 Section modulus of the side longitudinal stiffeners including effective flange, \( \text{cm}^3 \), shall be at least
\[
W = 6kd^2, \tag{2.4.41}
\]
where \( k \) and \( d \) are taken according to 2.4.36.

2.4.42 Where the side depth \( H_s \) exceeds 2 m, one side stringer shall be fitted; where the side depth is 4 m and more, at least two side stringers shall be fitted. Where side depth exceeds 2 m and there are two fender guards fitted, a side stringer shall be fitted at the level of the lower fender guard. When a ship is fitted with fender strips, a side stringer is mandatory. Scantlings of side stringers shall be not less than those required for web frames or side frames, in case of the uniform transverse framing system.

2.4.43 In order to enlarge the designed area of the hull girder's upper flange, in case of the transverse side framing system, it is allowed to fit mitered intercostal longitudinal stiffeners (made of the profile used for ordinary frames) along the sheer strake and the upper part of the inner side. Stiffeners may be made of a flat with a thickness equal to the plating thickness and having a height equal to maximum 10 times the thickness. The distance between ends of the stiffeners and the frames shall not exceed 30 mm.

Intercostal longitudinal stiffeners are not included into the hull girder, while their effective flanges are.

2.4.44 The inner side plating shall either be extended to the bottom plating, or, when it terminates on the double bottom plating, be prolonged in the double-bottom space as an additional keelson.

Both transverse and longitudinal systems of the inner side framing are permitted. Scantlings of the web and ordinary members shall be not less than those required for the outer side without taking into account ice strengthening.

2.4.45 In double-sided ships, platforms may be fitted instead of inner and outer side stringers situated at the same level, and diaphragms may be fitted instead of web girders. Thickness of the platforms and diaphragms shall be in compliance with 2.3.21, and when the double-bottom space is used as a ballast tank, to be in compliance with 2.4.1. Cutouts for manholes sized according to 2.3.28 shall be made to provide access to all double bottom areas. Platforms and diaphragms shall be reinforced by stiffeners according to 2.3.20 and 2.3.30. The height of cutouts in the diaphragms may be increased provided that additional reinforcements are available, which will provide section moduli for the framing members as required by the Rules.

2.4.46 Required section moduli of web girders of inner and outer sides may be reduced by 30% if one platform is provided or
by 50% if two platforms are provided. The section moduli may be reduced in a similar way if one or two cross-members are fitted. The minimal cross-member cross section area \( F, \text{ cm}^2 \), shall be at least

\[
F = 0.22dH^2, \quad (2.4.46-1)
\]

and minimal area moment of inertia of cross-member \( I, \text{ cm}^4 \) shall be at least

\[
I = 0.25H^2dl^2, \quad (2.4.46-2)
\]

where \( H \) — side depth, m;

\( d \) — web spacing, m;

\( l \) — length of the cross-member span, m.

**Deck framing**

2.4.47 Web beams shall be fitted in the plane of each web frame, as well as in the planes of transverse coamings of cargo hatches, trunks of engine rooms and in way of reinforcements under the deck machinery and arrangements.

2.4.48 Section modulus of the beams with effective flange, \( \text{cm}^3 \), shall be not less than:

1. for parts of decks intended for cargo stowage,

\[
W = 0.1k_0k_1k_2dB_1^2p, \quad (2.4.48.1-1)
\]

where \( k_0 \) — coefficient equal to:

- for ordinary beams, where loading and unloading by clamshells are not provided
- for ordinary half-beams
- for web beams
- for web half-beams of single-sided ships

\( k_1 \) — coefficient, which for ordinary beams and half-beams shall be taken as \( k_1 = 1 \) and for web beams from Table 2.4.11-1 where instead of the word “keelson” the word “carling” shall be read;

\( k_2 \) — coefficient, which for ordinary beams and half-beams shall be taken as \( k_2 = 1 \) and for web beams from Table 2.4.11-2 where instead of the word “floor” the word “beam” shall be read;

\( d \) — spacing for ordinary beams and half-beams; distance between adjacent web beams or half-beams for web beams and half-beams, m;

\( B_1 \) — the greatest distance, m;

between sides or between a side and a longitudinal bulkhead (truss) or between the bulkheads (trusses) – for web beams;

between carlings or between a carling and a longitudinal bulkhead (side) – for ordinary beams. The value \( B_1 \) for web beams shall be taken not less than \( B_1/3 \) in case of three or four longitudinal bulkheads (trusses), and not less than \( B_1/4 \) in case of five or more longitudinal bulkheads (trusses);

\( p \) — design cargo pressure, kPa, determined by the formula

\[
p = 9.81M/f, \quad (2.4.48.1-2)
\]

where \( M \) — maximum weight of cargo, t, that may be placed onto the given loaded deck part;

\( f \) — area of the given loaded part of the deck, \( \text{m}^2 \).

If there is a number of pillars installed in the hull between the side and the longitudinal bulkhead (truss), the value of \( W \) may be reduced by 20%. The distance between the pillars shall not exceed the double distance between the floors.

The pressure \( p \) shall be not less than the cargo pressure obtained in accordance with 2.2.19. If loading and unloading by clamshells are provided, the value of \( W \) for web beams shall be not less than that obtained according to 2.4.48.5;

2. for deck parts of tankers in the cargo tanks area

\[
W = k_0k_1k_2dB_1^2, \quad (2.4.48.2)
\]

where \( k_0, k_1, k_2 \) — coefficients (see 2.4.48.1);

3. for open parts of decks not intended for cargo stowage for all types of ships other than tankers:

\[
W = k_0k_1k_2dB_1^2, \quad (2.4.48.3)
\]

where \( k_0 \) — coefficient equal to:

- for ordinary beams of ships of M-СП, М-ПП, М, О-ПП and О classes
- for ordinary beams of ships of P and JI classes
- for ordinary beams of ships of M-СП, М-ПП, М, О-ПП and О classes
- for ordinary half-beams of ships of P and JI classes

between sides or between a side and a longitudinal bulkhead (truss) or between the bulkheads (trusses) – for web beams;

between carlings or between a carling and a longitudinal bulkhead (side) – for ordinary beams. The value \( B_1 \) for web beams shall be taken not less than \( B_1/3 \) in case of three or four longitudinal bulkheads (trusses), and not less than \( B_1/4 \) in case of five or more longitudinal bulkheads (trusses);

\( p \) — design cargo pressure, kPa, determined by the formula

\[
p = 9.81M/f, \quad (2.4.48.1-2)
\]

where \( M \) — maximum weight of cargo, t, that may be placed onto the given loaded deck part;

\( f \) — area of the given loaded part of the deck, \( \text{m}^2 \).

If there is a number of pillars installed in the hull between the side and the longitudinal bulkhead (truss), the value of \( W \) may be reduced by 20%. The distance between the pillars shall not exceed the double distance between the floors.

The pressure \( p \) shall be not less than the cargo pressure obtained in accordance with 2.2.19. If loading and unloading by clamshells are provided, the value of \( W \) for web beams shall be not less than that obtained according to 2.4.48.5;

2. for deck parts of tankers in the cargo tanks area

\[
W = k_0k_1k_2dB_1^2, \quad (2.4.48.2)
\]

where \( k_0, k_1, k_2 \) — coefficients (see 2.4.48.1);

3. for open parts of decks not intended for cargo stowage for all types of ships other than tankers:

\[
W = k_0k_1k_2dB_1^2, \quad (2.4.48.3)
\]

where \( k_0 \) — coefficient equal to:

- for ordinary beams of ships of M-СП, М-ПП, М, О-ПП and О classes
- for ordinary beams of ships of P and JI classes
- for ordinary beams of ships of M-СП, М-ПП, М, О-ПП and О classes
- for ordinary half-beams of ships of P and JI classes
for web beams of ships of M-СП, M-
P, M, O-ПП and О classes
for web beams of ships of P and І clases
for web beams of single-sided ships of
M-СП, M-ПП, M, O-ПП and О classes
for web half-beams of ships of P and І clases

2.4.49 Depth of web of a web beam or web
half-beam shall be taken not less than 2/3 of
that of a web frame near the deck. Cross-
sectional area of free flange of a web beam or
web half-beam shall be not less than 0.75 of
cross-sectional area of free flange of the web
frame near the deck.

2.4.50 Area moment of inertia of a web
beam with effective flange, cm4, shall be not
less than

\[ I = 3B_W \]  

Moment of inertia, cm4, of an ordinary
beam or a half-beam shall be not less than
that defined by formula (2.4.12-2), where:
\[ c \] — the greatest distance between carlings
or between a carling and a longitudinal bulk-
head (side), m;
\[ t \] — deck plating thickness, cm.

2.4.51 Section modulus of longitudinal un-
der-deck stiffeners with effective flange, cm3,
shall be not less than:

\[ W = k_1a_d \]  

1. for deck parts intended of cargo stow-
age in ships where loading and unloading by
clamshells are not provided
\[ W = 115ka_s, \]  

2. for decks of flush deck ships where
loading and unloading by clamshells are pro-
vided:
\[ W = 115ka_d, \]  

3. for deck parts of tankers in the cargo
tanks area
\[ W = 115ka_d, \]  

4. for open parts of decks not intended
for cargo stowage for ships of all types of
M-СП, M-ПП, O-ПП, M and О classes
other than tankers:
in the middle part of ship
\[ W = 15a_d^2, \]  

\[ W = k_1a_d^2 \]  

where \( a_1 \) — distance between the stiffeners, m;
\[ d \] — distance between web beams, m;
\( p \) is taken according to 2.4.48.1;

\[ W = 15a_d^2, \]  

k is determined according to 2.4.30.

\[ W = 15a_d^2, \]  

where \( L_b/B_1 < 0.7 \), dimensions of web
beams shall be taken equal to that of carlings
deﬁned according to 2.4.53.

Here, \( L_b \) — distance between transverse
bulkheads or trusses.
in fore and aft extremities

\[ W = 7.5a_{1}d^{2}, \quad (2.4.51.4-2) \]

for ships of P and J classes in the middle part of ship

\[ W = 10a_{1}d^{2}, \quad (2.4.51.4-3) \]

in fore and aft extremities

\[ W = 5a_{1}d^{2}, \quad (2.4.51.4-4) \]

.5 for enclosed parts of the hull decks intended for passengers and crew accommodation, for ships of all classes, in the middle part of ship

\[ W = 2.5a_{1}d^{2}; \quad (2.4.51.5-1) \]

in fore and aft extremities

\[ W = 2.5a_{1}d^{2}; \quad (2.4.51.5-2) \]

.6 for parts of superstructure decks not participating in global bending and intended for passengers and crew accommodation

\[ W = 2.5a_{1}d^{2}. \quad (2.4.51.6) \]

For top decks of superstructures and wheelhouses not intended for cargo stowing and non-accessible for passengers, the value of \( W \) may be reduced by 30% in comparison with that calculated by the formula (2.4.51.6).

2.4.52 Area moment of inertia of under-deck stiffeners with effective flange, \( \text{cm}^4 \), shall be not less than:

\[ i = 0.0127R_{e1} \left( f + 100a_{1}t \right) d^{2}, \quad (2.4.52) \]

where \( R_{e1} \) — yield point of the material, MPa;

\( f \) — cross-section area of the under-deck stiffener without effective flange, \( \text{cm}^2 \);

\( t \) — deck plating thickness, cm;

\( a_{1}, d \) are taken according to 2.4.51.

2.4.53 Scantling of carlings where \( L_{b}/B_{1} \geq 0.7 \) shall be not less than the scantlings required for web beams.

Section modulus of carling \( W, \text{cm}^3 \), where \( L_{b}/B_{1} < 0.7 \) shall be not less than:

.1 for parts of decks intended for cargo stowage

\[ W = 0.72k_{1}k_{2}b_{1}l_{c}^{2}p, \quad (2.4.53.1) \]

where \( k_{1} \) — coefficient equal to 1 for one web beam supporting the carling and is determined from Table 2.4.53-1 for three or more beams;

\( k_{2} \) — coefficient determined from Table 2.4.53-2;

<table>
<thead>
<tr>
<th>( B_{1}/l_{c} )</th>
<th>with web stays of transverse bulkheads</th>
<th>without web stays of transverse bulkheads</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4</td>
<td>0.73</td>
<td>0.85</td>
</tr>
<tr>
<td>1.5</td>
<td>0.75</td>
<td>0.90</td>
</tr>
<tr>
<td>1.6</td>
<td>0.77</td>
<td>0.95</td>
</tr>
<tr>
<td>1.7</td>
<td>0.80</td>
<td>1.0</td>
</tr>
<tr>
<td>1.8</td>
<td>0.85</td>
<td>1.0</td>
</tr>
<tr>
<td>1.9</td>
<td>0.90</td>
<td>1.0</td>
</tr>
<tr>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

2.4.54 Carlings shall be installed in the same planes with keelsons.
2.4.55 The width of a cutout in the deck shall not exceed 0.70 ship's breadth $B$ in the given place. The cutout may be increased up to 0.85$B$, when special measures are taken (increase in transverse framing strength, installation of double sides with half-bulkheads, reduction of cutouts' length).

2.4.56 Where the width of hatch cutout exceeds 0.70$B$, longitudinal coamings of hatches shall be continuous along the whole length of all holds and shall be terminated with knees having a length at least two heights of the coaming. Longitudinal coamings fitted along the length of each hatch shall be terminated with knees of a length equal to at least two heights of the coaming if the longitudinal coaming it is not smoothly conjugated with transverse coamings or if the longitudinal coaming is conjugated with transverse coaming by a horizontal knee with free flange fitted in the deck plane.

2.4.57 Coaming webs shall be in the same plane with the carling web.

2.4.58 No butt welds or cutouts may be located near corners of the hatches arranged in the middle part of ship within the area with dimensions shown on Figs. 2.4.58, where $r$ — rounding radius of hatch corner according to 2.3.24, $b_0$ — width of hatch.

2.4.59 Vertical brackets shall be fitted to coaming webs in the planes of web beams. The width of brackets at the deck level shall be not less than web beam height or half-height of the coaming, whichever is less, but not less than the width of the coaming flange. The upper edge of the bracket shall be welded to the coaming flange. Strips or flanges supporting the free edge of the bracket shall be mitered and not reach the coaming web, and near the deck they shall be mitered or widened and welded to the plating; here, stiffeners or brackets eliminating “dead points” shall be fitted on the reverse side of the plating.

2.4.60 Upper edges of coamings shall be reinforced by a strip or a profile to ensure adequate buckling strength of coaming plates. Where the coaming height to thickness ratio exceeds 40, the coaming web shall be reinforced also by horizontal stiffeners in accordance with 2.3.20.3.

2.4.61 Cargo hatch coaming plates shall be extended to the level of the lower edge of web beams, and the lower edge of coaming shall have a bent flange with the width in the range of 8 to 12 times the thickness of the coaming.

2.4.62 Single cutouts in designed deck located between the side and the line of cargo hatches in the middle part of ship, shall be located well away from the corners of openings of cargo hatches and machinery space trunks, as well as from end bulkheads of superstructures. When the width (diameter) of the cutout exceeds 20--fold thickness of the deck plating or 0.05 of the width of continuous part of deck as per Fig. 2.2.32 (whichever is less), the opening shall be reinforced in such a way that deck strength properties with cutout are not worse than without cutout.

**Fig. 2.4.58. Deck areas where butt welds may not be located**
Watertight bulkheads

2.4.63 The number and location of strong watertight transverse bulkheads shall be determined depending on ship operation area, type and purpose.

In ships, for which, according to 4 Part II of the Rules, floodability shall be provided, the number and location of watertight transverse bulkheads and half-bulkheads shall be substantiated by respective floodability calculations.

2.4.64 In all ships, forepeak and afterpeak transverse watertight bulkheads shall be provided.

The forepeak bulkhead shall be fitted abaft the fore perpendicular at a distance not less than the half-breadth of the hull. For ships with more than 14 m in breadth, the forepeak length may be reduced based on technical reasons.

2.4.65 For pushed ships suitable for being coupled to pushboat by either extremity, both peak transverse bulkheads shall comply with the requirements of the Rules specified for the forepeak bulkhead.

2.4.66 Self-propelled ships shall have watertight transverse bulkheads bounding the engine room.

2.4.67 All the transverse watertight bulkheads shall be extended from the bottom to the freeboard deck.

2.4.68 No doors or manholes in the forepeak and afterpeak bulkheads are allowed. If doors or manholes are made in other watertight transverse bulkheads, they shall be watertight and capable of being closed from both sides, and, moreover, they shall be capable of being closed from the main deck in ships, for which special floodability requirements are laid down.

2.4.69 All pipes, cables, moving parts of steering ropes going through watertight bulkheads shall be laid in bulkhead cups using sealing glands or other structures that ensure watertightness of the bulkheads.

2.4.70 For dry cargo ships, the minimal number of watertight transverse bulkheads, including forepeak and afterpeak bulkheads, shall be as follows depending on ship length, m:

<table>
<thead>
<tr>
<th>Number of bulkheads</th>
<th>20 to 60</th>
<th>61 to 80</th>
<th>81 to 100</th>
<th>≥101</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

2.4.71 In double-bottomed and doublesided ships, double side watertight half-bulkheads (diaphragms) shall be fitted for at least in each 15 spacings. The thickness of half-bulkheads shall be assigned as per 2.4.45, and their framing shall meet the requirements of 2.4.74, 2.4.75, 2.4.77, 2.4.78.

2.4.72 The flush deck ships shall be fitted with longitudinal bulkhead in the centre plane and trusses or pillar rows maximum 2.5 m apart. The distance between pillars shall not exceed the double distance between the floors.

For ships less than 50 m in length, a truss may be installed in the centre plane instead of longitudinal bulkhead.

In addition to transverse bulkheads as per 2.4.70, transverse trusses shall be fitted in these ships. The distance between transverse trusses or between transverse trusses and bulkhead shall not exceed 12-fold spacing for ships with a side depth of 2.5 m or less, and 18-fold spacing for ships with a side depth over 2.5 m.

2.4.73 Watertight bulkheads may be either flat or corrugated. Minimal thickness of watertight bulkhead plating shall be not less than specified in Tables 2.4.1-1, 2.4.1-2 and 2.4.1-4.

2.4.74 Flat bulkheads shall be reinforced by framing.

Transverse bulkhead stays fitted in the planes of keelsons and carlings shall be web stays.

If carlings and keelsons are in different vertical planes, partial web stays may be fitted, which are extended to the nearest shelf and have a transition to ordinary stays as per Fig. 2.3.9(c), and in case of horizontal stiffeners, they shall be terminated by a knee, which has
2 Structure and Strength of Steel Hull

2.4.75 Where side stringers are fitted, shelves shall be installed in the same planes on bulkheads.

Section modulus of a shelf with effective flange shall be not less than the required section modulus of a side stringer.

2.4.76 Ordinary stays of the forepeak bulkhead shall be fitted not more than 0.6 m apart from each other. On other bulkheads, ordinary stays shall be fitted not more than 0.75 m apart from each other.

In case of the longitudinal framing system of the deck and bottom, ordinary stays of transverse bulkheads shall be fitted in the planes of deck and bottom ordinary longitudinal girders and be attached to them by knees.

2.4.77 For watertight bulkheads, the section modulus of ordinary vertical stays with effective flange shall be not less than the required section modulus of an ordinary frame with effective flange required by 2.4.37.

2.4.78 Section modulus of horizontal stiffeners of watertight bulkheads with effective flange shall be not less than that required by formula (2.4.41); the value of \( d \), m, shall be taken equal to the distance between vertical web stays.

2.4.79 For longitudinal bulkheads, the area moment of inertia of the uppermost horizontal stiffener with effective flange shall be not less than required for decks as per 2.4.52.

2.4.80 Corrugated bulkheads shall be so designed as to meet the following instructions:

1. corrugated transverse bulkheads in hull shall be installed onto continuous tight floors or directly onto bottom plating or double bottom plating.

Centre lines of vertical corrugates of a transverse bulkhead shall coincide with planes of webs of the keelsons adjoining to the bulkhead.

Carlings, keelsons and ordinary longitudinal stiffeners of the deck and the bottom shall be attached to corrugations by means of knees (see 2.3.36);

2. bulkheads with vertical corrugations shall be reinforced by shelves fitted in the plane of side stringers.

Bulkheads with horizontal corrugations shall be reinforced by web stays fitted in the planes of web frames;

3. bulkhead corrugations shall have the section modulus not less than required by 2.4.77 and 2.4.78;

4. section moduli of corrugations (Fig. 2.3.35), cm³, are calculated by the following formulae:
   for trapeze corrugations
   \[
   W = th(a + b/3);
   \] (2.4.80.4-1)
   for wavy corrugations
   \[
   W = \gamma R^2,
   \] (2.4.80.4-2)
   where
   \[
   \gamma = \left( \beta_0 + 2\beta_0 \cos^2 \beta_0 - 1.5 \sin 2\beta_0 \right) / (1 - \cos \beta_0),
   \] (2.4.80.4-3)
   where \( \beta_0 \) — corrugation angle (see Fig. 2.3.35);

5. corrugations shall be sized in such a way (see Fig. 2.3.35) that the following ratios are fulfilled:
   for trapeze corrugations
   \[
   a/t < 55 \quad \text{when} \quad a \geq b,
   \]
   \[
   b/t < 55 \quad \text{when} \quad a < b;
   \] (2.4.80.5-1)
   for wavy corrugations
   \[
   R/t < 65.
   \] (2.4.80.5-2)

Pillars and trusses

2.4.81 Cross-sectional area of a pillar or a brace, m², shall be not less than an area calculated by the formula
\[ F = 98.1 \cdot 10^{-4} \frac{fm}{(nR_{eH})}, \quad (2.4.81-1) \]

where \( f \) — area of the deck or a platform supported by the pillar, including cargo hatches in the area under consideration, m\(^2\);

\( n \) — coefficient determined from Table 2.4.81 depending on the value \( N \) calculated by the formula

\[ N = \beta \sqrt{fm/(\eta_l l)}; \quad (2.4.81-2) \]

<table>
<thead>
<tr>
<th>( N )</th>
<th>Coefficient ( n ) for pillars and non-intersecting braces</th>
<th>Coefficient ( n ) for intersecting braces</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>0.085</td>
<td>0.125</td>
</tr>
<tr>
<td>0.2</td>
<td>0.168</td>
<td>0.250</td>
</tr>
<tr>
<td>0.6</td>
<td>0.250</td>
<td>0.370</td>
</tr>
<tr>
<td>0.8</td>
<td>0.315</td>
<td>0.475</td>
</tr>
<tr>
<td>1.0</td>
<td>0.375</td>
<td>0.500</td>
</tr>
<tr>
<td>1.2</td>
<td>0.420</td>
<td>0.500</td>
</tr>
<tr>
<td>1.4</td>
<td>0.450</td>
<td>0.500</td>
</tr>
<tr>
<td>1.6</td>
<td>0.475</td>
<td>0.500</td>
</tr>
<tr>
<td>1.8</td>
<td>0.495</td>
<td>0.500</td>
</tr>
<tr>
<td>2.0</td>
<td>0.500</td>
<td>0.500</td>
</tr>
</tbody>
</table>

\( \beta \) — coefficient taken equal to:

- for a tubular section 1.00
- for a square box section or cross-shaped section made of two equal-sided angle bars 0.61
- for a single equal-sided angle bar 0.44

\( \eta_l \) — coefficient equal to:

\[ \eta_l = \frac{R_{eH}}{235}; \quad (2.4.81-3) \]

\( l \) — pillar length, m;

\( R_{eH} \) — yield point of steel, MPa.

\( m \) — coefficient, for decks of cargo compartments of tankers \( m = 1.0 \), for dry-cargo ships decks intended for cargo stowage is determined by the formula

\[ m = M/f, \quad (2.4.81-4) \]

for parts of decks not intended for cargo stowing

\[ m = 0.5j; \quad (2.4.81-5) \]

where \( M \) — maximum weight of cargo, t, distributed over the deck area \( f \);

\( j \) — number of decks supported by the pillar.

2.4.82 The minimal area moment of inertia of a pillar or a brace, cm\(^4\), shall be not less than that determined by the formula

\[ I = \beta^2 F^2, \quad (2.4.82) \]

where \( \beta \) — coefficient determined according to 2.4.81;

\( F \) — cross-sectional area of a pillar or a brace calculated according to 2.4.81.

2.4.83 Pillars made of several shaped profiles shall be installed on connecting spacers placed every 1 meter or closer. Ends of pillars supporting cargo decks and decks of tankers shall be fastened to the bottom and deck framing by four knees; ends of pillars supporting other decks may be fastened only by two knees. The height of these knees shall be not less than the double height of pillars’ cross section.

2.4.84 Pillars shall be installed where floors intersect with keelsons and carlings with beams. If this is impracticable, where a pillar is installed outside a keelson to floor intersection, members of the same scantling as main web members in the given place extended to the nearest web members from both sides shall be installed under the pillar on the bottom. The like structure shall be where a pillar is connected with deck web members. No cutouts are allowed in webs of keelsons or floors just below pillars.

2.4.85 For flanged members, the pillar’s axis shall coincide with vertical webs of the members. The tubular pillars installed onto the flanged members shall be supported by horizontal knees.

2.4.86 Pillar axes shall be arranged in the same vertical plane in superstructure spaces and below the main deck.

2.4.87 Structure of transverse and longitudinal trusses (see Fig. 2.2.55) shall be formed by floors and beams or by keelsons and carlings, correspondingly, connected by pillars and braces.

2.4.88 Longitudinal and transverse members (keelsons plus carlings and floors plus beams, correspondingly) forming chords of
longitudinal or transverse trusses shall be made of T-profiles.

2.4.89 Knees or brackets shall be installed at ends of braces and where braces intersect with each other. Knees or brackets shall be sized in such a way as to end of the brace could be fastened to them over a length equal to the double height of the profile. The thickness of knees (brackets) shall be not less than thickness of the respective chord of the truss.

2.4.90 Braces made of several same profiles shall have at least three connecting spacers for trusses according to Fig. 2.2.55(a) and 2.2.55(b) and at least two connecting spacers for trusses according to Fig. 2.2.55(c).

2.4.91 Pillars of trusses shall be fabricated according to the instructions of 2.4.82 to 2.4.86.

**Hull framing in engine room**

2.4.92 Continuous floors shall be installed at each frame. A distance between web frames and beams shall not exceed 3-fold spacing. The spacing shall not exceed the spacing in the middle part of ship.

Bottom, side and deck members shall meet the requirements of 2.4.10 to 2.4.62, and their scantlings shall be not less than those required for respective members in the middle part of ship regardless of allowance for loading and unloading by clamshells.

Members in the engine room shall have an appropriate structural bond with members in the compartments adjacent to the engine room.

In engine room of ships of M-CTI class, each second frame shall be web frame, and section modulus \( W \) of carling with effective flange, \( m^3 \), for engine room shall not be less than:

\[
W = 5.8 \times 10^{-6} a_1 d_1^2, \tag{2.4.92}
\]

where \( a_1 \) — average breadth of the deck area supported by the carling, m;

\( d_1 \) — maximum carling span measured between transversal bulkheads or pillar centres and transversal bulkhead, m.

Profile of cross-section of beams of ships of M-CTI class shall be taken same as for carlings.

2.4.93 No floors or keelsons with bent flanges shall be used.

2.4.94 The engine room floor web thickness shall exceed the required thickness of the floor web in the middle part of ship by at least 1 mm. For dry cargo ships, the floor web thickness in the middle part of ship is determined in this case regardless of allowance for loading and unloading by clamshells.

2.4.95 The number and location of keelsons shall correspond to location of machinery foundations and keelsons in adjacent compartments.

One of the longitudinal girders of main engine foundations shall coincide with one of the keelsons. Where it is impracticable to have keelsons coinciding with longitudinal girders of main engine foundations, additional keelsons shall be fitted throughout the whole length of the engine room in the plane of longitudinal foundation girders (from bulkhead to bulkhead), and these keelsons shall be connected with vertical web stays of transverse bulkheads.

Scantlings of engine room keelsons shall be not less than those of floors.

**Framing of extremities**

2.4.96 Framing system in fore and aft extremities shall be transverse. In ships with sledge-shaped contours, longitudinal framing may be used in the forepeak and the afterpeak areas with floors two spacings apart.

The scantling shall be not less than that required for framing in the middle part of ship; here, requirements of 2.4.97 to 2.4.99 shall be met.

The distance between girders shall not exceed the respective values for the middle part of ship.

2.4.97 Framing of the fore extremity shall be made with due regard to the following instructions:
floors in the fore extremity shall be fitted at each transverse spacing which shall not exceed 550 mm. The floor web thickness shall exceed that required in the middle part of ship by 1 mm.

Floors installed in ordinary frame planes abaft from forepeak bulkhead within 0.2L from the fore perpendicular of ships of M-CP class shall have web thickness equal to thickness of webs of floors fitted in web frame planes, and height not less than 1/3 of height of double bottom in this area and not less than 2.5 of height of ordinary longitudinal girders. Free edges of these floors shall be reinforced by welded bent flanges.

For ships to be moored by bow to a non-equipped shore, the forepeak floor web thickness shall exceed that required by the Rules in the middle part of the ship by 2 mm.

For ships with a sledge-shaped or spoon-shaped fore extremity, section modulus of a floor including effective flange as calculated by formula (2.4.11-1) or (2.4.11-2) shall be increased by 1.5 times; here, $B_1$ is determined at the level of the floor flange nearest to the forepeak bulkhead. In ships with wedge-shaped fore extremity, the floor height shall be not less than 80% of the floor height in the middle part of ship;

the centre keelson shall be connected with the stem and stern and, where there is a transom, it shall be connected with the transom web stay.

Keelson profile sizes shall be not less than floor sizes;

distance between web frames shall not exceed two spacings.

Section modulus of web frames and ordinary frames shall be increased by 25% as compared with that determined by formulae (2.4.36-1) and (2.4.37);

forepeak of ships of M-CP class shall be provided with not less than three carlings. The web height of carlings and web beams shall be not less than 2.5 heights of ordinary beams;

Section modulus $W$ of ordinary beam with effective flange, for ships of M-CP class, within 0.2L from the fore perpendicular, $m^3$, shall be not less than:

$$W = 5.5 \cdot 10^{-6} dB_1^{1.5},$$  \hspace{1cm} (2.4.97.5)

where $d$ — distance between beams, m;

$B_1$ — maximum beam span measured between carlings or between carlings and a longitudinal bulkhead or side, m;

side stringers shall be installed in accordance with c 2.4.42.

Where a side stringer terminates at the stem, they shall be connected by a breasthook of thickness equal to the stringer thickness.

The length of the breasthook shall not be less than one spacing. Sizes of breasthook's free flange shall correspond to sizes of the side stringer's free flange.

If fore draught of a ship of M-CP class is less than 3.5% of ship length, the bottom structure reinforcement as per requirements of .1 to .6 shall be provided for 0.2L abaft the fore perpendicular.

2.4.98 The spacing in the afterpeak shall not exceed 550 mm.

In ships of M-CP, M-PI, O-PI, M, O and P classes, floors in afterpeak shall be installed at each frame. Floors shall be extended above propeller shaft or stern tube at a height of not less than half diameter of the opening in the floor web. They may be also extended to propeller shaft or stern tube, above which transverse connecting flats with flanges shall be welded to frames; the strip thickness shall be equal to the floor thickness (Fig. 2.4.98).

Keelons shall be extended as far abaft as possible as the continuation of keelons and foundation girders of the engine room. The distance between web frames shall not exceed two spacings.

Ships with full aft contours shall be fitted with cant frames located perpendicular to the shell plating. The distance between radial frames shall not exceed the spacing taken for the middle part of ship.

Section modulus of web frames and ordinary frames including effective flange shall be increased by 15% as compared with that determined by formulae (2.4.36-1) and (2.4.37).
2.4.98 Design of floor located below the propeller shaft

For ships of M-СП class, the above mentioned reinforcements shall be provided from the aft bulkhead of the engine room to fore extremity including afterpeak.

2.4.99 Ends of pushed ships shall be reinforced in such a way that loads from supports are distributed uniformly to sides and longitudinal hull members.

In the plane of supports, longitudinal bulkheads or trusses shall be installed, which shall be strongly connected with the hull and extended to the forepeak (afterpeak) bulkhead. Closed frame rings shall be arranged in the area of supports.

Stems, sterns, keels, propeller shaft brackets

2.4.100 Scantlings of a stem made of steel flats below the load waterline shall be not less than, mm:

\[
\begin{align*}
t &= 12 + 0.4L; \\
a &= 64 + 1.5L \quad \text{when } L \leq 50m; \\
a &= 90 + 1.0L \quad \text{when } L > 50m;
\end{align*}
\]

for ships of M-СП, M-ПП, О-ПП, М, О classes and tugboats/pushboats of all classes

\[
\begin{align*}
t &= 10 + 0.2L; \\
a &= 55 + 0.5L \quad \text{when } L \leq 50m; \\
a &= 30 + 1.0L \quad \text{when } L > 50m;
\end{align*}
\]

where \( t \) — flat thickness, mm; 
\( a \) — flat width, mm.

2.4.101 Diameter of the stem made of steel bars below the load waterline shall be not less than, mm:

for ships of M-СП, M-ПП, О-ПП, М, О classes and tugboats/pushboats of all classes

\[
d = 46 + 0.96L;
\]

(2.4.101-1)

for ships of P and J класс except for tugboats/pushboats

\[
d = 32 + 0.63L.
\]

(2.4.101-2)

2.4.102 The cross-sectional area of stems made of steel equal-sided angle bars below the load waterline shall be not less than, cm²:

for ships of M-СП, M-ПП, О-ПП, М, О classes and tugboats/pushboats of all classes

\[
F = 11 + 0.22L;
\]

(2.4.102-1)

for ships of P and J класс except for tugboats/pushboats

\[
F = 7 + 0.22L.
\]

(2.4.102-2)

2.4.103 Stem cross-sectional area above the load waterline may be reduced gradually down to 70% of that determined by the formulae (2.4.102-1), (2.4.102-2) at the upper end.

Where a stem consists of several parts, their butt connection shall not be located in the load waterline area.

The upper end of the stem shall be extended to the nearest deck or platform located above the load waterline.

The lower end of the stem shall be extended to a section located not more than 2 to 3 spacings forward from the forepeak bulkhead.

2.4.104 For bent stems (Fig. 2.4.104), steel plates of thickness exceeding by 25% the shell plating thickness in the fore extremity area may be used.

2.4.105 Stems together with adjacent shell plating shall be supported by breasthooks located corresponding with side stringers and
other framing members in the fore extremity. The thickness of breasthooks shall be not less than the thickness of adjacent shell plating.

2.4.106 For plate bent stems, the breasthook shall overlap the butt joint of the outer shell plating with the stem for at least 5-fold stem thickness (see Fig. 2.4.104).

2.4.107 Scantlings of stern frame’s sternpost above the propeller shaft stern boss, mm, made of steel bars shall be not less than:

For ships of M-СП, M-ПР and M classes

\[
t = 16 + 0.25L + 0.8H^2; \\
a = 55 + 2L \text{ when } L < 20 \text{ m}; \\
a = 65 + 1.5L \text{ when } 20 \leq L \leq 50 \text{ m}; \\
a = 90 + L \text{ when } L > 50 \text{ m};
\]

(2.4.107-1)

For ships of О-ПР and О classes

\[
t = 12 + 0.25L + 0.8H^2; \\
a = 30 + 2L \text{ when } L < 20 \text{ m}; \\
a = 50 + L \text{ when } 20 \leq L \leq 50 \text{ m}; \\
a = 40 + 1.2L \text{ when } L > 50 \text{ m};
\]

(2.4.107-2)

For ships of P and Й classes

\[
t = 10 + 0.18L + 0.8H^2; \\
a = 30 + 2L \text{ when } L < 20 \text{ m}; \\
a = 50 + L \text{ when } 20 \leq L \leq 50 \text{ m}; \\
a = 40 + 1.2L \text{ when } L > 50 \text{ m};
\]

(2.4.107-3)

where \(a, t\) — width and thickness of the sternpost, respectively, mm.

2.4.108 Thickness of the sternpost and the rudder post below the stern boss shall be increased by two times as compared with that obtained by formulae (2.4.107-1) to (2.4.107-3). Width of the sternpost and the rudder post in upper part may be reduced by 15% from the values determined by those formulae.

2.4.109 Sternpost boss web thickness (in reamed condition) shall be not less than 60% of the thickness calculated by formulae (2.4.107-1) to (2.4.107-3).

2.4.110 A sole between the sternpost and the rudder post shall be as short as practicable and have a cross-sectional area increased by 25% of the cross-sectional area with dimensions \(a\) and \(t\) as calculated by formulae (2.4.107-1) to (2.4.107-3).

In order to ensure a reliable connection with the shell plating, the stern frame’s sole shall extend forwards of the sternpost for at least 10-fold width of the cross-sectional area below the stern boss. The lower part of a stern frame sole shall slightly rise towards of the rudder post with a 1/10 slope.

At the upper part of stern frame, 1 or 2 stiffeners (bosses) shall be fitted for fastening the transverse framing members.

2.4.111 Where a bar keel is fitted, its cross-section shall be not less than determined by the formulae:

\[
h = 100 + L; \quad b = 12 + 0.4L,
\]

(2.4.111-1) (2.4.111-2)

where \(h, b\) — height and width of a bar keel, respectively, mm.

2.4.112 Brackets of propeller shafts may be either single or double-branched; branches shall be positioned at an angle of 80 to 100°, branch axes shall intersect at a propeller shaft axis.

Dimensions of double-branched brackets shall be not less than those determined by the formulae:
\[
\begin{align*}
t_b &= 0.45d; \\
F_b &= 0.47d^2; \\
\ell_h &= 3d; \\
\ell_h &= 0.33d, \\
\end{align*}
\]  
(2.4.112)

where \(t_b\), \(\ell_h\) — thickness of the branch and the hub correspondingly, mm;

\(d\) — diameter of the propeller shaft, mm;

\(F_b\) — cross-sectional area of the branch, \(\text{mm}^2\);

\(\ell_h\) — length of the hub, mm.

A hub web thickness for double-branched brackets may be reduced down to 0.25 \(d\) in ships up to 25 m in length.

Branches of brackets shall be attached to the hull framing members and to the outer shell by means of welding. Thickness of the outer shell plating in the area of bracket branch connection shall be increased by 25% in comparison with shell plating thickness in the aft extremity as determined from Tables 2.4.1-1, 2.4.1-2 and 2.4.1-4.

Hull strengthening for navigation in broken ice

2.4.113 Ships of all classes navigating occasionally in broken ice shall be provided with strengthening meeting the requirements of 2.4.115 to 2.4.129. These requirements are specified for fine broken ice thickness specified in Table 2.4.113.

<table>
<thead>
<tr>
<th>Ice strengthening notation</th>
<th>Fine broken ice thickness, cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>ice 10</td>
<td>10</td>
</tr>
<tr>
<td>ice 20</td>
<td>20</td>
</tr>
<tr>
<td>ice 30</td>
<td>30</td>
</tr>
<tr>
<td>ice 40</td>
<td>40</td>
</tr>
</tbody>
</table>

2.4.114 Ships intended for navigation in more severe ice conditions than specified in Table 2.4.113 shall be provided with hull strengthening designed with due regard to the type, purpose and conditions of navigation of the ship.

2.4.115 An ice strake of the outer shell shall be fitted throughout the whole length of a ship, with an upper edge located 0.5 m above the load waterline and lower edge 0.5 m below the lightship waterline, with due regard to possible trim of the ship.

When at the fore extremity a vertical distance between the lightship waterline and plates of the bottom outer shell plating is less than 0.5 m, thickness of the whole outer shell plating bellow the load waterline in the bow extremity to the parallel body but at least over a distance equal to a ship breadth shall be the same as the ice strake thickness.

2.4.116 Thickness of ice strake plates \(t_i\) shall be not less than specified by Table 2.4.116.

<table>
<thead>
<tr>
<th>Ice strengthening notation</th>
<th>Ice strake plate thickness depending on ice strengthening and ship length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(L), m</td>
</tr>
<tr>
<td>ice 40</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>160</td>
</tr>
<tr>
<td>ice 30</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>160</td>
</tr>
<tr>
<td>ice 20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>140</td>
</tr>
<tr>
<td></td>
<td>160</td>
</tr>
<tr>
<td>ice 5 and ice 10</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>80</td>
</tr>
</tbody>
</table>

Note. Fore section means a section with the after border corresponding to third actual frame of the hull’s parallel body, and for ships with a length of the parallel body being less than 0.3L — to a frame where the angle between tangent line to the waterline at fully loaded condition and the centre plane is \(7^\circ\), but over a length equal to at least the ship’s breadth.

When using the data in Table 2.4.116, the following shall be considered:

If spacing is taken greater than \(a_w\), than ice strake plating thickness specified in the Table 2.4.116, mm, shall be increased by the value:

\[
\Delta t = 0.8(\xi a/a_w - 1)t_i, \quad (2.4.116-1)
\]
where $a$ — actual spacing, mm;
\[ a_0 = \text{standard spacing taken equal to, mm:} \]
for the bow section (see Note to Table 2.4.116) 400
for other hull sections 550
\[ \xi = \left(10\chi h + 0.5a_0\right)/\left(10\chi h + 0.5a\right); \]
(2.4.116-2)
\[ h = \text{fine broken ice thickness taken depending on ice strengthening notation as per Table 2.4.113, cm;} \]
\[ \chi = \text{coefficient connecting the ice load application height and ice thickness and calculated by the formula:} \]
\[ \chi = \mu \left(0.001D\right)^{1/3} \leq 1.0; \] (2.4.116-3)
\[ \mu = \text{coefficient equal to:} \]
for fore section 0.55
for afterpeak section 0.39
for other sections of the ship 0.49

If spacing is taken less than $a_0$ and/or hull members are made of higher strength steel, than the ice strake plating thickness specified in Table 2.4.116, mm, may be reduced by the value:
\[ \Delta t = 0.8\left[1 - 15.3\xi a/\left(a_0\sqrt{R_{\text{ext}}}\right)\right]l, \] (2.4.116-4)
where $a$, $a_0$, $\xi$ — see 2.4.3 (if $a > a_0$, $a = a_0$);
\[ R_{\text{ext}} = \text{yield point of the member material, MPa.} \]

2.4.119 Section modulus of side web frames including effective flange $W$, cm$^3$, shall be not less than the values determined by the formulae:
\[ W = 18.5H_d\sqrt{2} + 0.085L; \] (2.4.119-1)
\[ W = 14.5H_d\sqrt{2} + 0.085L; \] (2.4.119-2)
\[ W = 12.5H_d\sqrt{2} + 0.085L, \] (2.4.119-3)
where $d$ — distance between side web frames, m;
\[ H_d = \text{side depth, m, in the relevant area of ship.} \]

2.4.120 Section modulus of main ordinary side frames including effective flange $W$, cm$^3$, shall be not less than determined by the formulae:
\[ W = 21.5la\sqrt{2} + 0.085L; \] (2.4.120-1)
\[ W = 17.5la\sqrt{2} + 0.085L; \] (2.4.120-2)
\[ W = 15la\sqrt{2} + 0.085L, \] (2.4.120-3)
where $a$ — spacing (a distance between main ordinary side frames), m;
\[ l = \text{the greatest distance measured over a side between the bottom (double bottom plat-} \]
ing and a side stringer, between side stringers, or between a side stringer and the deck, m, in the relevant area of ship.

2.4.121 Section modulus of intermittent side frames including effective flange shall be not less than 75% of the required section modulus of main ordinary frames including effective flange.

2.4.122 Throughout the length of a ship in the ice strake area, side stringers shall be provided with one of them being located below the load waterline. Where variations of operational draughts are not significant, one stringer may be sufficient.
2.4.123 Lower sections of intermediate side frames shall overlap the bilge. They shall be attached to the nearest bottom framing member or to the double bottom plating.

Upper ends of the intermittent frames shall be extended to a deck, a platform or a side stringer but shall not be below the upper edge of the ice strake.

2.4.124 In ships with full contours, frames in the forepeak and the afterpeak areas shall be installed perpendicularly to the shell plating.

2.4.125 Horizontal stiffeners shall be installed on the forepeak and afterpeak bulkheads and bulkheads enclosing the engine room, which shall be extended over 25% of the bulkhead’s width, at both sides, with a section modulus not less than that of the vertical ordinary stay. A bulkhead stay, up to which the stiffeners are extended, shall be reinforced.

2.4.126 Cross-sectional area of the stem shall be increased by 50% as compared with that required by 2.4.100 to 2.4.104. Plate edges of the outer shell plating adjacent to the stem shall be protected against ice.

2.4.127 Cross-sectional area of the stern frame shall be increased by 15% as compared with that required by 2.4.107 to 2.4.110.

2.4.128 Propellers and rudders shall be protected against ice by a cruiser-shaped aft, anti-ice bosses or any other structures.

2.4.129 Framing members in the area of the hull strengthening for the navigation in broken ice shall be welded by means of continuous welds.

Superstructures and steps on main deck

2.4.130 Superstructure transverse framing members shall be fitted in the same planes with the hull transverse framing members.

The section modulus of the superstructure side stringers including effective flange in ships of М-СП, М-ПР, О-ПР, М, О classes shall be at least 9 cm³.

2.4.131 Longitudinal walls of the superstructures shall be extended beyond the end bulkheads of the superstructures over a length equal to the superstructure height and smoothly connected to the deck.

The sheer strake throughout at least three spacings abaft each end bulkhead of the superstructure, as well as protruding part of the lowermost strake of the superstructure plating and its section extended into the superstructure for a length equal to one-half height of the superstructure, shall be thickened by 40% for ships of М-СП, М-ПР and М classes, by 25% for ships of О-ПР and О classes and by 10% for P and J classes.

Deck stringer of the upper deck shall be thickened along the same length as for the sheer strake by 20% for ships of М-СП, М-ПР, О-ПР, М, О classes and by 10% for ships of P and J classes.

Where a length of the forecastle and the poop is less than 0.25L, the thickening may be dispensed with.

2.4.132 In the area of the main deck step, special reinforcements shall be provided. Deck carlings shall be smoothly interconnected. The sheer strake in the stepped area shall be thickened by 35% at both sides of the step over at least three spacings.

In case of inclined step, it shall be extended for at least the double height.

A length of an area where the main deck and raised deck overlap, shall be determined with due regard to the global strength of the hull, and for ships of up to 50 m in length with due regard to conditions of 2.5.2, with the cross-sectional areas of the deck plating and the side plating of this area being included in calculations according to instructions of 2.2.32 to 2.2.34. Where a cross-sectional area of the deck plating of the above said decks is increased by means of installing longitudinal vertical brackets between them, length of the brackets shall be equal to at least double depth of the bracket, and thickness not less than required by the Rules for the bulkheads in that area. Bracket ends shall be attached in accordance with 2.3.7. The brackets shall be reinforced by stiffeners.
Where planes of longitudinal walls of a superstructure (wheelhouse) do not coincide with the side planes, they shall bear on the carlings fitted in planes of those walls.

**Bulwark**

2.4.133 Areas fitted with the bulwark, its extension and height shall be assigned in accordance with the requirements of 10.1 and 10.2.

2.4.134 Thickness of the bulwark plates may be taken by 2 mm less than that required for the side plating in the middle part of ship, but not less than 2 mm.

2.4.135 The bulwark shall be so designed as not to be participating in global bending of the hull.

2.4.136 The bulwark shall be reinforced by stanchions installed at least three spacings apart.

2.4.137 Supporting stanchions shall be installed in the areas of side hawsepipes and stair accesses; here, the thickness of the bulwark plates shall be increased by 1 mm as compared with the rest plates.

**Tanks**

2.4.138 Fuel, oil, oily water and sewage tanks may be independent or built-in.

2.4.139 Fuel tanks shall not have common bulkheads with drinking water tank or be placed in front of forepeak bulkhead.

2.4.140 Main fuel tanks shall be part of the ship's structure and shall be located outside machinery spaces where engines and boilers are installed. Where these tanks, other than double bottom tanks, are necessarily located adjacent to or within machinery spaces stated above, at least one of their vertical walls shall be contiguous to the machinery space bulkhead and shall have a common boundary with the double bottom tanks, and the area of the tank boundary common with the machinery space shall be kept to a minimum. Where such tanks are situated within the boundaries of machinery spaces where engines and boilers are installed, they shall not contain a fuel having a flashpoint less than 60°C.

2.4.141 In ships where independent main fuel tanks are used, they shall not be mounted in machinery spaces where engines and boilers are installed. Independent daily tanks and other fuel tanks shall be installed on a fuel-tight spill tray having a drain pipe leading to a spill oil tank.

2.4.142 Tanks shall be so designed as their content do not touch the bottom and side plating.

The distance between the bottom of built-in tanks in the its lowest part and the bottom plating shall be at least 800 mm, and the distance between the side walls of the tank and the side plating shall be such as to ensure the access for inspection and repair. Access to the independent tanks including cargo tanks shall be provided from all sides. The distance from independent tank bottom in the its lowest part to the bottom plating shall be at least 800 mm, and the distance between tank walls and side plating or transverse bulkheads shall be at least 760 mm.

2.4.143 The wall thicknesses of built-in tanks and plate structures shall comply with the requirements of 4.1 and 5.2 of Tables 2.4.1-1 and 2.4.1-2.

Section moduli of web and ordinary members shall be taken similar to the relevant bulkhead members.

**2.5 ADDITIONAL REQUIREMENTS FOR PARTICULAR TYPES OF SHIPS**

**Ships less than 50 m in length**

2.5.1 For ships of all classes less than 50 m in length, where the requirements of 2.5.2 are not complied with, calculations of global strength shall be made as per 2.2. In this case, the bending moment \( M_{\text{sw}} \) may be determined using data of the prototype ship having the same hull architecture and design as the ship under consideration, similar dimensions, displacement and similar longitudinal location of the engine room, or using the itemized calculation of the bending moment at the midship...
as the algebraic sum of moments from different weights and support forces. In all cases, absolute value of the bending moment shall be taken not less than, kN·m,

\[ M_{sw_{\min}} = a_0 D, \]

where \( a_0 = 1.1 \) for self-propelled ships and \( a_0 = 0.74 \) for non-self-propelled ships.

\( D \) — ship displacement in fully loaded condition, kN.

Distribution of the calculated value of \( M_{sw} \) over the ship’s length shall be assumed as constant within \( \pm 0.25L \) from the midship and linearly decreasing to the extremities.

When complying with the requirements of 2.3 and 2.4, calculations of local strength required by 2.2 may be omitted (see 2.1.6).

2.5.2 For ships less than 50 m in length, the total cross-sectional area of the deck and bottom strake longitudinal members taken separately shall be not less than, cm²:

\[ F = D' L \eta \alpha \left[ \left( 0.1L/T - 1 \right)/k_1 + k_2 \right]/H, \]

(2.5.2)

where \( D' \) — ship displacement in fully loaded condition, t;

\( k_1 \) — coefficient determined from Table 2.5.2;

\( \eta \) — coefficient equal for members:
- deck strake not bearing any local load 0.65
- bottom and deck strakes bearing local load 0.75

\( \alpha \) — coefficient depending on relative distance \( x/L \) of the design cross-section under consideration from the midship and taken as:

\[
\begin{align*}
\alpha &= 1.0 & \text{when } |x/L| \leq 0.25; \\
\alpha &= 2.0 - |x/L|/0.25 & \text{when } |x/L| > 0.25;
\end{align*}
\]

\( x \) — distance of the design cross-section under consideration from the midship, m.

The value of expression in brackets of formula (2.5.2) shall not exceed 0.125. For dry cargo ships, if such cargo handling operations are allowed in non-sheltered waters as cargo stowing in one layer by one crane or two cranes in the same direction, the total cross-sectional area of the deck strake and bottom strake longitudinal members, taken separately, shall be not less than the value calculated by formula (2.5.2) with \( k_2 \) increased by 20%. Values of coefficient \( k_1 \) in this case shall be assigned taking into account the operation area comprising such a water area. Value of parenthetical expression in formula (2.5.2) in this case shall not be taken above 0.15.

Where cargo is stowed in one layer by two cranes in different directions, the hull strength shall be verified by direct strength calculations using values of bending moments and shear forces on still water, determined as per requirements of 2.2.1 and 2.2.2.5.

The following shall be included in the total cross-sectional area of the deck strake:

- 65% of the cross-sectional area of the deck plating in case of the longitudinal framing system;
- full cross-sectional area of the plating sections with a breadth equal to 0.25 of the spacing at each side of a longitudinal member in case of the transverse framing system;
- 10% of the rest area of the plating in case of the transverse framing system;
- continuous longitudinal ordinary girders;
- continuous longitudinal coamings and continuous longitudinal girders supporting the aforementioned coamings;
- carlings;
- the upper part of the sheer strake raised over the deck, as well as a part of the sheer strake below the deck with a height equal to 0.5 of the spacing in case of the transverse side framing system and equal to 0.25 of the spacing in case of the longitudinal side framing system;

The following table shows the values of coefficient \( k_1 \) at ship length, m:

<table>
<thead>
<tr>
<th>Basin class</th>
<th>( k_1 ) at ship length, m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
</tr>
<tr>
<td>M</td>
<td>13</td>
</tr>
<tr>
<td>O</td>
<td>25</td>
</tr>
<tr>
<td>P</td>
<td>50</td>
</tr>
<tr>
<td>J</td>
<td>132</td>
</tr>
<tr>
<td>M-CII 4.5</td>
<td>15.3</td>
</tr>
<tr>
<td>M-CII 3.5</td>
<td>17.2</td>
</tr>
<tr>
<td>M-IIP</td>
<td>20.3</td>
</tr>
<tr>
<td>O-IIP</td>
<td>33.6</td>
</tr>
</tbody>
</table>

\(^{1}\) Maximum value of the expression in square brackets of the formula (2.5.2) is not limited.
the upper under-deck sections of longitudinal bulkheads and inner sides with a height of 0.5 of the spacing in case of the transverse framing system and 0.25 of the distance between longitudinal girders in case of the longitudinal framing system.

The following shall be included in the total cross-sectional area of the bottom strake:
- 65% of cross-sectional area of the bottom plating and the double bottom plating in case of the longitudinal framing system;
- full cross-sectional area of the bottom plating and the double bottom plating sections with a breadth equal to 0.25 of the spacing at each side of each longitudinal member in case of the transverse framing system;
- 10% of the rest area in case of the transverse framing system;
- continuous longitudinal ordinary bottom girders and keelsons with supporting continuous longitudinal girders;
- continuous longitudinal stiffeners of a double bottom plating ordinary girder;
- the bilge plate in the rounded part;
- lower part of longitudinal bulkheads, outer and inner sides up to the level located 0.25 of the spacing above the double bottom plating or floors.

Longitudinal members included into the total cross-sectional area of the deck and the bottom strakes shall comply with 2.2.31 with due regard to their position relatively to the cross-section in question, extension and connection with the hull.

Cross-sections, for which strength shall be verified according to the requirements of present paragraph, shall be selected as per 2.2.30.

Requirements of 2.5.1 and present paragraph do not apply to passenger displacement ships of M-CPI class.

**Dry cargo ships**

2.5.3 Ships of M-CPI class shall have double bottom and double sides in the cargo hold area.

2.5.4 In ships intended for carriage of cargo containers (see GOST R 53350), sockets for corner fittings of containers shall be provided and respective reinforcements shall be made.

**Tankers**

2.5.5 Oil transporting tankers shall have double bottom and double sides in the cargo tanks area, or cargo tanks shall be independent (see 2.5.111 to 2.5.126, 2.5.157 to 2.5.161) or built-in (see 2.5.142 to 2.5.156).

Provisions of 2.5.6 to 2.5.8 do not apply to ships with independent or built-in tanks.

2.5.6 Tankers up to 80 m in length shall be fitted with one longitudinal bulkhead in the centre plane in the cargo tanks area, and ships with a length of 80 m and more with at least two longitudinal bulkheads. In double-sided ships, one longitudinal bulkhead in the centre plane shall be sufficient.

Where no expansion trunks are provided above the cargo tanks, this shall be substantiated by calculations with due regard to the temperature conditions and the availability of free under-deck volumes.

2.5.7 In ships with $B/H > 3.5$, longitudinal trusses or pillars shall be fitted in addition to the longitudinal bulkheads. The distance between the longitudinal bulkhead and longitudinal truss or between longitudinal trusses and the side shall not exceed 2.5 m.

2.5.8 Tankers shall be fitted with transverse bulkheads located at the distance from each other of not more than, for ships with the side depth $H$, m:

- $\leq 2.5$ 24 frames
- $> 2.5$ 36 frames

Non-self-propelled tankers shall be fitted with transverse trusses or pillars or non-tight transverse bulkheads between transverse bulkheads. The distance between the transverse bulkheads or the bulkheads and the trusses shall not exceed 12-fold spacing for ships with the side depth $H \leq 2.5$ m and 18-fold spacing for ships with the side depth $H > 2.5$ m.

**Displacement passenger ships**

2.5.9 Hulls of displacement passenger ships may be of the following types:
one-decked ships with light superstructures not participating in the hull global bending;

2 multi-decked ships with strong main deck and strong superstructure deck of the first tier included in the hull girder;

3 open ships fitted with or without the double bottom and with a superstructure either participating in global bending or not.

2.5.10 If a superstructure (wheelhouse) is participating in hull global bending, the strength of its upper strong deck members and strength of superstructure connections with the hull in way of the greatest tangent stresses at ends of its continuous longitudinal walls shall be provided.

In case the aforementioned requirements are not met, structural measures shall be taken to reduce superstructure (wheelhouse) participation in the hull global bending and to prevent excessive stress concentration in the superstructure and in the deck on which the superstructure rests.

2.5.11 Longitudinal walls of the superstructure (wheelhouse) with a length exceeding 6-fold height of the superstructure not coinciding with the hull sides, shall be connected with transverse end walls smoothly according to a radius of at least 1/3 of the superstructure height. For superstructures (wheelhouses) of a smaller length the aforementioned rounding radius may be reduced pro rata. Superstructures (wheelhouses), whose longitudinal walls do not coincide with longitudinal walls of the superstructures situated below, shall also meet this requirement.

2.5.12 Thickness of a stringer of the uppermost strong deck and of the deck next below of passenger ships shall be not less than required in 2.1 of Tables 2.4.1-1 and 2.4.1-2.

2.5.13 Thickness of the deck plating of passenger ships in the middle part shall be not less than required in 2.1 of Tables 2.4.1-1 and 2.4.1-2.

2.5.14 Thickness of the superstructure (wheelhouse) walls shall be not less than required in 5.6 of Tables 2.4.1-1 and 2.4.1-2, and of superstructure (wheelhouse) participating in global bending of the hull not less than required in 5.7 of Tables 2.4.1-1 and 2.4.1-3.

Tugboats and pushboats

2.5.15 Thickness \( t \) of the outer shell plating of tugboats and pushboats in the middle part and in the aft extremity shall be not less than, mm:

\[
 t = \left( L + 100 \right) / 30 + t_{\text{add}},
\]

(2.5.15)

where \( t_{\text{add}} = 0 \) for ships with power of 330 kW or less;

\[
t_{\text{add}} = 0.06 \sqrt{1.36P_e - 450} \quad \text{— for ships with power exceeding 330 kW, where } P_e \text{ — power of the tugboat/pushboat, kW.}
\]

For lock and harbour tugboats and pushboats of all classes, as well as for raft transporting ships of M and O classes, the outer shell plating thickness shall be increased by 2 mm as compared with the thickness determined by formula (2.5.15).

In all cases, the outer shell plating thickness in the middle part of ship shall be not less than specified in Tables 2.4.1-1 and 2.4.1-4.

2.5.16 Sheer strake and bilge strake thickness shall be taken equal to the outer shell plating thickness in the given hull section, but not less than specified in 1.3 and 1.4 of Tables 2.4.1-1 and 2.4.1-4.

2.5.17 Outer shell plating thickness of the fore part of tugboats and pushboats shall be not less than thickness in the middle part of ship determined as per 2.5.15 and 2.5.16, but not less than the shell plating thickness in the fore extremity specified in Tables 2.4.1-1 and 2.4.1-4.

2.5.18 The deck stringer thickness in the middle part of ship shall be not less than the side shell thickness. The deck stringer width shall be not less than 500 mm.

2.5.19 The deck plating thickness of tugboats and pushboats in the middle part of ship and in the fore and aft extremities, mm, shall be not less than:

for open areas
\[ t = \left( \frac{220 + L}{60} \right) + t_{\text{add}} \tag{2.5.19-1} \]

for areas enclosed by superstructures
\[ t = \left( \frac{180 + L}{60} \right) + t_{\text{add}} \tag{2.5.19-2} \]

where \( t_{\text{add}} \) is taken as per 2.5.15.

For lock and harbour tugboats and pushboats, the deck plating thickness shall be not less than the outer shell plating thickness in the middle part of ship required by the Rules.

2.5.20 Bulkhead plate thickness shall be not less than determined as per Tables 2.4.1-1 and 2.4.1-2 plus 1 mm.

2.5.21 Thickness of the transom bulkhead plate in pushboats and thickness of stop plates shall be not less than the deck plating in the fore extremity.

2.5.22 Fore extremities of pushboat hulls shall be reinforced in such a way that to provide the uniform distribution of forces from stops to sides and longitudinal hull members.

In the plane of supports, longitudinal bulkheads or trusses shall be installed, which shall be strongly connected with the hull and extended to the forepeak bulkhead.

In the area of stops, closed frame rings (floors, side web frames and beams) shall be arranged.

Icebreakers

2.5.23 The requirements of 2.5.24 to 2.5.68 apply to ice-breakers which meet the condition \( D^{1/3}P^{1/3} < 230 \) and have the following main dimension ratios and hull lines:
- \( L/B = 3.3 \pm 5.0 \);
- \( B/T = 4.0 \pm 6.5 \);
- \( \alpha = 15 \pm 35 \);
- \( \varphi = 11 \pm 25 \);
- \( \beta = 30 \pm 50 \);
- \( \beta_M = 10 \pm 25 \),

where \( D \) — ship displacement at the draught at design waterline, kN;
- \( P \) — total propeller shaft power, kW;
- \( L \) — design waterline length, m;
- \( B \) — design waterline breadth amidships, m;
- \( T \) — moulded draught / draught to design waterline, m;
- \( \varphi \) — angle between a tangent to the stem line and base plane at the level of the design waterline, deg;
- \( \alpha \) — angle between a tangent to the design waterline and the centre line at 0.15\( L \) from the fore perpendicular, deg;
- \( \beta \) — angle between a vertical line and a tangent to the theoretical frame at 0.15\( L \) from the fore perpendicular at the design waterline level, deg;
- \( \beta_M \) — angle between a vertical line and a tangent to the midship at the design waterline level, deg.

2.5.24 The following definitions of the ship sections are adopted in 2.5.25 to 2.5.68:
- **fore part** is a hull section within 0.3\( L \) from the fore perpendicular;
- **middle part** is a hull section 0.5\( L \) long between the fore and aft sections;
- **aft part** is a hull section within 0.2\( L \) from the aft perpendicular.

2.5.25 Hulls of ice-breakers (excepting the outer shell plating) shall be made of hull structural steel of not less than D and E grades, and the outer shell plating shall be made of steel of at least E grade.

2.5.26 Strength and buckling calculations, permissible stresses, structural design and scantlings of ice-breaker hull members shall comply with the requirements of 2.1 to 2.4, 2.6, unless otherwise specified in 2.5.27 to 2.5.68.

2.5.27 When calculating local strength of the hull structures for ice loads, permissible stresses shall be taken equal to 0.95 of the yield point of the material \( R_{th} \).

2.5.28 For the bottom and the side longitudinal members subject to ice load, general and local bending stresses are not to be summed up.

2.5.29 Design ice pressure applied to the ice strake shell plating in the fore part \( p_f \) is determined by the formula, MPa,
\[ p_f = 1.4 + 0.004D^{1/4}P^{1/3} \tag{2.5.29} \]

where \( D \) and \( P \) — see 2.5.23.

2.5.30 Design ice pressure applied to the ice strake shell plating is determined by the formula, MPa:
in the middle part
$$p_m = 0.60 p_f ;$$  
(2.5.30-1)
in the aft part
$$p_a = 0.75 p_f ,$$  
(2.5.30-2)
where \( p_f \) — see 2.5.29.

2.5.31 Design ice pressure applied to the bottom plating outside the ice strake \( p_{bot} \) is determined by the formula, MPa:
$$p_{bot} = p_f D^{1/4} P^{1/3} / 400 ,$$  
(2.5.31)
where \( p_f \) — see 2.5.29,
\( D, P \) — see 2.5.23.
Pressure \( p_{bot} \) shall not exceed \( p_m \).

2.5.32 Design intensity \( q_f \) of ice load applied to the side framing in the fore part of the ice strake in case the ship would strike against ice cover is determined by the formula, kN/m
$$q_f = 12.6 k \sqrt{D v^2 p_f^2} ,$$  
(2.5.32)
where \( k \) — dimensionless coefficient taken from curve in Fig. 2.5.32 depending on angles \( \alpha \) and \( \beta \);

![Fig. 2.5.32 Curves for determining coefficient k](image)

\( v \) — design speed of the ice-breaker at the moment when the ship strikes against ice, m/s, taken equal to 60% of maximum speed of the ice-breaker in clear water;
\( D \) — see 2.5.23; \( p_f \) — see 2.5.29.

2.5.33 Design intensity of ice load applied to the side framing shall be taken as follows, kN/m:
in the middle part, not less than the greatest value of
$$q_m = 0.6 q_f ;$$  
(2.5.33-1)
$$q_m = 0.028 L^2 / \sin \beta_m ;$$  
(2.5.33-2)
in the aft part
$$q_a = 0.75 q_f ,$$  
(2.5.33-3)
where \( q_f \) — see 2.5.32.
In any case the intensity \( q_f \) shall be not less than the taken value of \( q_m \).

2.5.34 Design intensity \( q_{bot} \) of ice load applied to longitudinal girders and ordinary frames of the bottom outside the ice strake, kN/m:
$$q_{bot} = 10 p_{bot} L .$$  
(2.5.34)
The intensity \( q_{bot} \) shall not exceed the value of \( q_m \) determined by the formula (2.5.33-1).

2.5.35 The spacing in the fore part shall be taken not over 300 mm. It may be increased up to 600 mm provided that intermediate side frames are fitted.

2.5.36 The spacing in the middle part and aft part of the ice-breaker shall not exceed 500 mm. It may be increased up to 650 mm provided that intermediate side frames are fitted.

2.5.37 The ice strake of the outer shell plating shall be fitted over the whole length of ice-breaker’s hull.

2.5.38 The upper edge of the ice strake shall be located at least 0.6 m above the waterline corresponding to the greatest draught, and the lower edge of the ice strake shall be 0.02 \( L \) but not less than 0.8 m below the waterline corresponding to 10% stores and fuel without ballast.

2.5.39 In the fore part over a length of at least 0.2 \( L \) from the fore perpendicular and in the aft part over a length of at least 0.15 \( L \) from the aft perpendicular, the lower edge of the ice strake shall be extended to the centre line.
2.5.40 The thickness of the ice strake plating shall be taken not less than calculated by the formula, mm:

\[ t = 720s\sqrt{p/R_{th}}, \]  

(2.5.40)

where \( s \) — distance between framing girders, m;

\( p \) — design ice pressure determined by formulae (2.5.29) to (2.5.31) depending on longitudinal position of the plates, MPa;

\( R_{th} \) — yield point of the outer shell plating material, MPa.

2.5.41 The outer shell plating thickness outside the ice strake shall be determined by the formula (2.5.15), where \( P_a \) is taken equal to the total propeller shaft power \( P \), kW.

2.5.42 Thickness of outer shell plating shall be decreased smoothly along the height so that adjacent plates differ not more than by 30% of the thickness of the thinner connected plate.

2.5.43 Thickness of the deck plating shall be determined by formulae (2.5.19-1) and (2.5.19-2) with due regard to 2.5.15.

2.5.44 A distance between the web frames in the fore part of the ship shall not exceed 1.2 m, while over the rest length of the ship this distance shall not exceed 2.0 m.

Minimum thickness of webs of the web frames within the ice strake is 10 mm and for the rest length of the ship is 8 mm.

2.5.45 A side stringer or a platform shall be fitted throughout the length of an ice-breaker at design waterline level (or maximum 0.25 m lower).

2.5.46 Within the ice strake, a distance between the side stringers (a stringer and the deck or a platform, a stringer and the bottom) shall be taken not more than 1.2 m; thickness of the mentioned stringer webs and platform plates adjacent to the outer plating in the ice strake area shall be not less than the web thickness of web frames fitted in this area.

2.5.47 In places where ordinary frames and side stringers intersect, knees shall be fitted.

2.5.48 Ordinary side frames are calculated as multi-spanned girders resting on stringers (platforms), deck plating, keelson or bilge bottom plate. Concentrated load \( Q \), kN, to which side ordinary frames are calculated, shall be obtained by the formula

\[ Q = qs, \]  

(2.5.48)

where \( q \) — design intensity of ice load, kN/m, for relevant section of the ice strake (see 2.5.24) as per 2.5.32 and 2.5.33;

\( s \) — distance between ordinary frames or between the ordinary frame and the web frame, m.

A point of force \( Q \) application shall be taken in the middle of the longest frame span within the ice strake.

Where intermediate frames are fitted, \( s \) in formula (2.5.48) shall be taken equal to the distance between the intermediate and ordinary frames. Intermediate frames are calculated as ordinary ones.

In case of the homogeneous transverse side framing system, the side frames are calculated as ordinary frames in case of the side framing system with deep frames. It shall be kept in mind that in case of the homogeneous framing system, the side stringers distribute the load and, therefore, they shall not be considered as supports for frames.

2.5.49 Strength of side stringers and web frames shall be calculated considering them being included in the side grillage; for this purpose, in the middle part of ship, the ice load application length is taken throughout the whole length of the side grillage. A length of ice load application, m, in the fore and aft parts is calculated by the formula

\[ l = 0.01q/p, \]  

(2.5.49)

where values of the design pressure \( p \) and the design ice load intensity \( q \) are obtained according to 2.5.29 to 2.5.34.

2.5.50 Webs of ordinary and web frames at the level of the ice strake throughout the ship’s length shall be connected to the outer shell plating by a continuous double-sided weld.
2.5.51 Frames installed in extremities shall meet the requirements of 2.4.124.

2.5.52 Continuous floors shall be fitted at each frame throughout the fore and the aft parts of ship.

A distance between continuous floors amidships shall not exceed 2.0 m.

2.5.53 Strength of continuous floors and keelsons shall be calculated considering them a part of bottom grillages loaded by uniformly distributed ice pressure equal to 0.3\( p_{\text{bot}} \), where \( p_{\text{bot}} \) is determined by formula (2.5.31).

2.5.54 Bottom ordinary frames shall be considered as a single-span girders constrained at the ends and having a length equal to the greatest distance between keelsons or between a keelson and the side or a longitudinal bulkhead. A concentrated load \( Q \), kN, to which the bottom ordinary frames are calculated, shall be considered as applied in the middle of the span and determined by the formula:

\[
Q = q_{\text{bot}} s,
\]

where \( q_{\text{bot}} \) — design ice load intensity, kN/m, determined by formula (2.5.34);

\( s \) — distance between the bottom ordinary frames or between a bottom ordinary frame and a floor, m.

Longitudinal ordinary girders are calculated on the assumption that span’s length is equal to the distance between continuous floors, and the \( s \) value is equal to the distance between the girders.

2.5.55 Transverse bulkheads shall be flat and their structure shall meet the requirements of 2.5.20, 2.5.21, 2.5.56 to 2.5.59.

2.5.56 Thickness of the bulkhead plate adjacent to the side and bottom platings shall be not less than the thickness of webs of web frame and floor, correspondingly.

2.5.57 Horizontal stiffeners connected to the side framing members shall be fitted on transverse bulkheads. Length of these stiffeners from each side to the centre line shall be not less than 10% of the bulkhead’s width. The nearest bulkhead stay, to which these stiffeners are extended, shall be a web stay.

Section modulus of stiffeners shall comply with the requirements of 2.4.78, and the stiffeners’ ends shall be mitered. In addition, the following conditions shall be met:

1. the distance \( a \) between the stiffeners shall be not less than obtained by the formula, m:

\[
a = 0.88 t \sqrt[3]{R_{EH}},
\]

where \( t \) — thickness of the bulkhead plate in the section adjacent to the side, mm;

\( R_{EH} \) — yield point of the bulkhead material, MPa;

2 moment of inertia \( i \), cm\(^4\), of a stiffener with effective flange of the bulkhead plating with a width of 1/6 of a length of stiffener’s span shall be not less than determined by the formula:

\[
I = 191 p s l^2,
\]

where \( p \) — design ice pressure applied to the ice strake plating for the relevant part of a ship, MPa;

\( s \) — distance between the ordinary frames and between the ordinary and web frames, m;

\( l \) — stiffener span, m;

3 moment of inertia \( I \), cm\(^4\), of a bulkhead web stay with effective flange, to which horizontal stiffeners are extended, shall be not less than determined by the formula:

\[
I = 0.32 \left( \frac{l}{l_1} \right)^3 l,
\]

where \( l_1 \) — stay span, m;

\( l \) — stiffener span, m;

\( i \) — moment of inertia of the stiffener with effective flange, cm\(^4\).

2.5.58 Horizontal stiffeners and shelves fitted on transverse bulkheads at the level of the ice strake shall be welded to bulkhead plates by continuous double-sided weld.

2.5.59 Strength of transverse bulkheads shall be calculated for buckling and bending under ice loading and under hydrostatic pressure of water filling the compartment up to the deck, respectively.
2.5.60 If a longitudinal bulkhead is fitted in the centre line above the stem, its length shall be not less than stem length, and the bulkhead plate thickness shall be not less than forepeak bulkhead plate thickness.

2.5.61 The stem and stern frame of an ice-breaker shall be made of forged or cast steel. The stem may be made of steel plates with a thickness being at least two times more than thickness of the ice strake plates adjacent to the stem.

2.5.62 The stem shall have a rabbet or other similar structure protecting edges of adjacent outer shell plates from striking against ice.

2.5.63 The stem is fitted in the centre line throughout the entire bow raising of the bottom from the upper deck till the nearest transverse bulkhead.

2.5.64 The stem shall be connected with the adjacent outer shell plating and a longitudinal bulkhead fitted as per 2.5.60 by a continuous weld.

2.5.65 In the ice strake area, the stem shall be supported by breasthooks maximum 0.5 m from each other in the vertical plane. Here, the breasthook web and flange sizes shall be taken equal to those of web frames fitted in the forepeak. Breasthooks shall be extended to the frames.

2.5.66 Cross-sectional area of the stem, \( F \), at the ice strake level shall be not less than that determined by the formula:

\[ F = 2L. \]  
(2.5.66)

Upwards from the ice strake, the cross-sectional area of the stem may be smoothly reduced down to 70% of the value \( F \) calculated by formula (2.5.66).

2.5.67 Cross-sectional area of the stern frame shall be increased by 1.5 to 2 times compared with the values determined by formula (2.4.107-1). The requirements of 2.4.110 shall be met as well.

2.5.68 In the aft extremity of an icebreaker, provision shall be made to protect propellers and rudders against broken ice when moving astern.

**Industrial ships**

2.5.69 Industrial ship scantlings shall be taken as per 2.1.6, and the requirements of 2.5.70 to 2.5.73 shall be met.

2.5.70 Calculations of global and local strength, rigidity and vibration of the hull shall be performed with due regard to operational conditions of industrial ships and specific operation of special mechanisms, devices and equipment.

2.5.71 In the dredging tower and the frame lifting tower areas, the framing of the main hull shall be reinforced. Supports of the frame lifting tower may be ended at the deck. Pillars, web stays and other equivalent structures shall be provided under them. Supports of the dredging tower shall be extended to the bottom and be attached to the longitudinal and transverse members, or transverse bulkheads shall be fitted under them.

The deck plating in places where dredging tower supports pass through and below the supports of the frame lifting tower shall be thickened by 25%.

2.5.72 The side framing system in the area of suction tube connections shall be of transverse type with web frames being provided; thickness of the outer shell plating shall be increased by 25%.

2.5.73 In the soil pump room, watertight sections of floors and keelsons forming a drainage well shall be provided.

**Ships less than 25 m in length**

2.5.74 The requirements of 2.5.75 to 2.5.110 apply to ships less than 25 m in length, types of which are specified in 2.1.4.

These ships shall comply with the requirements of 2.1, 2.3, 2.4, 2.5.75 to 2.5.110.

2.5.75 Thickness of the hull members shall be taken not less than 2.5 mm in all cases.

2.5.76 Thickness of the bottom plating and the bilge strake plating \( t \), mm, in the middle
part and the aft extremity of ship shall be not less than obtained by the formula:

\[ t = 1060a \sqrt{p + r + m R_{\text{sh}}} \]  \hspace{0.5cm} (2.5.76)

where \( a \) — spacing, m;
\( T, r \) — see 2.4.11;
\( m \) — a value, m, taken equal to, for ship classes:
\[ \begin{array}{c|c|c}
\text{M-СП, М-ПР, О-ПР, М, О} & 0.6 \\
P and І & 0.9
\end{array} \]
\( R_{\text{sh}} \) — yield point, MPa.

2.5.77 Thickness of the bottom and the bilge strake plating of tugboats and ships, which may operate in shallow waters and for timber rafting, shall be increased by 1 mm in comparison with that required by formula (2.5.76).

2.5.78 Thickness of the outer shell plating in the fore part of all ships (except those mentioned in 2.5.79) shall be increased by 1 mm in comparison with that required by 2.5.76.

2.5.79 Thickness of the outer shell plating of ships operating in shallow water and timber rafting shall be increased by 2 mm in comparison with that required by formula (2.5.76).

2.5.80 Thickness of the side shell plating may be taken by 1 mm less than it is required for the bottom plating of ships of all purposes, except for tugboats and ships intended for timber rafting.

2.5.81 Deck plating thickness, mm, shall be not less than determined by the formula

\[ t = 35a \sqrt{p R_{\text{sh}}} \]  \hspace{0.5cm} (2.5.81)

where \( a \) — spacing, m;
\( p \) — design load taken according to 2.2.26, kPa.

2.5.82 Bulkhead plate thickness, mm, shall be not less than

\[ t = 62a \sqrt{H_s R_{\text{sh}}} \]  \hspace{0.5cm} (2.5.82)

where \( a \) — distance between stays, m;
\( H_s \) — side depth in the given section, m.

2.5.83 Floor web thickness in extremities may be taken equal to floor web thickness in the middle part of ship.

2.5.84 Web framing thickness may be taken by 1 mm less than shell or flooring thickness, but not less than 2.5 mm.

2.5.85 Angle bars may be installed in way of the bilge with sharp lines, and the side and the bottom plating shall be overlap welded to bilge angle bar. Thickness of angle flanges shall be equal to the bottom plating thickness, but not less than 4 mm.

2.5.86 In case of the longitudinal framing system, section modulus of the bottom and deck longitudinal girders with effective flange shall be not less than, cm³,

\[ W = 130pal^2 R_{\text{sh}} \]  \hspace{0.5cm} (2.5.86)

where \( p \) — design load on grillage, kPa, determined as per 2.2.16 to 2.2.29;
\( a \) — distance between girders, m;
\( l \) — girder span, m.

2.5.87 Bulkheads shall be reinforced by stays. Section modulus of stays with effective flange, cm³, shall be not less than

\[ W = 75pal^2 R_{\text{sh}} \]  \hspace{0.5cm} (2.5.87)

where \( p \) — design pressure at the level of the lower end of the stays determined according to 2.2.25, kPa;
\( a \) — distance between stays, m;
\( l \) — span of the stay, m.

Ends of the stays shall be fastened by knees or mitered.

2.5.88 A distance between continuous floors shall be aliquot to the spacing and shall not exceed 1.5 m, and for tugboats 1.0 m.

2.5.89 The height and the cross-sectional area of a keelson may be reduced by 15% as compared with the height and the area of continuous floors over the whole compartment or a part thereof.

2.5.90 Longitudinal ordinary girders and longitudinal web members fitted along the bottom or the deck may be intercostal at the peak bulkheads in the same section.
2.5.91 Length of the knee as per 2.3.9 may be taken equal to the spacing.

2.5.92 Side web frames, beams and bulkhead stays as well as continuous floors, shelves and side stringers may be dispensed with, when the hull strength is provided by non-web members. Here, the required section moduli of longitudinal and transverse members shall be determined from strength calculation carried out in accordance with 2.2.

2.5.93 At least two transverse bulkheads shall be installed.

2.5.94 The engine room shall be separated by bulkheads from other spaces. The engine room bulkhead may be considered as the afterpeak bulkhead provided that requirements of the Rules for floodability and damaged stability are met.

2.5.95 The requirements of 2.3.7 do not apply to the ships up to 12 m in length.

2.5.96 Corrugated structures may be used for bulkhead plates, side plating, deck plating, superstructure walls, as well as for enclosures, walls, roofs of wheelhouses and other secondary walls and flooring plates.

2.5.97 For side plating, trapeze or semicircle corrugates shall be used. Corrugates of watertight hull bulkheads shall be continuous of trapeze, wavy semi-circle or rounded-tip triangle cross-section. For deck plating, only semicircle cross-section corrugates shall be used.

2.5.98 The total height of cutouts in webs of web members for ordinary girders shall not exceed 50% of web member height.

2.5.99 The height of cutouts for drain opening in members shall not exceed 30% of the member height.

2.5.100 Breadth of deck area between the side and the cutout shall be not less than 0.2 m.

2.5.101 Cutouts in the deck plating more than 6 spacings in length and more than 0.2B in width situated in the middle part of ship and forward of the aft engine room shall be rounded with a radius of not less than 10% of the cutout width; similar cutouts situated in the rest part of the deck shall be rounded with a radius of at least 5% of the cutout width. Other cutouts shall be rounded with a radius of at least 5-fold thickness of the deck plating.

2.5.102 Thickness of the bulwark plates may be taken by 2 mm less than that required for the side plating in the middle part of ship, but not less than 1.5 mm.

2.5.103 Cross-section area of the stem made of flat or rod steel determined according to 2.4.100, 2.4.101 may be reduced by 25%.

2.5.104 Cross-section area of the stem made of steel equal-sided angle bars determined according to 2.4.102 may be reduced by 50%. Other symmetrical rolled profiles may be used also.

2.5.105 Cross-section area of the bar keel determined as per 2.4.111-1 and 2.4.111-2 may be reduced by 50%.

2.5.106 Global strength calculations required by 2.2 may be dispensed with, provided that the requirements of 2.5.2 are met. Here, coefficient $k_1$ shall be taken from Table 2.5.2 for ships with the length of 25 m.

2.5.107 Hull global vibration calculation may be omitted.

2.5.108 Watertight bulkheads with a thickness of 3 mm and less (except for the forepeak bulkhead, the afterpeak bulkhead and tank bulkheads) shall be connected to the outer shell plating by continuous single-side weld with a leg equal to the bulkhead plate thickness; the same applies to the butt welds of these bulkheads.

2.5.109 Free ends of girders shall be connected to the shell plating or floor plating by intermittent or dotted welds with reduced pitch and shall be welded around as per 2.3.49.

2.5.110 Framing girders may be connected to each other by overlapping knees. For overlapping joint, the connection places shall be welded around the whole contour.
Tankers with vertical independent tanks

2.5.111 The requirements of 2.5.112 to 2.5.126 apply to tankers fitted with vertical cylindrical independent tanks (cargo tanks), which have draft in fully loaded condition not exceeding 2.25 m and gross tonnage not exceeding 1000 t. The requirements of 2.1, 2.2, 2.3 and 2.4 shall be met as well, if they do not contradict with the requirements of 2.5.112 to 2.5.126.

2.5.112 The main dimension ratios $L/H$ and $B/H$ shall be not more than indicated in Tables 2.1.3-1 and 2.1.3-2 for self-propelled and non-self-propelled dry cargo ships with holds.

2.5.113 Minimum number of watertight transverse bulkheads shall comply with the requirements of 2.4.70.

2.5.114 Design mean wear rate of deck plating shall be taken according to 1.1, 1.5, that of underdeck framing according to 7.1.1, 7.1.5, that of coamings according to 2 of Table 2.2.88, and that of uppermost, middle and lowermost plates of inner sides and bulkheads within cargo holds area according to 5.1.1, 5.1.4 and 6.1.1 of Table 2.2.87. Design mean wear rates of other members are designated according to Table 2.2.87.

2.5.115 Minimum thicknesses of hull members are assigned from Tables 2.4.1-1 and 2.4.1-2 as for dry cargo ships. Here, thickness of all the strakes of watertight bulkheads and inner sides bounding the cargo compartments shall be designated according to 4.1, thickness of the deck plating between the side and a cargo tank of flush deck ships according to 2.1, and thickness of the plating of trunk decks and decks of flush deck ships throughout the breadth of cargo tanks according to 2.3 of Tables 2.4.1-1 and 2.4.1-2.

2.5.116 Vertical independent tanks shall be fitted on and be connected with the web framing of the bottom. One cargo hold bounded at ends by transverse watertight bulkheads may accommodate maximum two cargo tanks. Additionally, transverse trusses shall be installed between the tanks inside the cargo holds. For double-sided tankers, trusses shall be installed in the same plane as the double-side half-bulkheads required by 2.4.71.

In tankers with single sides, in the plane of longitudinal coamings of the cargo holds or carlings situated between the side and the cargo tank, longitudinal trusses or pillars shall be installed in places where respective keelsons intersect with each floor.

In tanker’s deck, in the way of vertical independent tanks, circular cutouts fitted with coaming shall be provided. Diameter of the clear cutout shall exceed the tank diameter by 80 to 100 mm and shall not be more than 0.75 of the ship’s breadth.

Vertical independent tank shall be connected with the ship’s deck by a horizontal circumference member laid around the shell and connected both to the shell and to the coaming of the relevant deck cutout by continuous weld.

2.5.117 Bottom in the cargo holds may be of single type. The distance between floors shall be aliquot to the spacing and shall not exceed 2.0 m.

2.5.118 When determining loads taken for strength calculations of bottom grillage of the cargo compartment, the gravity force of light tank and the gravity force of loaded tank may be assumed distributed uniformly over the whole surface of the grillage. Here, loads $p_{\text{light}}$ and $p_{\text{load}}$, kPa, from the weight of a light tank and loaded tank correspondingly are determined by the formulae:

$$p_{\text{light}} = 9.81Q_{\text{light}}/(L_b B_l); \quad (2.5.118-1)$$

$$p_{\text{load}} = 9.81Q_{\text{load}}/(L_b B_l), \quad (2.5.118-2)$$

where $Q_{\text{light}}$, $Q_{\text{load}}$ — weight of a light tank and loaded tank correspondingly, t;

$L_b$ — see Table 2.4.11-1;

$B_l$ — design floor span taken equal to: for single-sided tankers not fitted with longitudinal trusses in the cargo hold – the ship’s breadth B; for single-sided tankers fitted with longitudinal trusses between the cargo tank and the side – the distance between the longitudinal trusses; for double-sided tankers — the distance between inner sides.
2.5.119 When choosing design spans of floors and beams and when determining design loads on pillars for trunk deck tankers, if there is a continuous longitudinal coaming with the rigidity exceeding the rigidity of the keelson situated under the coaming in question by at least 8 times, and if there are pillars fitted between the coaming and the keelson in places where the keelson intersects with each floor, the system “coaming + keelson” is considered equal to a longitudinal truss.

2.5.120 Section modulus, cm², of a floor of the cargo hold with effective flange, if no double bottom is provided, shall be not less than

\[ W = \frac{0.428k_1k_2dB^2}{p} \]  

(2.5.120-1)

where \( p \) — design pressure on the bottom, kPa, taken equal to the greatest of the values obtained from the formulae:

\[ p = 9.81(T + r + m) - p_{\text{light}} \]  

(2.5.120-2)

\[ p = p_{\text{load}} - 9.81(T - r - m) \]  

(2.5.120-3)

where \( k_1, k_2, d, T, r \) — see 2.4.11;

\( p_{\text{light}}, p_{\text{load}} \) — see 2.5.118;

\( m \) — value, m, taken equal to, for ship classes:

- M-СП, M-ПП, O-ПП, М, О 0.6
- P and ІІ 0.9

Value of \( p \) calculated by formula (2.5.120-3) shall not exceed \( p_{\text{load}} \).

2.5.121 The cargo hold bottom area supported by one pillar of a traverse truss, m², is calculated by the formula:

\[ f = 0.5L_bB_1/(n_k + 2n_t) \]  

(2.5.121-1)

where \( L_b \) — taken from Table 2.4.11-1;

\( B_1 \) — taken as per 2.5.118;

\( n_k \) — number of keelsons between longitudinal trusses or inner sides and, where the latter are not provided, between the outer sides;

\( n_t \) — number of floors between transverse bulkheads or between a transverse bulkhead and a truss.

The cargo hold bottom area supported by a pillar of a longitudinal truss, m², is calculated by the formula:

\[ f = 0.5L_bB_1/(n_k + n_t) + 0.5L_bB/(n_t + 1) \]  

(2.5.121-2)

where \( b \) — distance between the side and the longitudinal truss.

Design load taken by a pillar of the truss, kN, is determined by the formula:

\[ P = fp \]  

(2.5.121-3)

where \( p \) — see 2.5.120.

If there are no longitudinal trusses in the hold, the force taken by one pillar of the longitudinal row of pillars is determined as per 2.2.54 and 2.2.26.3.

2.5.122 Design load on the sides in the independent tanks area is determined in accordance with 2.2.24 as for dry cargo ships. If there is no double bottom, in formulae (2.2.24-1) and (2.2.24-2) it shall be taken as \( h_{db} = 0 \).

2.5.123 Design load applied to transverse cargo hold bulkheads in the area of vertical independent tanks is determined according to 2.2.25.3.

2.5.124 Design load for tanker deck in the vertical independent tanks area is determined according to 2.2.26.3.

2.5.125 Section modulus of beams and half-beams with effective flange in the vertical independent tanks area is determined according to 2.4.48.3.

2.5.126 Section modulus of under-deck longitudinal girders with effective flange in the vertical independent tanks area is determined according to 2.4.51.4.

Floating cranes

2.5.127 The requirements of 2.5.128 to 2.5.141 apply to non-propelled boom grab-hooked floating cranes of O-ПП (неа) and O (nea) classes with full-swing upper lifting structure non-movable along the hull (pontoon) with a lifting capacity up to 25 t, a length up to 50 m and main dimensions ratio \( L/H \leq 15, B/H \leq 7 \).

In addition, the requirements of 2.1 to 2.3 shall be met if they are not contradict with the requirements of 2.5.128 to 2.5.141.
Note: the О-ПП and О classes for floating cranes are assigned according to the navigation conditions for towing with boom fastened in the cruising position. Limiting wind and wave operation conditions are designated by a designer.

If main dimension ratios differ from those given in this paragraph, structure and scantlings shall be verified by additional strength calculations.

2.5.128 Structure of crane foundation shall consist of a bearing ring, a drum and a cross made of longitudinal and transverse bulkheads (Fig. 2.5.128).

Fig. 2.5.128 Crane foundation design
1 — bearing ring, 2 — drum, 3 — longitudinal bulkheads of the cross, 4 — transverse bulkheads of the cross, 5 — forepeak bulkhead, 6 — afterpeak bulkhead

2.5.129 Peak bulkheads shall be located at the distance of at least one spacing towards the middle frame from the beginning of the parallel body. In all cases, the forepeak length shall be not less than 7-fold spacing and the afterpeak length not less than 5-fold spacing.

2.5.130 Pontoon sides, the forepeak and the afterpeak shall have the transverse framing system. The spacing in the forepeak and the afterpeak shall be not more than 400 mm and floors shall be installed at each frame.

Where the spacing is over 400 mm, in the fore and aft extremities intermediate frames shall be fitted at the sides with the section modulus with effective flange meeting the requirements of 2.4.121.

2.5.131 Transverse bulkheads of the cross shall be flat over the entire pontoon’s breadth and longitudinal bulkheads of the cross shall be flat over at least three spacings forwards of and abaft the place of connection with the drum. Other bulkheads of floating cranes may be corrugated.

Longitudinal bulkheads of the cross shall be installed either over the entire pontoon’s length or between the forepeak and the afterpeak bulkheads.

Ordinary framing of the flat bulkheads as well as corrugations shall be arranged vertically.

2.5.132 Thicknesses of the below mentioned pontoon hull members with regard to ice strengthening shall be taken not less than, mm:
- outer shell plating and deck plating over the entire pontoon’s length 8.0
- plates of flat transverse bulkheads of the cross over the entire pontoon’s breadth and of longitudinal bulkheads of the cross over at least three spacings forward of and abaft the place of connection with the drum 8.0
- rest plates of bulkheads 6.0
- bilge strake over the entire pontoon’s length 10.0

2.5.133 Drum wall thickness \( \delta \), mm, shall be not less than one obtained by the formula

\[
\delta = \left( P_c + Q_c \right) \left( 1 + 2C/R \right) / (16R),
\]

(2.5.133)

where \( P_c \) — crane lifting capacity, t;
\( Q_c \) — crane weight (upper structure), t;
\( R \) — drum radius, m;
\( C \) — distance from the drum axis to the crane’s C.G. with the greatest load at the maximum boom reach, m.

Regardless of the calculation results, the drum wall thickness shall not be taken less than 8 mm.

2.5.134 A distance between the side and the longitudinal bulkhead of the cross shall be taken as a design span \( B_i \) of floors and web beams, when determining their section modulus; here, \( B_i \) shall be not less than 0.38 \( B \).

2.5.135 Section modulus of a side web frame with effective flange over the entire pontoon’s length, cm\(^3\), shall be not less than

\[
W = 0.14LBHd_i,
\]

(2.5.135)

where \( d_i \) — distance between the web frames in the middle part of ship, m.
2.5.136 Section modulus of a side ordinary frame with effective flange over the entire pontoon’s length, \( cm^3 \), shall be not less than

\[
W = 0.10LBla,
\]

(2.5.136)

where \( l \) — the greatest distance measured along the side between the bottom and a side stringer or between a side stringer and the deck, m;

\( a \) — spacing in the middle part of ship, m.

2.5.137 Transom stays shall be maximum 400 mm apart.

Web stays shall be installed in the keelson planes. Free flange of the web stay shall have a cross-sectional area of at least 0.65 of the cross-sectional area of a keelson free flange.

Section modulus of an ordinary stay or intermediate stay with effective flange shall be not less than a section modulus of an ordinary frame with effective flange determined in accordance with 2.5.136.

Where a distance between stays is more than 400 mm, intermediate stays shall be fitted and their section modulus with effective flange shall be not less than 75% of the section modulus of main ordinary stays with effective flange.

2.5.138 Thickness of a bearing ring web shall be not less than 10 mm, thickness of a free flange not less than 20 mm. Thickness of webs of vertical knees supporting the web and the flange shall be not less than 10 mm. A distance between the knees measured over a chord of the bearing ring shall not exceed 0.70 m.

Constructional difference in wall thickness of the bearing ring and the drum shall be compensated by fitting, between the bearing ring and the drum, a horizontal circular piece at least 12 mm thick which may be made of separate rectangular plates.

Fastening of the bearing ring to the deck shall be such as to prevent formation of stress concentration centres. Knees shall not be welded to non-reinforced deck plates; in the plane of knees under the deck a stiffener or another structural element shall be fitted which shall be adequately connected with the framing.

2.5.139 Section modulus of vertical web stays with effective flange of the drum and flat bulkheads of the cross (mentioned in 2.5.131) shall be not less than that determined for the side web frame according to 2.5.135.

2.5.140 Distance between vertical members of the drum measured over a chord shall not exceed 0.70 m.

Section modulus of ordinary stays with effective flange of the drum and flat bulkheads of the cross (mentioned in 2.5.131) shall be not less than that determined for the side ordinary frame according to 2.5.136.

2.5.141 Local strength of the forepeak and the afterpeak bulkheads shall be ensured with due regard to the design load as specified in 2.2.25.1.

**Tankers fitted with longitudinal round cylindrical built-in tanks**

2.5.142 The requirements of 2.5.143 to 2.5.156 apply to tankers fitted with one or two longitudinal cylindrical built-in tanks rigidly connected to the hull and participating in global bending.

2.5.143 In all cases not stipulated in 2.5.144 to 2.5.162, the requirements of 2.1 to 2.4 are applied.

2.5.144 Vertical distance between the upper edge of the cylindrical tank and the deck in the centreline plane shall not exceed, for ship classes:

- О-ПР, О, P, J — 0.7\( d_t \)
- М-СП, М-ПР, М — 0.6\( d_t \)

where \( d_t \) — diameter of the cylindrical tank, m.

2.5.145 Vertical distance between the lower edge of the cylindrical tank and the deck in the centreline plane shall not exceed, for ship classes:

- М-СП — 200
- М-ПР, М — 235
- О-ПР, О, P — 285
In any case, thickness $t$ shall be at least, mm, for ship class:

- M-СІІ: 14
- М-ПР, М: 12
- О-ПР, О, П: 10

Plating thickness $t_1$ of below-deck section of the cylindrical tank may be taken by 30% less than that of above-deck section. For ships of M-СІІ class the thickness $t_1$ of below-deck section of the cylindrical tank shall be at least 10 mm.

2.5.147 Constructional difference in wall thickness in butts and seams of the adjoining plates of the cylindrical tank shall not exceed 15% of the thickest plate thickness or 3 mm, whichever is less. Constructional angular offset of the cylindrical tank in the field joint area (angular offset of the cylinder generatrix may occur during ship construction due to constructional difference in shapes of cross-sections of the adjoining shells) shall not exceed the thickest plate thickness. Diameter tolerance of the cylindrical tank measured in any direction in the frame plane shall not exceed 0.3% of the design diameter value.

2.5.148 Provision shall be made for smooth ends of longitudinal cylindrical tanks in fore and aft extremities of the ship using flat inclined sections at the tank ends. The inclination angle of such a flat section to the deck shall not exceed 30°.

2.5.149 The transverse bulkheads and trusses shall be installed in the hull according to the 2.5.8. End transverse bulkheads and one midship transverse bulkhead in the tanks shall be arranged in the same vertical plane with the transverse hull bulkheads. Other transverse bulkheads may be fitted in the planes of hull’s web frames.

2.5.150 Below-deck cylindrical shells shall be reinforced by circular web frames fitted maximum 4 m apart and running along the external surface of the shell in the planes of hull’s web frames.

2.5.151 A keelson running over the whole length of the tank shall be fitted between each cylindrical tank and the hull bottom. The tanks shall be connected to the bottom by means of brackets fitted between the tank’s circular web frames and the hull’s floors. At each side of the keelson, brackets shall be fitted over the floor length equal to the shell radius.

2.5.152 Scantlings of the ships under consideration are determined according to 2.4 as for single-bottom dry cargo ships; here, the value of $B_1$ (see 2.4.11) is not less than $B/2$ for tankers with one tank and not less than $B/3$ for tankers with two tanks.

2.5.153 Minimal thickness of the shell plating, sheerstrake and deck stringer in the middle part of ship shall be determined from Tables 2.4.1-1 and 2.4.1-2 as for ships with reduced length

$$L_{red} = LH/H_1,$$

where $H_1$ — hull girder height, m.

2.5.154 Maximum normal stresses in the upper edge of longitudinal cylindrical shell under compression in the limit state (during ship sagging), MPa, shall not exceed the critical stresses determined by the formula:

$$\sigma_{cr} = kE t/R,$$  \hspace{1cm} (2.5.154)

where $k$ — coefficient equal to 0.36 for $75 < R/t < 300$;

$E$ — Young’s modulus of the shell material, MPa;

$R/t$ — cylindrical shell radius to thickness ratio in the above-deck section.

2.5.155 Critical pressure $p_{cr}$ caused by depression due to cargo unloading and uniformly distributed along the cylindrical shell surface, kPa, shall comply with the following condition

$$p_{cr} \geq 1.5p_E,$$  \hspace{1cm} (2.5.155-1)

where $p_E$ — vacuum during cargo unloading, corresponding to the breathing valve setting, kPa, equal to 7 kPa.

The critical stress value, kPa, is taken as the following

$$p_{cr} = 920E(R/L_1)(t/R)^{2.5},$$  \hspace{1cm} (2.5.155-2)

where $E$ — Young’s modulus of the shell material, MPa;
$R$ — cylindrical shell radius, mm;  
$L_t$ — maximal length of the cargo hold (distance between transverse bulkheads in the cylindrical tank), mm;  
$t$ — cylindrical shell thickness in the above-deck section, mm.

2.5.156 Circular normal stresses in the lowermost point of the cylindrical shell (in the longitudinal plane), MPa, shall comply with the following condition

$$
\sigma_y = \left( p_e + 19.62 \cdot 10^{-3} R \right) \left( R/t_1 \right) \cdot 10^{-3} \leq 0.8 R_{th},
$$

(2.5.156)

where $p_e$ — excessive pressure in the cargo hold corresponding to the breathing valve setting, kPa;  
$R$ — cylindrical shell radius, mm;  
t_1 — cylindrical shell thickness in the below-deck section, mm;  
$R_{th}$ — yield point of the cylindrical shell material, MPa.

Tankers fitted with longitudinal cylindrical independent tanks

2.5.157 The requirements of 2.5.158 to 2.5.161 apply to tankers fitted with one or two longitudinal cylindrical independent tanks not participating in global bending. The tanks shall be fastened in such a manner as to prevent transfer of loads or displacements with respect to the hull structures. Weight of independent tanks and loads induced by them shall be uniformly distributed between the hull structures.

2.5.158 The pressurized tanks shall be designed for strength according to 8 Part IV of the Rules, and testing methods shall comply with the requirements of Appendix 10 RTSC.

2.5.159 Cargo tank material shall be resistant to aggressive cargoes or the internal surfaces of the cargo tanks shall have a suitable protective coating.

2.5.160 Covers of the cargo tank hatches and manholes shall be tight.

2.5.161 The distance between the independent tanks and the side or bottom shall be not less than that for ships with built-in tanks.

2.6 VIBRATION STRENGTH

General requirements

2.6.1 The present requirements are set up to provide strength of the hull structures and reliable operation of onboard equipment.

2.6.2 When calculating vibration, it is necessary to verify the absence of resonance by comparing natural oscillation frequencies with frequencies of exciting forces due to operation of main and auxiliary engines, propellers and other sources of vibration.

2.6.3 In addition to meeting the requirements of 2.6.2, the following shall be verified:

1. global vertical oscillations of the hull for the first two tones in design loading conditions: fully loaded condition and lightship condition with ballast;
2. local first-tone oscillations of ordinary members, stiffeners and outer shell plating, decks, platforms, bulkheads and webs of web members.

2.6.4 Local oscillations shall be checked in the following areas:

1. the bottom between the transom and a section located 3 propeller diameters forward of the centre of propeller disc for single-propeller ships and 4 propeller diameter forward of the centre of propeller disc for two- or three-propeller ships;
2. ship compartments where engines (main and auxiliary) and other similar machinery are installed;
3. tanks adjacent to the engine room.

2.6.5 Calculations of global and local vibration, as well as experimental determination of vibration parameters shall be carried out for:

1. first ship in a series;
2. ships of single construction;
3. ships after a major overhaul repair;
4. ship on which main and auxiliary engines or other similar machinery were replaced or propellers of different dimensions were installed.

Global vibration calculation

2.6.6 In order to prevent resonance, natural oscillation frequencies of the first tone
shall differ by 15%, and those of the second tone by 20%, from the frequency of exciting forces equal to:

.1 propeller revolution frequency;
.2 propeller revolution frequency multiplied by the number of blades;
.3 engine crankshaft revolution frequency;
.4 doubled engine crankshaft revolution frequency;
.5 engine crankshaft revolution frequency multiplied by a number of operation cycles \( n_c \) in the engine cylinders per revolution as obtained by the formula:

\[
n_c = ki, \quad (2.6.6.5)
\]

where \( k \) — coefficient equal to:

- for two-stroked engine 1
- for four-stroked engine 0.5

\( i \) — number of engine cylinders;
.6 running frequency of the scoop chain when running from the upper drum;
.7 bottom scoop drum revolution frequency;
.8 mechanical loosener revolution frequency;
.9 mechanical loosener revolution frequency multiplied by the number of cutters.

2.6.7 Frequency \( N_1 \) of the first-tone natural vertical oscillations relating to the hull, Hz, shall be determined by the formulae:

.1 for cargo ships (including tankers)

\[
N_1 = 6.25 \cdot 10^6 \sqrt{I/[1.2 + B/(3T)]D' L^2}; \quad (2.6.7.1)
\]

.2 for passenger ships and cargo-and-passenger ships

\[
N_1 = 5.92 \cdot 10^6 \sqrt{I/[1.2 + B/(3T)]D' L^2}; \quad (2.6.7.2)
\]

.3 for tugboats and pushboats

\[
N_1 = 5.27 \cdot 10^6 \sqrt{I/[1.2 + B/(3T)]D' L^2}; \quad (2.6.7.3)
\]

where \( I \) — area moment of inertia of the hull girder midship section, \( m^4 \) (see 2.2.9);

\( B \) — ship breadth, m;

\( T \) — ship draught amidships, m;

\( D' \) — ship displacement, t;

\( L \) — ship length at the actual waterline, m.

Values of these parameters are taken for design loading conditions.

The moment of inertia shall be determined with due regard to the superstructure participation in the hull global bending as per 2.2.34.

2.6.8 Frequency \( N_2 \) of natural vertical oscillations of the second tone relating to the hull, Hz, shall be determined by the formulae:

.1 for cargo ships

\[
N_2 = 2.6N_1; \quad (2.6.8.1)
\]

.2 for passenger ships and tugboats (pushboats)

\[
N_2 = 2.3N_1. \quad (2.6.8.2)
\]

Local vibration calculation

2.6.9 In order to prevent resonance, natural oscillation frequencies of the first tone shall exceed – by at least 50% for plates and by 30% for ordinary members and stiffeners – the frequencies of exciting forces equal to:

.1 shaft revolution frequency multiplied by the number of propeller blades;
.2 engine crankshaft revolution frequency multiplied by the number of operating cycles in the engine cylinders per revolution of the crankshaft;
.3 revolution frequency of lower or upper scoop drum, whichever is greater;
.4 mechanical loosener revolution frequency multiplied by the number of cutters (see footnote in 2.6.9.1).

The required frequency excess shall be ensured for all basic operational modes of the ship.

Note. For basic operational modes of prime movers, generators and cargo pumps, the exciting

1 In the area of intensive affection of exciting forces due to operation of propellers (see 2.6.4.1).

2 In the area of compartments where the engines and other machinery are installed.

3 In the area of effectors.
force frequency may exceed (by at least 30%) the natural oscillation frequency.

If the required frequency excess is not ensured, design measures shall be provided to increase the natural oscillation frequency. Efficiency of these measures shall be verified by repeated calculation.

The above frequencies may be exceeded by 25% for plates and by 15% for ordinary framing and stiffeners, provided that a designer submits a well-grounded calculation of forced vibration to prove that oscillation amplitude of the mentioned components does not exceed the permissible value (see 2.6.25).

2.6.10 Natural oscillation frequency $N$ of the first tone of an outer shell plate resting on web members and not reinforced by ordinary members or stiffeners, Hz, is determined by the formula:

$$N = \pi \left(1 + a^2 / b^2\right) \sqrt{E / \left[12 \rho (1 - \mu^2)\right]} / \left(2a^2\right),$$

(2.6.10)

where $a$ — shorter side of the plate, m;
$b$ — longer side of the plate, m;
$E$ — Young’s modulus of the plate material, Pa;
$\rho$ — plate material density, kg/m$^3$;
$\mu$ — Poisson’s ratio of the plate material.

2.6.11 Natural oscillation frequency $N^*$ of the plate with due regard to added masses of liquid, Hz, shall be calculated by the formula:

$$N^* = N / \sqrt{k_p},$$

(2.6.11-1)

where $N$ — see 2.6.10;
$k_p$ — added mass coefficient to natural oscillation frequencies of plates determined by the formulæ:

- when the plate is washed by liquid from one side,
  $$k_p = 1 + \alpha \rho_{liq} a / (\rho t)$$
  (2.6.11-2)
- when the plate is washed from both sides by liquids of different densities,
  $$k_p = 1 + \alpha \rho_{liq} / (\rho_{liq} + \rho_{liq}^* ) / (\rho t)$$
  (2.6.11-3)

$\rho_{liq}$, $\rho_{liq}^*$ — densities of liquids, kg/m$^3$;
$\rho$ — plate material density, kg/m$^3$;
$\alpha$ — coefficient determined depending on the plate sides ratio from Table 2.6.11;
$t$ — plate thickness, m.

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</tbody>
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2.6.12 Natural oscillation frequency $N_p$ of the first tone of outer shell plate cells resting on web members and reinforced by ordinary members or stiffeners (Fig. 2.6.12), Hz, is determined by the formula:

$$N_p = 0.5 \pi \left(1 + c^2 / l^2\right) \sqrt{E t^2 / [12 \rho (1 - \mu^2)]} / (2c^2),$$

(2.6.12)

where $c$ — shorter side of the plate cell formed by web and ordinary members, m;
$l$ — longer side of the plate cell, m;
$E$, $t$, $\rho$, $\mu$ — see 2.6.10 and 2.6.11.

2.6.13 Natural oscillation frequency $N_{p*}$, Hz, of the plate cell with due regard to added masses of liquid shall be calculated by the formula (2.6.11-1). Here, liquid added mass coefficient is determined by the formulæ:
when the plate is washed by liquid from one side,
\[ k_p = 1 + \alpha a p_{\text{liq}} / (p t), \] (2.6.13-1)
when the plate is washed from both sides by liquids of different densities,
\[ k_p = 1 + \alpha a (p_{\text{liq}}' + p_{\text{liq}}^*) / (p t), \] (2.6.13-2)
where \( \alpha \) — coefficient determined from Table 2.6.11 depending on the ratio of the cell sides.

\( c \) — shorter side of the plate cell, m;
\( \rho_{\text{liq}}, \rho_{\text{liq}}', \rho, t \) — see 2.6.11.

2.6.14 Natural oscillation frequency of the first tone of the ordinary members or stiffeners, Hz, is determined by the formula:
\[ N_p = K \sqrt{E i / (m_p t^4)}, \] (2.6.14-1)
where \( K \) — coefficient equal to:
- when both ends of profiles are freely resting \( 1.57 \)
- when one end of profile is freely resting and the other one is constrained \( 2.46 \)
- when both ends of profile are constrained \( 3.56 \)
\( E \) — Young’s modulus, Pa;
\( i \) — area moment of inertia, \( m^4 \), of a stiffener or ordinary member with effective flange of the plating, whose scantlings are determined according to 2.2.53.1;
\( m_p = p (f + ct), \) (2.6.14-2)
\( l \) — length of the stiffener, m;
\( f \) — cross-sectional area of the isolated stiffener, \( m^2 \);
\( t \) — see 2.6.10;
\( c \) — see 2.6.12.

2.6.15 Natural oscillation frequency \( N_{fr}^* \), Hz, of the ordinary members or stiffeners with due regard to the added masses of liquid shall be calculated by the formulae:
\[ N_{fr}^* = N_{fr} / \sqrt{k_{fr}}, \] (2.6.15-1)
where \( k_{fr} \) — coefficient of the added masses effect which shall be determined regardless of orientation of stiffeners by the formula:
\[ k_{fr} = 1 + \alpha p_{\text{liq}} a / (\rho t_{\text{red}}), \] (2.6.15-2)
where \( p_{\text{liq}} \) — see 2.6.11.

Values of coefficient \( \alpha \) shall be taken from Table 2.6.11 depending on the \( a/b \) ratio, i.e. dimensions of plates before ordinary members or stiffeners are fitted.

Reduced thickness \( t_{\text{red}} \) of plate with stiffener, m:
\[ t_{\text{red}} = t + f / c, \] (2.6.15-3)
where \( t, f, c \) — see 2.6.14.

When the plate reinforced by ordinary members is washed by liquid from both sides, \( k_{fr} \) is determined by the formula
\[ k_{fr} = 1 + \alpha (p_{\text{liq}}' + p_{\text{liq}}^*) a / (\rho t_{\text{red}}), \] (2.6.15-4)
where \( p_{\text{liq}}' \) and \( p_{\text{liq}}^* \) — see 2.6.11.

2.6.16 A ratio of natural oscillation frequencies of the ordinary members (or stiffeners) and an outer shell plate shall meet the condition \( N_p^*/N_{fr}^* > 2 \).

2.6.17 Natural oscillation frequency \( \sigma \), Hz, of the first tone of the inner structure plates resting on web members and not reinforced by ordinary members or stiffeners shall be determined by the formula:
\[ N = 1.13 \pi \sqrt{1 + 0.605 a^2 / b^2 + a^4 / b^4} \times \sqrt{E i / \left[ 12 \rho (1 - \mu^2) \right]} \right] / a^2, \] (2.6.16)
where \( a, b, E, t, \mu \) — see 2.6.10.

2.6.18 Natural oscillation frequency of plates mentioned in 2.6.17 with due regard to added masses of liquid shall be calculated by formulae (2.6.11-1) to (2.6.113). Coefficient \( \alpha \) shall be taken according to Fig. 2.6.18 depending on the \( a/b \) side ratio from the \( n = 1 \) curve.

2.6.19 Natural oscillation frequency, Hz, of the inner structure plate cells resting on web members and reinforced by ordinary members or stiffeners (see Fig. 2.6.12) shall be determined by the formula:
\[ N_p = 1.13 \pi \sqrt{1 + 0.605 c^2 / l^2 + c^4 / l^4} \times \sqrt{E i / \left[ 12 \rho (1 - \mu^2) \right]} \right] / c^2. \] (2.6.19)
2.6.20 Natural oscillation frequency $N_{sp}^*$, Hz, of the plate cell with due regard to added masses of liquid shall be calculated by formula (2.6.11-1). Added-mass coefficient shall be determined by formulae (2.6.13-1) and (2.6.13-2). Coefficient $\alpha$ in these formulae shall be selected using Fig. 2.6.18 depending on the ratio of cell sides $c/l$ from the curve corresponding to $n$ equal to number of cells.

2.6.21 Natural oscillation frequency of the first tone of the ordinary members or stiffeners for inner structures, when they oscillate in the air, shall be determined by formulae (2.6.14-1) and (2.6.14-2). The liquid added masses is regarded by formulae (2.6.15-1) to (2.6.15-4).

2.6.22 Calculation of natural oscillation frequency of plates and ordinary members or stiffeners for inner structures shall be considered completed, when $N_{sp}^*/N_{sp}^* > 2$ (or $N_{sp}/N_{p} > 2$ for structures in the air). Otherwise, interaction between the plates and stiffeners, when they oscillate, shall be considered (see 2.6.23).

2.6.23 Natural oscillation frequency $N_c$, Hz, of the first tone of the plates by the inner structure stiffeners, which support these plates, with due regard to its interaction shall be calculated by the formula:

$$
N_c^2 = \frac{A_1 + A_2 \pm \sqrt{(A_1 + A_2)^2 - 4A_1A_2(1-\beta_1\beta_2)}}{2(1-\beta_1\beta_2)},
$$

(2.6.23-1)

where $A_1$ and $A_2$ — squares of natural frequencies of a plate and a stiffener (or an ordinary member) correspondingly, determined as per 2.6.19 to 2.6.21;

$\beta_1, \beta_2$ — coefficients calculated by the formulae:

$$
\beta_1 = 4\left[1 + \sqrt{1.5(k_p^2 - 1)(k_p^2 - 1)t_{red}/l}\right]/(3k_p);
$$

(2.6.23-2)

$$
\beta_2 = 0.5r\left[1 + \sqrt{1.5(k_p^2 - 1)(k_p^2 - 1)t_{red}/l}\right]/(t_{red}k_p);
$$

(2.6.23-3)

$t_{red}$ — reduced thickness of the plate with a stiffener determined by the formula (2.6.15-3).

Frequency $N_c$ shall comply with the requirements of 2.6.9 as for plates.

**Vibration norms**

2.6.24 Regardless of the calculation results of global and local vibration in ships listed in 2.6.5, vibration amplitudes and frequencies of the following structures shall be measured:

1. the aft extremity of hull;
2. plates of the outer shell plating and the inner structures of the hull and the superstructure;
3. ordinary members and stiffeners;
4. bearing surfaces of foundations;
5. web members in the grillage;
6. engines and similar equipments.

In these ships, it is recommended to obtain experimentally frequencies of vertical hull oscillations of the first two tones and to compare them with frequencies obtained by calculation.

In these ships, it is recommended to obtain experimentally frequencies of vertical hull oscillations of the first two tones and to compare them with frequencies obtained by calculation.

These measurements shall be made on deep water\(^1\), as well as at limited depth under

\(^1\) Deep water means that depth $H$ of a water body does not affect propulsion performance
of the bottom (shallow water conditions) at design draught in loaded conditions and lightship conditions for all basic operational modes of the main and auxiliary engines and onboard equipment in accordance with the program of vibration testing elaborated by a designer meeting the requirements of the Rules and approved by the River Register.

2.6.25 Oscillation amplitudes measured during the experiment shall not exceed the vibration norms defined by the following formulae:

1. Permissible amplitudes $A_1$, mm, of vertical oscillations of the aft extremity of ship are defined by the formula:

$$ A_1 = 2 \left( 1 + 0.04N^2 \right) \frac{N}{1 + 0.04N^2}, $$

where $N$ — actual oscillation frequency measured during the experiment, Hz.

2. Permissible oscillation amplitudes $A_2$, mm, of bearing surfaces of the engine foundations for frequencies $N = 10$ Hz are 0.5; for frequencies over 10 Hz the amplitudes $A_2$ are determined by the formula:

$$ A_2 = 1 \left( 0.02N^2 \right), $$

3. Permissible oscillation amplitudes $A_3$, mm, of plates in their centre are determined by the formula:

$$ A_3 = 0.125 \left( \frac{a}{100t} \right)^2 t, $$

where $a$ — shorter side of the plate, mm;
$t$ — plate thickness, mm.

4. Permissible oscillation amplitudes $A_4$, mm, of ordinary members and stiffeners in the middle of the span are determined by the formula:

$$ A_4 = 4000W^2 \left( E_i \right), $$

where $W$ — section modulus of the profile with effective flange, $m^3$;
$l$ — span of an ordinary member or a stiffener, m;
$E$ — Young’s modulus of the material, MPa;
$i$ — area moment of inertia of the profile with effective flange, $m^4$;

5. Permissible oscillation amplitudes $A_5$, mm, of web members in the grillage are defined as the least of the two values determined by formulae (2.6.25.1) and given below:

$$ A_5 = 1250W^2 \left( E_i \right). $$

Vibration reducing measures

2.6.26 When vibration exceeds the normative value, measures aimed at its reducing down to the values required by respective norms shall be developed.

Efficiency of the introduced measures shall be proved by repeated measurements of vibration for all basic operational modes of main and auxiliary engines of the ship.

2.6.27 Measures aimed at reducing the global vibration at the frequency equal to the propeller shaft revolution frequency include:

1. Checking propeller’s geometry (pitch of blades, pitch of sections and positional relationship of the axis of blades on the propeller circle). Where deviations exceeding the design limits are found, this propeller shall be replaced;

2. Filling or discharge of ballast tanks;

3. Changing propeller shaft revolution frequency.

2.6.28 Measures aimed at reducing the global vibration with frequency aliquot to the number of propeller blades include:

1. Changing location of the propeller with respect to the hull or a propeller duct;

2. Changing the number of propeller blades;

3. Changing the contours of protruding parts in order to have them streamlined;

4. Fitting special arrangements to make the field of velocities in the propeller disc more even;

5. Fitting shock absorbers in the hull above the propellers.

2.6.29 In order to reduce local vibration of frequency aliquot to the number of propeller
blades, in addition to the measures listed in 2.6.28 proceed as follows:

1. thicken the oscillating plates or reinforce them by intermediate stiffeners;
2. check correctness of design of connections in the places of intersection of longitudinal and transverse members; arrange closed framing rings; check quality of welded joints.

2.6.30 In order to reduce local vibration of frequency aliquot to the frequency of the engine crankshaft revolution, in addition to the measures listed in 2.6.29 proceed as follows:

1. place engines on shock absorbers or suspended joist foundations;
2. connect the engines installed on shock absorbers with other onboard machinery by elastic couplings.

2.6.31 The list of measures stated in 2.6.29 and 2.6.30 is not exhaustive. Other measures to reduce vibration down to the required values shall be taken in each particular case on the basis of analysis of vibration measurements.
3 DESIGN OF DISPLACEMENT SHIP ALUMINUM ALLOY HULLS

3.1 GENERAL REQUIREMENTS

3.1.1 In regard to provisions not specified in the present Section, refer to the requirements of 2.1 to 2.5.

3.2 MATERIALS AND MINIMUM THICKNESSES OF HULL MEMBERS

3.2.1 The materials used for fabrication of hull structural components of aluminum alloys shall comply with the requirements of 4 Part X of the Rules.

3.2.2 The minimum permissible plate thickness of the hull members shall not be less than that stated by the requirements of the Rules to steel ship hulls.

3.3 DETERMINATION OF HULL STRENGTH MEMBERS’ SCANTLING

3.3.1 Influence of the hull flexibility on the bending moment and shear force shall be regarded, if

$$L^4 B/(EI) > 6.01 \cdot 10^3,$$  \hspace{1cm} (3.3.1)

where $L, B$ — design DWL length and breadth of a ship, m;
$E$ — Young’s modulus of the hull material, MPa;
$I$ — area moment of inertia of the hull girder, m$^4$;

3.3.2 When calculating the framing girders, width of effective flange, cm, shall be determined by the following formulae:

1. for the bottom and double bottom longitudinal stiffeners, ordinary frames and beams (Fig. 3.3.2.1, a, d)

$$c_1 = 0.5a;$$  \hspace{1cm} (3.3.2.1)

2. for floors, beams and frames in case of the longitudinal framing system, keels and carlings in case of the transverse framing system (Fig. 3.3.2.1 b, d)

$$c_2 = c_1 + (b - c_1)\varphi_1,$$  \hspace{1cm} (3.3.2.2)

where $c_1$ — width of effective flange as per 3.3.2.1, cm;
$\varphi_1$ — coefficient equal to zero for compressed effective flange and defined from Table 3.3.2.2 for tensioned effective flange of plating;

3. for floors, beams and frames in case of the transverse framing system, keels and carlings in case of the longitudinal framing system (Fig. 3.3.2.1, b, d)

$$c_3 = 0.5na(1 + \varphi_2),$$  \hspace{1cm} (3.3.2.3)

where $n$ — number of rigid and reduced sections;
$\varphi_2$ — coefficient equal to 1 for tensioned effective flange and defined from diagram on Fig. 3.3.2.3 for compressed effective flange.
### Table 3.3.2.2

<table>
<thead>
<tr>
<th>$\sigma_{\text{perm}}$ (MPa)</th>
<th>Design pressure $p$, kPa</th>
<th>Values of $\varphi$ at $100 \frac{t}{a}$ equal to</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>70.6</td>
<td>10</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>0.18</td>
</tr>
<tr>
<td>98.2</td>
<td>10</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>0.18</td>
</tr>
<tr>
<td>137</td>
<td>10</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>0.19</td>
</tr>
</tbody>
</table>

**Note.** $\sigma_{\text{perm}}$ — permissible stress; $t$ — plate thickness, cm.

#### 3.3.5 For constrained plates, maximum stresses $\sigma$ in a section at the bearing contour, when subjected to transverse load, shall be determined by Fig. 3.3.5.

#### 3.3.6 For plates, for which stresses in the bearing sections are not regulated, $\sigma$ due to transverse load shall be found by Fig. 3.3.6.

#### 3.3.7 Euler’s stresses in plates, MPa, shall be calculated by the formulae:

- in case of compression along the long side of the bearing contour
  \[ \sigma_E = 26 \left( \frac{100t}{a} \right)^2; \]  
  (3.3.7-1)
- in case of compression along the short side of the bearing contour
  \[ \sigma_E = 120 \left( \frac{100t}{a} \right)^2; \]

### Notes
- The effective flange width in all cases shall not exceed $\frac{1}{6}$ length of design span of the girder concerned.
- **3.3.3** Webs of profiles, in case of web height to thickness ratio exceeds 60, shall be reinforced by stiffeners.
- **3.3.4** A free flange width $b_f$ to thickness $t_f$ ratio shall not exceed the value determined by the formula:
  \[ b_f/t_f = 100 \sqrt{2.65/R_{\text{Hy}}} \]  
  (3.3.4)
  where $R_{\text{Hy}}$ — yield point of the material, MPa.
  The $b_f/t_f$ ratio shall not exceed 14.
\[ \sigma_E = 6.37 \left( 100 t / a \right)^2 \left( 1 + a^2 / b^2 \right)^2; \]  
(3.3.7-2)

in case of shear forces (the side plates)

\[ \tau_E = 6.37k \left( 100 t / a \right)^2, \]  
(3.3.7-3)

where \( t \) — plate thickness, cm;
\( a \) — length of the short side, cm;
\( b \) — length of the long side, cm;
\( k \) — coefficient determined from Table 2.2.75.

3.3.8 The spacing of a transversely framed hull shall be taken not more than 500 mm.

In case of the longitudinal framing system of the bottom and decks, the spacing shall not exceed 600 mm.

The spacing in way of forepeak shall be decreased down to 400 mm.

3.3.9 Continuous floors shall be installed at least every three spacings. Bracket floors are not allowed.

3.3.10 Section modulus of the continuous floors, \( cm^3 \), shall be at least

\[ W = 62.5Q B_t / \sigma_p, \]  
(3.3.10)

where \( Q \) — total load on the floor, kN;
\( B_t \) — hold width at a level of the upper floor edge, m;
\( \sigma_p \) — permissible stresses, MPa.

3.3.11 Keelsons shall be installed in such a way that a distance between them, for ships of all classes, does not exceed 2 m. Area moment of inertia of centre keelson shall not be less than 1.5 of the area moment of inertia of continuous floor and 0.75 of that of the side keelsons.

3.3.12 The minimum thickness of the outer shell plating shall be specified based on the calculation results.

3.3.13 Area moment of inertia of side branch of a web frame, \( cm^4 \), shall not be less than

\[ I_1 = 2IH / B_t, \]  
(3.3.13)

where \( I \) — area moment of inertia of the floor, \( cm^4 \);
\( H \) — height of the side frame branch, m;
\( B_t \) — hold width at the level of the upper floor edge, m.

3.3.14 Where the side depth is 2 to 3 m, one side stringer is required; when it exceeds 3 m, two side stringers are required.

3.3.15 Thickness of the side outer shell plating shall be taken the same as that of the bottom.

3.3.16 A ratio of critical normal stress and the yield point is a buckling criterion of the grillage's girders \( \sigma_{cr} / R_{el} \); this ratio is determined by the diagram (Fig. 3.3.16) and shall be not less than the following:

for longitudinal web members of the deck and bottom grillages (carlings, keelsons) of all ship types

for longitudinal girders of the deck grillages:

where keelsons are participating in global bending of the grillages;

where keelsons are not participating in global bending at \( l / B_c > 1.5 \) (\( l_c \) and \( B_c \) are the length and width of the grillage, respectively);

for longitudinal girders of the deck grillages:

for open ships

for closed ships

for longitudinal girders of the deck and bottom grillages for flush deck ships

![Diagram for determination of critical normal stresses](image-url)
3.4 PERMISSIBLE STRESSES

3.4.1 For stresses caused by global bending and local load and for summary stresses, the unsafe normal stresses $\sigma_0$ of a constant nature shall be taken as follows, MPa:

1. under tension

$$\sigma_0 = kR_{p_{0.2}}, \quad (3.4.1.1)$$

where $R_{p_{0.2}}$ — yield point of the material corresponding to residual deformation of 0.2%, MPa.

Values of $k$ are taken equal to:

- for riveted structures 0.9
- for welded structures:
  - at $3 \leq t < 4$ 0.7
  - at $t \geq 4$ 0.8

Here, $t$ — thickness of structure elements to be connected, mm;

2. under compression

$$\sigma_0 = \sigma_{cr}, \quad (3.4.1.2)$$

3. unsafe tangent stresses are taken as

$$\tau_0 = 0.57\sigma_0. \quad (3.4.1.3)$$

3.4.2 The regulated permissible normal and tangent stresses are stated in Table 3.4.2.

<table>
<thead>
<tr>
<th>Name and characteristic of the hull members</th>
<th>Characteristic of design stresses due to loads</th>
<th>Regulated permissible stresses as percentage of the unsafe stresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rigid members of the hull girder participating only in global strength and not carrying any local load (longitudinal deck members)</td>
<td>Normal and tangent stresses due to global bending</td>
<td>0.75</td>
</tr>
<tr>
<td>2. Rigid members of the hull girder participating in global strength and carrying local load</td>
<td>Ditto</td>
<td>0.60</td>
</tr>
<tr>
<td>3. Longitudinal girder participating in global strength and carrying local load</td>
<td>Total normal and tangent stresses due to global bending and grillage bending:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.90</td>
</tr>
<tr>
<td>4. Transverse framing</td>
<td>Total normal and tangent stresses due to global and local bending:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.90</td>
</tr>
<tr>
<td>5. Shell plating and flooring of the hull, bulkhead and tank plates</td>
<td>Normal stresses due to local load:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.95</td>
</tr>
<tr>
<td>6. Longitudinal and transverse bulkheads (including tank walls): web stays and shelves, ordinary stays</td>
<td>Ditto:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.90</td>
</tr>
<tr>
<td>7. Pillars and braces checked for buckling</td>
<td>Ditto: for separately working members</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>for intersecting braces</td>
<td>0.75 (but not more than $0.5R_{p_{0.2}}$)</td>
</tr>
</tbody>
</table>
3.5 WELDING JOINTS

3.5.1 Tee-joints with double-sided welds shall be applied for welding of:
.1 joints of the main hull structure members (floors to keelsons, frames to stringers, beams to carlings and coamings, etc.);
.2 watertight bulkheads, floors, keelsons, etc. to the outer shell plating and flooring;
.3 hull structures in areas of engine room and propulsion units and areas of local vibration, alternate or impact loads;
.4 foundations of engines (main and auxiliary) and of other machinery.

3.5.2 Intermittent fillet welding is not allowed for tee-joints of strength hull structures.

3.5.3 Free ends of girder webs, stiffeners, knees and flanges, as well as sections of girder webs and bulkheads in way of cutouts, in case of single-side welding, shall be continuously welded around with the weld passed over to the other side for at least 30 mm.
4 DESIGN OF CATAMARAN HULLS

4.1 GENERAL REQUIREMENTS

4.1.1 The requirements of the present section apply to the following types of catamaran of M, O, P and J classes:
1. self-propelled aft-engined one-decked dry cargo ships;
2. passenger ships;
3. tugboats and pushboats.

4.1.2 Catamaran general dimensions:
- $L$ — design waterline length, m;
- $B$ — design waterline breadth amidships, m;
- $B_h$ — one hull design waterline breadth amidships, m;
- $H$ — outer side depth amidships, m;
- $H_{fb}$ — freeboard amidships, m;
- $c$ — horizontal clearance (the least distance between inner sides of the hulls at design waterline), m;
- $h_{vi}$ — vertical clearance at $i$th theoretical frame (a distance from the design waterline to plating of the bridge or bottom point of a framing measured at the centre line), m.

4.1.3 The requirements of present chapter are applied to ships whose general dimension ratios correspond to the following conditions:
- $L / H < 25$;  \hspace{1cm} (4.1.3-1)
- $L / B = 4 \div 6$;  \hspace{1cm} (4.1.3-2)
- $h_{vi} / H_{fb} > 0.65$,  \hspace{1cm} (4.1.3-3)

where $h_{vi}$ — vertical clearance amidships in fully loaded condition.

4.1.4 The catamaran hulls shall be made of steel or aluminum alloys complying with the requirements of Part X of the Rules.

4.1.5 In the present chapter, a connection of the catamaran hulls is provided by one of the following ways:
1. by means of a strong superstructure or wheelhouse, whose length is not less than a half of the hull’s length and which are fitted with at least three transverse bulkheads (in the fore, middle and aft parts of a superstructure or a wheelhouse);
2. by means of a bridge, which is a system of transverse girders with a single-sided or double-sided lining. When calculating a strength, short superstructures of a length not exceeding $0.15L$ in the fore and aft extremities shall be considered as a part of the bridge.

4.1.6 Cutouts with width exceeding a half of one hull breadth and with length exceeding a half of the hold length are not allowed in catamaran hull decks if they are connected by means of the bridge. This requirement does not apply to cutouts, above which superstructures or wheelhouses with strong walls (bulkheads) are installed, if requirements of 4.4.3 and 2.4.55 to 2.4.57 are met.

4.1.7 The requirements for checking catamaran hulls’ strength specified in this chapter apply to ships with length-based Froude number not exceeding 0.4.

4.1.8 In regard to issues not specified in this section, refer to the requirements of 2 for steel catamaran hulls and 3 for light alloy catamaran hulls.

4.1.9 A sufficient strength of the hull shall be verified by strength tests of the lead ship in a series conducted according to a program approved by the River Register. The test program shall provide instrumental measurements of both wind and wave conditions and associated loads and stresses, as well as a possibility of subdividing the latter into statical variables and impact components.

The strength assessment of the hull members, the sensors shall be placed in sections where maximum stresses and deformations are expected from the calculations. The
number of sensors shall be sufficient to plot the stress diagram in the section.

During the tests, a stress condition shall be evaluated in components of connecting structures participating in the transverse strength, including transverse bulkheads of superstructures or wheelhouses with adjacent parts of plating. Sensors shall be placed near the inner sides and in the centre plane in order to evaluate symmetrical and unsymmetrical deformations of the transverse members.

A synchronous record of sensor readings shall be ensured.

4.1.10 Design and scantlings of catamaran hull members shall meet the requirements of 4.4.

The scantling of hull members of ships with a length over 50 m shall be also verified by calculation in accordance with the requirements of 4.2 and 4.3.

4.2 CALCULATION OF GLOBAL LONGITUDINAL STRENGTH

4.2.1 Bending moments $M_{sw}$ and shear forces $F_{sw}$ on still water shall be calculated by integrating a load curve over at least 21 equidistant ordinates.

4.2.2 Additional wave bending moment in the middle part of ship, kN·m,

$$M_{aw} = \pm 2 \cdot 9.81 k_0 k_1 k_2 k_3 B_0 L^2 h,$$

(4.2.2-1)

where $k_0$ — coefficient calculated by the following formulae:

for ships of M and O classes

$$k_0 = 1.24 - 1.7 B_0 / L,$$

(4.2.2-2)

for ships of P and Î classes

$$k_0 = 1.24 - 2 B_0 / L,$$

(4.2.2-3)

values of $k_0$ shall not exceed 1;

$B_0$ — design breadth to be taken equal to:

breath of one hull $B$, where the ship’s length $L \leq 30$ m for ships of M class and $L \leq 20$ m for ships of all the rest classes;

breath of ship B, where the ship’s length $L \geq 60$ m for ships of M class and $L \geq 40$ m for ships of all the rest classes;

intermediate values of $B_0$ between $B_0$ and $B$ shall be determined by linear interpolation;

$k_1$ — coefficient determined from Table 4.2.2;

$k_2$ — coefficient taken equal to the greatest of the three values:

$$k_2 = 1;$$

(4.2.2-4)

$$k_2 = 2 - 20 T_f / L;$$

(4.2.2-5)

$$k_2 = 1 + 4.5 k_{av} [1 - (k_{av} / h)^2] \sqrt{1 - (k_{av} / h)^2} / B_0,$$

(4.2.2-6)

$T_f$ — forward draught for design loading condition of the ship, m;

c — horizontal clearance amidships, m;
$h_{av}$ — average value of a vertical clearance over a section from the bridge’s fore extremity to the fifth theoretical frame, if the bridge is extended to the plane of a zero theoretical frame, m,

$$h_{av} = 0.2 \left[ 0.5 (h_{s1} + h_{s5}) + h_{s2} + h_{s4} + h_{av} \right],$$

(4.2.2-7)

when the fore extremity lays at the distance $x_0$, m, to the aft from the theoretical frame,

$$h_{av} = \left[ 0.5 (h_{s1} + h_{s4}) + h_{s2} + h_{s3} + h_{s5} + 0.5 (h_{s4} + h_{s5}) (1 - 2 x_0 / L) / \sqrt{5 - 20 x_0 / L},$$

(4.2.2-8)

$h_{av}$ — vertical clearance at the fore extremity of the bridge;

$k$ — coefficient equal to:

$$k = 2 \beta_c \beta_h / (1 + 3 \psi_c \psi_h);$$

(4.2.2-9)

$\beta_c$, $\beta_h$ — coefficients considering influence of horizontal and vertical clearances in the fore extremity on constraint of flow between the hulls.

### Table 4.2.2

<table>
<thead>
<tr>
<th>Basin</th>
<th>Coefficient $k_1$ at ship length L, m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>M</td>
<td>0.0234</td>
</tr>
<tr>
<td>O</td>
<td>0.0207</td>
</tr>
<tr>
<td>P</td>
<td>0.0168</td>
</tr>
<tr>
<td>Î</td>
<td>0.0123</td>
</tr>
</tbody>
</table>
\[ \beta_c = (0.15 + 3.5 \frac{h}{L}) c_2 / B_h \quad (4.2.2-10) \]
\[ \beta_h = 1 \quad \text{when } h_2 / h \leq 1.25 \]
\[ \beta_h = -0.56 + 1.25 h_2 / h \quad \text{when } h_2 / h > 1.25 \]  
\[ (4.2.2-11) \]
\[ c_2 \] — horizontal clearance at the second theoretical frame, m;
\[ \psi_c, \psi_h \] — coefficients considering influence of the clearances amidships on pitching of catamarans:
\[ \psi_c = 0.43 c / B_h \quad (4.2.2-12) \]
\[ \psi_h = 0.2 + 0.07 \left( 2h_{v10} / h \right) \quad (4.2.2-13) \]
\[ k_3 \] — coefficient dependent on the length-based Froude number:
\[ k_3 = \begin{cases} 1 & \text{when } Fr \leq 0.2 \\ 0.6 + 2Fr & \text{when } 0.2 < Fr \leq 0.4 \end{cases} \quad (4.2.2-14) \]
\[ k_4 \] — coefficient considering the influence of decrease of the bridge length in the fore extremity on reduction of the impact moment; it is taken equal to 1 if the bridge is extended to the zero theoretical frame; where the fore extremity of the bridge is located at the distance \( x_b \) to the aft from the theoretical frame, it is calculated by the following formulae:
\[ k_4 = \begin{cases} 1 & \text{when } 0 \leq x_b / L \leq 0.05 \\ 0.5 & \text{when } x_b / L > 0.05 \end{cases} \quad (4.2.2-15) \]
\[ \delta \] — block coefficient for the design loading conditions, for which the value of \( M_{sw} \) is obtained;
\[ h \] — design wave height, m, taken from Table 2.1.2;

4.2.3 Normal and tangent stresses due to global longitudinal bending shall be calculated according to 2.2.40; here, bridge members are included into the hull girder.

4.2.4 Stresses in longitudinal members due to global longitudinal bending and local bending are summed in accordance with the requirements of 2.2.61 to 2.2.66.

4.2.5 Maximum normal and tangent stresses due to global longitudinal bending and summary stresses shall not exceed permissible stresses specified in:

1. Table 2.2.68 for steel ships;
2. Table 3.4.2 for ships of light alloys.

4.2.6 The global strength of the hull shall be verified checked with regard to ultimate moments in accordance with 2.2.76 to 2.2.94.

4.3 STRENGTH CALCULATIONS OF A BRIDGE STRUCTURE

4.3.1 Calculations proving a sufficient strength of members connecting the hulls in case of unfavorable combination of loads shall be made.

4.3.2 Strength calculations of members connecting the hulls shall be made in accordance with strength calculation method of catamaran hull body bridges (Appendix 1) or other method approved by the River Register.

4.4 DESIGNING OF THE HULL

4.4.1 The minimum permissible thicknesses of hull member plates shall correspond to Table 2.4.1-1. For ships with a length less than 25 m, the minimum thickness is determined according to 2.5.74 to 2.5.84, 2.5.101.

For hulls with deadrise, keel strake thickness shall be not less than that indicated in Table 2.4.1-1 for the bilge strake. For ships with a length of less than 25 m, the bilge strake thickness shall be not less than that specified in 2.5.75.

The minimum thickness of strong lining participating in global and local strength of the bridge shall be taken according to thicknesses specified in Table 2.4.1-1 for the outer shell plating in the middle part of ship. For ships with a length of less than 25 m, the strong lining thickness shall be not less than specified in 2.5.75.

The minimum thickness of strong lining participating in global and local strength of the bridge shall be taken according to thicknesses specified in Table 2.4.1-1 for the outer shell plating in the middle part of ship. For ships with a length of less than 25 m, the strong lining thickness shall be not less than specified in 2.5.75.

4.4.2 If the transverse system is used for bridge framing, the transverse web and ordinary members of the bridge shall be placed in the same plane with appropriate hull members.

4.4.3 Where cutouts in hull deck exceed 0.7 of the hull breadth, the deck shall be rein-
forced in the area of such a cutout plus over a distance of 0.5 cutout width forwards and abaft the cutout.

4.4.4 In case of curvilinear shape of cross-sections of the hulls in the area of the parallel body, and in case of the transverse framing system of the side and the longitudinal framing system of the bottom, ordinary side frames shall be finished at the side keelsons or strengthened longitudinal girders.

4.4.5 Where a transverse strength of a catamaran is ensured by superstructure transverse bulkheads or trusses installed above the deck, transverse bulkheads shall be installed in the hulls in the planes of these bulkheads or trusses. If, due to arrangement of spaces, this requirement is impracticable, strengthened side web frames with a web depth at least 1.5 floor depth may be provided instead of the bulkheads. In joints of the strengthened side web frames and web beams, knees shall be fitted.

4.4.6 Thickness and scantlings of superstructure bulkhead members participating in global transverse strength of the catamaran shall be specified according to the requirements of 2.4.63 to 2.4.80. Here, horizontal stiffeners shall be fitted between the centre lines of the hulls, and web stays shall be fitted in vertical planes passing through the upper edge of inner side plating (unless longitudinal bulkheads are provided in these planes).

In the superstructure bulkheads participating in the global transverse strength, cutouts with a width exceeding 0.5 of the bulkhead height are not permitted and existing openings shall be reinforced by coamings. Door cutouts shall be clear of web stays located in planes of inner sides and of bulkhead ends at least for a half of the height of the opening.

4.4.7 Bridge structure shall be so designed as to be accessible for inspection and repair.

The height of a closed (doubled) bridge confined by a watertight strength lining from the bottom and by a watertight deck from the top shall not be not less than 800 mm.

4.4.8 Minimum web thickness of web beams and carlings of the closed bridge shall be taken according to 5.1 to 5.3 of Table 2.4.1-1.

4.4.9 Depth of hull's web beam in way of inner side shall be equal to the depth of closed bridge's web beam. The beam depth shall decrease gradually at least over a distance from the inner side to the nearest carling of the hull. An area of the strip in this section shall be increased by 1.5. In the hulls at the level of bridge lining, stringers according to Fig. 4.4.9-1 or strengthened knees according to Fig. 4.4.9-2 shall be provided.

![Fig. 4.4.9-1 Fitting a stringer at the level of bridge lining](image)

4.4.10 When specifying scantlings of web beams of the bridge open from the top or from the bottom (including bridges with a light bottom lining not participating in strength of bridge members and global strength of the ship and bridges with detachable upper deck) requirements of 2.4.48 shall be met.

Scantling of bridge's web beams shall be not less than scantling of hull's web beams.

4.4.11 In the place where web beam of the bridge open from the bottom is attached to the inner side, vertical knees corresponding to directions of 2.3.12 and 2.3.13 or horizontal knees according to Fig. 4.4.11 shall be fitted.

4.4.12 Flange of a web beam of a bridge open from the top shall be connected to the deck by means of horizontal knees according to Fig. 4.4.12.
4.4.12 In case of the transverse framing system in the closed bridge and the bridge opened from the top and fitted with detachable deck, between the web beams, bracket beams shall be fitted consisting of upper and lower ordinary girders connected by brackets in way of carlings and inner sides.

4.4.13 Width of the brackets shall be not less than 0.3 of height of the closed bridge or the distance between the lining and detachable deck; thickness of the brackets shall be not less than the web beam's web thickness; if bracket width to thickness ratio exceeds 35, free edges of the bracket shall have welded to bent flanges.

4.4.15 In a span between the brackets, the upper and lower girders may be connected by means of cross-members. For the bridge opened from the top, where a distance between carlings or between a carling and the inner side exceeds 1.5 m, the installation of the cross-members is mandatory. Cross-sectional area of the cross-member shall be
not less than the cross-sectional area of the least of girders being connected.

4.4.16 Scantling of ordinary beams of bridge deck and upper girders of the bracket beams shall be specified in accordance with requirements of 2.4.48. Here, in case of detachable deck, section modulus of the upper girder shall be taken without effective flange.

4.4.17 Scantling of ordinary beams of the bridge lining shall be not less than those taken for ordinary frames or for inner side stiffeners.

4.4.18 Where cross-members are fitted, section moduli of the upper and lower girders of a bracket beam may be reduced by 40%.

4.4.19 In case of the longitudinal framing system of the inner side and the hull deck, a knee extended to the uppermost side stiffener shall be fitted between the deck longitudinal stiffener and the side plating in the plane of bracket beam’s bracket.

4.4.20 Ordinary beam of the deck of the bridge open from the bottom shall be connected to the inner side by means of a knee.

4.4.21 Where a transverse strength of catamaran is provided by particular strengthened girders (i.e. where the bridge structure is not homogeneous), these girders shall coincide with hull’s transverse bulkheads. If the above is impracticable, strengthened ring structures may be used instead of the bulkheads.

Web of the strengthened girders shall be fitted in the same plane with web frames of the hulls.

4.4.22 Connection of the strengthened girder with the hull shall be effected by means of extending the girder inside the hull over at least 0.25 the hull’s breadth or by means of festoons fitted in the hull at a level of the bottom flange of the girder. Knees shall be fitted where the girder flange is connected with the inner side.
5 DESIGN OF HYDROFOIL CRAFT HULLS

5.1 GENERAL REQUIREMENTS

5.1.1 The requirements of present chapter applies to hydrofoil craft of O-ΠП, O, P and Л classes with two lightly submerged foils and the following characteristics:

\[ I / D' L^3 > 3 \cdot 10^{-8}, \]  

(5.1.1-1)

for rigidity

\[ \sqrt[3]{D'} < 18, \]  

(5.1.1-2)

for speed

where \( I \) — area moment of inertia of the weakest cross-section of the hull girder in the middle part of ship, \( m^4 \);  

\( D' \) — ship displacement in fully loaded condition, t;  

\( L \) — the greatest length of hull (Fig. 5.1.1), m;  

\( v \) — design speed in foilborne mode on still water, m/s.

5.1.2 The requirements of present chapter are focused on the longitudinal framing system of the hull and superstructure.

In the present Section, superstructure means a part of the ship above the lower edge of window cutouts and, where the latter are not provided, a part of the ship above the upper deck.

5.1.3 For fabrication of hull and superstructure structures, aluminum alloys shall be used which comply with the requirements of 4 Part X of the Rules.

5.1.4 Materials to be submitted to the River Register shall comprise the calculations of:

1. global strength of ship;
2. local strength of ship;
3. strength of foil arrangements;
4. vibrations.

5.1.5 The lead ship in a series of every design shall be tested to verify strength and vibration level under a program approved by the River Register.

The test results shall be submitted to the River Register.

5.1.6 Ships with strength meeting the requirements of 5.2, are allowed to operate in displacement mode at wave height, \( m \), in basin of category:

\[ \begin{array}{c|c}
O-ΠП, O & 2.0 \\
P & 1.2 \\
Л & 0.6 \\
\end{array} \]

5.2 GLOBAL STRENGTH AND BUCKLING CALCULATIONS

5.2.1 The global strength of a ship shall be checked with regard to normal and tangent stresses caused by design bending moments and shear forces in foilborne mode at design wave height.
The buckling of structures in the whole and their elements shall be checked also.

5.2.2 For a hydrofoil craft underway in foilborne mode, the values of design wave height $h$ shall be taken at least equal to that specified below, $m$, for basin of category:

<table>
<thead>
<tr>
<th>O-IP, O</th>
<th>P</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3</td>
<td>0.8</td>
<td>0.4</td>
</tr>
</tbody>
</table>

5.2.3 Design bending moment $M_d$, kN·m, and shear force $N_d$, kN, shall be calculated by the formulae (see Fig. 5.1.1):

- \[ M_d = M_s \left(1 + k_M n\right) \], \quad (5.2.3-1)
- \[ N_d = N_s \left(1 + k_N n\right), \quad (5.2.3-2) \]

where $M_s$, $N_s$ — bending moment, kN·m, and shear force, kN, in a cross-section under consideration in foilborne mode on still water;

$k_M$, $k_N$ — coefficients depending on the longitudinal position of the cross-section under consideration and defined by the formulae:

- \[ k_M = 1 - 0.040j \]; \quad (5.2.3-3)
- \[ k_N = 0.7 - 0.015j \], \quad (5.2.3-4)

where $j$ — number of the design frame: for extreme fore frame $j = 0$ and for extreme aft frame $j = 20$;

$n$ — additional design overload (ratio between additional acceleration in a cross-section above the bow foil arrangement in foilborne mode at design waves and the acceleration of gravity).

The value of $n$ shall be obtained using a prototype or from model tests. Where those data are not available, it may be calculated by the formula

\[ n = kmw^2 \sqrt{h/D_{\text{red}}}, \quad (5.2.3-5) \]

where $D_{\text{red}}$ — reduced displacement of ship, t:

\[ D_{\text{red}} = D/\left[1 + 15 \left(l_L/L\right)^2\right], \quad (5.2.3-6) \]

$l_L$ — distance between the centre of gravity and the centre of supporting force at the fore foil (point 0 in the Fig. 5.2.3-1);

$k$ — coefficient equal to, at $h$, $m$:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>0.035</td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>0.030</td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td>0.020</td>
<td></td>
</tr>
<tr>
<td>0.4</td>
<td>0.010</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 5.2.3-1 Determination of point of supporting force at the fore foil

$m$ — coefficient determined from Fig. 5.2.3-2 and depending on design deadrise angle of the bottom $\beta$, deg, in section A–A (Fig. 5.2.3-3);

- \[ m = \text{Fig. 5.2.3-2 Coefficient } m \text{ vs. design bottom deadrise angle } \beta \]

\[ \text{Fig. 5.2.3-3 Cross-section where bottom deadrise angle } \beta \text{ is determined} \]

$v_w$ — ship’s speed in foilborne mode in design wave conditions, km/h, determined by the formula

\[ v_w = 0.85v, \quad (5.2.3-7) \]

where $v$ — ship’s speed in foilborne mode on still water, km/h.
For intermediate values of wave height, coefficient $k$ is to be determined by linear interpolation.

Values of $v_w$ and $k$ shall be adjusted based on model testing or prototype ship trials.

Values of $n$ in formulae (5.2.3-1) and (5.2.3-2) shall be not less than, at $h$, m:

<table>
<thead>
<tr>
<th>$n$</th>
<th>1.5</th>
<th>1.0</th>
<th>0.9</th>
<th>0.8</th>
<th>0.6</th>
<th>0.4</th>
<th>0.3</th>
</tr>
</thead>
</table>

Design wave height in foilborne mode (within the wave height range for the relevant operation area) shall be specified on the basis of the technical design assignment. This value of the wave height is limiting for a ship in foilborne mode and shall be indicated in the Operation Manual.

5.2.4 When calculating bending moments $M_t$ and shear forces $N_t$, the following directions shall be complied:

.1 a load curve shall be plotted by a common way using at least 21 equidistant ordinates;

.2 design values of foil supporting force, kN, shall be determined by the formulae:

for the fore foil

$$F_{sb} = 9.81D' - F_{ss},$$  (5.2.4.2-1)

for the aft foil

$$F_{ss} = 9.81D'l / l_0;$$  (5.2.4.2-2)

where $l_0$ — distance between supporting force point at the fore and aft foils, m;

.3 points of foil supporting forces $F_{sb}$ and $F_{ss}$ are determined according to Fig. 5.2.3-1;

.4 foil supporting forces $F_{sb}$ and $F_{ss}$ are distributed over the design spacings depending on extension of the fore (aft) foil struts along the hull.

5.2.5 Checking the ship’s global strength due to normal design stresses shall be carried out in cross-sections (see Fig. 5.1.1) where the greatest normal stresses are assumed:

in section I — I in way of the fore foil arrangement, where a continuous part of superstructure wall is not available forwards of the foil arrangement.

If the design bending moment in section I — I differs from a moment in section II — II or III — III by less than 10%, the calculation of the global strength in section I — I may be omitted.

5.2.6 When determining the hull girder section moduli, in sections I — I, II — II and III — III the hull and superstructure members shall be considered and in section IV — IV only hull members shall be considered.

For riveted superstructure and welded hull, superstructure members shall be included in the hull girder with a coefficient of 0.9.

5.2.7 If the breadth of window cutouts is greater than the distance between them, two extreme continuous parts of superstructure walls shall be provided with a length $c$ (see Fig. 5.1.1) exceeding the window height by at least 20% or other construction measures shall be taken to prevent the superstructure from participation in global bending of the ship.

5.2.8 Compressed plates are included to the hull girder with a reduction coefficient

$$\phi = \sigma_{cr} / \sigma_p \leq 1,$$  (5.2.8-1)

where $\sigma_{cr}$ — critical normal stress of the compressed plate which is determined by Fig. 3.3.16 depending on the ratio $\sigma_E / R_{sh}$

$\sigma_E$ — normal Euler’s stress of a plate, MPa, which shall be calculated by formula (3.3.7-1) in case of the longitudinal framing system;

$\sigma_p$ — permissible normal stress due to global bending of the ship.

Parts of the plate adjacent to longitudinal girders of width equal to the following values at each side are not subject to reduction:

$$0.25a \quad \text{when} \quad a/t \leq 80;$$  (5.2.8-2)

$$20t \quad \text{when} \quad a/t > 80,$$  (5.2.8-3)

where $a$ — distance between the longitudinal girders;

$t$ — plate thickness.
5.2.9 Design normal stresses in extreme members of the hull girder shall be determined by the formulae:

\[ \sigma_u = 10 \alpha_u M_d / W_u ; \]  
\[ \sigma_l = 10 \alpha_l M_d / W_l ; \]

where \( \sigma_u, \sigma_l \) — design stresses in the uppermost and lowermost members of the hull girder (superstructure), MPa;

\( \alpha_u, \alpha_l \) — coefficients equal to:
- for sections passing through continuous parts of superstructure walls (beyond the window cutouts) as well as for section IV — IV (see Fig. 5.1.1) 1.0
- for sections in way of window cutouts 0.85 and 1.40

\( M_d \) — design bending moment in the cross-section under consideration (see 5.2.3);

\( W_u, W_l \) — section moduli for the uppermost and lowermost members of the hull girder (see 5.2.6).

For riveted superstructure and welded hull, coefficient \( \alpha_u \) shall be reduced by 10 %.

5.2.10 Global strength due to tangent stresses shall be checked in sections where the greatest tangent stresses are expected:
- in sections V — V and VI — VI (see Fig. 5.1.1) where the greatest shear force occurs;
- in weakened sections;
- in sections in extreme continuous parts of the superstructure walls.

5.2.11 Design tangent stresses, MPa, shall be determined by the formula:

\[ \tau = N_d S / (I \sum t) , \]  

where \( N_d \) — design shear force in a cross-section, kN;

\( I \) — area moment of inertia of the hull girder, m\(^4\);

\( S \) — static moment, relative to the axis, of the part of hull girder cross-section situated either above or below the given horizontal cross-section, in which tangent stresses are calculated, m\(^3\);

\( \sum t \) — the sum of thicknesses of the sides, longitudinal coaming plates and longitudinal bulkheads in the given horizontal section, in which tangent stresses are calculated, mm.

5.2.12 In sections weakened by the window or door cutouts, the design tangent stresses \( \tau \) shall be determined by formula (5.2.11) regardless of a part of the superstructure above the cutout.

5.2.13 In sections in extreme continuous parts of superstructure walls, the design tangent stresses \( \tau' \), MPa, shall be taken equal to the greatest of those calculated in accordance with directions of 5.2.11 and by the formula

\[ \tau' = \sigma_d f / (k t c) , \]

where \( \sigma_d \) — design stresses in the superstructure deck in section II — II (see Fig. 5.1.1), MPa;

\( f \) — cross-sectional area of the superstructure longitudinal members above the window cutouts in section II — II having regard the reduction, cm\(^2\);

\( k \) — coefficient equal to:
- for extreme continuous part of the superstructure deck in section II — II having regard the reduction, 3.0
- for extreme continuous part of the superstructure wall in the middle part of ship, 1.5

\( t, c \) — thickness and length of the given extreme continuous part of the superstructure wall, correspondingly, cm.

5.2.14 Critical normal stresses shall meet the following conditions:
- for the superstructure deck longitudinal stiffeners

\[ \sigma_{cr} / \sigma \geq 1.5 ; \]

(5.2.14-1)

for the bottom longitudinal stiffeners

\[ \sigma_{cr} / R_{p0.2} \geq 0.7 , \]

(5.2.14-2)

where \( \sigma \) — design stresses in the superstructure deck, MPa;

\( R_{p0.2} \) — yield stress of the material, MPa, corresponding to residual deformation of 0.2%.

Critical normal stresses of a stiffener \( \sigma_{cr} \) are determined according to Fig. 3.3.16 depending on the ratio \( \sigma_d / R_{p0.2} \), where \( \sigma_d \) is Euler’s normal stress of a stiffener material when the stiffener ends are assumed resting freely.
5.2.15 Euler’s normal stresses of plates of the side plating and the superstructure walls shall meet the condition

\[ \tau_h / \tau \geq 1.5, \]  

(5.2.15)

where \( \tau \) — design tangent stresses of plates in the section.

When determining \( \tau_h \), plates shall be considered freely resting around the contour.

5.3 LOCAL STRENGTH CALCULATIONS

5.3.1 Values of local loads specified by a design pressure \( p \), kPa, over ship length for checking strength of plates of bottom plating and longitudinal bottom stiffeners shall be taken equal to (Fig. 5.3.1-1):

\[ p = \alpha p_0 \]  

(5.3.1)

\( p_0 \) — load applied along a section from the zero design frame to section A — A (see Fig. 5.3.1-1);

\[ p_0 = kmv \sqrt{D_{\text{red}}} \]  

(5.3.1)

\( \alpha p_0 \) at the 10th design frame;

\( 0.7 \alpha p_0 \) at the 20th design frame;

where \( \alpha \) — coefficient determined from Fig. 5.3.1-2 depending on the ratio \( \beta_{10}/\beta_{A} \) (here, \( \beta_{10} \) and \( \beta_{A} \) are the angles measured as shown in Fig. 5.2.3-3, at the 10th design frame and in section A — A).

5.3.2 Strength of the floors and bottom grillages shall be checked with regard to uniformly distributed load specified by pressure equal to 0.5\( p \), where \( p \) is a pressure for the floor under consideration or a floor located in the middle of the span (when calculating the grillage) according to 5.3.1.

5.3.3 A design load on a side shell plating and side framing shall be uniformly distributed over the side depth according to a trapezoidal law and specified by a pressure varying from 3 kPa at the level of the lower edge of window cutouts up to 0.5\( p \) at the bilge level, where \( p \) is a pressure determined according to 5.3.1 for shell plating and longitudinal stiffeners and according to 5.3.2 for frames and side grillages.

5.3.4 Design load, kPa, shall be set by pressure equal to:

- for decks and platforms intended for transportation of passengers and crew as well as for parts of superstructure decks where passengers may be present while boarding
- for decks in way of passenger seats
- for superstructure decks

Those loads shall be taken for deck parts bordered by a line, for which an angle between a tangent to the shell plating and the base line is not less than 30°.
5.3.5 Strength of beams and half-beams of the superstructure deck shall be checked with regard to bending moment, kN·m, calculated by the formula:

\[ M_k = 9.81 \cdot 10^7 k_b B^2, \]  

(5.3.5-1)

where \( k_b \) — coefficient obtained from Fig. 5.3.5;

\[ B \] — ship’s breadth at the deck level, m.

When determining bending moment for beams, \( d \) shall be taken equal to, m:

\[ d = 0.500 (d_1 + d_2), \]  

(5.3.5-2)

where beams and half-beams are fitted

\[ d = 0.375 (d_1 + d_2), \]  

(5.3.5-3)

where \( d_1, d_2 \) — distances from the beam under consideration to the nearest beams or transverse bulkheads, m.

When calculating bending moment of half-beams, \( d \) shall be taken equal to

\[ d = 0.500 (d'_1 + d'_2), \]  

(5.3.5-4)

where \( d'_1, d'_2 \) — distances from the half-beam under consideration to the nearest beams or transverse bulkheads, m.

Scantling of beams and half-beams may be obtained taking load as uniformly distributed and equal to 1.47\( d \), kN/m.

Area moment of inertia, cm\(^4\), of beams and half-beams including effective flange shall be not less than

\[ I = 0.55dB^3. \]  

(5.3.5-5)

5.3.6 The design load, kPa, on front walls and windows of the superstructure shall be taken as follows for basin of category:

<table>
<thead>
<tr>
<th>Category</th>
<th>( P )</th>
<th>( J )</th>
</tr>
</thead>
<tbody>
<tr>
<td>O-IIP, O</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>P</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Design pressure on the side walls and windows of the superstructure shall be taken equal to 3 kPa.

5.3.7 Design load on transverse watertight bulkheads shall be taken uniformly distributed according to triangle law and specified by maximum pressure at the level of the ship’s bottom which is equal to a distance between the bottom to the bulkhead deck and, where the latter is not provided, double average draught in displacement mode.

5.3.8 Design load on structures enclosing the tanks is taken distributed over a height according to trapeze law and specified by maximum pressure at the tank bottom level which is equal to a distance between the tank bottom and the upper end of an air outlet.

5.3.9 During strength calculations for the loads specified in the present chapter, the plates shall be considered absolutely rigid and constrained at a bearing contour not subject to deformation.

During local strength calculations, longitudinal girders shall be considered constrained.

5.3.10 Elements of cross-sectional area of the framing girders shall be determined with due regard to effective flanges or flooring. For members directly connected to the shell plating, the effective flange width \( c \) shall be taken equal to:

\[ c = 0.5a \quad \text{at} \quad a/t \leq 80; \]  

(5.3.10-1)

\[ c = 40t \quad \text{at} \quad a/t > 80, \]  

(5.3.10-2)

where \( a \) — average distance between the same-name members;

\( t \) — thickness of shell plating or flooring.
The effective flange width in all cases shall not exceed 1/6 of the design span of the girder.

For members laid onto the longitudinal girders (attached framing system), the effective flange width shall be taken equal to zero.

5.3.11 During buckling calculations of girders, when determining their cross-sectional area, the effective flange width shall be taken equal to the average distance between the same-name girders, and when determining the area moment of inertia of girders, the effective flange width shall be taken according to 5.3.10.

5.3.12 Local strength calculations for dry docking and lifting by a crane shall be carried out for light ship condition. Here, buckling strength of the structures shall be provided with a safety factor of 1.5 relatively to design stresses.

5.3.13 Local strength and buckling calculations of the hull structures in the places where the foil arrangements are attached shall be carried out for loads specified in 5.4.1.

5.3.14 Dimensions of bridges between windows shall meet one of the following ratios:

\[ \frac{h_0}{b_0} > 5 ; \]  
\[ \frac{h_0}{b_0} < 2.5 , \]

where \( h_0 \) — height of a bridge/window, m; \( b_0 \) — width of a bridge (i.e. distance between windows), m.

Rounding radius for window cutout corners, m, shall be not less than

\[ r = 0.15h_0 . \]

5.4 CALCULATION OF FOIL ARRANGEMENT STRENGTH

5.4.1 A foil arrangement shall be calculated as a frame consisting of rods with cross-sections varied over rod length and with struts rigidly attached to the hull.

Foil arrangement strength shall be checked for the effect of loads specified by vertical forces equal to:

for the fore foil

\[ P_b = kF_{sb} ; \]  
\[ P_5 = 0.75kF_{ss} , \]

where \( k \) — coefficient equal to the following for ships designed for the design wave height \( h \), m (in foilborne mode):

\[
\begin{array}{c|c|c}
\text{wave height} & k \\
\hline
1.5 & 2.2 \\
1.3 & 2.0 \\
0.8 and less & 1.8 \\
\end{array}
\]

\( F_{sb}, F_{ss} \) — supporting forces at the fore foil and the aft foil determined by formulae (5.2.4.2-1) and (5.2.4.2-2).

For intermediate wave heights, value of \( k \) is to be determined by linear interpolation.

Strength of foil arrangements, kN, shall be checked also for simultaneous action of the forces \( F_{sb}, F_{ss} \) and horizontal loads generated by horizontal point forces applied at places where the struts connect with respective foils, and the resultant force shall be calculated by the formula

\[ P_r = 20.59 \cdot 10^{-3} D Y^2 / l_0 , \]

where \( l_0 \) — distance between points of supporting force at the fore and aft foils, m;

Resultant force \( P_r \) shall be distributed between the struts pro rata projections of their submersed surfaces onto the centre plane.

Forces \( F_{sb}, F_{ss}, P_f \) and \( P_{af} \) shall be taken uniformly distributed over the foil spread and directed perpendicularly to the foil bottom plane (Fig. 5.4.1).

5.4.2 Euler’s stresses in plates of hollow foils plating shall be not less than stresses obtained at calculation of the foil arrangement for loads \( P_f \) and \( P_{af} \).
5.4.3 Strength of additional bow foils and flaps, kN, shall be checked for the effect of load due to vertical force \( Q \)

\[
Q = 0.49 k c_L v_1^2 S_1,
\]

(5.4.3-1)

where \( v_1 \) — minimal speed corresponding to additional foil borne mode on still water, m/c;

\( c_L \) — lift coefficient at an angle of attack \( \alpha_1 \) corresponding to additional bow foil;

\[
\alpha_1 = \alpha_{set} + \psi - \alpha_0;
\]

(5.4.3-2)

where \( \alpha_{set} \) — setting angle of additional foil or flap;

\( \psi \) — angle of trim corresponding to additional foil borne mode on still water;

\( \alpha_0 \) — zero lift angle of the profile of additional foil or flap;

\( k \) — coefficient determined according to 5.4.1;

\( S_1 \) — area of the additional bow foil or flap, m².

Where experimental data are not available, it is allowed to take:

\[
k c_L = 1; \quad (5.4.3-3)
\]

and

\[
v_1 = 0.7 v. \quad (5.4.3-4)
\]

5.5 NORMS OF PERMISSIBLE STRESSES AND MINIMUM THICKNESSES

5.5.1 Permissible normal stresses \( \sigma_p \) for global and local strength calculations shall be taken equal to the least of the values specified in Table 5.5.1 (in fractions of the yield strength \( R_{p0.2} \) or tensile strength \( R_m \) of the material).

5.5.2 Permissible tangent stresses \( \tau_p \) shall be taken equal to 0.57 of corresponding permissible normal stresses:

\[
\tau_p = 0.57 \sigma_p. \quad (5.5.2)
\]

5.5.3 Value of critical normal stress in a structure element shall be not less than double normal stress due to design loads.

5.5.4 Thicknesses of the outer shell plating, the deck plating and the bulkhead plating regardless of the material grade shall be not less than those specified in Table 5.5.4.

5.6 VIBRATION CALCULATIONS AND NORMS

5.6.1 Local vibration shall be checked for ship hull structures in the aft extremity area and the engine room area, as well as for the aft foil arrangement and propeller shaft brackets.

<table>
<thead>
<tr>
<th>Name of member</th>
<th>Minimum thicknesses of hull member plates, mm, for ships of classes</th>
<th>( \sigma_0 ), ( \sigma ), ( p ), ( \bar{p} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom shell plating</td>
<td>3.0, 2.5, 2.0</td>
<td>3.0, 2.5, 2.0</td>
</tr>
<tr>
<td>Side shell plating</td>
<td>2.5, 2.0, 1.5</td>
<td>2.0, 2.0, 1.5</td>
</tr>
<tr>
<td>Hull deck plating and platforms</td>
<td>2.0</td>
<td>2.0, 1.5</td>
</tr>
<tr>
<td>Superstructure plating</td>
<td>1.5, 1.0, 0.8</td>
<td>1.5, 1.0, 0.8</td>
</tr>
</tbody>
</table>

Table 5.5.1

<table>
<thead>
<tr>
<th>Name of the structure</th>
<th>Characteristic of design stresses due to loads</th>
<th>Regulated permissible normal stresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hull and superstructure members</td>
<td>Stresses due to global bending</td>
<td>( 0.35 R_{p0.2} ) or ( 0.25 R_m )</td>
</tr>
<tr>
<td>Foils and flaps</td>
<td>Stresses due to local loads and stresses due to dry-docking:</td>
<td>( 0.80 R_{p0.2} ) or ( 0.55 R_m )</td>
</tr>
<tr>
<td>Foil arrangement struts</td>
<td>in the framing</td>
<td>( 0.95 R_{p0.2} ) or ( 0.70 R_m )</td>
</tr>
<tr>
<td>Parts of the lifting device and their reinforcements</td>
<td>in the plating</td>
<td>( 0.95 R_{p0.2} ) or ( 0.55 R_m )</td>
</tr>
<tr>
<td>Ditto</td>
<td>Stresses due to design loads</td>
<td>( 0.80 R_{p0.2} ) or ( 0.45 R_m )</td>
</tr>
<tr>
<td>Local stresses during lifting by crane</td>
<td>Ditto</td>
<td>( 0.20 R_m )</td>
</tr>
</tbody>
</table>

Table 5.5.1

Regulated permissible normal stresses depending on structure element and design stress characteristics.
5.6.2 In order to avoid a resonance, natural oscillation frequencies of particular structures, as calculated according to 2.6.9 to 2.6.23, shall exceed frequencies of exciting forces in basic operational modes (foilborne and displacement modes):

1. propeller revolution frequency by at least 30%, for the aft foil arrangement and propeller shaft brackets;
2. propeller shaft revolution frequency multiplied by the number of blades by at least 50%, for plates of hollow foils;
3. propeller revolution frequency and that multiplied by the number of blades by at least 50% and 30% correspondingly, for the bottom plates and stiffeners in the aft extremity;
4. crankshaft revolution frequency and doubled crankshaft revolution frequency of the main and auxiliary machinery by at least 50 and 30% correspondingly, for plates and hull framing members in the engine room area.

5.6.3 Reduction of difference in frequencies as compared with that regulated by 5.6.2 may be allowed on condition that justified data are submitted proving that the amplitudes of and stresses due to vibration do not exceed the permissible levels (see 5.6.4 and 5.6.5).

5.6.4 Permissible amplitudes of vibration in the centres of plates of the hull and superstructure, mm, shall not exceed the values determined by the formula:

\[ A_p = k \left( \frac{a}{100t} \right)^2, \]  

(5.6.4)

where \( k \) — coefficient equal to:

for plates welded around the contour by means of continuous double-sided weld or riveted to the framing: 2.90
for plates welded around the contour by continuous single-sided or intermittent double-sided weld: 1.45
\( a \) — short side of the plate, cm;
\( t \) — plate thickness, cm.

5.6.5 Vibration of the framing is considered to be permissible, if the greatest stresses measured or calculated from measured amplitudes do not exceed 20 MPa.

5.6.6 In places where engine foundations are installed, where foil arrangements are attached to the hull, and where pulsating pressure caused by propellers acts, plates shall be welded around the bearing contour by continuous double-sided weld.
6 DESIGN OF HOVERCRAFT HULL

6.1 GENERAL REQUIREMENTS

Scope of application

6.1.1 The requirements of the present chapter apply to passenger, crew and cargo hovercraft of skeg and amphibian types of O-IIP, O, P and J classes capable of moving in the hovering and displacement modes and complying with the following conditions:

\[ \frac{EI}{(D'L)} > 13 \]  \hspace{1cm} (6.1.1-1)

\[ \frac{L}{\sqrt{g} L} < 2 \]  \hspace{1cm} (6.1.1-2)

where \( E \) — Young’s modulus, kPa;

\( I \) — area moment of inertia calculated on the assumption that a strength superstructure is fully participating in global bending, m\(^4\) (for hovercraft without strength superstructure it is area moment of inertia of the hull only);

\( g \) — acceleration of gravity, m/s\(^2\).

Other designations are given in 6.1.10.

For skeg-type hovercraft, the requirements of the present chapter apply to craft with main dimension ratios meeting the following conditions:

\[ \frac{L}{H} < 20 \]  \hspace{1cm} (6.1.1-3)

\[ \frac{L}{B} = 3 + 6 \]  \hspace{1cm} (6.1.1-4)

\[ \frac{H}{h_{kh}} = 2 + 3 \]  \hspace{1cm} (6.1.1-5)

6.1.2 Requirements of present chapter apply to hovercraft made of aluminum alloys meeting the requirements of 4 Part X of the Rules.

6.1.3 The present chapter considers the most unfavorable loading conditions of ship hull of skeg and amphibian types which are assumed. Particular scope of calculations (for instance, the necessity of global transverse strength calculation) is defined by a designer depending on design features of a ship.

Grounds for sufficiency of the scope of calculations for estimation of global and local strength of the hull shall be included in the materials which are submitted to the River Register.

6.1.4 Design wave height for basins of O-IIP, O, P and J categories is taken according to Table 2.1.2.

Design speed values for hovering and displacement modes are stated in the design specification of a ship.

6.1.5 The first ship in a series shall undergo trials under conditions provided by the design specification according to a test program approved by the River Register.

The test results shall be submitted to the River Register.

6.1.6 Permissible wave characteristics with regard to strength and the corresponding speeds of hovercraft in hovering and displacement modes are adjusted on the basis of tests of the first ship in a series.

Definitions and explanations

6.1.7 In the present chapter superstructure means a part of the ship above the bottom edge of window cutouts and, where the latter are not available, a part of the ship above the uppermost deck.

6.1.8 Overload means a ratio of summed vertical acceleration in the given point of the hovercraft hull and the acceleration of gravity.

6.1.9 The following designations have been adopted in the present section:

\( L \) — design waterline length in displacement position, m;

\( B \) — design waterline breadth amidships, m;
$H$ — ship’s depth amidships measured from the bottom edge of skeg (or from the bottom, when skegs are not available) to a superstructure line defined in accordance with 6.1.7, and for ship without superstructure — to the uppermost deck, m;

$T$ — ship’s draught in displacement position measured from the bottom edge of skeg (or from the bottom, when skegs are not available) to the design waterline, m;

$D'$ — ship displacement in fully loaded condition, t;

$D'_a$ — total displacement of skegs corresponding to the design displacement of a ship $D'$, t;

$h_a$ — height of a skeg, m;

$l_0$ — distance of ship’s centre of gravity from the after perpendicular, m;

$v$ — design speed of a ship in hovering mode on still water, m/s;

$L_{ac}$ — air cushion length, m;

$F_{ac}$ — air cushion area, m$^2$;

$p_{ac}$ — pressure in the air cushion at normal operation conditions, MPa.

6.2 STRENGTH AND BUCKLING CALCULATIONS

Design loads at global bending and torsion

6.2.1 Design loads bringing to global bending and torsion of a hovercraft hull are determined for the following conditions:

.1 moving in hovering mode at design rolling;

.2 moving in displacement mode at design rolling;

.3 entering the shore (erection on supports);

.4 lifting by crane.

6.2.2 For conditions indicated in 6.2.1 the most unfavourable load cases shall be considered depending on design and performance features of a hovercraft.

6.2.3 Design loads which bring to global bending and torsion of a hovercraft hull, are defined by the greatest loads measured in the centre of gravity $G$ of a ship (Fig. 6.2.5). Values of overloads at hovercraft moving in rolling conditions shall be defined by results of model scale tests of a ship in design or by a prototype (separately for each mode and each kind of global deformation of the hull).

Values of overloads in other points are determined by the formula

$$ n = \left[ 1 + \mu_1 \left( \frac{(x_1 - x_g)(x - x_g)}{\rho_1^2} + y_1y/\rho_2^2 \right) + 
\mu_2 \left( \frac{(x_2 - x_g)(x - x_g)}{\rho_1^2} + y_2y/\rho_2^2 \right) \right] n_g, $$

(6.2.3-1)

where $\mu_1$, $\mu_2$ — coefficients determined by Table 6.2.5;

$x_1$, $x_2$, $y_1$, $y_2$ — co-ordinates of external forces in accordance with Fig. 6.2.5;

$x_g$ — abscissa of the centre of gravity of a ship;

$x$, $y$ — co-ordinates of a point where the overload is calculated;

$\rho_1$ — radius of inertia of the ship mass related to transverse axis crossing the centre of gravity, m;

$\rho_2$ — radius of inertia of the ship mass related to longitudinal axis crossing the centre of gravity, m;

$n_g$ — overload in the centre of gravity of the ship.

Where the data are not available, at initial stages of designing an overload in the centre of gravity of a hovercraft for moving in hovering mode, which is required for longitudinal strength calculation, is recommended to be determined by the formula

$$ n_g = 1 + \left( 0.085\sqrt{h} + 0.04 \right) v^2 \sqrt{D'}. $$

(6.2.3-2)

6.2.4 Overload values are adjusted at trials of the first ship in a series in accordance with 6.1.5 with the following correction of strength calculations on the basis of actual overload values.

6.2.5 Scheme of application and design ratios of external forces for hovering and displacement modes in rolling conditions are taken in accordance with Fig. 6.2.5 and Table 6.2.5.
### Parameters of areas of applying external forces at turbulent state in different modes

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Longitudinal bending</th>
<th>Transverse bending</th>
<th>Torsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>l₁</td>
<td>0.2L</td>
<td>0.4L</td>
<td>2L₀</td>
</tr>
<tr>
<td>l₂</td>
<td>2L₀</td>
<td>2L₀</td>
<td>2L₀</td>
</tr>
<tr>
<td>b₁</td>
<td>B</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>b₂</td>
<td>B</td>
<td>B</td>
<td>B</td>
</tr>
<tr>
<td>x₁</td>
<td>0.4L</td>
<td>xₛ</td>
<td>xₛ</td>
</tr>
<tr>
<td>x₂</td>
<td>xₛ</td>
<td>xₛ</td>
<td>xₛ</td>
</tr>
<tr>
<td>y₁</td>
<td>0</td>
<td>0</td>
<td>e₂</td>
</tr>
<tr>
<td>y₂</td>
<td>0</td>
<td>0</td>
<td>e₂</td>
</tr>
<tr>
<td>μ₁</td>
<td>(nₛ-1)/nₛ</td>
<td>(nₛ-1)/nₛ</td>
<td>(nₛ-1)/nₛ</td>
</tr>
<tr>
<td>μ₂</td>
<td>1/nₛ</td>
<td>1/nₛ</td>
<td>1/nₛ</td>
</tr>
</tbody>
</table>

Note. For amphibian-type hovercraft: e₁ = 0.2B; e₂ = 0.4B; for skeg-type hovercraft: e₁ = bₛ; e₂ = 0.5(B+bₛ).

Values of external forces are taken equal to, kN:

\[ P₁ = 9.81 \mu₁ \sigma_ x ; \quad (6.2.5-1) \]
\[ P₂ = 9.81 \mu₂ \sigma_ y \] ; \quad (6.2.5-2)

### 6.2.6 Design loads for the erection on supports and lifting by crane

Supports and hoisting rings shall be so located that bending moments in hovercraft cross-sections do not exceed values corre-
sponding to operational loading cases as far as practicable.

6.2.7 Summed bending moments $M$ and shear forces $N$ at longitudinal bending shall be calculated by means of integration of design load curve, which is a difference of gravity forces $g(x)$ multiplied by overload factor $n_g$ in the centre of transverse spacing under consideration and buoyancy forces calculated according to 6.2.3 to 6.2.6.

6.2.8 Summed bending moment, kNm, amidships at longitudinal bending at initial design stages shall be determined by the formulae:

1. when moving in hovering mode for amphibian and skeg types

$$M_0 = 9.81\left[k_{sw} \pm 0.5(0.15 \pm k_{sw})(n_g - 1)\right]D'L;$$

(6.2.8.1)

2. when moving in displacement mode for amphibian-type ships

$$M_0 = 4.9\left(0.15 \pm k_{sw}\right)D'L n_g;$$

(6.2.8.2)

3. when moving in displacement mode for skeg-type ships

$$M_0 = 9.81\left[k_{sw} \pm 0.5(0.15 \pm k_{sw})\left(n_g + D'_k / D'\right)\right]\times$$

$$\times D'L \pm 50b_h \left(0.1L\right)^2 h,$$

(6.2.8.3)

where $k_{sw} = M_{sw} / (9.81D'L)$ — coefficient of longitudinal bending moment on still water (with due regard to the sign);

$M_{sw}$— longitudinal bending moment at still water calculated with regard to requirements of 2.2.1.

$n_g$— is determined by the formula (6.2.3-2). The sign (+) in formulae (6.2.8.1), (6.2.8.2) and (6.2.8.3) corresponds to hogging. Coefficient $n_g$ in formulae (6.2.8.2) and (6.2.8.3) is determined by a prototype or by results of model scale testing.

Maximum shear force

$$N_0 = 4M_0 / L.$$

(6.2.8.4)

Calculated values of summed bending moments and shear forces in hovercraft cross-sections in this case are taken according to Fig. 6.2.8.

6.2.9 Bending moments $M'$ and shear forces $N'$ at transverse bending are calculated by means of integration of the design load curve, which is a difference of gravity forces $g(y)$ multiplied by the overload factor in the centre of the transverse spacing under consideration and buoyancy forces calculated in accordance with 6.2.3 to 6.2.6.

6.2.10 Summed bending moment, kNm, in the hovercraft centre line at transverse bending at initial design stages shall be determined by the formulae:

1. when moving in hovering mode for amphibian and skeg types

$$M'_0 = 9.81\left[k'_{sw} - 0.5(0.15 - k'_{sw})\left(n'_g - 1\right)\right]D'B;$$

(6.2.10.1)

2. when moving in displacement mode for amphibian-type ships

$$M'_0 = 4.9\left(0.15 - k'_{sw}\right)D'B n'_g;$$

(6.2.10.2)

3. when moving in displacement mode for amphibian-type ships

$$M'_0 = 9.81\left[k'_{sw} - 0.5\left(0.25 - b_h / k'_{sw}\right)\right]D'B n'_g,$$

(6.2.10.3)

where $k'_{sw} = M_{sw} / (9.81D'L)$ — coefficient of transverse bending moment on still water (with due regard to the sign).

$M_{sw}$— transverse bending moment calculated with regard to the requirement of 2.2.1 where instead of the word “longitudinal” the word “transverse” shall be read. Coefficient $n'_g$ in formulae (6.2.10.1), (6.2.10.2) and (6.2.10.3) is determined by a prototype or by results of model scale testing.

Maximum shear force, kN, is calculated by the formula
6.2.11 External torsion moments \( M_{\text{ext}} \), kN·m, are calculated by means of integration of the design torsion moment intensity curve. The latter is algebraic sum of moment intensity \( m_1 \) due to buoyancy force \( P_1 \), moment intensity \( m_2 \) due to buoyancy force \( P_2 \) and linear moment \( m_3 \) due to inertia forces on the ship masses relating to a longitudinal axis of revolution. Here:

\[
\begin{align*}
  m_1 &= 9.81 \mu_1 D' n_g y_1 / l_1 ; \\
  m_2 &= 9.81 \mu_2 D' n_g y_2 / l_2 ; \\
  m_3 &= -g(x)(\mu_1 y_1 + \mu_2 y_2) .
\end{align*}
\] (6.2.11-1, 6.2.11-2, 6.2.11-3)

Values of the moment intensity \( m_1 \) and \( m_2 \) over ship length are taken in accordance with Fig. 6.2.5 and Table 6.2.5. Value of moment intensity \( m_3 \) is throughout the whole length of a ship.

6.2.12 At the strength trials of a first ship in a series at waves according to 6.1.6 a summed bending moment amidships at longitudinal bending shall be adjusted.

When a found value is over than that calculated according to 6.2.8, strength calculations, design and scantlings of the hull members of serial ships shall be adjusted in accordance with longitudinal bending moment of hovercraft amidships obtained at the strength trials.

Design local loads

6.2.13 Local load applied to the bottom and skegs is determined for the following cases:

1. pressure in the air cushion (when there is no contact between the structure and water);
2. impact of structures by the water;
3. hydrostatic pressure (for displacement mode);
4. erection on supports.

6.2.14 Distribution of air cushion pressure on the bottom over hovercraft length, when there is no contact with water is taken as uniform.

![Distribution of air cushion pressure on the bottom over hovercraft length](image)

Ordinates of the pressure diagram are equal to:

\[
\begin{align*}
  p_1 &= 9.81 \times 2 D' n_g / F_{ac} ; \\
  p_2 &= 9.81 D' n_g / F_{ac} .
\end{align*}
\] (6.2.14-1, 6.2.14-2)

Design pressure value shall be not less than pressure induced by ventilator installation at zero air output increased by 30%.

6.2.15 Pressure distribution throughout the length at flat impact of the bottom by a wave is taken in accordance with Fig. 6.2.15. The pressure is taken as uniformly distributed over the ship’s breadth.

![Pressure distribution throughout the length at flat impact of the bottom by a wave](image)

Pressure values applied to the structure during the impact are taken equal to, kPa:

\[
\begin{align*}
  p_0 &= 9.81kD'n_g / (0.3LB) ; \\
  p_{10} &= 9.81kD'n_g / (0.4LB) ; \\
  p_{20} &= 9.81kD'n_g / (0.4LB) .
\end{align*}
\] (6.2.15-1, 6.2.15-2, 6.2.15-3)

where \( k \) — non-uniformity coefficient equal to:

1. for calculation of grillages
2. for calculation of longitudinal girders and plates in way of 0 — 10 frames;
3. for calculation of longitudinal girders and plates in way of 20th frame.

\( N'_0 = 4M'_0 / B . \) (6.2.10.4)
6.2.16 Hydrostatic pressure, kPa, is taken equal to:

- on the bottom
  \[
  p = 9.81 \left( T + 0.5h - h_{sh} \right);
  \]  
  \[
  (6.2.16-1)
  \]

- on skegs and sides
  \[
  p = 9.81 \left( T + 0.5h - z \right),
  \]  
  \[
  (6.2.16-2)
  \]

where \( h \) — design wave height, m;

\( z \) — distance over a height from the base plane to the skeg or side point under consideration, m.

6.2.17 Local loads on the bottom and skegs at erection on supports are defined in accordance with 6.2.6.

6.2.18 Air cushion pressure on inner surfaces of skegs is taken uniformly distributed over the depth. Air cushion pressure is taken distributed over the length of hovercraft in accordance with Fig. 6.2.14.

6.2.19 Design load, kPa, for decks is taken equal to:

- 1.0 for parts of decks where accumulation of passengers or crew members may be crowded;
- 2.0 for decks in way of passenger seats;
- 3.0 for plates and longitudinal girders of superstructure decks;
- 4.0 for beams of superstructure decks.

6.2.20 Uniformly distributed design load, kPa, on front walls and windows of the first tier superstructure is taken equal to, for basin category:

- O-ПР, O: 20
- P: 10
- Ю: 5

For side walls and windows of the first tier superstructure the uniformly distributed design load is taken equal to 3.0 kPa.

6.2.21 Design loads applied to the structures bounding tanks and watertight compartments are taken in accordance with the requirements of 2.2.

6.2.22 Design load applied to watertight bulkheads is taken as distributed by a triangle over a bulkhead height having a maximum force at the base plane level equal to a distance from the base plane of a ship to bulkhead deck; where the bulkhead deck is not available — to double hovercraft draught in displacement condition.

6.2.23 As design load applied to cargo decks shall be taken the cargo pressure with due regard to possible non-uniformity multiplied by the overload factor in the point under consideration. When carrying wheel or caterpillar vehicles, the loads applied to the deck are determined on the basis of load distribution on axes, the number and the area of wheel prints, dimensions of bearing surface of tracks having regard to actual disposition of the vehicles in the cargo compartment and ship overload when moving in rolling conditions.

Global strength calculations

6.2.24 The global strength of the hull shall be checked with regard to normal and tangent stresses. At longitudinal bending the checking with regard to summed stresses and ultimate bending moments shall be carried out also.

6.2.25 The checking of the global longitudinal strength shall be performed for the most unfavourable cases of the design load corresponding to maximum hogging and sagging of the hull. Here, the most distinctive hull sections with regard to strength shall be considered: in way of action of maximum bending moments and shear forces as well as torsion moments; in way of large cutouts. The number of sections to be checked is taken depending on the design features of a designed ship and shall be grounded in strength calculations submitted to the River Register.

6.2.26 When calculating the longitudinal strength, the members shall be included in the hull girder as per 2.2.33. Cross-sectional area of superstructure horizontal grillages with the ratio of the superstructure length and the grillage breadth less than five shall be included in the hull girder with a reduction coefficient \( \phi_r \), considering non-uniformity of distribution of normal stresses along the breadth which is determined from Table 6.2.26, where:
6 Design of Hovercraft Hull

$B_l$ — grillage breadth, m;

$l_s$ — design length (a distance between the end bulkheads) of the superstructure, m.

**Table 6.2.26**

<table>
<thead>
<tr>
<th>$B_l/l_s$</th>
<th>$\varphi_r$</th>
<th>$B_l/l_s$</th>
<th>$\varphi_r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>1.00</td>
<td>0.5</td>
<td>0.66</td>
</tr>
<tr>
<td>0.3</td>
<td>0.83</td>
<td>0.6</td>
<td>0.58</td>
</tr>
<tr>
<td>0.4</td>
<td>0.74</td>
<td>0.7</td>
<td>0.52</td>
</tr>
</tbody>
</table>

6.2.27 Buckling strength of entire grillages and its particular elements (framing girders and plates) shall be checked in accordance with 6.2.5. Rigid parts of plates adjacent to longitudinal girders at either side are taken equal to:

0.25 of the spacing if $h/t \leq 80$

20t at $h/t > 80$.

6.2.28 Stresses in cross-sections of a hovercraft with a strength superstructure are calculated with due regard to participation of the superstructure in global bending. Where a superstructure is riveted and the hull is welded, cross-sectional area of the superstructure members shall be included in the hull girder with a coefficient of 0.9.

6.2.29 Normal stresses due to constrained torsion in the hull cross-sections are not regarded.

6.2.30 Summed design values of normal and tangent stresses between windows of a strength superstructure are determined by the formulae:

$$\sigma_0 = \sigma_{0, \text{tor}} + \sigma_{0, \text{ben}},$$

$$\tau_0 = \tau_{0, \text{tor}} + \tau_{0, \text{ben}},$$

where $\sigma_{0, \text{tor}}$, $\sigma_{0, \text{ben}}$, $\tau_{0, \text{tor}}$, $\tau_{0, \text{ben}}$ — normal and tangent stresses between windows due to the ship torsion, MPa;

$\sigma_{0, \text{ben}}$, $\tau_{0, \text{ben}}$ — normal and tangent stresses between windows due to global longitudinal bending of the ship, MPa.

6.2.31 Summed design tangent stresses in cross-sections of the hull are taken equal to:

$$\tau = \tau_{\text{tor}} + \tau_{\text{ben}},$$

where $\tau_{\text{tor}}$ — tangent stresses in the hull due to torsion, MPa;

$\tau_{\text{ben}}$ — tangent stresses in the hull due to the global longitudinal bending, MPa.

6.2.32 To ensure the global ultimate strength of a ship the following condition shall be met

$$M_{\text{lim}} \geq kM_b,$$

(6.2.32)

where $M_b$ — bending moment at longitudinal bending or hogging, kN·m;

$M_{\text{lim}}$ — limiting bending moment, kN·m;

$k$ — safety factor of limiting moment taken equal to 1.5.

6.2.33 When moving in displacement mode the ultimate global strength shall be checked with regard to summed stresses of global and local bending in the bottom and skeg members. Local load is taken having regard to directions of 6.2.16.

For ships carrying cargoes the checking shall be made also for the cargo deck (platform) when moving in both hovering and displacement modes. Local load in the latter case is determined by 6.2.23.

6.2.34 Scope and method of global transverse strength calculations are taken depending on the design features of a designed ship.

**Local strength calculations**

6.2.35 At local strength calculations a sag of beams not exceeding 10% of grillage breadth need not be considered.

6.2.36 For girders directly connected to the shell plating an effective flange width $d$, cm, is taken equal to:

1 at calculation of ordinary members and web members located perpendicularly to the ordinary members,

$$d = 0.5b \text{ at } b/t \leq 80;$$

(6.2.36.1-1)

$$d = 40t \text{ at } b/t > 80;$$

(6.2.36.1-2)

2 at calculation of web members of the same direction with ordinary members

$$d = 0.5A/b \text{ at } b/t \leq 80;$$

(6.2.36.2-1)

$$d = 40tA/b \text{ at } b/t > 80;$$

(6.2.36.2-2)
where \( b \) — distance between same-name ordinary girders, cm;
\( A \) — distance between the same-name web members, cm.

Stiffeners of the same direction with web members located at the effective flange level shall be included into the effective flange.

For web members laid above ordinary stiffeners (attached framing structure), the effective flange is taken equal to zero.

In all cases the effective flange shall not exceed 1/6 length of design span of a girder.

**Buckling strength calculations**

6.2.37 At buckling strength calculations of framing girders in order to determine its cross-sectional area the effective flange width is taken equal to an average distance between same-name girders, while at determination of the area moment of inertia of girders, the effective flange is taken in accordance with 6.2.36.

6.2.38 Corrected (critical) Euler’s normal stresses of stiffeners shall meet the following condition
\[
\sigma_{cr} \geq 1.5 \sigma .
\] (6.2.38)

6.2.39 Euler’s tangent stresses in a plate of side, superstructure and bulkhead plating participating in global bending shall meet the following condition
\[
\tau_E \geq 1.5 \tau .
\] (6.2.39)

6.2.40 Buckling strength of web members of compressed grillages is determined by the required rigidity of transverse web members, at which the grillage withstands the given compressing stress.

6.2.41 Buckling strength of separately working members (pillars, braces, etc.) shall be ensured with a safety factor of 2 as compared with design stresses.

**Permissible stresses**

6.2.42 Permissible stresses \( \sigma_p \) and \( \tau_p \) at global and local strength calculation of the hovercraft hull are taken according to Table 6.2.42 as fractions of unsafe stresses.

6.2.43 Unsafe normal stresses are taken equal to:
- at tension \( \sigma_0 = kR_{p0.2} \);
- at compression \( \sigma_0 = \sigma_{cr} \).

<table>
<thead>
<tr>
<th>Name and characteristic of the hull members</th>
<th>Characteristic of design stresses due to loads</th>
<th>Permissible stresses in fractions of unsafe stresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hull and strength superstructure members participating in global longitudinal or transverse bending (including bridges between windows of the strength superstructure)</td>
<td>Normal and tangent stresses due to global longitudinal or transverse bending</td>
<td>0.50</td>
</tr>
<tr>
<td>Hull web members participating in global longitudinal bending and bearing local load (cargo deck and bottom members)</td>
<td>Summed normal and tangent stresses due to global longitudinal bending and torsion</td>
<td>0.70</td>
</tr>
<tr>
<td>Hull ordinary members participating in global longitudinal bending and bearing local load (members of cargo deck, bottom and skeg members)</td>
<td>Summed normal and tangent stresses due to global bending and bending of grillages or individual web members:</td>
<td></td>
</tr>
<tr>
<td>Hull shell plating and superstructure plating, bulkhead and tank plates</td>
<td>in a span</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>Summed normal and tangent stresses due to global bending, local bending of grillage, if any, and local bending of a stiffener:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>Normal stresses due to local load:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in a span</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>on a bearing</td>
<td>0.95</td>
</tr>
</tbody>
</table>

| Permissible stresses for hovercraft hull |
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Name and characteristic of the hull members

<table>
<thead>
<tr>
<th>Characteristic of design stresses due to loads</th>
<th>Hull and superstructure web members not participating in global bending</th>
<th>Hull and superstructure ordinary members not participating in global bending</th>
<th>Web frames of bulkheads and tanks</th>
<th>Ordinary frames of bulkheads and tanks</th>
<th>Pillars and braces checked for buckling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal and tangent stresses due to local load:</td>
<td>Normal and tangent stresses due to local load:</td>
<td>Normal and tangent stresses due to local load:</td>
<td>Normal and tangent stresses due to local load:</td>
<td>Normal and tangent stresses due to local load:</td>
<td>Normal and tangent stresses due to local load:</td>
</tr>
<tr>
<td>in a span</td>
<td>in a span</td>
<td>in a span</td>
<td>for separately working members</td>
<td>for intersecting braces</td>
<td>0.75</td>
</tr>
<tr>
<td>on a bearing</td>
<td>on a bearing</td>
<td>on a bearing</td>
<td></td>
<td></td>
<td>0.75 (but not more than 0.5(R_{p0.2}))</td>
</tr>
</tbody>
</table>


where \(R_{p0.2}\) — yield stress of the material, MPa, corresponding to residual deformation of 0.2%.

\(\sigma_{ct}\) — critical stresses of the stiffener calculated having regard to correction for Young’s modulus, MPa;

\(k\) — coefficient taken equal for structures:

<table>
<thead>
<tr>
<th></th>
<th>at thickness of connected elements (t), mm</th>
<th>riveted</th>
<th>any</th>
<th>welded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(t \leq 3)</td>
<td>0.9</td>
<td>0.6</td>
<td>0.7</td>
</tr>
<tr>
<td>(t \geq 4)</td>
<td></td>
<td>0.9</td>
<td>0.6</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Unsafe tangent stresses \(\tau_0\) are taken equal to 0.57 of unsafe normal stresses \(\sigma_0\) in the given section.

6.3 DESIGNING OF THE HULL

6.3.1 Thickness of hull members shall be not less than indicated in Table 6.3.1.

6.3.2 Plates of the outer shell plating in way of engine foundations, propeller shaft and water-jet brackets and plates subject to intensive mechanical wearing are thickened by at least 40%.

6.3.3 The distance between ordinary girders (the spacing) shall not exceed 300 mm at plating thickness of less than 3 mm and 400 mm in the rest cases.

<table>
<thead>
<tr>
<th>Minimum hull member thicknesses for hovercraft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of member</td>
</tr>
<tr>
<td>Bottom shell plating</td>
</tr>
<tr>
<td>Side shell plating</td>
</tr>
<tr>
<td>Hull deck plating and bulkhead plating</td>
</tr>
<tr>
<td>Skeg plating</td>
</tr>
<tr>
<td>Receiver plating</td>
</tr>
<tr>
<td>Superstructure plating</td>
</tr>
</tbody>
</table>

\(^*\) Hovercraft do not belong to small vessels.
6.3.4 The distance between web frames shall not exceed 1200 mm in case of the spacing up to 300 mm and 1500 mm in the rest cases.

6.3.5 The distance between keelsons as well as between a keelson and a side or a longitudinal bulkhead shall not exceed 1500 mm in ships without double bottom and 2000 mm in ships with double bottom.

6.3.6 In the bottom edge area the skeg shall be strengthened by means of thickening a plating or fitting a special reinforcement. Strengthening thickness shall be not less than double thickness of the skeg plating. In ships intended for operating in fresh water only, steel reinforcement brackets may be applied.

6.3.7 Measures shall be taken for increase of deck rigidity in areas where passengers may be crowded during boarding. The deck thickness in that area shall be at least 3 mm.

6.3.8 Where window cutout are located close to each other in the superstructure, two continuous end parts (fore and after) shall be provided in the superstructure walls. The length of each of the above parts shall exceed the window cutout height by at least 20%.

6.4 VIBRATION STRENGTH AND VIBRATION NORMS OF THE HULL

General requirements

6.4.1 Vibration calculations means checking of the absence of resonance by means of determination of natural oscillation frequencies and comparing them with frequencies of exciting forces due to the operation of the ship machinery and the propulsion unit.

The following shall be checked:

.1 general vertical oscillations of the hull for the design loading conditions of ship, i.e. full loaded condition and lightship condition;
.2 local oscillations of members, stiffeners and outer shell plating, deck and bulkhead plating.

6.4.2 Local oscillations shall be checked for the following areas:

.1 the bottom in the propulsion unit area;
.2 the bottom in the area of engines and ventilators.

Global and local vibration calculations

6.4.3 At global vibration calculations natural oscillation frequencies of the hull of the first, second, and higher tones shall be determined for the ship in displacement and hovering modes based on methods developed in accordance with requirements of the Rules and agreed with the River Register. Those frequencies shall be different from exciting force frequencies at basic operational modes which are numerically equal to:

.1 propeller rotor revolution frequency;
.2 propeller rotor revolution frequency multiplied by the number of blades;
.3 engine crankshaft revolution frequency;
.4 revolution frequency of engine crankshaft multiplied by the number of ignitions per one revolution;
.5 ventilator revolution frequency multiplied by the number of blades.

6.4.4 Frequency difference assigned by a designer shall be grounded by a calculation which shall prove that global vibration amplitudes do not exceed the permissible values (see 6.4.13).

6.4.5 Natural oscillation frequency of the hull of the first, second and higher tones shall be adjusted by experience on the first ship in a series.

6.4.6 In order to avoid resonance, natural oscillation frequencies of the first tones of particular hull structures shall exceed frequencies of exciting forces at basic operational modes (in hovering and displacement modes) as the following:

.1 for plates and stiffeners of the hull bottom in the aft extremity — the propeller rotor revolution frequency by at least 50 and 30% correspondingly;
.2 for plates and stiffeners in way of main engines — crankshaft revolution frequency and double crankshaft revolution frequency of the main engines by at least 50 and 30% correspondingly.
6.4.7 Natural oscillation frequencies of the plates and stiffeners shall differ from frequencies of exciting forces numerically equal to:

.1 in the aft extremity — the propeller rotor revolution frequency multiplied by the number of the blades;
.2 in way of main engines — the engine crankshaft revolution frequency multiplied by the number of ignitions per revolution of the crankshaft;
.3 in way of ventilators — the ventilator revolution frequency multiplied by the number of the blades.

6.4.8 Difference between the natural oscillation frequency and the frequency of exciting forces assigned by a designer (see 6.4.7) shall be substantiated by forced vibration calculation to verify that amplitudes at vibration shall not exceed the permissible values (see 6.4.14).

6.4.9 Natural oscillation frequency of plates, Hz, resting on web members and not reinforced by intermediate ordinary members or stiffeners may be calculated by the formulae (2.6.10), (2.6.11-1), (2.6.11-2).

6.4.10 Natural oscillation frequency of plates, Hz, resting on web members and reinforced by intermediate ordinary members or stiffeners is calculated by the formulae (2.6.12) to (2.6.13-2).

6.4.11 Natural oscillation frequency of intermediate ordinary members or stiffeners, Hz, determined regardless of its interaction with the plate is calculated by the formula (2.6.14).

6.4.12 At trials of the first ship in a series according to 6.1.5 periodical exciting forces due to propellers, engines, ventilators, dynamic interaction forces with waves etc. and its ranges shall be obtained in experimental way according to methods developed in accordance with the Rules and agreed with the River Register. The test results shall be submitted to the River Register.

Vibration norms

6.4.13 Permissible amplitudes of vibration of the aft extremity shall not exceed the values calculated by formula (2.6.25.1).

6.4.14 Permissible amplitudes of vibration in the centre of plates of the hull and superstructure, mm, shall not exceed the values determined by the formula

\[ A_p = k \left( \frac{a}{100t} \right)^2 t, \]  

(6.4.14)

where \( k \) — coefficient equal to:

- for plates welded around the contour by means of continuous double-sided weld or riveted to the framing: \( k = 2.90 \);
- for plates welded around the contour by continuous single-sided or intermittent double-sided weld: \( k = 1.45 \);

\( a \) — shorter side of the plate, cm;
\( t \) — plate thickness, cm.

6.4.15 Vibration of the framing is considered to be permissible, if the greatest stresses measured or calculated from measured amplitudes do not exceed 20 MPa.

6.5 DESIGN REQUIREMENTS AND STRENGTH NORMS OF AIR CUSHION FLEXIBLE SKIRT

6.5.1 The requirements stated in this chapter apply to flexible skirts of air cushion (FS) of skeg and amphibian type inland navigation hovercraft made of rubber-textile materials complied with the Rules using glue-pierced, bolted and riveted joints.

6.5.2 Dimensions, design, type of connections and joints of FS shall be chosen at the initial stages of hovercraft designing according to the design specification with due regard to design and operation experience of similar craft and data on physical and mechanical properties of FS materials submitted by the manufacturer and obtained by laboratory tests.

6.5.3 In case if FS structure has novelty in design, materials or it is intended for specific operation conditions, manufacture and tests of an experimental model of FS shall be provided. FS experimental model shall undergo test cycle on a type hovercraft in operation conditions during the service period planned for this FS according to the methods developed according to the requirements of the Rules and agreed with the River Register.
6.5.4 FS shall be designed so as to meet the following requirements:
1. it shall ensure hovercraft reliable operation in operation conditions;
2. metal parts of FS fastenings shall be made of corrosion-resistant alloys or have corrosion-resistant coating;
3. it shall be processable, easily accessible for maintenance, repair, mounting, dismantling and ensure the possibility of replacement or repair of defect components and parts outside the workshop conditions;
4. FS shape and structure in hovering mode above the even screen shall ensure the adequate air cushion height and prevent unforeseen bending deformations and air leakages at sheet butts and in fastening joints of the bag member.

Flexible skirt strength calculations and norms

General directions

6.5.5 Global strength of the FS main structural components shall be checked according to tension calculation methods in soft shells subject to excessive internal pressure. The calculation method shall be agreed with the River Register.

6.5.6 FS strength condition is determined by the formula:
\[ T \leq T_{\text{perm}}, \]  
(6.5.6)

where \( T \) — design tension,
\( T_{\text{perm}} \) — permissible tension in FS components.

6.5.7 Permissible tension in FS material at the hovercraft design stage is determined as:
\[ T_{\text{perm}} = mR_{\text{H}}, \]  
where \( R_{\text{H}} \) — tensile stress of FS material, kN/cm,
\( m \) — strength reducing coefficient due to processing tolerances for FS assembling, wear and natural ageing of the material, which is assigned according to Table 6.5.7.

6.5.8 At the hovercraft design stage the dynamic stress increasing coefficient relating to basic calculation case \( n \) shall be assigned according to Table 6.5.7.

6.5.9 Basic calculation cases are as follows:
1. still hovering above the horizontal screen on calm water (basic case)
2. interaction with the water surface at waves and in hovering cruise mode with amplitude equal to the air cushion height:
\[ 2z = h_{\text{c}}, \]
3. contacting obstacles longitudinally and transversely oriented relatively to the FS plane view in hovering mode.

6.5.10 Correction of coefficients \( n \) and \( m \) is made with regard to operational trials of hovercraft’s FS.

<table>
<thead>
<tr>
<th>Calculation case</th>
<th>Coefficient double-tier bag member</th>
<th>Coefficient double-tier half-bag member</th>
<th>Coefficient skeg hovercraft</th>
<th>Coefficient detachable fingers of amphibian hovercraft or inflatable skegs</th>
</tr>
</thead>
<tbody>
<tr>
<td>0. Still hovering above the horizontal screen on calm water (basic case)</td>
<td>( n ) 1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>( m ) 0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.09’</td>
</tr>
<tr>
<td>1. Interaction with the water surface at waves</td>
<td>( n ) 2.4</td>
<td>2.4</td>
<td>3.5</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>( m ) 0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.09’</td>
</tr>
<tr>
<td>11. Contacting with an obstacle:</td>
<td>longitudinal</td>
<td>( n ) 1.5</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>transverse</td>
<td>( n ) 2.2</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( m ) 0.2</td>
<td>0.2</td>
<td>—</td>
</tr>
</tbody>
</table>

* Including additional wear of the aforementioned FS components when contacting the ground.
6 Design of Hovercraft Hull

6.5.11 Bag member is the upper tier shell of double-tier full-contour FS secured to the hovercraft hull by upper and lower fastenings as well as inflatable skeg (bag) as FS component of respective hovercraft types.

6.5.12 Tensions in the outer branch of the bag member shell (bounding the ambient atmosphere) $T_B$ in the still hovering mode (basic calculation case) are determined using the formula:

$$T_B = 10^{-4} P_B r_{out},$$

where $P_B$ — pressure in the bag member, kPa;
$r_{out}$ — radius of curvature of the outer branch of the bag member shell, cm.

Note. According to equilibrium conditions of the FS bag member shell, tensions in the inner branch of the shell (bounding the air cushion) are equal to tensions in the outer shell.

6.5.13 Maximal tensions in the shell of the bag member cylindrical section $T_B^c$ in hovering cruise mode at waves (calculation cases 1 and 2), kN/cm, are determined by the formula:

$$T_B^c = n P_{ac} r_{out} \cdot 10^{-4},$$

where $n$ — pressure increasing coefficient determined for each calculation case according to the test results of similar prototype or, if such prototype is not available, according to Table 6.5.7.

6.5.14 Maximal tensions in toroidal sections of the bag member shell $T_B^{tor}$ (fore section and aft angular sections) are determined by the formula, kN/cm:

$$T_B^{tor} = 1.5 \cdot 10^{-4} n P_B r_{out}.$$

6.5.15 Half-bag member is the upper tier shell of double-tier half-contour FS secured to the hovercraft hull only by upper fastening.

6.5.16 Tensions in the shell of the half-bag member cylindrical sections $T_{HB}^c$, kN/cm, are determined by the formula:

$$T_{HB}^c = n P_{ac} r_{out} \cdot 10^{-4},$$

where $P_{ac}$ — pressure in the air cushion, kPa.

6.5.17 Maximal tensions in toroidal sections of the half-bag member shell (fore section and aft angular sections) $T_{HB}^{tor}$ are determined by the formula, kN/cm:

$$T_{HB}^{tor} = 1.5 \cdot 10^{-4} n P_{ac} r_{out}.$$

6.5.18 Tensions in the material of open-type finger $T_e$, kN/cm, are determined by the formula:

$$T_e = n P_{ac} r_e \cdot 10^{-4},$$

where $r_e$ — radius of curvature of the outer branch of the finger cross-section, cm.

6.5.19 Tensions in the material of closed-type finger are determined by the respective formulae for the bag member.
7 DESIGN OF REINFORCED-CONCRETE HULL

7.1 GENERAL REQUIREMENTS

7.1.1 The present Section sets up requirements for the materials, structure, strength and construction of reinforced-concrete hulls and superstructures.

7.1.2 All the materials used to construct ships shall comply with the requirements of Part X of the Rules.

7.2 DESIGNING OF HULL AND SUPERSTRUCTURE

General requirements

7.2.1 Hull of reinforced-concrete ships may be framed by the transverse, longitudinal or combined framing systems.

For floating objects of landing stage and fire-watch types up to 35 m in length a hull may be designed according to non-frame (non-rib) system with transverse bulkheads the number of which exceeds the one required by the Rules based on floodability conditions.

A combined construction of a hull made of rib and non-rib elements is allowed. The latter shall be used for inner parts of the hull (e.g. bulkheads and platforms).

7.2.2 Hulls of reinforced-concrete ships may be of assembled, assembled-monolithic and monolithic design.

7.2.3 Parts of weather decks in reinforced-concrete ships shall be inclined to ensure drainage of water overboard. Bottom of floating objects more than 30 m in length shall be risen above the load waterline at the extremities.

7.2.4 Watertight bulkheads shall be so located in the hull as to provide the ship’s floodability in accordance with the requirements of 4 Part II of the Rules.

7.2.5 Floating objects of P and J classes bulkheads may be permeable in way of their connection with the deck, provided that for the most unfavourable flooding conditions the freeboard depth is not less than 0.7 m. The above does not apply to forepeak and afterpeak bulkheads as well as to bulkheads of the engine room which in all cases shall be tightly connected with the deck.

7.2.6 Outer parts of the hull subject to impacts during operation shall be protected by fender bars, special baffles or platings.

Protective structures of the hull shall transfer forces of impacts to rigid members (bulkheads, framing girders or special reinforcements).

7.2.7 Surfaces subject to intensive local wear (plates of shell plating and decks in way of anchor hawsepipes, cargo hatch coamings) shall be lined with metal or other protective material.

7.2.8 Number and location of armature in elements of reinforced-concrete hull shall be designated on condition of ensuring strength and restriction of crack propagation with observance of respective structural requirements of the Rules.

7.2.9 Cross-sectional area of tensioned armature as a share of geometrical section area of the element shall be as follows, %, min, for armature made of steel of grade:

<table>
<thead>
<tr>
<th>Type</th>
<th>Grade</th>
<th>Cross-sectional Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-I</td>
<td>A240</td>
<td>0.5</td>
</tr>
<tr>
<td>A-II</td>
<td>A300</td>
<td>0.4</td>
</tr>
<tr>
<td>A-III</td>
<td>A400</td>
<td>0.3</td>
</tr>
</tbody>
</table>

7.2.10 For all hull components, the required cross-sectional area of armature shall be ensured using the greatest possible number of rods of minor diameter thus maintaining the minimum permissible distance between the rods (see 7.2.11). Here, the rod diameter
shall be not less than 10 mm for longitudinal armature rods of girders and 6 mm for lathing of plates and loops and for armature designated from a construction point of view.

7.2.11 Location of armature rods in the hull elements shall meet the following requirements:

1. clear distance between the nearest parallel rods shall be not less than their diameter, but not less than 20 mm;
2. minimum clear distance between extended parts of overlaps and onlays of butts and the nearest parallel armature rods shall be 10 mm and more;
3. armature rods shall not enclose the openings through which concrete is supplied to the lower parts of construction, by more than 40% of their area.

7.2.12 Hull armature shall be welded and consist of flat welded lathings or volume welded carcasses.

Tied armature is allowed for the manufacture of monolithic parts of a hull, as well as for particular sections on condition that their armature is assembled on the place of manufacture and is not transported in assembled condition.

7.2.13 Butt connections of the rods shall be performed by means of contact or arc welding (by side fillet welds or bath method in channel onlays). In all cases the armature in the place of connection shall be equally strong to the rods to be connected and, when connecting rods of different diameters, equally strong to the least diameter rod.

7.2.14 Connections of intersecting rods shall be performed by spot welding, semi-automatic CO2–shielded welding, manual arc welding in hardly accessible places.

7.2.15 Connections of the rods with metal structures shall be fulfilled by arc welding (by continuous, spot gas-shielded or submerged arc welding).

7.2.16 Ends of armature rods shall be reliably fastened, for this the following is necessary:

1. to complete by end hooks all regarded in strength calculation tensioned rods of armature of 10 mm in diameter and more, as well as all the anchors subject to tension and of less than 20 diameters in length;
2. to fasten tensioned rods within compressed zone;
3. to overlap the rods at places, where they are required by the calculation, for the following length:
   - strained rods of armature steel (see 2.10 Part X of the Rules) of A-I (A240) and A-II (A300) grades — for 30 diameters, of A-III (A400) grade — for 40 diameters;
   - compressed rods of steel A-I (A240) grade without hooks — for 30 diameters, of other grades — for 10 diameters less than tensioned ones;
4. to weld all loaded longitudinal rods ending up in a point of intersecting or abutting of girders to special anchors and the nearest intersecting rods.

7.2.17 Armature bends are carried out by arc of a radius not less than 10 diameters.

Normal end hooks of armature shall be of a clear diameter not less than 2.5 rod diameter, straight hooks shall have a length of bent part of not less than 3 diameters.

7.2.18 Hogging of tensioned armature at angles less than 165° is not allowed. In this case the armature shall consist of individual intersecting rods located along side edges of connected elements.

At angles exceeding 165° the hogging of tensioned armature is allowed provided that loops are installed.

7.2.19 Thickness of protection concrete layer for all outer surfaces of the hull and inner surfaces subject to moistening shall be not less than 10 mm and for other surfaces — not less than 5 mm.

Parts of the hull contacting with sea water as well as deck parts subject to high wearing which are not covered with special coating shall have a thickness of protection layer increased by at least 5 mm in comparison with the aforementioned.
For armature of more than 10 mm in diameter thickness of protection layer shall be not less than a rod diameter.

7.2.20 When designing a hull, no new strength concentration spots shall be formed. For this the following shall be complied with:
   .1 ends of rods in the main hull members shall be distributed over a length and breadth of the element in such a way that in one section an area of a tensioned armature is changed by not more than 25% for plates and 30% for girders, and for compressed armature — by not more than 40%;
   .2 ending members shall be fastened to the nearest intersecting members or reinforced parts of plates;
   .3 to change the thickness of plates and dimension of girders smoothly, with a slope not more than 1:3;
   .4 to provide chamfers of at least 25 mm for right and acute corners of concrete parts.

Plates

7.2.21 Thickness of the hull plates shall be designated depending on the type and main dimensions of a ship, her construction and strength condition. In all cases a thickness of plates shall be not less than that indicated in Table 7.2.21.

<table>
<thead>
<tr>
<th>Hull elements</th>
<th>Minimum permissible plate thickness, mm, for concrete class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulkheads and covered parts of decks</td>
<td>40</td>
</tr>
<tr>
<td>Bottom and open parts of decks</td>
<td>40 to 50</td>
</tr>
<tr>
<td>Sides and transoms</td>
<td>50 to 60</td>
</tr>
</tbody>
</table>

Notes. 1. The less values of thickness relate to ships up to 40 m in length.
2. In ships with non-framed structure thickness of shell plating shall be not less than 60 mm.

7.2.22 Thickness of plates in way of bilge, as well as in way of built-in parts locations or fastening of machinery and arrangements shall be increased by at least 25%.

7.2.23 Hull plates shall be reinforced by two single lathings apart at a distance not less than a thickness of the protection layer (see 7.2.19).

7.2.24 When reinforcing thin plates not subject to impact loads (plates of bulkheads, enclosures and decks protected by covering) instead of the two single lathings one sesquialteral lathing may be used consisting of middle distributing rods to both sides of which perpendicularly located working rods are fitted.

Plates of shell plating shall not be reinforced by the sesquialteral lathing.

7.2.25 Armature of plates in way of bilge, deck stringer as well as in places subject to significant impact or concentrated loads shall be reinforced by increase of dimensions or installation of additional rods and local lathings.

7.2.26 Cross-sectional area of distributing armature located throughout a longer edge of a plate in all cases shall be not less than 20% of cross-sectional area of working armature located throughout a shorter edge of the plate but not less than that required by 7.2.9.

7.2.27 Dimensions and location of armature rods shall meet the following requirements:
   .1 in one row of the lathing over the whole span length there shall be not less than 5 and not more than 25 rods per 1 m of length;
   .2 a distance between working rods shall not exceed 2.5 times the plate thickness and that between distributing rods — 4 times the plate thickness;
   .3 rods of basic lathings at plate thickness up to 80 mm shall be located in staggered order and not one above the other;
   .4 a rod diameter shall be not less than 6 mm and more than 0.25 the plate thickness;
   .5 at reinforcing plates with rods of different diameters the latter may differ from each other by not more than 2 mm.

7.2.28 In the bottom, deck and bulkhead plates up to 40% of the total number of working armature of outer lathing may be made as
individual rods located in area of the plate bearing provided that their length is not less than the bearing breadth plus 0.4 times the plate span.

7.2.29 Supporting sections of plates shall be strengthened by means of haunches.

If a haunch is included in strength calculation, it shall be reinforced with special rods or lathings in such a way that there are at least 5 rods perpendicular to the rib per 1 m of the haunch length.

During arrangement of the haunch no separate rods mentioned in 7.2.28 may be used.

7.2.30 Armature of plates forming a corner shall be connected by means of welding or overlapping from one plate into another not less than 60% of rods to the length of 15 times rod diameter but not less than 150 mm.

7.2.31 Armature of plates forming T-section is connected by means of welding or bending out of all the lathing rods of abutting plate between lathings of another plate. A length of the bending shall be not less than 10 times the rod diameter.

**Girders**

7.2.32 A rib height shall not exceed 10 times the plate thickness and breadth shall be less than 1.5 times the plate thickness.

7.2.33 Working armature of girders shall meet the following requirements:

1. Diameter of working rods shall be not less than 10 mm and that of the assembling rods — not less than 6 mm;
2. The design armature shall be located by not more than 3 rows over the height and not less than 2 rows over the breadth both in compressed and tensioned zones;
3. Where a girder height is 500 mm and more, additional longitudinal armature of rods with a diameter not less than 8 mm shall be installed. A distance between the rods along the girder depth shall be not less than 200 mm.

7.2.34 Sloped armature of girders shall be effected by bending of longitudinal armature passed from tensioned zone to compressed zone or by entering of special bent out rods ending by straight sections and welded by overlap to longitudinal armature. An angle between the bendings and the girder axis shall be not less than 30° and not over 60°.

No individual rods not connected with the basic armature may be used.

7.2.35 Transverse armature of girders performed as loops shall meet the following requirements:

1. The loop diameter shall be 0.25 times the diameter of longitudinal armature but at least 6 mm;
2. A distance between the loops shall not exceed the least of the following values: 0.75 times the girder depth, 15 times the diameter of compressed armature rods and 250 mm.

In pillars and girders subject to longitudinal compression a loop pitch, besides that, shall not exceed 1.5 times the rib breadth;

3. If cross-sectional area of compressed armature exceeds 3% of cross-sectional area of the element, a distance between the loops shall not exceed 10 times the rod diameter of the aforementioned armature;

4. Each loop shall not embrace more than 6 compressed rods within the rib. If this is impracticable, additional loops, buckles or rods shall be installed to bind the longitudinal armature or opposite branches of the loops.

7.2.36 When reinforcing the girders with welded frames the latter shall have transverse members, i.e. rods or bars.

A distance between transverse members in tensioned zone of the rib shall not exceed 20 times the rod diameter of longitudinal armature, and shall be not more than 500 mm.

In compressed zone of the rib a distance between transverse members shall not exceed 15 times the diameter of longitudinal armature but shall be not more than twice rib breadth. If cross-section area of armature exceeds 3% of the girder cross section, a distance between the transverse members shall not exceed 10 times the diameter of longitudinal armature.

7.2.37 A connection of a girder with a plate is performed by:
.1 passing two longitudinal rods of the girder between lathings of the plate (at closed loops);
.2 entering bent ends of loops (tenons) of a length not less than 10 times diameter (at opened loops) between the plate lathings, here, above the bent end of the loops one rod is located passing over the entire length of the girder.

7.2.38 In framing members of the hull fuel and ballast compartments, water drain and air passing openings shall be arranged.

The drain openings shall not penetrate the longitudinal armature of the girders. A distance from the drain opening edges to the longitudinal armature shall be 10 mm and more.

7.2.39 In way of intersecting of the girders continuity of their longitudinal armature shall be ensured by means of locating the rods at different levels over the height.

If heights of the mentioned girders differ by more than 20%, a low girder shall be strengthened in way of connection with a high girder by means of reinforced haunch.

Haunches need not be fitted for girders, the dimensions of which are designated by the design.

Cutouts

7.2.40 Cutouts in the deck plates reducing a cross-sectional area of the element included in the hull’s girder by more than 15% shall be supported by compensating armature and reinforced-concrete or metal coamings.

7.2.41 All cut rods shall be reliably connected to the compensating armature and the coaming.

7.2.42 Corners of rectangular cutouts are recommended to be rounded or abated.

By corners of large cutouts where dangerous concentration of stresses is possible, rods shall be installed perpendicularly to the corner bisector.

7.2.43 Hull sections shall be joined to each other and to monolithic manufactured elements on armature dowels.

For joining of inner hull elements built-in parts may be employed.

Butts of sections shall be located as far as possible in less stressed areas. Relieve strength of concrete shall be not less than 70% of the grade strength (see GOST 26633).

7.2.44 When designing butts, the following conditions shall be observed:

.1 for butt joints on armature dowels, a distance between edges of sections shall be: for plates — not less than two plate thickness, and for girders — not less than double breadth or half of girder height and in all cases not less than 100 mm;
.2 a distance between parallel rods of armature or connecting details within the butt shall be equal to half an armature diameter but not less than 10 mm;
.3 in way of butts no plate thickenings protruding outside are allowed.

7.2.45 For butt joints on armature dowels connection of rods is carried out by overlap or butt welding with onlays.

In fillet joints armature dowels not subject to tension may be ended in concrete of the butt with due regard to requirements 7.2.16 in respect to anchoring of armature rod ends.

7.2.46 Butts of built-in parts shall be fastened.

In watertight butts a distance between the built-in parts shall not exceed 250 mm.

Construction of the built-in parts and their anchors shall permit easily laying of concrete at butt grouting.

7.2.47 Strength, water-tightness and frost-resistance properties of concrete of the butts shall be not less than those of concrete of the main hull.

7.2.48 Butt grouting shall be made by means of common (manual) or mechanised method. Butt grouting of inner hull elements of ships up to 35 m in length (butts of bulkheads and enclosures with the bottom, deck and sides, butts of superstructure elements with the hull and each other) may be performed by means of caulking.
7.2.49 Concreting butts and monolithic elements at negative temperatures may be performed only using the special technology developed by the Manufacturer and preventing the concrete freezing. The specified technology shall be agreed with the River Register.

7.2.50 Stripping of butts and monolithic-made elements is allowed after achieving by the concrete the following strength, % from grade strength, for elements:

- vertical: 35
- horizontal: 50

7.2.51 Loading of butts and monolithic elements (water-tightness test, move of ship along a slipway, launching) is allowed after the concrete has reached the strength of not less than 70% of the grade strength.

Fastening of machinery and equipment to the hull

7.2.52 A ship’s hull in way of ship’s equipment shall be reinforced.

7.2.53 Machinery and equipment shall be fastened to the hull by means of built-in parts, exit or anchor bolts.

7.2.54 Fastening by means of exit bolts is allowed only to the deck and framing girders as well as to protruding parts of the hull.

7.2.55 Anchor bolts of 12 mm in diameter and more may be used for fastening to all parts of the hull except plates of shell plating and watertight bulkheads provided that reliable connection is ensured.

7.2.56 If built-in parts are fastened by means of welding, their thickness shall be not less than 5 mm; for fitting of the detail into concrete at least two anchors are required of a diameter not less than 8 mm.

In order to avoid an excessive overheating of adjacent concrete and significant welding deformations of built-in parts, they shall be welded by spot or intermittent welds with a welded length not more than 40 mm and leg not over 5 mm.

7.2.57 Pipes piercing watertight bulkheads or shell plating shall be fastened to the plate by means of special built-in parts (sockets with flanges, boxes, built-in plates) fitted with anchors or welded to the plate armature.

7.2.58 Insulation and inner finishing may be secured to the hull by means of fitted into concrete armature dowels of 8 mm and more in diameter.

7.2.59 Fastening of elements active load in which do not exceed 20% of assumed by the Rules may be performed by means of screws and plates fitted in framing girders or in deck plates of at least 60 mm thick.

7.2.60 Non-essential and slightly loaded details may be fastened to concrete by special glues.

Reinforced-concrete superstructures

7.2.61 The reinforced concrete superstructure shall be so designed as not to be participating in global bending of the hull.

7.2.62 Where necessary, reinforced-concrete superstructures may be solid, i.e. participating in general bending of the hull. In these cases a reliable connection of the superstructure and the hull shall be provided ensuring their mutual work.

Material and structure of the solid superstructure shall meet the requirements of the present Section for the main hull.

7.3 STRENGTH CALCULATIONS AND NORMS

General requirements

7.3.1 Values of external loads are determined in accordance with the requirements of 2.2.

7.3.2 External loads acting on hull and its separate parts are divided into constant, occasional and extraordinary loads.

The constant load is a load acting all the time or within considerable period including: load weight, structure dead load, load on hull when a ship is at calm water, when design ship is at dry-docking (for floating docks).
The occasional load is a load acting within limited number of times including: wave load, load on hull when docking or on the stock; ice load, loads when constructing and testing, docking of an off-design ship (for floating docks).

The extraordinary load is a one-time load resulting from violation of specified operation conditions including loads arising when compartment flooding, grounding or

7.3.3 External loads acting to the damaged hull shall be determined from the condition of single- or two-compartment flooding (see 4.2.3 and 4.2.4 Part II of the Rules) which is the most unfavourable with regard to general strength of a ship.

7.3.4 In case of assembled elements strength checking during their transportation and mounting, the weight of the construction multiplied by dynamic coefficient equal to 1.5 is taken as design load.

7.3.5 When calculating the strength of the hull structures, the internal forces from total and local loads (normal and shear forces, bending moments) as well as transfer and turn angles shall be determined with regard to inelastic concrete deformations, crack formation and nonlinear relationship between stresses and deformations according to methods developed in accordance with the requirements of the Rules and agreed with the River Register.

**Design forces, moments and stresses due to global bending**

7.3.6 Basic designations:
- \( M \) — bending moment, \( \text{kNm} \);
- \( N \) — longitudinal forces, \( \text{kN} \);
- \( Q \) — shear force, \( \text{kN} \);
- \( \tau \) — tangential stresses, \( \text{MPa} \);
- \( I \) — area moment of inertia of reduced cross-sectional area of the hull girder, \( \text{cm}^4 \);
- \( S \) — static moment of reduced cross-sectional area of the hull girder located at one side of the neutral axis taken relating to the neutral axis of the hull girder, \( \text{cm}^3 \);
- \( S_e \) — static moment of reduced cross-sectional area of the considered element relating to the neutral axis of the hull girder, \( \text{cm}^3 \);
- \( F_e \) — reduced cross-sectional area of the considered element, \( \text{cm}^2 \);
- \( F_t \) — reduced cross-sectional area of bottom and deck strakes of the hull girder, \( \text{cm}^2 \);
- \( H \) — ship depth measured between outer plates of the bottom and deck, \( \text{m} \);
- \( \sum t \) — sum of thicknesses of the sides and longitudinal bulkheads at level of the neutral axis of the hull girder, \( \text{cm} \);
- \( E_c \) — initial Young’s modulus of elasticity of concrete, \( \text{MPa} \);
- \( E_a \) — Young’s modulus of elasticity of armature, \( \text{MPa} \).

7.3.7 For determination of design forces, moments and stresses due to global bending the hull shall be considered as the hull girder.

7.3.8 Design forces, moments and stresses shall be found for two possible positions of a ship: the sagging — at compressed deck, and the hogging — at compressed bottom.

7.3.9 Design forces, moments and stresses shall be calculated for sections in which elements are most stressed (sections in the middle part of ship, in way of cutouts, in way of change of framing system, discontinuity of longitudinal members).

7.3.10 Longitudinal members of the hull and reinforced-concrete superstructure shall be included in the hull girder in conditions mentioned in 2.2 as similar members of steel ships. Weakening due to individual cutouts which greatest dimension does not exceed 5 times the plate thickness and which do not reduce the section area of effective flange of the hull girder by more than 3% may not be regarded.

7.3.11 Longitudinal forces due to bending moment in elements of the hull girder shall be determined regardless of the concrete behaviour in tensioned zone by the formula, \( \text{kN} \):

\[
N = 100MS_{HG}/I .
\]  
(7.3.11-1)

For one-decked ships with flat single bottom the longitudinal forces due to bending
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7.3.11 The moment may be calculated by the formula, kN:

\[ N = MF_{HG} / (HF_F) \]  
\[ (7.3.11-2) \]

7.3.12 The whole cross-sectional area of the armature and cross-sectional area of concrete compressed zone multiplied by ratio \( E_c/E_a \) shall be included in the reduced cross-sectional area.

7.3.13 The greatest tangential stresses in vertical elements of the hull girder (sides and longitudinal bulkheads), MPa:

\[ \tau = 10QS / (I \sum t) \]  
\[ (7.3.13-1) \]

For one-decked ships with flat single bottom the greatest tangential stresses, MPa, may be determined by the following approximate formula:

\[ \tau = 0.1Q / (H \sum t) \]  
\[ (7.3.13-2) \]

Design forces, moments and stresses due to local load

7.3.14 Basic designations:
- \( Q \) — design load intensity, kN/m;
- \( p \) — design pressure on the strip girder, kPa;
- \( h_{wh} \) — water head creating hydrostatic load to a side or bulkheads, m;
- \( M_{bs} \) — bending moment in bearing section of strip girder, kN\( \cdot \)m;
- \( M_s \) — bending moment in the middle of a span of the strip girder, kN\( \cdot \)m;
- \( l \) — span of the strip girder between the axes of the supports, m;
- \( l_1 \) — clear span of the strip girder, m;
- \( l_h \) — length of haunch, m;
- \( h \) — plate thickness, cm;
- \( h_d \) — design thickness of a plate in way of the haunch, cm;
- \( h_h \) — entire height of the haunch, cm;
- \( h_{hd} \) — design height of the haunch, cm.

7.3.15 The design forces in hull members due to local bending are determined in accordance with the requirements of 7.3.5.

7.3.16 If the design forces in hull members due to local bending are determined using design methods of elastic systems not provided by the Rules, in order to determine the ratio of their stiffness in the reduced cross-sectional area of the members when calculating the moments of inertia, the whole concrete and armature cross-section multiplied by ratio of moduli of elasticity of armature and concrete \( E_c/E_a \) are included.

7.3.17 Rectangular plates resting on three or four edges are calculated as girders of a span equal to the shortest side of the plate, if a side ratio is more than 2:1.

At the side ratio equal or less than 2:1, rectangular plates may be calculated according to formulae for a thin isotropic plate.

Plates resting on two edges are calculated as girders of a span equal to a distance between the born edges.

7.3.18 A distance between axes of the supports shall be taken as a design span of girders and plates.

Geometrical dimensions of frame rings are taken over the internal surface of the plating.

7.3.19 In girders and plates having haunches with a ratio \( h_h/l_h \leq 1/3 \) haunches shall be fully accounted in relevant sections.

Haunches with a ratio \( h_h/l_h > 1/3 \) are assumed to have a ratio \( h_h/l_h = 1/3 \) (Fig. 7.3.19).

7.3.20 When determining framing girder elements, effective flanges of the plates shall be taken into account.

Design width of effective flange shall be taken equal to half-sum of plate spans adjacent to the stiffener but not more than 20
times the plate thickness (or 25 plate thickness, when it is connected to the stiffener reinforced with haunches). Here, effective flange width shall not exceed 1/3 of design span of the girder.

7.3.21 For continuous girders and girder plates a moment at bearing stiffener edge section is taken as design support moment. Here, for the strip girder constrained at the bearings with reinforced haunches and loaded by uniformly distributed load, bending moments, kN·m, may be determined as for a non-prismatic girder:

on a bearing
\[ M_s = -ql^2 \xi / 12 \]  
(7.3.21-1)
in a span
\[ M_s = ql^2 (3 - 2\xi) / 24 \]  
(7.3.21-2)
where \( \xi \) — coefficient to be determined by Table 7.3.21.

### Table 7.3.21

<table>
<thead>
<tr>
<th>( h/h_0 )</th>
<th>0.10</th>
<th>0.12</th>
<th>0.14</th>
<th>0.16</th>
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<td>1.06</td>
<td>1.07</td>
<td>1.07</td>
<td>1.08</td>
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7.3.22 When checking strength of side plates in case of the transverse framing system and bulkheads with vertical stiffeners design pressure on a strip girder is assumed equal to the greatest of the values calculated by the formulae, kPa:

\[ p = 9.81 (h_{wh} - 0.5l) \]  
(7.3.22-1)
\[ p = 9.81 \cdot 2h_{wh} / 3 \]  
(7.3.22-2)

### Strength checking of the elements of common reinforced concrete hull

7.3.23 Basic designations:
\( R_{ac} \) — tensile strength of concrete at axial compression, MPa;
\( R_{at} \) — tensile strength of concrete at axial tension, MPa;
\( R_{yH} \) — yield point of armature, MPa.
\( M \) — bending moment due to design load in normal section of the element, kN·m;
\( M_b \) — design breaking moment in normal section of the element, kN·m;
\( N \) — longitudinal force due to design load, kN;
\( N_d \) — design longitudinal breaking force, kN;
\( Q \) — shear force due to design load, kN;
\( Q_b \) — design breaking shear force, kN;
\( Q_c \) — projection of limiting force in a concrete of sloped section of the element on a perpendicular to the element axis, kN;
\( \sigma_{m.t} \) — main tension stresses, MPa;
\( \tau \) — greatest tangential stresses in the sides and longitudinal bulkheads due to global bending, MPa;
\( F_s \) — cross-sectional area of tensioned or the most tensioned armature, cm²;
\( F'_s \) — cross-sectional area of compressed or the least tensioned armature, cm²;
\( F_{sh} \) — cross-sectional area of vertical or horizontal armature per 1 m of a side or longitudinal bulkhead section length, cm²/m;
\( a \) — distance from the centre of gravity of armature \( F_s \) to the nearest edge of the section, cm;
\( h \) — entire height of rectangular or T-section; thickness of side and longitudinal bulkhead plates, cm;
\( b \) — breadth of rectangular cross-section; breadth of rib of T-section, cm;
\( h_0 \) — effective height of the section equal to \( h - a \), cm;
\( e_0 \) — eccentricity of the longitudinal force, equal to \( 10^7 \) M/N, cm;
\( k \), \( k_1 \) — safety factors taken according to Table 7.3.23.

7.3.24 Strength of the elements shall be checked:

.1 in normal sections for action of bending moments, longitudinal forces, as well as for mutual action of bending moments and longitudinal forces;

.2 in sloped sections for action of shear forces.
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Table 7.3.23

<table>
<thead>
<tr>
<th>Reason of destruction</th>
<th>Safety factor</th>
<th>Strength factors of Elements participating in global strength as well as global and local strength simultaneously</th>
<th>Strength factors of Elements participating only in local strength</th>
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<tr>
<td></td>
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<td>Constant loads</td>
<td>Constant and occasional loads as well as solely occasional loads</td>
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<td>Reaching tensile strength of concrete at compression or when the yield point of armature is reached</td>
<td>k</td>
<td>1.8</td>
<td>1.6</td>
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<td>Reaching the limit value of main tensile stresses in concrete</td>
<td>k_1</td>
<td>2.5</td>
<td>2.5</td>
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</tbody>
</table>

Note. When checking strength of assembled element due to action of forces occurring during transportation and mounting, the safety factors shall be not less than k = 1.5 and k_1 = 2.0.

Fig. 7.3.26 Sloped sections subjected to strength check

Sides and longitudinal bulkheads shall be also checked for action of shear force due to general bending.

7.3.25 Checking of strength in normal sections shall be performed in way of action of the greatest bending moment, abrupt change of the element cross-section and cut of the armature.

In this case the following conditions shall be complied with:

during action of bending moments

\[ M_p / M \geq k \]  

(7.3.25-1)

during action of longitudinal forces as well as mutual action of the bending moment and longitudinal forces

\[ N_p / N \geq k \]  

(7.3.25-2)

7.3.26 Checking of strength in sloped sections for action of shear force shall be performed (see Fig. 7.3.26) as applied to the following locations:

in way of action of the greatest shear force;

in way of abrupt change of cross section of the element;

sections passing through the support edge (section I – I);

sections passing through beginnings of bends located in tensioned zone (sections II – II, III – III, IV – IV);

sections passing through points of change of the transverse reinforcement intensity located in tensioned zone (section V – V).

Here, the following conditions shall be met:

\[ Q_p / Q \geq k_1 \]  

(7.3.26-1)

where k_1 — safety factor taken according to Table 7.3.23.

\[ Q \leq 0.1bh_0R_{sc} / 7 \]  

(7.3.26-2)
Where bent rods are available, value of design shear force is taken as follows:

for bends of the first plane — equal to value of the shear force in way of the support edge;

for bends of each of the following planes — equal to value of the shear force in way of lower point which is previous as regards support of the bending plane.

7.3.27 Check of strength in sloped sections for action of shear forces may be omitted, if the following condition is met
\[ 0.1b_{0}R_{p}Q / k_{1} \geq k_{1} \]  
(7.3.27)

7.3.28 Checking of strength of eccentrically compressed elements for action of shear forces shall be performed as for elements being bent regardless of axis compression.

7.3.29 Strength of eccentrically tensioned elements for action of shear forces shall be checked with due regard to the following directions:

1. at minor eccentricities (tension force is applied between the centres of gravity of cross-sectional areas $F_{a}$ and $F'_{a}$ of the armature) the entire shear force in sections located at an angle of 60° or less to longitudinal axis of the element at and less shall be assumed as transverse armature. Checking of strength in sections located at an angle over 60° to the longitudinal axis may be omitted;

2. at major eccentricities (tension force is applied outside the centres of gravity of cross-sectional areas $F_{a}$ and $F'_{a}$ of the armature) the checking of strength shall be performed as for bent elements.

If $e_{o} \leq 1.5h_{b}$, value of $Q$, calculated by the formula (7.3.49-2) shall be multiplied by a coefficient $k_{v}$ equal to
\[ k_{v} = e_{o} / h_{b} - 0.5 \]  
(7.3.29)

7.3.30 At major eccentricity checking of strength of eccentrically tensioned elements for action of shear forces may be performed if conditions (7.3.30-1) and (7.3.30-2) or at least one of the following conditions is met:
\[ \sigma_{mt} \leq R_{p} / k_{1} \]  
(7.3.30-1)
\[ Q \leq 0.1k_{v}R_{p}b_{0}h_{0} / k_{1} \]  
(7.3.30-2)
where $k$ — coefficient calculated by the formula (7.3.29).

At minor eccentricities checking of strength is not omitted if the condition (7.3.30-1) is met.

7.3.31 When checking strength of sides and longitudinal bulkheads for action of shear force due to general bending the following conditions shall be met:
\[ \tau \leq R_{ac} / 7 \]  
(7.3.31-1)
for vertical armature
\[ F_{ab}R_{cht} / (100th) \geq k \]  
(7.3.31-2)
for horizontal armature
\[ F_{ab}R_{cht} / (50th) \geq k \]  
(7.3.31-3)
Cross-sectional area of vertical or horizontal armature $F_{ab}$ may include cross-sectional area of vertical or horizontal stiffeners, respectively, assumed as uniformly distributed over the section.

7.3.32 Checking of strength of sides and longitudinal bulkheads for shear forces may be omitted, if the following condition is met:
\[ \tau \leq R_{p} / k_{1} \]  
(7.3.32)

Design characteristics of materials and formulae for determination of breaking forces and moments

7.3.33 Basic designations:

- $R_{ac}$ — tensile strength of concrete at axial compression (prism strength), MPa;
- $R_{at}$ — tensile strength of concrete at axial tension, MPa;
- $E_{c}$ — initial Young’s modulus of elasticity of concrete at compression and tension, MPa;
- $\sigma_{mt}$ — yield stress of compressed or the least tensioned armature, MPa; $\sigma_{cht}$ — yield stress of compressed or the least tensioned armature, MPa; $\sigma_{cht}$ — yield stress of compressed or the least tensioned armature, MPa; $\sigma_{cht}$ — yield stress of compressed or the least tensioned armature, MPa;
- $R_{cht}$ — material yield stress of bent rods located in one plane crossing the sloped section under consideration, MPa;
- $R_{cht}$ — material yield stress of bent rods located in one plane perpendicular to the element
axis and crossing the sloped section under consideration;

- $E_a$ — Young’s modulus of elasticity of armature, MPa;
- $M$ — bending moment due to design load in normal section of the element, kN·m;
- $M_n$ — design breaking moment in normal section of the element, kN·m;
- $N$ — longitudinal force due to design load, kN;
- $N_d$ — design longitudinal breaking force, kN;
- $Q$ — shear force due to design load, kN;
- $Q_d$ — design breaking shear force, kN;
- $Q_c$ — projection of limiting force in a concrete of sloped section of the element on a perpendicular to the element axis, kN;
- $q_\alpha$ — limiting force in transverse rods (loops) per unit of the element length, kN/m;
- $l_0$ — design length of the element, cm;
- $r$ — minimum radius of inertia of the element cross-sectional area, cm;
- $F$ — cross-sectional area of the whole element reduced to concrete, cm$^2$;
- $f_\alpha$ — cross-sectional area of the concrete, cm$^2$;
- $F_0$ — cross-sectional area of the whole longitudinal armature, cm$^2$;
- $F_a$ — cross-sectional area of the longitudinal armature, cm$^2$;

  for bent elements — armature within tensioned zone;

  for eccentrically compressed elements — armature located by the most distant section edge from a point of application of the longitudinal force $N$;

  for eccentrically tensioned elements — armature located by the most distant section edge from a point of application of the longitudinal force $N$;

- $F_{ben}$ — cross-sectional area of bent rods located in one plane crossing the sloped section under consideration, cm$^2$;
- $F_t$ — cross-sectional area of rods located in one plane perpendicular to the element axis and crossing the sloped section under consideration, cm$^2$;
- $f_\alpha$ — cross-sectional area of one branch of the loop, cm$^2$;
- $n$ — number of loop branches in one section of the element;
- $t$ — distance between transverse rods (loops) along the element length, cm;
- $a$ — angle of slope of the bent rods to the element axis, deg;
- $a^\prime$ — distance from the centre of gravity of armature $F$ to the nearest edge of the section, cm;
- $b$ — breadth of rectangular cross section; breadth of rib of T-section, cm;
- $h$ — total height of rectangular or T-section, cm;
- $h_0$ — effective height of the section equal to $h = a$, cm;
- $h_0'$ — effective height of the section equal to $h - a$, cm;
- $b_f$ — thickness of effective flange, cm;
- $z$ — height of compressed zone of concrete calculated with due regard to work of compressed armature, cm;
- $z_0$ — height of compressed zone of concrete calculated regardless of work of compressed armature, cm;
- $S_0$ — static moment of the whole cross-sectional area of concrete relative to an axis passing through the centre of gravity of cross-sectional area $F_a$ of the armature, cm$^3$;
- $S_0'$ — static moment of the compressed zone of concrete relative to an axis passing through the centre of gravity of cross-sectional area $F_a$ of the armature, cm$^3$.


\( e_0 \) — eccentricity of the longitudinal force, equal to \( 10^2 M/N \), cm;

\( e \) — distance between the line of action of the force \( N \) and the centre of gravity of cross-sectional area \( F_a \) of the armature, cm;

\( e' \) — distance between the line of action of the force \( N \) and the centre of gravity of cross-sectional area \( F_{a'} \) of the armature, cm;

\( c' \) — distance between the centre of gravity of the cross-sectional area and tensioned or the least compressed edge, cm.

7.3.34 Regulated strength characteristics of the hull structural concrete depending on concrete class are specified in Table 7.3.34-1, and the mechanical characteristics of armature — in Table 7.3.34-2.

<table>
<thead>
<tr>
<th>Armature steel grade</th>
<th>Mechanical properties</th>
<th>Yield stress ( R_{sh} ) (MPa)</th>
<th>Young’s modulus ( E_c ) (10^3MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-I ((A240))</td>
<td>A-II ((A300))</td>
<td>A-III ((A400))</td>
<td></td>
</tr>
<tr>
<td>A-I</td>
<td>A-II</td>
<td>A-III</td>
<td></td>
</tr>
<tr>
<td>235</td>
<td>295</td>
<td>390</td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>2.1</td>
<td>2.0</td>
<td></td>
</tr>
</tbody>
</table>

The concrete strength characteristics against axial tension in cases where concrete strength against tension are not controlled on production, but taken by 2nd line of Table 7.3.34-1 depending on concrete class as per compressive strength.

7.3.35 The concrete density shall be determined experimentally in accordance with manufacture specifications.

Where experimental data are not available at design stage, density of heavy concrete may be taken equal to 2.40 to 2.45 t/m and that of light concrete — as per Table 7.3.35.

<table>
<thead>
<tr>
<th>Concrete grade</th>
<th>Density (t/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B22.5</td>
<td>1.8</td>
</tr>
<tr>
<td>B25</td>
<td>1.9</td>
</tr>
<tr>
<td>B30</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Density of reinforced-concrete shall be determined as sum of concrete and armature masses per unit of volume of the structure.

7.3.36 Design breaking forces in centrally compressed elements, kN, \( N_d = 0.1 \phi \left( R_{sh} F_c + R_{sh} F_a + R'_{sh} F_{a'} \right) \), (7.3.36) where \( R_{sh}, R'_{sh} \) — yield stress of armature of various classes; \( F_c, F_a \) — cross-sectional areas of armature of various classes; \( \phi \) — coefficient of longitudinal bending determined by Table 7.3.36.

If the armature of one class is used, the third term of expression within round brackets of the right part of the formula (7.3.36) is excluded.

Design length of the element \( l_0 \) is determined by means of multiplication of its geometrical length by coefficient depending on extent of constraining and mobility of element ends and taken equal to:

- at complete constraining of both ends 0.5
- at complete constraining of one end and hinged support of the other one 0.7
- at hinged support of both ends 1
- at completely constrained one end and free the other one 2
- at partly constraining of the ends and in frames with fixed junctions 0.7

7.3.37 Design breaking forces in centrally tensioned elements, kN.

<table>
<thead>
<tr>
<th>Concrete grade</th>
<th>Values of regulated strength characteristics depending on strength concrete class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>heavy concrete</td>
</tr>
<tr>
<td>B22.5</td>
<td>23.5</td>
</tr>
<tr>
<td>B25</td>
<td>26.1</td>
</tr>
<tr>
<td>B30</td>
<td>31.4</td>
</tr>
<tr>
<td>B35</td>
<td>36.6</td>
</tr>
<tr>
<td>B40</td>
<td>41.9</td>
</tr>
<tr>
<td>B45</td>
<td>47.1</td>
</tr>
<tr>
<td>B22.5</td>
<td>22.1</td>
</tr>
<tr>
<td>B25</td>
<td>24.5</td>
</tr>
<tr>
<td>B30</td>
<td>29.4</td>
</tr>
</tbody>
</table>

**Table 7.3.34-1**

<table>
<thead>
<tr>
<th>Strength characteristic</th>
<th>Values of regulated strength characteristics depending on strength concrete class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>heavy concrete</td>
</tr>
<tr>
<td>B22.5</td>
<td>23.5</td>
</tr>
<tr>
<td>B25</td>
<td>26.1</td>
</tr>
<tr>
<td>B30</td>
<td>31.4</td>
</tr>
<tr>
<td>B35</td>
<td>36.6</td>
</tr>
<tr>
<td>B40</td>
<td>41.9</td>
</tr>
<tr>
<td>B45</td>
<td>47.1</td>
</tr>
<tr>
<td>B22.5</td>
<td>22.1</td>
</tr>
<tr>
<td>B25</td>
<td>24.5</td>
</tr>
<tr>
<td>B30</td>
<td>29.4</td>
</tr>
</tbody>
</table>
### Table 7.3.36

<table>
<thead>
<tr>
<th>$l_0/b$</th>
<th>$l_0/r$</th>
<th>Longitude bending coefficient $\phi$ for load occasion</th>
<th>constant $\phi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>35</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>12</td>
<td>42</td>
<td>0.96</td>
<td>0.96</td>
</tr>
<tr>
<td>14</td>
<td>48</td>
<td>0.92</td>
<td>0.92</td>
</tr>
<tr>
<td>16</td>
<td>55</td>
<td>0.88</td>
<td>0.87</td>
</tr>
<tr>
<td>18</td>
<td>62</td>
<td>0.84</td>
<td>0.79</td>
</tr>
<tr>
<td>20</td>
<td>69</td>
<td>0.79</td>
<td>0.71</td>
</tr>
<tr>
<td>22</td>
<td>76</td>
<td>0.75</td>
<td>0.64</td>
</tr>
<tr>
<td>24</td>
<td>83</td>
<td>0.70</td>
<td>0.58</td>
</tr>
<tr>
<td>26</td>
<td>90</td>
<td>0.65</td>
<td>0.51</td>
</tr>
<tr>
<td>28</td>
<td>97</td>
<td>0.61</td>
<td>0.45</td>
</tr>
<tr>
<td>30</td>
<td>104</td>
<td>0.56</td>
<td>0.39</td>
</tr>
<tr>
<td>32</td>
<td>111</td>
<td>0.51</td>
<td>0.34</td>
</tr>
<tr>
<td>34</td>
<td>118</td>
<td>0.47</td>
<td>0.29</td>
</tr>
<tr>
<td>36</td>
<td>125</td>
<td>0.42</td>
<td>0.25</td>
</tr>
<tr>
<td>38</td>
<td>132</td>
<td>0.38</td>
<td>0.21</td>
</tr>
<tr>
<td>40</td>
<td>139</td>
<td>0.34</td>
<td>0.17</td>
</tr>
</tbody>
</table>

$L_p = 0.1(R_{eh}F_a + R'_{eh}F'_a)$. (7.3.37)

If the armature of one class is used, the second term of expression within round brackets is excluded.

### 7.3.38 Design breaking moments in bending elements of rectangular section (Fig. 7.3.38), kNm:

$$M_d = \left[ R_{sh}bz(h_0 - z/2) + R'_{sh}F'_a(h_0 - a') \right] \cdot 10^3,$$

(7.3.38-1)

where

$$z = (R_{eh}F_a - R'_{eh}F'_a)/(R_{ac}b).$$

(7.3.38-2)

It is assumed here that value of $z$ calculated by the formula (7.3.38-2) meets the condition

$$2a' \leq z \leq 0.55h_0,$$

(7.3.38-3)

If

$$z < 2a' \leq z_0,$$

(7.3.38-4)

where

$$z_0 = R_{eh}F_a/(R_{ac}b),$$

(7.3.38-5)

then the design breaking moment is calculated by the formula (7.3.38-1) with an assumption that

$$z = 2a',$$

(7.3.38-6)

and

$$F'_a = (R_{eh}F_a - R_{ac}b2a')/R_{eh}.$$

(7.3.38-7)

If $z_0 < 2a'$, the design breaking moment is calculated by the formula (7.3.38-1) with an assumption that $F'_a = 0$.

### 7.3.39 Design breaking moments in bent elements of T-section including effective flange in tensioned zone are determined as for bending elements of rectangular section with a breadth equal to the stiffener breadth.

### 7.3.40 Design breaking moments, kN\cdot m, in bending elements of T-section including effective flange in compressed zone are calculated:

when

$$R_{eh}F_a \leq (R_{ac}h_1h_l + R'_{eh}F'_a)$$

(7.3.40-1)

by the formula (7.3.38-1) as for bending elements of rectangular section of $b_x \times h$ (Fig. 7.3.40-1);

![Fig. 7.3.40-1. Cross section of tee reinforced-concrete element](image)

at $R_{eh}F_a > (R_{ac}h_1h_l + R'_{eh}F'_a)$

(7.3.40-2)
by the formula

\[ M_p = \left[ R_{ac} b z \left( h_0 - z/2 \right) + 0.8 R_{ac} h_t \left( h_t - b \right) \times \left( h_0 - h_t / 2 \right) + F''_a R_{ch} \left( h_0 - a' \right) \right] \cdot 10^{-3}, \]

(7.3.40-3)

where

\[ z = \left[ \left( R_{ch} F_a - R_{ch}' F_a' \right) - 0.8 R_{ac} \left( h_t - b \right) h_t \right] / (R_{ac} b). \]

(7.3.40-4)

Here, the following condition shall be met (Fig. 7.3.40-2)

![Fig. 7.3.40-2. To calculation of static moments \( S_c \) and \( S_0 \)](image)

\[ S_c \leq 0.8 S_0. \]

(7.3.40-5)

**7.3.41** Design breaking forces \( N_b \) in eccentrically compressed elements of rectangular section (Fig. 7.3.41-1) meeting the condition

\[ 2a' \leq z \leq 0.55 h_0, \]

(7.3.41-1)

are determined by the formula, kN:

\[ N_p = 0.1 R_{ac} b z - (R_{ch} F_a - R_{ch}' F_a'), \]

(7.3.41-2)

where

\[ z = h_0 - e + \sqrt{\left( h_0 - e \right)^2 + 2 \left( R_{ch} F_a e + R_{ch}' F_a' e' \right) / (R_{ac} b)}, \]

(7.3.41-3)

Values of \( e \) and \( e' \) are calculated by the formulae

\[ e = 100 M / N + c - a'; \]

(7.3.41-4)

\[ e' = 100 M / N - c + a'; \]

(7.3.41-5)

at \( 100 M / N > c' - a' \),

(7.3.41-6)

and \( e' = c' - 100 M / N - a' \)

(7.3.41-7)

at \( 100 M / N \leq c' - a' \). (7.3.41-8)

In formula (7.3.41-3) sign of minus in the second term of the radicand is taken where the force \( N \) is applied outside the centre of gravity of armature \( F_a \) and \( F_a' \).

In elements of rectangular section meeting the condition

\[ z < 2a' \leq z_0, \]

(7.3.41-9)

where

\[ z_0 = h_0 - e + \sqrt{\left( h_0 - e \right)^2 + 2 \left( R_{ch} F_a e / (R_{ac} b) \right)}, \]

(7.3.41-10)

the design breaking forces are determined by the formula (7.3.41-2) with an assumption that

\[ 2a' \]

(7.3.41-11)

and

\[ F''_a = (R_{ch} F_a e - 2 R_{ac} ba' e') / (e' R_{ch}'), \]

(7.3.41-12)

At \( z_0 < 2a' \) the design breaking forces are determined by formula (7.3.41-2) regardless of compressed armature with an assumption that \( F''_a = 0 \).

In elements of rectangular section (Fig. 7.3.41-2) meeting the condition

\[ z > 0.55 h_0, \]

(7.3.41-13)
the design breaking forces are determined by the formula, kN:

\[
N_d = 0.1 \left[ R_{ch} F_a \left( h_0 - a' \right) + 0.5 R_{sc} b h_0^2 \right] / e .
\]  
(7.3.41-14)

Here, if the force \( N \) is applied between the centres of gravity of cross-sectional areas \( F_a \) and \( F_a' \) of the armature, the following condition shall be met

\[
N_d e' \leq 0.1 \left[ R_{ch} F_a \left( h_0 - a' \right) + 0.5 R_{sc} b h_0^2 \right] .
\]  
(7.3.41-15)

7.3.42 flange located in tensioned zone or in minor compressed zone are determined as for eccentrically compressed elements of rectangular section of breadth equal to breadth of the stiffener.

7.3.43 Design breaking forces in eccentrically compressed elements including effective flange located in compressed zone that meet the condition

\[
z \leq h_l ,
\]  
(7.3.43-1)
are determined as for eccentrically compressed elements of rectangular section of a breadth equal to width of effective flange, i.e. by formula (7.3.41-2) taking \( b = b_l \). If \( b = b_l \) at

\[
z > h_l ,
\]  
(7.3.43-2)
then the design breaking forces shall be determined by the following way:

1. height of a compressed zone, cm, is determined by the formula

\[
z = h_0 - e + \left( h_0 - e \right)^2 + 2 \left[ R_{ch} F_a e \pm R_{ch} F_a e' + R_{sc} h_l (h_0 - b) (h_0 - e - 0.5 h_l) / \sqrt{R_{sc} b} \right]^{0.5} .
\]  
(7.3.43.1)

A sign of minus in the second term of equation in square brackets is taken, where a point of application of the force \( N \) is outside the section part bounded by the centres of gravity of cross-sectional areas \( F_a \) and \( F_a' \) of the armature;

2. eccentric compression is considered by the following conditions:

\[
as at minor eccentricities
\]

\[
S_c > 0.8 S_0 ;
\]  
(7.3.43.2-1)

at major eccentricities

\[
N_d = 0.1 \left[ R_{ch} b z - (R_{ch} F_a - R_{ch} F_a') + R_{sc} (b_l - b) h_l \right] ;
\]  
(7.3.43.3)

If the whole section is compressed, the design breaking force found by the formula (7.3.43.4-1) is compared with the force \( N_c \), kN, calculated by the formula

\[
N_d = 0.1 \left[ R_{ch} F_a (h_0 - a' + 0.5 R_{sc} b h_0^2 + R_{sc} (h_l - b) h_l (h_0 - 0.5 h_l) / e .
\]  
(7.3.43.4-2)

For checking of strength the least of the breaking force values obtained from formulae (7.3.43.4-1) and (7.3.43.4-2) is taken.

7.3.44 Influence of flexibility on calculation of eccentrically compressed elements shall be accounted:

for rectangular sections at

\[
l_0 / b > 10 ;
\]  
(7.3.44-1)

for section of any shape at

\[
l_0 / r > 35 .
\]  
(7.3.44-2)

This influence is accounted by means of multiplication of value \( l_0 \) and coefficient \( \eta \) determined by the formulae:

for rectangular sections

\[
\eta = \left[ 1 - kN \left( l_0 / b \right)^2 / \left( 40 R_{sc} F \right) \right]^{-1} ;
\]  
(7.3.44-3)

for section of any shape

\[
\eta = \left[ 1 - kN \left( l_0 / r \right)^2 / \left( 480 R_{sc} F \right) \right]^{-1} ,
\]  
(7.3.44-4)

where \( k \) — safety factor taken according to Table 7.3.23.

7.3.45 If straining force is applied between centres of gravity of cross-sectional areas \( F_a \)
and $F'_a$ of the armature (Fig. 7.3.45), design breaking forces in eccentrically tensioned elements are determined by the formulae, kN:

$$N_d = 0.1F_a(\frac{h_0 - a'}{R_{ch}}/e')$$  \hspace{1cm} (7.3.45-1)

and

$$N_d = 0.1F'_a(\frac{h_0 - a'}{R_{ch}}/e),$$  \hspace{1cm} (7.3.45-2)

where $e$, $e'$ — parameters which values shall be determined by the formulae

$$e = c + 100M/N - a;$$ \hspace{1cm} (7.3.45-3)

$$e' = c' + 100M/N - a'.$$ \hspace{1cm} (7.3.45-4)

Here $c$ — distance between the centre of gravity of cross-sectional area of the whole armature and the most tensioned edge;

$c'$ — distance between the centre of gravity of cross-sectional area of the whole armature and the least tensioned edge.

For strength checking the least of obtained values of breaking force is taken.

7.3.46 Design breaking forces in eccentrically tensioned elements of rectangular section, when straining forces are applied outside centres of gravity of cross-sectional areas $F_a$ and $F'_a$ of armature cross-section

$$N_d = 0.1\left[\left(R_{ch}F_a - R'_{ch}F'_a - R_{ch}b'z\right)\right];$$ \hspace{1cm} (7.3.46-1)

where

$$z = h_0 + e - \sqrt{(h_0 + e)^2 - 2eF_aR_{ch}(\frac{1}{R_{ch}b})},$$ \hspace{1cm} (7.3.46-2)

where $e$, $e'$ — parameters which values shall be calculated by the formulae

$$e = 100M/N - c + a;$$ \hspace{1cm} (7.3.46-3)

and $F'_a$ of the armature (Fig. 7.3.45), design breaking forces in eccentrically tensioned elements are determined by the formulae, kN:

$$e' = c' + 100M/N - a'.$$ \hspace{1cm} (7.3.46-4)

where $c$ — distance between the centre of gravity of cross-sectional area of the element and tensioned edge;

$c'$ — distance between the centre of gravity of cross-sectional area of the element and compressed edge.

It is assumed here that height of the compressed zone of concrete meets the condition

$$2a' < z < 0.55h_0;$$ \hspace{1cm} (7.3.46-5)

If

$$z < 2a',$$ \hspace{1cm} (7.3.46-6)

the breaking force is determined by the formula (7.3.46-1) with an assumption that

$$2a' = 0.$$ \hspace{1cm} (7.3.46-8)

7.3.47 When the straining force is applied outside the centres of gravity of cross-sectional areas $F_a$ and $F'_a$ of the armature, design breaking forces in eccentrically tensioned elements of T-section including effective flange in the tensioned zone are determined as for eccentrically tensioned elements of a rectangular section of a breadth equal to breadth of the stiffener.
7.3.48 When the straining force is applied outside the centres of gravity of cross-sectional areas \( F_a \) and \( F_a' \) of the armature, design breaking forces in eccentrically tensioned elements of T-section including effective flange in the compressed zone, are determined by the following way:

at \( z < h_0 \), where \( z \) is calculated by the formula \((7.3.46-2)\) with an assumption that \( b = b_0 \), design breaking forces are determined as for elements of rectangular section of a breadth equal to width of effective flange;

at \( z > h_0 \) the design breaking forces \( N_c \) are determined by the formula, \( kN \):

\[
N_d = 0.1\left[ (R_{et} F_a - R_{et} F_a') - R_\infty b z - R_\infty (h_t - b) h_n \right],
\]

(7.3.48-1)

where

\[
z = h_0 + e - \left( h_0 + e \right)^2 + 2\left[ R_{et} F_a' - R_\infty e + R_\infty (h_t - b) h_t (h_0 + e - 0.5h_t) \right]/(R_\infty b)^{0.5}.
\]

(7.3.48-2)

7.3.49 Design breaking shear force in sloped section of element, \( kN \),

\[
N_d = 0.1 (R_{et} \sin a \cdot \sum F_{bent} + R_\infty \sum F_i + Q_e),
\]

(7.3.49-1)

where \( Q_e = 0.015 R_\infty b h_0^2 \). (7.3.49-2)

\( c_0 \) — design length of projection of the most unfavourable sloped section to the element axis, a length of which is got by increasing of loop pitches number up to the integer value \( c_0 \) equal to

\[
c_0 = \sqrt{0.015 R_\infty b h_0^2} \quad q_x,
\]

(7.3.49-3)

where \( q_x = 0.1 R_\infty e \). (7.3.49-4)

When bent rods are not available, the design breaking shear force, \( kN \), is determined as

\[
Q_d = \sqrt{0.06 R_\infty b h_0^2} - q_s t.
\]

(7.3.49-5)

7.3.50 Design breaking transverse force in elements subject to uniformly distributed load due to water pressure is determined in accordance with 7.3.49. Here, instead of value of \( q_s \), in calculating formulae \((7.3.49-3) - (7.3.49-5)\) the following shall be inserted

\[
q'_s = q_s + q,
\]

(7.3.50)

where \( q \) — design load due to water action per element length unit, \( kN/m \).

**Checking of hull elements for crack opening**

7.3.51 Basic designations:

- \( E_a \) — Young’s modulus of elasticity of armature, \( MPa \);
- \( M \) — bending moment, \( kNm \);
- \( N \) — longitudinal force, \( kN \);
- \( \sigma_a \) — stress in the armature due to longitudinal straining force, \( MPa \);
- \( \sigma_{ab} \) — stress in armature due to bending moment, \( MPa \);
- \( \sigma_i \) — initial tensile stress in armature due to concrete swelling, \( MPa \);
- \( a \) — distance from the centre of gravity of cross-section area of the most tensioned armature \( F_a \) to the nearest edge of the section, \( cm \);
- \( d \) — diameter of the most tensioned armature rods, \( mm \);
- \( a_c \) — design breadth of crack opening, \( mm \);
- \( l_{cr} \) — distance between cracks, \( cm \);
- \( F_0 \) — cross-sectional area of the whole longitudinal armature in the section under consideration, \( cm^2 \);
- \( F_a \) — cross-sectional area of tensioned armature in the element’s section under consideration, \( cm^2 \);
- \( b \) — breadth of rectangular cross section; breadth of rib of T-section, \( cm \);
- \( h \) — total height of rectangular or T-section, \( cm \);
- \( h_0 \) — effective height of the section equal to \( h - a \), \( cm \);
- \( t \) — distance between rods (pitch) of transverse armature, \( cm \).

7.3.52 All bending, centrally and eccentrically tensioned as well as eccentrically compressed hull elements, a strength of which is proved by calculation, shall be checked for
crack opening at action of constant or mutually applied constant and occasional loads.

7.3.53 Permissible width of crack openings for different reinforced-concrete elements and cases of loading shall be taken according to Table 7.3.53.

7.3.54 Design width of crack openings normal to axis of reinforced-concrete elements, mm

\[ \sigma_{cr} = (\phi_0 \sigma_{as} + \phi_b \sigma_{ab} - \sigma_{n}) l_{cr} / F_a , \]  

(7.3.54)

where \( \phi_{as}, \phi_b \) — coefficients to be taken by Table 7.3.54.

| Values of axial tension \( \phi_0 \) and bending \( \phi_b \) coefficients |
|-----------------|-----------------|
| Load type       | \( \phi_0 \)  | \( \phi_b \) |
| Random          | 0.65            | 0.8           |
| Constant        | 0.80            | 1.0           |
| Repeated, vibration | 0.95      | 1.2           |

For structures located in water \( \sigma = 20 \text{ MPa} \), for structures subject to prolonged drying \( \sigma = 0 \).

For eccentrically compressed elements action of normal compress force in calculation is not considered, it is taken as \( \sigma_{as} = 0 \).

7.3.55 Stresses in armature taken in calculation of crack opening are determined by the formulae:

1. due to longitudinal straining force, MPa,

\[ \sigma_{as} = 10N / F_b \]  

(7.3.55.1)

2. due to bending moment, MPa,

\[ \sigma_{ab} = 1000\Theta M / (F_a h_b \eta) \],  

(7.3.55.2)

where \( \Theta \) — coefficient taken equal to 1.0 in all cases except supporting sections of plates, for which \( \Theta \) is equal to 0.8;

\( \eta \) — coefficient taken equal to 0.85 for plates and T-profile girder with effective flange in the tensioned zone, and 0.90 — for T-profile girders with effective flange in the compressed zone.

7.3.56 Distance between cracks, mm, for bending, centrally and eccentrically tensioned and eccentrically compressed elements

\[ l_{cr} = 20\delta \rho (3.5 - 100 \mu) \frac{1}{\sqrt{d}} , \]  

(7.3.56-1)

where \( \delta \) — coefficient taken for centrally and eccentrically tensioned elements with minor eccentricity equal to 1.2, in other cases \( \delta = 1 \);

\( \rho \) — coefficient taken equal to 1.0 for rods of periodic profile and 1.3 — for smooth rods;

\( \mu \) — reinforcement coefficient of the section determined by the following formulae, but not more than 0.02;

for plates

\[ \mu = F_a / (bh_b) \]  

(7.3.56-2)

for girders with effective flange in the compressed zone

\[ \mu = F_a / (bh_b h) \]  

(7.3.56-3)

for girders with belt in the tensioned zone

\[ \mu = F_a / \left[ b_s h_s + b_t (h_0 - h_t) \right] \]  

(7.3.56-4)

where \( b_s \) — breadth of girder stiffener, cm;

\( b_t \) — width of effective flange, cm;

<table>
<thead>
<tr>
<th>Hull structural elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible width of crack openings, mm, for</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Plates of bottom plating, transom and sides of underwater part</td>
</tr>
<tr>
<td>Side plates of shell plating above the waterline. Deck plates in enclosed sections. Plates and framing girders in ballast compartments</td>
</tr>
<tr>
<td>Deck plates in closed sections. Plates of bulkheads and framing girders in dry compartments</td>
</tr>
</tbody>
</table>
$h_s$ — beam height, cm.

Notes. 1. For girders with effective flange in tensioned zone the armature of a stiffener and a plate within width of effective flange shall be included into $F_a$.

2. At different diameters of tensioned armature an assumed value of diameter $d_c$ is being used in the calculation which is determined by the formula, mm,

$$d_c = (n_1d_1 + n_2d_2 + \ldots + n_id_i)/(n_1 + n_2 + \ldots + n_i),$$

where $n_i$ — number of rods of the given diameter $d_i$, mm, included into the tensioned armature;

3. In plates having in tensioned zone transverse armature of a diameter $d_1 > 0.07h_s$ arranged with a pitch $t$ and located parallel to the cracks a distance between the cracks is taken equal to $t$ on condition that $0.7l_{cr} \leq t \leq 1.3l_{cr}$.

**Calculation and designing of built-in parts**

7.3.57 Basic designations:

- $M$ — bending moment determined relative to an axis located in the outer edge plain of built-in part plate and passing through the centre of gravity of all the anchors, kNm;
- $N$ — normal force acting on a built-in part, kN;
- $Q$ — shear force acting on a built-in part, kN;
- $F_{an}$ — total cross-sectional area of anchors of the most stressed row, cm$^2$;
- $N_{an}$ — maximum tensile force in one anchor row, kN;
- $Q_{an}$ — shear force per one anchor row, kN;
- $R_{ch}$ — yield point of the anchor armature, MPa;
- $N_{an}'$ — maximum compression force in one anchor row, kN;
- $z$ — distance between edge anchor rows, cm;
- $f_{an}$ — area of anchor rod of the most stressed row, cm$^2$;
- $l$ — length of a built-in part’s anchors, mm;
- $d$ — diameter of a built-in part’s anchors, mm;
- $s$ — thickness of a built-in part’s plate, mm;
- $R_{pl}$ — yield stress of a built-in part’s plate, MPa.

7.3.58 The cross-sectional area of anchors butt-welded to flat elements of steel built-in parts during action of bending moments, normal and shear forces, shall be determined as per Fig. 7.3.58 and by the formula

$$F_{an} \geq 13 \sqrt{N_{an}^2 + \left(\frac{Q_{an}}{1.07} / (1.05)\right)^2 / R_{ch}^2},$$

where $N_{an} = 100 M/z + N/N_{an}$,

$Q_{an} = (Q - 0.3N_{an}')/N_{an}$,

$N_{an}' = 100 M/z - N/N_{an}$,

$n_{an}$ — number of anchors along the direction of shear force. If uniform transfer of shear force $Q$ to all anchor rows is not provided, when determining the shear force $Q_{an}$ not more than 4 rows shall be considered;

- $\lambda$ — parameter:
  $$\lambda = 6 \cdot \frac{3}{\sqrt{1 + \omega}} \{1 + 0.15 f_{an} / \sqrt{R_{ch}}\} \leq 0.7;$$

- $\delta$ — coefficient:
  $$\delta = \frac{1}{\sqrt{1 + \omega}} \geq 0.15;$$

- $\omega$ — pressure coefficient:
  $$\omega = \frac{0.3N_{an}/Q_{an}}{N_{an}' > 0} \text{ (there is pressure)};$$
  $$\omega = \frac{0.6N/Q}{N_{an}' \leq 0} \text{ (there is not pressure)}.$$

Fig. 7.3.58. To determination of cross-sectional area of the anchors.
If the anchors have not straining forces, coefficient $\delta$ is taken equal to unit.

Anchors cross-sectional area of the rest rows shall be taken equal to total cross-sectional area of anchors of the most stressed row.

Force $N$ is considered positive if it is directed from the build-in detail.

In case of forces $N_{an}$ and $Q_{an}$ calculated by the formulae (7.3.58-2) and (7.3.58-3) are negative, in the formula (7.3.58-1) they are taken equal to zero. If the force $N'_{an}$ calculated by the formula (7.3.58-4) is negative, in the formula (7.3.58-3) $N$ is taken instead of $N'_{an}$.

When placing a build-in detail on the upper (when concreting) surface of an item, the parameter $\lambda$ is decreased by 20% and value $N'_{an}$ is taken equal to zero.

7.3.59 The cross-sectional area of anchors welded to a plate by overlap under acting of shear force shall be determined as per Fig. 7.3.59 and by the formula

$$F_{an} \geq 12Q/R_{th} \quad (7.3.59)$$

Fig. 7.3.59. To determination of cross-sectional area of anchors welded to plate by overlap under acting of shear force

Shear force resistance of lap-welded anchors is considered at $Q > N$, where $N$ is tension force and anchor bend angle is from 15 to 30°. The butt-welded anchors shall be installed with sizes calculated by the formula (7.3.58-1) at $\delta = 1.0$ and $Q_{an}$ equal to 0.1 from the shear force determined by the formula (7.3.58-3).

7.3.60 The anchors length shall be not less than 15 times their diameters.

If this requirement can not be met, the length of anchors may be decreased to 3 times diameters providing that any of the following elements are welded perpendicularly to the anchor ends:

- square plates of not less than 5 mm thick with a square side not less than 4 times diameters of the anchor or 30 mm whichever is greater (Fig. 7.3.60, a);
- round washers of not less than 5 mm thick having the diameter of not less than three anchor diameters or 30 mm whichever is greater (Fig. 7.3.60, b);
- two transverse rods of the same diameter as the anchor with a length equal to 5 times diameters of the rod at $d \geq 12$ mm or one such rod at $d < 12$ mm (Fig. 7.3.60, c).

7.3.61 The thickness of build-in detail plates installed in an item plain shall correspond to the following condition:
\[ s = 0.5d_{\text{pl}} \frac{R_{\text{ct}}}{R_{\text{ci}}} \geq 5. \] (7.3.61)

### 7.4 Designing and Calculation of the Hull Made of Pre-Stressed Reinforced Concrete

#### General requirements

**7.4.1** Pre-tensioned reinforced concrete may be used for manufacturing the elements of ship hull and superstructure.

**7.4.2** When pre-stressed reinforced concrete is used, assemble or assemble-and-monolith methods shall be applied. Intersectonal connections are recommended to be made with cogging. Stressed joints may be used provided they are performed with relevant force.

#### Designing of connections

**7.4.3** General cogging of a hull shall be performed by means of preliminary stress of special armature rods or bunches located in longitudinal girders or strengthened elements of the hull (deck stringer, bilge, parts of longitudinal bulkheads adjacent to the bottom and the deck). Local cogging of the hull shall be carried out by means of pre-stressing of the armature of plates and framing girders.

**7.4.4** Pre-stressing of the armature shall be carried out by means of jacking on abutment or consolidated concrete. Thermal method of section armature jacking is allowed on condition that maximum temperature does not exceed 350°C for rod armature and 300°C for wire armature.

**7.4.5** Armature subject to pre-stressing shall be fastened in concrete by means of special anchors or by other way. When placing the armature in channels the latter shall be filled with cement grout.

**7.4.6** Ends of pre-stressed elements on sections of a length equal to two lengths of anchor devices and, if the anchors are not available, over a length of 10 rod diameters but at least 200 mm, shall be strengthened by weld lathings or closed loops. Here, the rod and loop diameters shall be not less than 6 mm.

**7.4.7** Thickness of the protection layer of the armature subjected to pre-stressing shall be equal to a rod diameter but not less than 10 mm.

When such armature is placed in channels or slots, the thickness of the protection layer shall be equal to diameter of the channel or half of the slot width respectively, but at least 20 mm.

Thickness of the protection layer of the armature not subject to pre-stressing shall be designated according to the requirements of 7.2.19.

#### Strength calculations

**7.4.8** Basic designations:

- \( R_{\text{ac}} \) — tensile strength of concrete at axial compression (prism strength), MPa;
- \( R_{\text{at}} \) — tensile strength of concrete at axial tension, MPa;
- \( N \) — longitudinal force due to design load, N;
- \( N_0 \) — longitudinal force decreasing stress in the concrete caused by its cogging, N;
- \( M \) — bending moment, N-cm;
- \( \sigma_{\text{as}} \) — design stresses in the armature due to longitudinal straining force, MPa;
- \( \sigma_{\text{ab}} \) — design stresses in armature due to bending moment, MPa;
- \( F_0 \) — cross-sectional area of the whole longitudinal armature, cm²;
- \( F_s \) — cross-sectional area of tensioned armature in the element's section under consideration, cm²;
- \( h \) — total height of rectangular or T-section, cm;
- \( h_0 \) — effective height of the section equal to \( h - a \), cm;
- \( e_0 \) — distance from the centre of gravity of cross-sectional area of the armature to the line of action of the force \( N_0 \), cm;
- \( \eta, \Theta \) — coefficients determined by the directions of 7.3.55.

**7.4.9** Hull elements fabricated of pre-stressed reinforced concrete shall be checked for crack resistance; for strength of compressed zone of the concrete; for strength
against breaking forces according to the requirements of the Rules. Elements of combined structures (consisting of pre-stressed and common reinforced concrete) as well as pre-stressed elements reinforced by hot-rolled rods and not contacting with water may be checked only for strength against breaking forces and crack resistance.

7.4.10 Calculation of pre-stressed structures is performed for affection of the following loads: design loads combined with preliminary cogging of the concrete, preliminary cogging of the concrete at a stage of the structure fabrication, forces arising during transportation and mounting of assembled elements in combination with preliminary cogging of the concrete.

7.4.11 Values of forces, moments and stresses arising in pre-stressed structures due to design loads shall be determined as for elastic systems according to the methods agreed with the River Register.

7.4.12 Safety factors in calculations of crack resistance and strength against breaking forces shall be not less than those indicated in Table 7.4.12.

7.4.13 Stresses in the compressed zone of the concrete due to mutual action of preliminary cogging and design load shall not exceed 0.6$R_{ac}$ in the hull elements subject to compression or both bending and compression, and 0.7$R_{ac}$ in elements subject to bending.

7.4.14 Pre-stressed elements shall be checked for main straining stresses, and elements with a wall thickness equal to or less than $h/15$ — also for main compression stresses.

### Table 7.4.12

<table>
<thead>
<tr>
<th>Design loads</th>
<th>Safety factors of the elements whose strength shall be verified in calculations of global strength or global and local strength simultaneously</th>
<th>Safety factors of the elements whose strength shall be verified in calculations of local strength only</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>for crack resistance</td>
<td>for strength</td>
</tr>
<tr>
<td>Constant</td>
<td>1.35</td>
<td>2.1</td>
</tr>
<tr>
<td>Constant and occasional, as well as solely occasional</td>
<td>1.20</td>
<td>1.9</td>
</tr>
<tr>
<td>Emergency</td>
<td>not regulated</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Here, value of the main straining stresses shall not exceed 0.8$R_{at}$, and of the main compression stresses — 0.5$R_{ac}$.

7.4.15 Crack resistance of pre-stressed structures, strength of which may be controlled by breaking forces, shall be checked in accordance with the directions of 7.3.51 to 7.3.56. Here, stresses in the armature shall be determined by the following formulae:

- due to action of axial straining force
  \[
  \sigma_{as} = 0.01 \left( N - N_0 \right) / F_0 ;
  \]  
  (7.4.15-1)

- due to action of bending moment
  \[
  \sigma_{ab} = 0.01 \left[ \Theta M + N_0 \left( e_s - k_0 \eta \right) \right] / ( F_0 h \eta ) .
  \]  
  (7.4.15-2)

7.4.16 Together with strength checking of the structure itself, strength of concrete under anchors shall be also checked. Values of local compression stresses of the concrete under the anchors shall not exceed 0.7$R_{ac}$. 
8 DESIGN OF GRP HULLS

8.1 GENERAL REQUIREMENTS

8.1.1 The requirements of present chapter apply to ships of all classes with GRP hulls.

8.2 DESIGNING OF CONNECTIONS

8.2.1 At the construction of ship’s hulls both monolith and sectional methods may be used.

At the sectional method of construction butts shall be located apart from each other for at least a length of the lining.

8.2.2 For quality control of glass-reinforced plastic when manufacturing shell and main bearing framing girders of ships more than 15 m in length a tolerance of sheets shall be provided and a length of one of the girders of the section shall be enlarged.

Properties of the material of other details may be determined on samples of the finished batch.

For ships up to 15 m in length and the ship hulls made by the monolith method simultaneously with a hull of the first ship of a series under the same conditions the control panels shall be formed, thickness and structure of which shall precisely correspond to a thickness and structure of the hull glass-reinforced plastic.

8.2.3 Rivets, bolts and screws applied for connections of structures made of glass-reinforced plastic shall be installed perpendicularly to the glass-reinforced plastic layers.

Places of the connections may be preliminary reinforced with metal plates.

8.2.4 Connection of the elements of structures made of hot hardening plastic with each other and with other materials (glass-reinforced plastics, metals) may be performed on connecting linings or kneepieces by means of glue, rivets, screws or bolts.

8.2.5 While manufacturing multi-layered structures (plating, members) using foamed plastics, honeycomb plastics or wood the tight filling of inner chambers and glue of the fillers to outer layers over the whole surface shall be ensured.

8.2.6 For ships over 15 m in length the longitudinal framing system shall be used for the bottom and decks, and the transverse framing system shall be used for sides. The other framing systems may be used meeting the requirements to hull strength specified in 8.3.

8.2.7 In forepeaks, the transverse framing system shall be applied.

8.2.8 For hulls of ships of P and JI classes over 15 m in length and ships up to 15 m in length of all classes, as well as for superstructures, wheelhouses, light bulkheads and enclosures of all ships, frameless or framed three-layered plating is allowed.

8.2.9 In case of the longitudinal framing system, the distance between longitudinal framing girders shall be taken not more than 250 mm.

8.2.10 Framing girders participating in global bending shall be continuous throughout the hull length without interruptions on transverse framing and bulkheads.

8.2.11 In case of the transverse framing system, spacing shall be taken 500 mm for ships of all the classes. Here, closed framing member rings shall be provided.

8.2.12 The distance between keelsons, m, shall be taken for basin category:

<table>
<thead>
<tr>
<th>Category</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-СП, M-ПР, М</td>
<td>1.00</td>
</tr>
<tr>
<td>О-ПР, О</td>
<td>1.25</td>
</tr>
<tr>
<td>P</td>
<td>1.5</td>
</tr>
</tbody>
</table>
8.2.13 Members shall be connected with the plating (Fig. 8.2.13) by means of double-sided symmetrical connecting angle bars of the same material as the elements to be connected. Dimensions of the angle bars are designated depending on the member dimensions and shall be substantiated. In all cases a width of the angle bar flange shall be not less than 30 mm, and thickness $t$ — not less than a girder web thickness.

Fig. 8.2.13. Connection of members with shell

8.2.14 Connection of framing member elements shall be carried out by means of double-sided symmetrical connecting linings; butt gaps shall not exceed 2 mm. The linings shall be made of glass-reinforced plastic of the same structure as the girder web. Dimensions of linings are defined by dimensions of the members and shall be substantiated. A length of the lining $l_1$ shall be not less than 1.5-fold profile depth, thickness $\delta_1$ — not less than a half of girder web thickness $t$ (Fig. 8.2.14). All gaps shall be filled with fiberglass impregnated by a resin.

8.2.15 For ships up to 10 m in length the bottom plating, the side plating and the deck plating may be made of mats, evaporated fibre or their compositions. For ships over 10 m in length, glass fabric or roving cloth with various reinforcement schemes shall be used.

8.2.16 If the connection of outer plating with a deck is performed by means of double-sided connecting angle bars, their sized shall be defined by the least thickness of the plates to be connected. The base in the angle bar layers shall be directed longitudinally.

8.2.17 Connection of the outer shell plating, the deck plating or bulkheads between each other shall be carried out by means of double-sided symmetrical linings. The length of the lining shall be not less than 200 mm and thickness — not less than 0.5 of thickness of plates to be connected. Butts shall be positioned in different longitudinal positions and be located, as far as possible, in the less stressed hull sections. The base in the lining layers shall be directed transversely to the butt.

8.2.18 Thickness of the outer shell plating and the deck plating is determined by a calculation on the conditions of global and local strength; thickness values shall not be less than specified in Table 8.2.18.

8.2.19 In the area of ends of strong superstructures in ships over 15 m in length reinforcement of the outer plating and the deck plating shall be provided.

8.2.20 For bulkheads in ships up to 15 m in length as well as of light bulkheads and enclosures in ships over 15 m in length frameless constructions with box and wave corrugates may be used.

For light bulkheads and enclosures finished three-layered panels may be used with outer layers made of hot hardening plastics.
8.2.18 Minimum thicknesses of outer shell and deck plating

<table>
<thead>
<tr>
<th>Type of glass filler</th>
<th>Deck structure</th>
<th>Minimal thickness of the outer plating / deck plating, mm, at the ship’s length, m:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>≤15</td>
</tr>
<tr>
<td>Glass fabric</td>
<td>One-layered</td>
<td>3 / 3</td>
</tr>
<tr>
<td></td>
<td>Three-layered</td>
<td>2 / 2</td>
</tr>
<tr>
<td>Glass mat (chopped glass fibre)</td>
<td>One-layered</td>
<td>4 / 3</td>
</tr>
<tr>
<td></td>
<td>Three-layered</td>
<td>2 / 2</td>
</tr>
<tr>
<td>Glass-fibre mat</td>
<td>One-layered</td>
<td>3 / 3</td>
</tr>
<tr>
<td></td>
<td>Three-layered</td>
<td>2 / 2</td>
</tr>
</tbody>
</table>

8.2.21 Connection of bulkheads of glass-reinforced plastics with the hull shall be carried out by means of double-sided connecting angle bars of glass-reinforced plastic. Here, a width of the angle bar flanges for watertight bulkheads shall be not less than 60 mm.

Connection of panels between each other and with adjacent structures shall be carried out by means of metal, plastic or GRP angle-bars and beads with screws and glue.

8.2.22 Dimensions and choice of the bulkhead materials shall be substantiated. Here, thickness of watertight bulkhead plating shall be not less than, mm, at ship length, m:

<table>
<thead>
<tr>
<th>thickness</th>
<th>≤15</th>
<th>&gt;15</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8.2.23 When choosing the framing system and designating the dimensions of strong superstructure members in ships over 15 m in length, the requirements for the main hull shall be considered. Light superstructures and wheelhouses in ships over 15 m in length and superstructures in ships up to 15 m in length may be of three-layered structure as well as with corrugated framing.

Thickness of walls and decks of light superstructures and wheelhouses shall be not less than specified in Table 8.2.23.

8.2.24 Connection of superstructure walls with a hull of glass-reinforced plastic shall be carried out by means of double-sided connecting angle bars of glass-reinforced plastic. Here, the angle bar flange for strong superstructures shall be not less than 90 mm and for light superstructures and wheelhouses — 60 mm.

8.2.25 Connection of superstructure walls made of GRP or plastic with decks made of other materials may be carried out by means of bolts, rivets, glue and combinations of glue and bolts (rivets). Here, fastening shall be carried out on metal coamings.

8.2.26 Design measures shall be provided to reduce the stress concentration at ends of strong superstructures extended from side to side.

8.2.27 In the base hull members all cutouts of dimensions over 20 thicknesses (except for openings in members where active stresses do not exceed 0.3 of the permissible ones) shall be reinforced.

All rectangular cutouts shall be rounded in corners by a radius of not less than 0.2 of the opening width.

8.2.28 Openings shall be reinforced by means of increase of the plate thickness or fitting linings over the cutout perimeter. Thickness of the lining (or enlarged plate thickness) for minor cutouts (of a width equal to or less than 50-fold thickness) may be taken equal to the plate thickness; at the greater openings (over 50-fold thickness) it is determined by the calculation.

8.2.29 Strength and rigidity of foundations and supports for engines, arrangements, as well as strength of fastening the engines and the arrangements to the foundations shall ensure the normal operation of the engines and the arrangements during the voyage.

<table>
<thead>
<tr>
<th>Type of glass filler</th>
<th>Minimum thickness of walls and decks of light superstructures and wheelhouses at the shell plating structure, mm:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>one-layered</td>
</tr>
<tr>
<td>Glass fabric</td>
<td>2.0</td>
</tr>
<tr>
<td>Glass mat (chopped glass fibre)</td>
<td>3.0</td>
</tr>
<tr>
<td>Glass-fibre mat</td>
<td>2.5</td>
</tr>
</tbody>
</table>
8.3 STRENGTH AND BUCKLING CALCULATIONS

8.3.1 The following stresses are taken as unsafe normal stresses $\sigma_0$ and unsafe tangent stresses $\tau_0$, MPa:

$$\sigma_0 = k R_m; \quad (8.3.1-1)$$
$$\tau_0 = k \tau_m, \quad (8.3.1-2)$$

where $k$ — strength reduction coefficient of the material;

$R_m$ — tensile strength of the material at the corresponding type of deformation (as per laboratory tests of dry samples), MPa;

$\tau_m$ — shear ultimate strength of the material in the considered direction (as per laboratory tests of dry samples), MPa.

Strength reduction coefficients of the materials shall take into consideration the following:

1. difference of physical and mechanical properties of the material manufactured in plant conditions from those of laboratory samples;
2. change of the material properties due to moistening;
3. change of the material properties due to ageing in unloaded condition;
4. change of the material properties due to heating.

For structures not subject to constant loads, for glass-reinforced plastics with glass fillers treated by hydrophobic adhesive compositions (or similar materials) the coefficient $n$ may be taken equal to:

- for open deck platings: 0.50
- for platings of covered decks, platforms and bulkhead plating: 0.75
- for the bottom and side plating: 0.60
- for the deck, platform and bulkhead framing: 0.75
- for the bottom and side framing: 0.65

For hot-hardened plastics coefficient $n$ is taken equal to 0.80.

8.3.2 For structures subject to prolonged action of constant loads when calculating unsafe stresses the strength reduction coefficient $k$ shall be reduced and may be taken equal to 0.2.

8.3.3 For normal and tangent stresses that may lead to the buckling failure of the structure, Euler's normal stresses $\sigma_E$ and tangent stresses $\tau_E$ calculated with due regard to anisotropy for the plating and shear for the framing members are taken as unsafe stresses.

When calculating Euler's stresses design moduli shall be determined by the following expressions:

$$E_p = n E; \quad (8.3.3-1)$$

where $n$ — reduction coefficient of modulus of elongation of the material;

$E$ — modulus of elongation of the material (as per laboratory tests of dry samples);

shear modulus $G_p = n G, \quad (8.3.3-2)$

where $G$ — shear modulus deformation (as per laboratory tests of dry samples).

For glass-reinforced plastics with glass fillers treated by hydrophobic adhesive compositions (or similar materials) the coefficient $n$ may be taken equal to:

- for open deck platings: 0.50
- for platings of covered decks, platforms and bulkhead plating: 0.75
- for the bottom and side plating: 0.60
- for the deck, platform and bulkhead framing: 0.75
- for the bottom and side framing: 0.65

8.3.4 Values of unsafe stresses $\sigma'_0$ in the area of butt joints with two linings for glass-reinforced plastics shall be determined by the formula

$$\sigma'_0 = p R_t, \quad (8.3.4)$$

where $p = k$ — at bending and compression deformations ($k$ — see directions of 8.3.1 and 8.3.2) and $p = 0.8$ — at strain deformation.

Values of $R_t$ for glass-reinforced plastics based on glass fabric at bending deformations (at two linings) and compression deformations are taken equal to values of tensile strength of the material at the same deformation types. At strain deformation they shall be not less than $R_{t_re}$. Designated by Fig. 8.3.4 respectively for various thickness $t$, mm, of plates to be connected and lining lengths $l$.

8.3.5 Permissible stresses are determined in fractions of unsafe stresses.

At global strength calculations the permissible normal stresses are taken equal to 0.60 of $\sigma_0$ and tangent stresses — equal to 0.60 of $\tau_0$, where $\sigma_0$ and $\tau_0$ — see 8.3.1.
8 Design of GRP Hulls

Fig. 8.3.4 Values of $R_m$ depending on thickness of connected plates and lining length

At local strength calculations the permissible stresses are taken equal to 0.75 of $\sigma_0$ and tangent stresses — equal to 0.75 of $\tau_0$.

8.3.6 Euler’s normal stresses $\sigma_E$ of rigid hull members of ships of all classes calculated according to the requirements of 8.3.3 shall meet the condition

$$\frac{\sigma_E}{\sigma_0} \geq 0.95,$$  (8.3.6)

where $\sigma_0$ — see 8.3.1.

For ships over 15 m in length Euler’s stresses of grillages shall be defined with due regard to shear and anisotropy.

For ships up to 15 m in length the shear and anisotropy may be not considered.

8.3.7 Euler’s normal stresses $\sigma_E$ of the shell plating shall meet the condition

$$\frac{\sigma_E}{\sigma} \geq 1.5,$$  (8.3.7)

where $\sigma$ — design normal stresses due to global bending or total stresses.

8.3.8 In addition to the strength checking with regard to stresses, particular members and the hull in whole shall be checked with regard to value of deformations. Here, together with sagging due to bending for ships over 15 m in length and for particular members a sagging due to shear shall be also taken into account.

Permissible sags shall not exceed, mm:

1. due to global bending of the hull — $L/400$;
2. due to local loads for the base hull members:
   for framing girders — $l/100$;
   for plating — $l/50$.

Here, $L$ and $l$ — length (span) of the hull and particular members correspondingly, mm.

Note. At control measurements of span arrows the structures shall be loaded for at least 0.5 h.

8.3.9 For glued glass-reinforced plastic angle connections, i.e. a framing with a plating, a side with a deck and a strong superstructure with the hull made according to the directions of the present chapter, tangent stresses in the connection area shall not exceed 6.86 MPa.

When plucking loads are applied, value of stresses, MPa, at abruption shall not exceed the following, for the thickness of:

- $\geq 6$ mm — 5.88
- 3 mm — 2.94

For intermediate values of thickness from 6 to 3 mm the value of unsafe normal stresses is determined by linear interpolation.

Total thickness of connecting angle bars is taken for the design thickness.

8.3.10 Determination of design bending moments and shear forces at global bending and of loads at local strength calculation shall be carried out according to the requirements of the Rules specified for steel ships.

Here, for ships up to 15 m in length an influence of ship sagging on values of bending moments shall be taken into account.

Hull sagging shall be defined both due to bending and to shear having regard to directions of 8.3.3.

8.3.11 Calculation of hull girder elements is carried out for design cases of loading conditions and cross sections of the hull mentioned in Section 2.

8.3.12 At calculation of hull girder elements the hull members shall be included in the calculation with coefficients that consider:
- changes of the material properties (see 8.3.1 and 8.3.3);
difference of moduli of elasticity of the members as well as anisotropy of glass-reinforced plastics.

8.3.13 Flexible members are included in the hull girder with reduction coefficients. Parts of the plates adjacent to a rigid contour of a width equal to 1/6 of the shorter side of a bearing contour are not subject to reducing at all approximations during the calculation of the hull girder.

8.3.14 The reduction coefficients of the flexible hull members (plates) shall be determined by the method given in 2.2.38 and 2.2.39.

Euler's normal stresses $\sigma_E$ for plates of anisotropic glass-reinforced plastics shall be determined with due regard to anisotropy of elastic properties of the material, and for plates of glass mat they shall be determined with due regard to anisotropy of materials. Here, the requirements of 8.3.3 shall be considered.

8.3.15 Buckling strength of girders in ships over 15 m in length and of grillages in all ships shall be checked with due regard to shear.

8.3.16 Width of effective flange on the basis of fabric or mat at a parallel reinforcing structure shall be taken equal to the least of the values of a distance between the framing girders or 1/10 of the girder span. Width of effective flange on the basis of mat or evaporated glass-reinforced plastic shall be taken equal to a distance between the framing girders or 1/6 of the girder span, whichever is less.

Here, possible difference of moduli of elasticity of the plating and the framing members shall be regarded.

8.3.17 At local strength calculation of glass-reinforced plastic girders the same calculation schemes shall be used as for the calculation of girders made of isotropic materials with due regard to 8.3.16. Values of the section elements shall be designated with due regard to the directions of 8.3.16; here, the girder web area shall be taken regardless of connecting angle bars.

8.3.18 Girders shall be checked for the stability of flat bending shape.

8.3.19 Buckling strength of girders shall be calculated with due regard to requirements of 8.3.15 and 8.3.16.

8.3.20 Calculation of plates of anisotropic glass-reinforced plastics shall be carried out with due regard to anisotropy.

8.3.21 Calculation of three-layered plates with a light filler of rigid foam type shall be carried out with due regard to affection of shear deformations of the filler on outer layers.

8.3.22 At strength calculation of the framing members and plating joints and other similar connections the static moment and the moment of inertia shall be calculated with due regard to the area of connecting angle bars and the web thickness shall be taken equal to double thickness of the angle bar flange.
9 EQUIPMENT OF SHIP SPACES

9.1 GENERAL REQUIREMENTS

9.1.1 Requirements of the present Section apply to arrangement and equipment of accommodation and service spaces for the crew and passengers, wheelhouse, dry cargo holds, to passageways, doors, ladders and rescue manhole-sculltes.

9.1.2 Requirements of location and equipment of machinery spaces are specified in 1.8 to 1.10 Part IV of the Rules.

9.2 PASSAGEWAYS, DOORS, LADDERS

9.2.1 A width of the passageways shall not be less than:

.1 0.8 m in main corridors of common passenger spaces, corridors of passenger accommodation and public spaces as well deck passages of passenger ships leading to muster stations;

.2 0.6 m on decks between the bulwark and the wheelhouse for ships with power below 590 kW, or less than 25 m in length, or with a gross tonnage below 300 t, and 0.7 m for ships with greater power, length or gross tonnage values;

.3 0.7 m in the crew accommodation corridors;

.4 0.6 m in corridors of spaces in ships less than 25 m in length;

.5 0.5 m in corridors of spaces on dynamically supported craft less than 25 m in length;

.6 0.5 m on decks in places of installation of bollards, stanchions, hatchways.

9.2.2 Doors of superstructures and wheelhouses leading to the open deck shall be designed to open outwards.

Doors of public spaces (saloons, mess-rooms) shall be designed to open outwards or to either side. Cabin doors shall open inwards and be fitted with beat-out panels of 0.4×0.5 m in their lower part. On the cabin doors from the inner sides of those panels there shall be inscriptions “Emergency exit — beat out in case of emergency”.

Where cabins are fitted with scuttles or windows with clear dimensions of at least 400 mm, beat-out panels need not be fitted.

9.2.3 Passenger spaces located in superstructures of second and third tiers shall be fitted with at least two ladders located at the opposite ends of the superstructures.

9.2.4 In hold passenger spaces with a number of passengers less than 20 persons one ladder per each space may be provided.

9.2.5 When a number of passengers in the hold passenger space is 20 persons and more, there shall be two ladders located at the opposite ends of the space with one of them giving access to an open deck outside the deck structures as far as practicable.

9.2.6 When a number of passengers in the hold passenger space is from 20 to 50 persons inclusive, emergency ladder may be replaced by vertical ladder.

9.2.7 In addition to exits from hold spaces specified in 9.2.4 — 9.2.6, each space shall be fitted with rescue scuttles with one scuttle at each side according to 9.3.

9.2.8 Hold crew accommodation spaces for 20 persons and more shall be provided with at least two ladders located at the opposite ends of the space and giving access to the main deck; one of them (emergency ladder) shall be led to an open deck outside the deck structures or through insulated steel enclosure in the superstructure which provides safe exit to an open part of the main deck or deck overboard extension in the event of fire. Emer-
gency ladder may be replaced by vertical ladder.

9.2.9 Where hold spaces are intended for accommodation of 10 to 20 crew members and there is an exit giving access to an open deck, additional ladder need not be fitted provided that rescue scuttles are fitted at the side opposite to the main exit, with one scuttle at each side of the ship.

9.2.10 Where hold spaces are intended for accommodation of less than 10 crew members and there is an exit giving access directly to the main deck, additional ladder or rescue scuttles need not be fitted.

9.2.11 The ladders shall be arranged to provide free access of escape. Before entering / leaving a ladder as well as places where the next ladder builds on previous one shall be provided with free areas of a lengths not less than 0.8 m — for outer ladders and 0.6 m — for inner and vertical ladders, and a width not less than ladder width. The areas shall not have transverse coamings or shoulders. Angle of ladder slope to horizontal plain shall not exceed 50° — for accommodation and service spaces, and 55° — on decks and in machinery spaces. In order to access to equipment located in rooms and compartments of a ship the ladders with slope angle of 60° may be installed, and in periodically unattended machinery spaces where the ladders are difficult to install the stairways may be used.

9.2.12 Intermediate areas stated in 9.2.11 shall be arranged if the ladder length, mm, exceeds, for:

- inclined ladder 4000
- vertical ladder 9000

9.2.13 Ladder width for a number of passengers of 50 and less in the given space shall be at least 0.8 m. Ladder width shall be increased by 5 cm per each 10 passengers in excess of 50 persons. In crew spaces the stairway width shall be at least 0.8 m and in ships up to 25 m in length — not less than 0.65 m. In ships of a length up to 25 m the ladder width may be decreased up to 0.5 m if the requirement of present paragraph is not technically feasible.

9.2.14 Ladders with more than three steps shall be equipped with handrails or guardrail.

9.2.15 On hydrofoil craft and hovercraft each passenger mess-room intended for 20 persons and more shall be fitted with at least two exits located at the opposite sides of the mess-room. One of these exits may be an emergency exit.

9.3 SCUTTLES

9.3.1 The side scuttles shall be arranged to meet the requirements of 5.6.24 to 5.6.27 Part II of the Rules.

No scuttles are allowed in spaces intended for cargo carriage.

9.3.2 In hold spaces intended for passengers and crew as well as in engine room rescue scuttles shall be provided with a clear width of 400 mm.

Note. Rescue scuttles are required only in ships where a freeboard depth is sufficient for its free arrangement.

9.3.3 In hold spaces intended for passengers and crew rescue scuttles shall be located in common cabins or in corridors with one scuttle at each side of the ship.

9.3.4 In the machinery spaces one rescue scuttle shall be provided at each side of a ship. Where a door is arranged in the bulkhead separating the machinery space and the boiler room, at least one scuttle shall be provided in each of the spaces being located at the opposite ends of the space.

9.3.5 Where an emergency exit is provided in the hold space for passengers or crew as well as in the machinery space which gives access directly to the open main deck, rescue scuttles need not be fitted.

9.3.6 Lower edges of rescue scuttles shall not be located below the lower edges of ordinary side portholes.
9.3.7 Free access shall be provided to rescue scuttles. Hand irons shall be fitted in sides to facilitate the access to scuttles.

9.3.8 Frames of rescue scuttles shall be painted red and shall bear relevant inscriptions. Location indicators of rescue scuttles shall be placed on visible places.

9.3.9 On ships of М-СП, М-ПР, О-ПР, M, O and P classes the rescue scuttles located in spaces intended for passengers below the freeboard deck shall be fitted with automatic alarm led to the wheelhouse which warns that the rescue scuttles are open.

9.4 WHEELHOUSE

9.4.1 The wheelhouse shall be so arranged and equipped that the navigator can continuously and without unnecessary actions perform its functions.

9.4.2 The wheelhouse shall be provided with free vision in all directions.

The blind area for navigator before a ship for all the operating cases regardless of optical devices that can reduce the blind area shall be equal to double length of ship (convoy) but not more than 250 m.

The vision area from ordinary workplace of the navigator shall be a sector to the direction of horizon determined by angle not less than 240°. Not less than 140° of this angle shall be accounted for a half of round before a ship.

9.4.3 The direction of ordinary vision area of the navigator (in diametrical plane) shall be free from any superstructures. Masts, stays and other structures shall not occupy more than 1.0° of vision area in usual workplace of the navigator.

9.4.4 If free vision aftward is not provided, the mirrors, vision facilities and other auxiliary optical means may be installed in order to improve the vision.

9.4.5 The free vision through wheelhouse windows at any time shall be provided by means of lighting fixtures (spotlights).

9.4.6 Transparency of glasses used in wheelhouses shall be at least 75%.

9.4.7 The requirements to controls and automated system elements arranged in the wheelhouse are specified in 11.12 Part IV and 12 Part V of the Rules.

9.5 ACCOMMODATION AND SERVICE SPACES

9.5.1 When calculating passenger capacity of ships the following area shall not be included in the area for passenger accommodation:

1. the forepeak, the deck above the forepeak and the afterpeak;
2. mess-rooms, smoking saloons and other saloons, restaurants, canteens and similar spaces;
3. deck in the area of passages for boarding passengers, passages to lifeboats and embarkation ladders, as well as the deck not accessible for passengers;
4. deck area within 1 m apart from ship’s arrangements (steering gear, boat gear, cargo handling gear, mooring, towing, coupling and anchor arrangements);
5. cargo hatches, engine hatches, hatches of accommodation and service spaces.

On board inland navigation ships where the crew performs work, but accommodates ashore, the rooms listed in subparagraph 2 of this paragraph shall be included in the area for passenger accommodation when calculating the passenger capacity.

9.5.2 Ship spaces located on deck overboard extensions shall be located at least 300 mm apart from the extension edge. No berths may be arranged along the side bulkheads of superstructures or wheelhouses located on deck extensions.

9.5.3 Accommodation spaces and galleys as well as canteens used as recreation spaces may be located in the vicinity of tanks with fuel or above them only when a horizontal cofferdam at least 600 mm high or a vertical cofferdam of width equal to the spacing is provided.
Cofferdams shall be equipped with ventilation independent of the ventilation of accommodation spaces.

No cutouts for manholes or other cutouts are allowed in decks and bulkheads in way of the above spaces.

9.5.4 The following spaces shall not be used for the crew accommodation:
.1 the forepeak and the afterpeak spaces;
.2 spaces with cargo hatches not enclosed by trunks;
.3 machinery spaces and boiler rooms;
.4 accommodation spaces, public spaces, household, service and sanitary spaces;
.5 spaces with exits giving direct access through doors or manholes to spaces containing engines, boilers, pumps, or storage spaces for oil products, coal as well as paint stores and lamp stores;

9.5.5 In ships of M-СП, M-ПР, О-ПР, M, O classes equipment and furniture (cupboards, tables, sofas, pianos, chairs) shall be fastened.

9.5.6 Above the emergency exits there shall be provided illuminated inscription “Emergency exit”.

9.6 HALLS AND SPACES FOR MULTIMEDIA PRESENTATIONS

9.6.1 Halls and spaces equipped for multimedia presentations, film exhibition, etc. on passenger ships, living quarter barges, floating exhibitions shall be fitted with exits giving access directly to an open deck with one exit per 50 spectators, but at least two exits at the opposite ends of the space. Each exit shall be fitted with a door which opens outwards; minimal width of the door and the passage shall be not less than 1.1 m.

Above the each exit there shall be provided illuminated inscriptions “Exit” or “Emergency exit”.

Furniture in the halls shall be made of low flame-spreading materials (see 1.2.1.16 Part III of the Rules) and fastened.

No carpets and carpet strips may be used in the halls.

9.6.2 Film exhibition on non-self-propelled tankers is not allowed.

9.7 SPACES FOR ELECTRIC-GAS-WELDING OPERATIONS AND STORAGE OF RECEPTACLES

9.7.1 Storage places of oxygen and acetylene receptacles shall meet the requirements of 2.5.7 to 2.5.11 Part III of the Rules, and spaces for electric-gas-welding operations on board a ship – to 2.5.12 Part III of the Rules.

9.8 GALLEY ROOMS

9.8.1 Galley rooms shall meet the requirements of 4.1.1 and 4.1.2 Part III of the Rules.

9.8.2 Bulkheads and decks of the galley rooms shall be made of steel or another equivalent material.

Structures made of non-combustible materials near the cooking ranges shall meet the requirements of 2.3.3 Part III of the Rules.

9.9 SAUNAS

9.9.1 On ships fitted with saunas the following requirements shall be met:
.1 ceiling, walls and floor shall be plated with hard wood;
.2 door handles of sauna shall be made of poorly conducting material or covered with the same;
.3 sauna door shall open outwards by pushing; no shut-off devices are permitted on the door;
.4 distance of the lower edge of sauna door to floor plating shall be not less than 0.05 m;
.5 metal fittings of sauna lining boards, railings, grids shall be countersunk;
.6 all standard equipment of the sauna (beds, shelves, bowls, bailers) shall be made of wood or low-heat-conductivity materials and shall not have open thermally insulated parts;
.7 in order to control the temperature in sauna, the non-mercury thermometer shall be mounted;
.8 lamps, thermometers and other devices mounted in sauna shall have guards prevent-
ing the possibility their mechanical damage and therefore prevent burns from unintentional contact with them;

.9 electric fireplace shall be grounded and fitted with a fence not less than 1.2 high. The fence elements shall be made of thermally nonconductive material, and distance between elements shall not exceed 0.38 m;

.10 control switchboard of electric fireplace and switch of lighting in sauna shall be located outside the sauna. The electric fireplace shall be provided with a circuit breaker when the temperature reaches the limit;

.11 lighting fixtures shall be moisture-proof, and glass — heatproof;

.12 heating elements of the electric fireplace above shall be covered with rocks.

In addition, the saunas shall meet the requirements of 2.5.13 Part III of the Rules.
10 RAILING, HANDRAILS, GANGWAYS, COMPANIONWAYS

10.1 GENERAL REQUIREMENTS

10.1.1 Along the perimeter of open decks, bridges and superstructures as well as around the open areas and workplaces located at a height over 0.5 m, the bulwark and guard rails shall be provided. Openings and doorways in decks, sides, bulkheads, bulwark shall be provided with railings preventing the possible fall or injury of people while operating a ship.

10.1.2 Fixed railings (coamings, bulkwark, rails and guard rails) with regard to type, purpose and operating conditions of a ship shall minimize a risk of man-overboard, falls into machinery space trunk, opening in deck, from floating dock tower, from bridge wings, from maintenance area, from other workplaces.

In order to protect passengers and crew against overboard risk, ships are fitted with handrails, gangways, companionways in addition to the fixed railings.

Companion hatchways and other openings in decks, bulkheads, sides shall be equipped with movable or removable railings.

10.1.3 The railings shall withstand loads arising out during operation. Connections and fittings of railings shall be so designed that they are not reduced by vibration. Structural provisions shall be taken to prevent loss of fittings (bolts, nuts, pins).

10.1.4 Height of bulkwark or guard rail along a perimeter of decks and bridges as well as around the open areas located at a height more than 0.5 m above the deck shall be not less than 1100 mm, and the railings height inside rooms and compartments shall not be less than 1000 mm. Guard rail on the upper awnings may be omitted.

For ships less than 20 m in length the height of a bulwark or a guard rail may be reduced, but shall be not less than 900 mm when relevant grounds of adequate protection of the crew and passengers are submitted to the River Register.

10.1.5 Bulwark or guard rail shall be fitted on all open decks of the hull, superstructures and wheelhouses. On self-propelled ships up to 10 m in length handrail may be fitted along the perimeter of a superstructure or a deck.

10.1.6 On passenger ships of all classes railings on decks accessible for passengers shall be made as solid bulwark or guard rail with protective mesh screen.

10.1.7 In areas where bollards and fairleads are installed, the guard rail or bulkwark shall not have parts that require change of their position when operating with mooring lines.

10.1.8 In places where gangways are handled, the doors or removable, telescopic, hinged and similar types of railings shall be provided.

10.1.9 Removable railings shall have special safety hooks, design of which provides quick installation and ease removal of railings and prevents spontaneous release under the weight of falling person.

10.1.10 Decks of ferries and other ships intended for transportation of wheeled vehicles shall be fenced by fender beams with a height of at least 0.45 m.

10.2 BULWARK

10.2.1 Drainage cutouts shall be provided at each continuous section of the bulwark with the total area of not less than 10% of the area of continuous part of the bulwark.

10.2.2 Exit cutouts in the bulwark shall have folding doors which open inwards, or a removable railing.
10.2.3 A bulwark rail shall be fitted on the top of the bulwark.

10.3 GUARD RAIL

10.3.1 The distance between guard rail stanchions shall not exceed three spacings.

10.3.2 The guard rail of 1100 mm high shall be four-row, of 1000 mm high — three-row. The lower rail shall be located not higher than 230 mm above the deck. The distance between other rails shall not exceed 380 mm. The guard rail of decks accessible for passengers shall be fitted with protective screens. Side of screen cell shall not exceed 100 mm.

10.3.3 On non-self-propelled ships of all classes a handrail shall be provided in way of superstructures and wheelhouses, and on non-attended ships — in way of forecastle and poop.

On non-self-propelled ships of O, P and Â classes including non-attended ships the guard rail in the area of cargo hold and cargo bunker may be replaced by waist bar and handrail along the perimeter of cargo hatch coaming or the cargo bunker wall.

On flush deck barges without cargo bunker in the area of cargo platform a waist bar is to be installed.

On flush deck barges being unloaded by inclination or capsizing method a guard rail may be dispensed with provided that through passage is provided under the deck.

10.3.4 The upper edge of the waist bar shall be raised above the deck for at least 100 mm. The waist bar shall not impede water drainage from the deck.

10.3.5 In places of interruption of the bulwark and the guard rail (the deck machinery area, stairway flights etc.) removable chain rails shall be provided.

10.3.6 Clearances (gaps) between guard rails as well as between railings and other structures of a ship shall not exceed 150 mm.

10.3.7 Design of removable rigid or flexible guard rails shall provide their quick removal. In case of flexible guard rails (chain, rope) the possibility to tight rails shall be provided.

10.3.8 In people passages, the chain railings may be used only. Length of such railing (distance between stays) shall not exceed one meter. The maximum sagging of chain guard rail shall not exceed 40 mm.

10.4 HANDRAILS, GANGWAYS, COMPANIONWAYS

10.4.1 Ladders shall be fitted with railings and handrails of a height not less than required by the Rules.

10.4.2 Where a passage is provided along the deck extension, handrails shall be fitted on outer walls of the superstructures.

10.4.3 On oil tankers of M-СП, M-ПР, O-ПР, M and O classes between separate accommodation spaces and service spaces as well as in order to provide the crew with safe access to the afore part of the ship in any operating conditions gangways shall be provided raised above the deck. The gangways shall:

1. be at least 1 m wide and be located in way of the centre line;
2. be fitted with handrails at least 1.1 m high with stanchions not more than three spacings apart;
3. have side entries from the deck not more than 40 m apart from each other.

Be arranged by shelters of practicable design not more than 45 m apart from each other, when the open deck is extended for more than 70 m.

Each shelter shall be sufficient for at least one person and shall protect him against bad weather.

10.4.4 Pushboats and pushed vessels shall be fitted with gangways and stairways which provide safe passage of the crew from one ship to the other.
10.5 PASSENGER SPACES ON HIGH SPEED CRAFT

10.5.1 The high speed craft shall be fitted with seat for passengers in quantity corresponding to a ship passenger capacity.

10.5.2 Seats for passengers shall be fastened. Strength of seats fastening shall comply with the requirements of Appendix 10 "Criteria of test and assessment of seats for passengers and crew" of the International Code of Safety for High-Speed Craft (HSC Code).

10.5.3 Seats and their fastenings shall be designed to minimize the risk of injury of sitting passengers and to provide free exit of passengers, if required.
   Unless otherwise provided, the seats shall be fitted with life-saving appliances.

10.5.4 The seats shall be so installed that provide free exit and not to obstruct access to emergency equipment, life-saving appliances and escape routes.

10.5.5 Passenger seats shall be fitted with safety belts of design approved by the River Register.
STRENGTH CALCULATION METHOD OF JOINING STRUCTURES OF CATAMARAN HULL BODIES

1 In strength calculations of the bridge deck structure three basic deformations shall be considered: transverse bending, transverse twisting and unsymmetrical deformation caused by a vertical bend of hull bodies in the opposite directions.

The strength of the bridge deck members shall be checked at three wave-related positions of ship:

1. beam to sea (relative bearing \( \varphi = 90^\circ \)), when the transverse bending moment is maximal; the moment shall be calculated by formulae (A1.6-2) and (A1.7-1), and internal forces and stresses shall be calculated as per requirements of 16 of this Appendix;

2. quartering sea, when the transverse twisting occurs simultaneously with the transverse bending. To define maximum total stresses in the bridge deck member calculations shall be made for several values of \( \varphi \) nearly similar to the value of \( \varphi_1 \) determined by the formula (A1.8-10). The external forces shall be determined according to requirements of 8 and the internal forces — according to requirements of 17 and 19 of this Appendix;

3. quartering sea, when the hulls are bent in the opposite directions. To define maximum total stresses due to the deformation caused by the wave-induced bending of the hull bodies and due to the transverse bending in calm water, calculations shall be made for several values of \( \varphi \) nearly similar to the value of \( \varphi_2 \) defined by the formula (A1.9-7). The loads shall be determined according to requirements of 9 and the internal forces — according to requirements of 21 of this Appendix.

2 If the hull bodies have been joined with the help of a strength superstructure or a wheelhouse, it is sufficient to check the bridge deck strength at the transverse bending according to requirements of 10 of this Appendix.

3 The bridge deck strength shall be checked by calculations for the fully loaded condition and an emergency condition according to 2.2.7. For cargo ships the maximal non-uniformity of the cargo distribution over the ship’s breadth shall be considered as permitted by the Instruction on Loading and Unloading.

4 In calm water conditions the transverse bending moments shall be calculated in the same manner as the longitudinal moments: by integrating the loads considering not less than 21 ordinates. Two design values of the transverse bending moment in calm water shall be calculated by direct summing the moments of the weight forces and the supporting forces:

\[ M_1 \] in a plane section crossing an inner side amidships parallel to the centre line;

\[ M_2 \] in the centre line section.

If lines of submerged parts of the hull bodies are symmetric in relation to the centre plane of both hull bodies, and the weight load is symmetric in relation to the centre line of the catamaran body as a whole, then \( M_1 \) and \( M_2 \), kN·m, may be calculated by formulae
\[ M_1 = -0.5P_bB_h - P_hy_h; \quad (A1.4-1) \]
\[ M_2 = -B_c \left[ 0.5(B_h + c) - y_b \right] - P_hy_h, \quad (A1.4-2) \]

where \( P_b \) — weight of half of the bridge with cargo and other kinds of load (between a secant plane crossing the inner side amidships parallel to the centre plane and the centre plane of the whole ship), kN;

\( P_h \) — weight of one hull body and adjoining part of the bridge in the extremities together with the cargo, equipment, systems and other kinds of load up to the section crossing the inner side amidships parallel to the centre plane, kN;

\( y_h \) — distance between the centre of gravity of the weight \( P_h \) and the centre plane of the hull body; this distance is positive, when the centre of gravity is closer to the inner sides, m;

\( y_b \) — distance between the centre of gravity of the weight \( P_h \) and the centre plane of the whole ship, m.

5 Additional forces applied to the bridge deck at rough water may be calculated by the formulae given below. Design wave length included in these formulae shall be taken equal to: 40 m for ships of Ì-ÑÏ, Ì-ÏÐ and Ì classes, 20 m for ships of Î-ÏÐ and Î classes, 12 m for ships of P class and 6 m for ships of Ë class.

When the inequality is complied with
\[ \lambda \leq 2(c + B_h) \quad (A1.6-1) \]
the maximal additional transverse bending moment, kN\(\cdot\)m, occurring when a ship is abeam the waves, may be calculated by the formula:
\[ M'_3 = \pm 30.8hLBR_t m_1 \sin \left[ \frac{\pi(B_h + c)}{\lambda} \right] \times \left[ T(H_1 - T/2) m_b - B_c^2 m_2/12 \right]/\lambda, \quad (A1.6-2) \]

where \( T \) — draught amidships, m;

\( H_1 \) — distance from the neutral axis of a transverse member of the bridge to the base plane amidships (distance of the neutral axis of an hull girder of a superstructure or wheelhouse from the base plane, when the hull bodies are joined by strength superstructure or a wheelhouse), m;

\( m_1, m_b \) — coefficients taken from Table A1.6 depending on the actual waterline coefficient of one hull body \( \alpha \) and \( b_0 \) equal to \( b_0 = 0.5B_c/(B_h + c) \). (A1.6-3)

| Table A1.6 |
|---|---|---|---|---|
| \( \alpha \) | Coefficient \( m_1 \) at \( b_0 \) equal to | Coefficient \( m_b \) at \( b_0 \) equal to |
| 0.5 | 0.307 | 0.252 | 0.500 | 0.469 | 0.385 |
| 0.6 | 0.384 | 0.366 | 0.315 | 0.600 | 0.561 | 0.457 |
| 0.7 | 0.512 | 0.485 | 0.413 | 0.700 | 0.649 | 0.511 |
| 0.8 | 0.673 | 0.636 | 0.532 | 0.800 | 0.732 | 0.553 |
| 0.9 | 0.833 | 0.784 | 0.651 | 0.900 | 0.816 | 0.595 |
| 1.0 | 1.000 | 0.940 | 0.774 | 1.000 | 0.900 | 0.637 |

Simultaneously with moment \( M'_3 \), the bridge deck is subject to of either tension (positive) or compression (negative) force, kN,
\[ T'_{js} = \pm 30.8hLBR_t m_6 / \lambda. \quad (A1.6-4) \]

In formulae (A1.6-2) and (A1.6-4) either upper or lower signs shall be taken. The positive transverse bending moment causes tension of the top fibres of the bridge.

7 In case the inequality (A1.6-1) is not complied with, the maximal transverse bending moment which occurs when a ship is abeam the waves, kN\(\cdot\)m,
\[ M''_3 = \pm 30.8hLBR_t m_1 \sin \left[ \frac{\pi(B_h + c)}{\lambda} \right] \times \left[ T(H_1 - T/2) m_b - B_c^2 m_2/12 \right]/\lambda, \quad (A1.7-1) \]

where \( m_1, m_b \) shall be taken from Table A1.6 depending on the actual waterline coefficient of one hull body \( \alpha \) and \( b_0 \), which shall be assumed equal to
\[ b_0 = B_h / \lambda. \quad (A1.7-2) \]

Compression or tension force applied to the bridge, kN,
\[ T_{js}^* = \pm 30.8hLBR_t m_6 \sin \left[ \frac{\pi(B_h + c)}{\lambda} \right]/\lambda. \quad (A1.7-3) \]

8 In ship’s position at which the centre plane of a ship constitutes an angle \( \varphi \) relating to the wave propagation direction, the following forces are applied to the bridge:
additional transverse bending moment, kN-m,

\[ M_4 = \pm 30.8hL_B \sin \varphi \sin \varphi \times \left[ T \left( H_1 - 0.5T \right) m'_4 - B_5^m_4 \right] \lambda, \]

(A1.8-1)

torsion moment, kN-m,

\[ M_5 = \pm 1.23h_B L^2 h'_5 \sin \varphi, \]

(A1.8-2)

brings to the transverse axis pivot turn of the hull body relatively to the other one, and the compression or tension force, kN,

\[ T_{j\theta} = \pm (3.8hL_B T m'_4 \sin \varphi \sin \varphi) \lambda. \]

(A1.8-3)

Here:

\[ \varphi = \pi (B_h + \epsilon)(\sin \varphi)/\lambda; \]  

(A1.8-4)

\[ h_0 = B_6 \sin \varphi)/\lambda; \]

(A1.8-5)

\[ m'_2 = \left[ 1 - (0.57 + 0.33\alpha_1) h_0^2 \right] m_2; \]

(A1.8-6)

\[ m'_3 = \left[ 1 - 1.4 (\alpha_1 h_0)^2 \right] m_3; \]

(A1.8-7)

\[ m'_4 = m_4 - \left( 1.5 - 0.1\alpha_1^2 \right) h^2_0 m_2. \]

(A1.8-8)

Coefficient \( m_1 \) shall be taken from Table A1.8-1, coefficient \( m_2 \) from Table A1.8-2, coefficient \( m_3 \) from Table A1.8-3 depending on the actual waterline coefficient of one hull body \( \alpha_i \) and

\[ l_0 = L(\cos \varphi)/\lambda. \]

(A1.8-9)

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</table>

Moment \( M_5 \) reaches the maximal value at an angle close to

\[ \varphi_1 = \arccos \left( 0.75\lambda/L \right) \]

(A1.8-10)

Vertical forces constraining either of the hull bodies in position at which the centre plane of the ship constitutes an angle \( \varphi \) in relation to the wave propagation direction are assumed to be distributed throughout the hull body full length under the law, kNm,
\[ q = \pm 9.81 B_0 h \left( b_1 \cos \left( \pi x/L \right) + b_2 \cos \left( 3\pi x/L \right) \right) \]

(A1.9-1)

when the point of origin is located amidships and axis \( x \) is directed forward.

The load applied to one hull body is assumed as of positive value while the other one is of negative value.

Coefficients \( b_1 \) and \( b_2 \)

\[ b_1 = 1.85 \left[ (1.212 - i_2 / \alpha_1 ) p - 4 m \sin \nu \right] \]

(A1.9-2)

\[ b_2 = 5.55 \left[ (0.363 - i_2 / \alpha_1 ) p - 4 m \sin \nu \right] \]

(A1.9-3)

where

\[ p = \left( i_1 m'_1 \sin \nu - \alpha_1 m'_1 \cos \nu \right) / \left( 6 \left[ 1 + c / (2 B_0) \right] \right)^2 \alpha_1 + 2 i_1 \]

(A1.9-4)

\[ m = -m'_2 \sin \nu / 8 + i_2 p / (4 \alpha_1 ) \]

(A1.9-5)

where

\[ m'_2 = m_5 \left( 1 - \left[ 1.45 - 2 \alpha_1 (1 - \alpha_1 ) \right] b_0^2 \right) \]

(A1.9-6)

Values of \( \nu \) shall be determined by the formula (A1.8-4), \( b_0 \) by the formula (A1.8-5), coefficients \( m_3 \) and \( m_4 \) by the formulae (A1.8-6) and (A1.8-8), coefficients \( i_1 \) and \( i_2 \) by Table A1.9-1 depending on the actual waterline coefficient of one hull body \( \alpha_1 \), coefficient \( m_5 \) by Table A1.9-2 depending on the actual waterline coefficient of one hull body \( \alpha_1 \) and \( b_0 \) calculated by the formula (A1.8-9).

Maximal loads take place at an angle \( \varphi \) close to the angle

\[ \varphi_2 = \arccos \left( \lambda / L \right) \]

(A1.9-7)

When the hull bodies are joined by a strength superstructure or a wheelhouse (see 4.1.5.1) the strength of the joint shall be checked at the transverse bending moment. Calculation shall be made in the same way as the calculation by the longitudinal bending moment. Stresses in two longitudinal sections shall be defined:

in a plane section crossing an inner side amidships parallel to the centre plane where the moment \( M_1 + M_2 \) is applied;

\[ 
\begin{array}{|c|c|c|c|c|c|}
\hline
\alpha_1 & i_1 & i_2 & \alpha_1 & i_1 & i_2 \\
\hline
0.5 & 0.307 & 0.150 & 0.8 & 0.675 & 0.330 \\
0.6 & 0.384 & 0.210 & 0.9 & 0.822 & 0.407 \\
0.7 & 0.512 & 0.267 & 1.0 & 1.000 & 0.500 \\
\hline
\end{array}
\]

Table A1.9-1

Values of coefficients \( i_1 \) and \( i_2 \)

\[ 
\begin{array}{|c|c|c|c|c|c|c|}
\hline
i_1 & l_1 & l_2 & \alpha_1 & i_1 & l_2 \\
\hline
0 & 0 & 0 & 0 & 0 & 0 \\
0.1 & 0.0008 & 0.0013 & 0.0018 & 0.0020 & 0.0025 & 0.0041 \\
0.2 & 0.0031 & 0.0052 & 0.0069 & 0.0083 & 0.0108 & 0.0160 \\
0.3 & 0.0068 & 0.0115 & 0.0151 & 0.0184 & 0.0240 & 0.0349 \\
0.4 & 0.0117 & 0.0197 & 0.0258 & 0.0316 & 0.0413 & 0.0592 \\
0.5 & 0.0176 & 0.0295 & 0.0385 & 0.0471 & 0.0615 & 0.0870 \\
0.6 & 0.0243 & 0.0403 & 0.0524 & 0.0641 & 0.0832 & 0.1161 \\
0.7 & 0.0314 & 0.0514 & 0.0667 & 0.0813 & 0.1050 & 0.1443 \\
0.8 & 0.0386 & 0.0624 & 0.0805 & 0.0978 & 0.1254 & 0.1694 \\
0.9 & 0.0456 & 0.0726 & 0.0931 & 0.1126 & 0.1432 & 0.1893 \\
1.0 & 0.0520 & 0.0814 & 0.1037 & 0.1247 & 0.1571 & 0.2026 \\
1.1 & 0.0578 & 0.0884 & 0.1117 & 0.1336 & 0.1662 & 0.2080 \\
1.2 & 0.0624 & 0.0934 & 0.1167 & 0.1386 & 0.1698 & 0.2052 \\
1.3 & 0.0660 & 0.0960 & 0.1186 & 0.1395 & 0.1678 & 0.1942 \\
1.4 & 0.0682 & 0.0951 & 0.1171 & 0.1362 & 0.1601 & 0.1757 \\
1.5 & 0.0691 & 0.0940 & 0.1125 & 0.1290 & 0.1473 & 0.1511 \\
\hline
\end{array}
\]

Table A1.9-2

Values of coefficient \( m_5 \)

\[ \sigma_{WH} = T_{js} \cdot 10^{-3} / F_{js} \]

(A1.10)
ceed the permissible stresses at global longitudinal bending.

11 Relative width of the effective flange of the bridge deck or the superstructure roof taken in shares from the bulkhead length attached to a wall of a strength superstructure or the wheelhouse bulkhead shall be taken from Table A1.11 for symmetrical loading condition, when the transverse bending is under consideration, and for unsymmetrical loading condition, when the calculation is made with due regard to the transverse torsion or the deformation due to vertical bending of the hull bodies in the opposite directions.

Table A1.11

<table>
<thead>
<tr>
<th>( a/l_b )</th>
<th>Relative width of the effective flange of the bridge deck or the superstructure roof</th>
<th>At symmetric loading</th>
<th>Inner side cross-section at anti-symmetric loading</th>
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<td>0.32 0.32 0.12</td>
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<tr>
<td>0.5</td>
<td>0.28 0.28 0.08</td>
<td>0.28 0.28 0.08</td>
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</tbody>
</table>

The following symbols are adopted in Table A1.11:

\( a \) — distance from the bulkhead end to the inner side (length of a bulkhead portion within the limits of either hull body), m;

\( l_b \) — length of a transverse bulkhead of the superstructure equal to its wall length, m.

The width of an effective flange shall not be more than the distance up to the next strength transverse bulkhead. For butt end bulkheads of the superstructure the width of an effective flange shall be assumed twice lesser than in the case when the flange is located to one side from the bulkhead.

12 Where the hull bodies are joined by a bridge, when determining stresses in the bridge members the catamaran shall be assumed as statically indeterminate system consisting of two longitudinal girders (hull bodies) connected with transverse girders and plates (the bridge deck and plating).

Hull bodies are subject to bending deformation in vertical and horizontal planes as well as twisting deformation; bridge transverse girders are subject to bending deformation (for shorter girders with a length less than 10 heights the shifting deformation shall be considered also); plates are in the flat stressed condition.

When meeting the requirements of 4.1.6, the conclusion on the bridge strength may be made on the basis of the rapid calculation method (see below) in which twisting of the hull bodies and connection between longitudinal deformations of the hull bodies via the bridge deck and plating are dispensed with.

13 For each transverse bridge girder the turn stiffness shall be calculated, which is assumed equal to the bending moment \( M_i \), kN·m, applied to that girder at symmetrical turning of the hull bodies at a unit angle. When the \( i \)th girder is located in the bulkhead of half-bulkhead plane of the hull, then

\[
M_i^* = 2EI_i/l_i^*,
\]

where \( E \), \( I \) — area moment of inertia and the length of the \( i \)th girder of the bridge, respectively.

For other girders the moment \( M_i^* \) shall be determined by the calculation of unloaded frames with the given shift of the junctions (with the given angles of turn of the straight bars joining the member ends).

14 Stresses in the bridge members due to local loading shall be determined.

The bar system consisting of the frame members of the bridge and the hull bodies shall be calculated, assuming that the hull bodies are fixed (do not turn in relation to one another). The transverse girders of the bridge in the plane of transverse bulkheads or half-bulkheads of a hull body are assumed to be rigidly fastened at the ends; the rest girders are shall be considered as a part of the framework with fixed junctions formed by the frames of the hulls and the transverse girder of the bridge. Local loading applied to transverse members of the bridge and the hull bodies shall be calculated for the given ship loading condition. For each \( i \)th girder, the bending
moments \( M'_i \) acting in the plane crossing the inner side amidships parallel to the centre plane shall be obtained as a result of calculation.

When determining stresses due to local bending loads, \( i \)-th transverse member of the bridge shall be assumed as a freely resting girder bearing the local load with two equal opposite moments applied to the ends, kNm:

\[
M_{ij} = M'_i - M'_i \sum M'_j / \sum M'_i.
\]  
(A1.14)

Values of \( \sum M'_i \) and \( \sum M'_i \) are determined by summing for all transverse girders.

15 Moments applied to the ends of \( i \)-transverse member at global transverse bending in calm water are, kNm:

\[
M_{i2} = M'_i M_1 / \sum M'_i.
\]  
(A1.15)

16 Additional waving moments applied to the ends of the bridge transverse members, when the ship is beam to the sea, are, kNm:

\[
M_{i3} = M'_i M_3 / \sum M'_i,
\]  
(A1.16-1)

where \( M_i \) shall be determined by the formula (A1.6-2) or (A1.7-1).

The force \( T_{ih} \) determined by the formula (1.6-4) or (A1.7-3) induces tension or compression stresses, MPa,

\[
\sigma_{WI} = T_{ih} \cdot 10^{-3} / \sum F_i,
\]  
(A1.16-2)

where \( F_i \) — cross-sectional area of \( i \)-th transverse member, m².

17 Additional transverse bending moment \( M_4 \) calculated by the formula (A1.8-1) that occurs in case of quartering sea and induces the following moments at the ends of \( i \)-th transverse member of the bridge, kNm:

\[
M_{i4} = M'_i M_4 / \sum M'_i,
\]  
(A1.17)

and the force \( T_{i4} \) calculated by the formula (A1.8-3), induces the stress \( \sigma_i \) determined by the formula (A1.16-2).

18 For each transverse member of the bridge its linear vertical shifting stiffness shall be calculated, i.e. the shearing force resulted from the movement of one hull body one unit upwards, and another — one unit downwards. This force is numerically equal to reaction \( R_i \) (Fig. A1.18). When \( i \)-th member is located in the hull half-bulkhead plane, then

\[
R_i = 24 E I_j / \left( f_j^3 + 31.2 I_j / f_j \right),
\]  
(A1.18)

where \( f_j \) — area of \( i \)-th member's web.

19 At the calculation of the bridge considering transverse torsion by moment \( M_5 \) the hull stiffness at bending and torsion shall be assumed as infinite large.

Shearing force, kN, acting in the transverse member, being located at the distance \( x_i \) from amidships (the axis \( x \) is directed forwards),

\[
N_{i5} = \left( c_1 + c_2 x_i / L \right) R_{i1},
\]  
(A1.19-1)

and bending moments at the ends, kN-m,

\[
M_{i5} = \pm 0.5 f / \left( c_1 + c_2 x_i / L \right) R_{i1},
\]  
(A1.19-2)

where \( c_1 \) and \( c_2 \) shall be found from the equations set:

\[
\begin{align*}
\sum R_1 & + \sum \left( R_1 x_i / L \right) = 0 \\
\sum \left( R_1 x_i / L \right) & + \sum \left[ R_1 \left( x_i / L \right)^2 \right] = M_5 / L.
\end{align*}
\]  
(A1.19-3)

20 When defining stresses in transverse members of the bridge due to bending of the hull bodies in the opposite directions, it may be assumed that the hull bodies are connected only by transverse girders which form the elastic base frame for the hull bodies. The influence of the bridge flooring and plating on this deformation shall be considered by introducing to the section of one of the hull bodies
the bridge longitudinal members located on one side from the centre plane of the ship. The loads applied to the hull bodies shall be determined by the formula (A1.9-1), and the forces in the bridge members — according to requirements of 21 of this Appendix; the angle \( \varphi \) shall be selected so that the stresses are maximal.

21 At bending of the hull bodies in the opposite directions in \( i \)th transverse member of the bridge the shearing force shall be determined by the formula, kN,

\[
N_{\varphi i} = R_1 (a_0 f_{0i} + a_1 f_{1i} + a_2 f_{2i} + a_3 f_{3i} + a_4 f_{4i}) h B_1 L
\]

(A1.21-1)

and bending moments at the ends, kN⋅m,

\[
M_{\varphi i} = \pm 0.5 N_{\varphi i} l_i
\]

(A1.21-2)

where \( R_1 \) — stiffness of \( i \)th member determined according to 18;

\[
\begin{align*}
 f_{0i} &= 1; \\
 f_{1i} &= x_i / L; \\
 f_{2i} &= \cos \left( \pi x_i / L \right); \\
 f_{3i} &= \sin \left( 2\pi x_i / L \right); \\
 f_{4i} &= \cos \left( 3\pi x_i / L \right).
\end{align*}
\]

(A1.21-3)

Here \( x_i \) — distance between the \( i \)th member and the midship (the axis \( x \) is directed forwards).

Coefficients \( a_0 \) to \( a_4 \) shall be determined from the equations set (A1.21-4), where \( I_b \) — area moment of inertia of one hull body and a half of the bridge (see par. 20) amidships, m\(^4\); \( p \), \( b_1 \), \( b_2 \) — the loading parameters determined by formulae (A1.9-2), (A1.9-3) and (A1.9-4) accordingly.

\[
\begin{align*}
\sum_{j=0}^{4} \left[ a_j \sum \left( R_{1j} f_{0j} f_{\varphi i} \right) \right] &= p \\
\sum_{j=0}^{4} \left[ a_j \sum \left( R_{1j} f_{1j} f_{\varphi i} \right) \right] &= 0 \\
\sum_{j=0}^{4} \left[ a_j \sum \left( R_{1j} f_{2j} f_{\varphi i} \right) \right] + (43.8a_2 + 49.6a_4) \times EI_b / L^3 &= 0.5b_1, \\
\sum_{j=0}^{4} \left[ a_j \sum \left( R_{1j} f_{3j} f_{\varphi i} \right) \right] + 370 a_3 EI_b / L^3 &= 0 \\
\sum_{j=0}^{4} \left[ a_j \sum \left( R_{1j} f_{4j} f_{\varphi i} \right) \right] + (49.6a_2 + 2942a_4) \times EI_b / L^3 &= 0.5b_2
\end{align*}
\]

(A1.21-4)

The summing shall be made for all bridge girders.

22 The width of an effective flange for the bridge transverse girders shall be assigned according to requirements of 2 and 3.

23 Superstructures (wheelhouses) of more than 0.15\( L \) long (see 4.1.5.2) when calculating the bridge strength shall be changed by transverse girders located in plain of transverse bulkheads of these superstructures (wheelhouses) structurally connected with hulls. Geometrical parameters of the girders shall be defined according to the requirements of 9.
Part II

STABILITY. FLOODABILITY. FREEBOARD. MANEUURABILITY
1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION

1.1.1 This Part of the Rules covers the following inland and river-sea navigation ships and their operating conditions:

.1 all the ships navigating in displacement mode;
.2 hydrofoil craft in operation and transient modes;
.3 hovercraft in operation mode.

1.1.2 The requirements of this Part of the Rules apply also to skimmers, sailing ships, captured air bubble craft, WIG craft and floating docks.

1.1.3 The requirements related to the river-sea navigation ships apply to the ships engaged on coastal voyages. For the ships engaged on international voyages and for the ships of Ì-ÑÍ 4.5 class irrespective of the type of their voyages (coastal or international voyages), the requirements of the International Convention for the Safety of Life at Sea 1974 as amended, International Code on Intact Stability for all types of ships 2008, and International Convention on Load Lines (ICLL 66/88) are mandatory as applicable to this Part of the Rules.

1.1.4 The requirements of the present part of the Rules apply to the designed ships and ships under construction if otherwise is stated in the corresponding clauses and chapters of the present part of the Rules.

1.2 TERMS AND DEFINITIONS

1.2.1 For the terms and definitions related to the Rules common terminology, see 2.1 and 2.2 Part 0 of the Rules. For the purpose of this Part of the Rules, the following definitions have been adopted:

.1 Damage waterline means waterline of a damaged ship with one or more compartments flooded;
.2 Roll amplitude means an assumed rated roll amplitude at irregular waves, whose intensity is set by the wave height in water basins of a given category;
.3 Weathertightness means a characteristic of the hull structural components and/or equipment that prevents water ingress inside the ship when watering by dissipated water jet perpendicular to the tested surface;
.4 Watertightness means a characteristic of the hull structural components and equipment that prevents water ingress inside the ship when affected by a water jet from an applicator with an outlet diameter of not less than 16 mm with water head of 10 m. The water jet shall be directed to the closing connection. A distance from the nozzle to the tested section shall not exceed 1.5 m, and applicator travel speed along the tested connection shall not exceed 0.2 m/s;
.5 Wave height means a rated height of wind waves with a probability of overtopping accepted for water basins of a given category;
.6 Freeboard means the distance between the upper edge of the deck line and the upper edge of the maximum draught line measured vertically on the side amidships;

1 It is defined according to Appendix 2 of Technical Regulations on Safety of Inland Marine Transport Facilities approved by Decree of the Government of the Russian Federation No. 623 dated 12.08.2010 depending on the basin category.
7. Wind pressure means an assumed rated wind pressure, either static or dynamic;

8. Ship length \( L \) means the distance between the perpendiculars laid from the outmost points of the hull at the level of the uppermost load waterline;

9. Closed ship means a ship with closures of the cargo and other hatches located on the open parts of the freeboard deck; the watertightness of those closures complies with the requirements of these Rules;

10. Closed openings means openings in the main deck or hull sides, as well as in the decks, sides and bulkheads of superstructures and wheelhouses, with strong watertight closures complying with the requirements in 5.6.

For the purposes of stability assessment by the main stability criterion (see 2.1), strong watertight opening type scuttles, hatches and doors shall be considered as closed openings.

When assigning a freeboard and assessing the floodability, the following openings shall be considered as closed:

- all hatches, trunks, access holes, doors, manholes and other openings fitted with strong watertight covers
- dead side and deck scuttles
- opening type scuttles with permanently attached storm shutters

11. Grain means seeds of cereal crops (wheat, rye, barley, oats, corn, rice, sorghum, etc.), leguminous plants (pea, bean, soybean, vetch, chick-pea, lentil, etc.) and processed forms thereof;

12. Volume permeability coefficient of a space \( k_v \) means the ratio of the volume within that space, which is assumed to be occupied by water in case of full flooding of the compartment, to the total theoretical volume of the space;

13. Surface permeability coefficient \( k_s \) shall be calculated by the following formula:

\[
k_s = \frac{S_s}{S}
\]

where \( S_s \) — the waterline area of the flooded compartment except for the areas of the cargo, machinery and equipment crossed by that waterline;

\( S \) — the waterline area of the flooded compartment;

14. Maximum draught line means the band whose upper edge defines the deepest draught of a ship when navigating in a basin of the relevant category;

15. Heeling moments mean the design values of static and dynamic heeling moments;

16. Maximum permissible moments mean design values of maximum permissible moments with due regard to the required parameters of the ship's stability at static or dynamic inclinations;

17. Draught \( T \) means a vertical distance from the baseline to a given load waterline;

18. Main stability criterion means the ratio between heeling moment due to gust wind pressure on a ship and the maximum permissible moment corresponding to the angle of capsizing or the angle of downflooding and is determined with or without due regard to rolling (depending on ship class);

19. Open ship means a ship without closures of the cargo or other hatches located on the open parts of the freeboard deck, or with closures on such hatches whose watertightness does not comply with the requirements of these Rules;

20. Free-flooding openings (for assessing stability) mean openings in the main deck or sides, as well in decks, sides and bulkheads of superstructures and wheelhouses not fitted with strong weathertight closures.

For the purposes of stability assessment by additional requirements (see 3 of this Part), opening type scuttles, hatches and doors shall be considered as free-flooding openings.

For the purposes of floodability assessment, openings in bulkheads, decks and sides through which water may penetrate and spread inside the hull, except those specified in 1.2.1.10, shall be considered as free-flooding openings;

21. Compartment means a part of inner volume of the hull limited by the bottom or inner bottom, sides or longitudinal bulkheads, freeboard deck (if available) or the
upper edge of the side (when there is no deck), and two adjacent transverse watertight bulkheads or a peak bulkhead and an extremity;

.22 **Freeboard deck** means the deck, from which the freeboard is measured. As a rule, it is a bulkhead deck, which limits the watertight bulkheads from above.

On ships with a designed trim or with stepped freeboard deck, the freeboard deck is the lowest part of the open deck or its extension parallel to the upper part of the deck in the area of the step;

.23 **Bulkhead deck** means the uppermost deck, up to which the transverse watertight bulkheads extend;

.24 **Deck line** means a horizontal strip at the mid-length of the ship marked on the side in such a manner that its upper edge coincides with the lowest point of the intersection line of the freeboard deck plating's upper surface with the outer surface of the side plating. Where marking the deck as specified above is not possible or practicable, it may be applied from another fixed point on the side of the ship with respective correction of the freeboard height;

.25 **Passenger spaces** mean spaces intended for accommodation and servicing of passengers, except for the luggage spaces, storerooms, provision stores and post rooms. Spaces located below the margin line and intended for accommodation and servicing of the crew shall be considered as passenger spaces;

.26 **Windage area** means the projected lateral area of the above-water portion of the ship on the centre line plane, when the ship is in the upright position with average draught to actual waterline;

.27 **Maximum length of flooding at the given point** means – for a ship with continuous bulkhead deck – the maximum length of an assumed compartment with the abscissa of its volume centre in the given point of the number axis along the ship’s length, after flooding of which with permeability coefficients indicated in 4.3.11, at the draught corresponding to the relevant subdivision load waterline and in the absence of initial trim, the emergency waterline is tangent to the margin line;

.28 **Margin line** means the intersection line of the freeboard deck plating's outer surface with the side plating's outer surface. For the ships with a rounded deck, it is the intersection line of the deck plating outer surface extension with the side plating outer surface extension;

.29 **Maximum angle of heel** means an angle of heel, which shall not be exceeded according to the present Rules;

.30 **Righting of a ship** means the process of eliminating or reducing heel or trim;

.31 **Angle of downflooding θ_{down}** means the minimum angle of heel, at which downflooding of inner spaces of a ship starts through the free-flooding openings;

.32 **Angle of capsizing θ_{caps}** means an angle of heel, at which a ship is capsized due to dynamically applied heeling moment;

.33 **Windage center** means the center of gravity of the windage area;

.34 **Ship breadth B** means the maximum breadth between the outer edges of the frames at the level of the assigned freeboard.

### 1.3 GENERAL REQUIREMENTS

1.3.1 Stability of ships depending on their type and class shall be assessed for all the loading conditions specified in 1.3.2 to 1.3.7. Where there are no requirements to a particular type or class of ships, stability shall be checked for the following loading conditions:

.1 ship at draught corresponding to the assigned freeboard;

.2 ship without cargo, with ballast and with 10% of stores and fuel.

1.3.2 Stability of passenger and other ships carrying people shall be assessed for the following loading conditions:

.1 ship in the fully loaded condition, with full stores and fuel, and the full number of cabin and deck passengers with their luggage;

.2 ship in the fully loaded condition, with 10% of stores and fuel, and the full number of cabin and deck passengers with their luggage;

.3 ship without cargo, but with 10% of stores and fuel, and the full number of cabin and deck passengers with their luggage;
.4 ship without cargo and passengers, but with 10% of stores and fuel;  
.5 ship without cargo, with full stores and fuel and with full number of cabin and deck passengers with their luggage (only for the ships of M-ClII class);  
.6 ship without cargo and passengers, with full stores and fuel (only for the ships of M-ClII class).

1.3.3 Stability of the dry cargo ships shall be checked for the following loading conditions:  
.1 ship with draught corresponding to the assigned freeboard, with fully homogeneous cargo equally distributed between the holds, with full stores;  
.2 ship with fully homogeneous cargo and 10% of stores;  
.3 ship without cargo, with ballast and full stores;  
.4 ship without cargo, with ballast and 10% of stores.

1.3.4 Stability of tankers shall be checked in the following loading conditions:  
.1 ship with draught corresponding to the assigned freeboard with full cargo and full stores;  
.2 ship with full cargo and 10% of stores;  
.3 ship without cargo, with ballast and full stores;  
.4 ship without cargo, with ballast and 10% of stores.

1.3.5 Stability of container ships shall be checked in the following loading conditions:  
.1 ship with maximum number of containers with the mass of each container with cargo being equal to the same part of the maximum gross weight for each type of containers with full stores and, where necessary, with liquid ballast at draught corresponding to the summer load line;  
.2 ship in the same loading condition as in 1.3.5.1, but with 10% 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 and, where necessary, with liquid ballast;  
.4 ship in the same loading condition as in 1.3.5.3, but with 10% of stores;  
.5 ship with maximum number of empty containers, with ballast and full stores;  
.6 ship in the same loading condition as in 1.3.5.5, but with 10% of stores.

1.3.6 Stability of the ships carrying timber cargoes on the deck shall be checked for the following loading conditions:  
.1 ship carrying timber cargo with specified stowage rate \( \mu \) (if the stowage rate is not specified, it is taken equal to \( \mu = 2.3 \, \text{m}^3/\text{t} \)) in the holds and on the deck, with full stores. If liquid ballast intake is provided at full load with timber in the holds and deck according to the handling instructions, the ballast shall be considered in calculations;  
.2 ship in the same loading condition as in 1.3.6.1, but with 10% of stores;  
.3 ship with timber cargo, having the greatest stowage rate specified, in holds and on the deck, with full stores;  
.4 ship in the same loading condition as in 1.3.6.3, but with 10% of stores.

1.3.7 Stability of the fishing ships shall be checked for the following loading conditions:  
.1 departure for fishing with full stores and fuel;  
.2 arriving at port from fishing with full catch in holds and on deck (if provision is made in the design for stowage of cargo on deck) and with 10% of stores and fuel;  
.3 arriving at port from fishing with no catch in holds but with cargo on deck (if provision is made in the design for stowage of nets, fish or other cargo on deck) and with 10% of stores and fuel.

1.3.8 If the loading conditions, according to the ship operational conditions, as regards stability are less favorable than those listed in 1.3.1 or specified in 1.3.2 to 1.3.7, stability shall be also checked for these conditions.

1.3.9 In the stability calculations, the free surface effect in ballast, fuel and other tanks may be omitted provided that the following condition is met:  
\[
\nu b y k \sqrt{\delta_{1} / D_{\text{light}}} \leq 0.01, \quad (1.3.9-1)
\]
where $v$ — the total volume of the tank, m$^3$

$b$ — the maximum breadth of the tank, m

$\gamma$ — liquid density, kN/m$^3$

$D_l$ — lightship displacement weight, kN

$\delta_1$ — block coefficient of the tank:

$$\delta_1 = \frac{v}{\gamma l b h}$$

$l$, $b$, $h$ — maximum length, breadth and height of the tank, m

$k$ — coefficient calculated by the formula:

$$k = 0.01 \left[ -0.817 + 6.694 \frac{b}{h} - 0.917 \left( \frac{b}{h} \right)^2 + 0.017 \left( \frac{b}{h} \right) \right]$$

(1.3.9-2)

or obtained from Table 1.3.9 depending on $b/h$.

<table>
<thead>
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<th>$k$</th>
<th>$b/h$</th>
<th>$k$</th>
</tr>
</thead>
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<td>0.050</td>
</tr>
<tr>
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<td>0.009</td>
<td>1.5</td>
<td>0.072</td>
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<tr>
<td>0.75</td>
<td>0.037</td>
<td>3.0</td>
<td>0.110</td>
</tr>
</tbody>
</table>

1.3.10 Permissible angles of heel shall be determined at coextensive inclinations of the ship.

1.3.11 When using the tables given in this Part, intermediate values of the parameters shall be determined by linear interpolation.

**1.4 STABILITY CURVES**

1.4.1 Stability of a ship by the main criterion and additional requirements shall be assessed by the dynamic and static stability curves for corresponding loading conditions.

1.4.2 Stability curves shall be plotted considering the liquid cargo's free surfaces in all the cases when the condition specified in 1.3.9 is not met. The swash bulkheads shall be considered permeable. When assessing dynamic stability of a ship (by the main stability criterion), these bulkheads may be considered as watertight.

Stability curves for the ships of M-CPI class intended for operation at negative temperatures, as well as for the ice breakers, shall be plotted considering icing. The icing parameters shall be taken according to 1.7.2.

Correction to the metacentric height for liquid cargo's free surfaces in the tanks, where the mass of liquid is being changed during the ship operation, shall be taken according to the maximum value regardless of filling taken for calculation of weight loads. Correction to the metacentric height for liquid cargo's free surfaces in the tanks with constant filling level (ballast tanks, cargo tanks with liquid cargo) shall be taken according to actual filling of these tanks.

When calculating the ship's stability, residues of liquid cargoes in empty tanks may be omitted where their level does not exceed 5 cm.

1.4.3 Corrections to the metacentric height for liquid cargo are determined as a product of the liquid cargo densities and intrinsic transverse moments of inertia of free surfaces in the tanks calculated for the ship's upright position considering 1.4.2.

1.4.4 Corrections to the arms of the stability curves can be determined using one of the following methods:

1 by calculating actual heeling moment caused by motion of liquid in the tanks for each considered angle of heel;

2 by calculating intrinsic transverse moment of inertia of the liquid free surfaces in the tanks for the ship's upright position with further recalculation for each considered angle of heel by multiplying the received moment of inertia by sine of the angle of heel.

1.4.5 When plotting the stability curves, the influence of superstructures, wheelhouses and cargo hatch coamings may be considered when they are extended over at least 0.15 of the design hull length; in addition, those superstructures, wheelhouses and coamings as well as closures for openings and cutouts in them shall be strong and watertight.

1.4.6 When carrying timber cargo on the deck, additional righting moment caused by immersing the deck cargo shall be considered
by real geometric volume of cargo with the following permeability coefficients for timber:

- packaged 0.75
- round 0.60

**1.5 INFORMATION ON STABILITY AND FLOODABILITY**

1.5.1 Each ship shall be provided with a document named Information on Stability and Floodability prepared according to the Instructions on drawing up the Information on Stability and Floodability of Ship (Appendix 1). For the ships engaged on international voyages, the Information on Stability and Floodability shall be also prepared in English.

1.5.2 The Information on Stability and Floodability shall be prepared on the basis of stability and floodability calculation results according to the requirements of this Part of the Rules. It shall be amended on the basis of the inclining test results, with due regard to 1.6.2, when the deviations between the calculated results and experimental data exceed:

- ±2 % for lightship displacement;
- ±5 % for metacentric height;
- ± 0.01L for longitudinal center of gravity.

The Information on Stability and Floodability shall be prepared according to the Instructions on preparing the Information on Stability and Floodability of Ship (Appendix 1).

1.5.3 For the serial ships, the Information on Stability and Floodability shall be prepared on the basis of the inclining test results of the lead ship in the series.

1.5.4 The Information on Stability and Floodability for the floating cranes shall contain information on stability at various reaches and hook weights.

**1.6 INCLINING TEST**

1.6.1 The following ships shall undergo the inclining test to refine the position of the center of gravity:

- 1 the lead ship of each design;
- 2 a series ship with structural changes brought to essential changes of stability as compared to the first ship of the series exceeding the limits specified in 1.5.2. Such ship shall be considered as the first ship of a new series as regards stability;
- 3 ships after repair, conversion or modernization, if stability might be deteriorate;
- 4 ships, which have no information on stability.

1.6.2 It is allowed not to carry out the inclining test on a ship, which, as a result of modernization, conversion or repair, was subject to structural changes resulting in calculated change in lightship displacement by less than 2 %, in height of center of gravity by less than 4 cm, and in longitudinal center of gravity by less than 1 % of the ship length. The calculations of the lightship displacement and longitudinal center of gravity shall be confirmed by weighting according to 4.2 of Appendix 2.

1.6.3 The inclining test of a ship, except for a passenger ship, may be replaced by weighting, if the requirements of this Part of the Rules are met in case the center of gravity of a light ship is increased by 20 % as compared with the design value.

1.6.4 The inclining test shall be prepared and the results shall be processed according to the Instructions on Finding the Location of the Ship’s Center of Gravity from Experiment (Appendix 2).

**1.7 CONDITIONS OF SUFFICIENT STABILITY**

1.7.1 A ship is considered to be stable when, it complies, at all the loading conditions as specified in this Part of the Rules, with:

- 1 main stability criterion determined according to 2.1 to 2.4 depending on the ship’s class;
- 2 additional requirements to stability taken as in 3.1 to 3.9 depending on the ship’s type and purpose;
- 3 requirements to the static stability curve parameters according to 2.5;
- 4 requirement to initial stability, according to which the transverse initial metacentric
height shall be not less than 0.2 m with due regard to corrections for liquid cargo free surfaces for all the ships and also with due regard to icing for the ships of M-CHI class (see 1.4.2) and ice breakers.

Stability of the ships carrying hazardous goods shall also comply with the applicable requirements of Part IX of the Rules.

1.7.2 The initial metacentric height with due regard to icing shall be determined for the most unfavourable loading conditions for stability. Mass of ice per square meter of the total area of the open deck horizontal projection shall be taken equal to 15 kg. Mass of ice per square meter of the windage area shall be taken equal to 7.5 kg. The total horizontal projection of decks shall include the sum of horizontal projections of all exposed decks and gangways regardless of the availability of awnings.

The vertical moment due to this loading is determined for heights of the centres of gravity of the relevant areas of decks and gangways.

The deck machinery, arrangements, hatch covers and other objects installed on the decks are included in the projection of the decks and are not taken into account individually.

1.8 STABILITY CONTROL MEANS

1.8.1 The requirements of the present chapter apply to oil tankers operated in sea areas and BORO ships carrying oil and oil products.

The requirements of the present chapter apply to the designed ships, ships under construction and ships in service specified in the above paragraph of the present item. For the ships in service as well as for the ships under construction, the keel of which was laid down before 1 January 2016, the requirements of the present chapter shall be met at the earliest ordinary survey but not later than 1 January 2021.

1.8.2 All oil tankers and BORO ships of 24 m length and more carrying oil and oil products and operated in sea areas shall be equipped with stability control means which allow to evaluate ship’s compliance with intact stability and damaged stability requirements. Stability control means consist of software and hardware and allow to decide satisfiability of stability requirements specified for the given ship in the Information Stability and Floodability. The software shall be approved by the River Register.

The requirements for the stability control means software are specified in MSC.1/Circ.1461 "Guidelines for Verification of Damage Stability Requirements for Tankers", MSC.1/Circ.1229 "Guidelines for the Approval of Stability Instruments" and "International Code of Intact Stability 2008".

The Hardware (personal computer) of stability control means shall comply with the system requirements specified by the developer of the software.

The means shall comply with the requirements specified in 1.1.2 Part VI of the present Rules and shall be checked according to 8.1.3 of RTSC.
2 GENERAL REQUIREMENTS TO STABILITY

2.1 MAIN STABILITY CRITERION

2.1.1 Stability of a ship (except for the passenger ship of Ì-ÑÏ class) by the main criterion is considered to be sufficient when it withstands dynamically applied wind pressure on still water or at waves (according to the ship’s class), i.e. the following condition is met:

\[ M_{\text{heel}} < M_{\text{perm}} \quad \text{or} \quad K = \frac{M_{\text{perm}}}{M_{\text{heel}}} \geq 1 \]  \hspace{1cm} (2.1.1)

where \( M_{\text{heel}} \) — heeling moment due to the dynamic wind pressure, kN·m, determined as per 2.2

\( M_{\text{perm}} \) — maximum permissible moment at dynamic inclinations, kN·m, determined as per 2.3

2.1.2 Stability by the main criterion shall be checked for the ships of Ì-ÇП, Ì-ГП, Ì, Í-ГП and Í classes with due regard of roll (see 2.4) and for the ships of Ì and Ì class on still water.

2.1.3 Stability of the passenger ships of Ì-ÑÏ class is considered to be sufficient if the following condition is met:

\[ K = \frac{b}{a} \geq 1 \]  \hspace{1cm} (2.1.3)

where \( a \) and \( b \) are the areas determined from the static stability arm curve (see Fig. 2.1.3) when meeting the following conditions:

1. Ship is subject to a steady wind acting perpendicular to the centreline plane, this wind corresponds to the arm of wind heeling moment \( l_{w1} \);

2. Ship is inclined under the wave action to lee side from the static angle of heel \( \theta_0 \) (which shall not exceed 16°) caused by a steady wind action and corresponding to the first intersection point of the horizontal line \( l_{w1} \) and the righting arm curve \( l = f(\theta) \) to an angle equal to the roll amplitude \( \theta_{m1} \);

3. Inclined ship is subject to a dynamic gust of wind, which corresponds to the arm of heeling moment \( l_{w2} \);

4. To determine \( K \), areas \( a \) and \( b \) shaded in Fig. 2.1.3 shall be calculated and compared. The area \( b \) is limited by the righting arm curve \( l = f(\theta) \), the horizontal line at the level of the arm of heeling moment \( l_{w2} \) and the minimum angle of the following compared angles: angle of heel \( \theta_2 = 50° \); angle of downflooding \( \theta_{\text{down}} \) and angle of capsizing \( \theta_{\text{cap}} \). The area \( a \) is limited by the righting arm curve \( l = f(\theta) \), the horizontal line at the level of the arm of heeling moment \( l_{w2} \) and the angle of heel equal to \( \theta_0 - \theta_{m1} \);

5. The wind heeling lever \( l_{w1} \) is taken constant for all the angles and is calculated by the formula, m:

\[ l_{w1} = 0.001 p_s S z \left( g D \right) \]  \hspace{1cm} (2.1.3.5)

where \( p_s \) — rated static wind pressure, \( p_s = 252 \text{ Pa} \);

\( z \) — reduced heeling arm at simultaneous heel and lateral drift of ship determined according to the requirements in 2.2.5 and 2.2.6,

\( S \) — windage area of the ship at a draught with the checked loading condition, m²;
D — the displacement of the ship in the checked loading condition, t,

\[ g \] — acceleration of gravity, \( g = 9.81 \text{ m/s}^2 \);

The heeling arm \( l_{w3} \) is calculated by the formula

\[ l_{w3} = 1.5l_{w1} \, . \quad (2.1.3.6) \]

2.1.4 Roll amplitude \( \theta_m \) is determined according to the requirements in 2.4.10.

2.1.5 A gust speed limit is imposed on the ships depending on the ship class according to Table 2.1.5:

<table>
<thead>
<tr>
<th>Gust speed limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship class</td>
</tr>
<tr>
<td>M-CP, M-IP, M</td>
</tr>
<tr>
<td>O-IP, O</td>
</tr>
<tr>
<td>P, I</td>
</tr>
</tbody>
</table>

2.2 HEELING MOMENT DUE TO THE DYNAMIC WIND PRESSURE

2.2.1 The heeling moment applied to a ship due to the dynamic wind pressure is calculated by the formula, kN·m:

\[ M_{\text{heel}} = 0.001pS z \, , \quad (2.2.1) \]

where \( p \) — assumed rated gust wind pressure, Pa;

\( S \) — windage area of the ship at average draught to actual waterline, m\(^2\);

\( z \) — reduced heeling lever arm at simultaneous heel and lateral drift of the ship, m.

The values in the second member of the formula (2.2.1) shall be taken according to the requirements in 2.2.2 to 2.2.6.

2.2.2 The assumed design dynamic wind pressure shall be taken according to the ship class from Table 2.2.2 depending on the height of the windage center \( z_t \), m, above the actual waterline plane (at average draught \( T \)):

\[ z_t = z_w - T \, , \quad (2.2.2-1) \]

where \( z_w \) — the height of the windage center above the baseline of the ship, m.

The said assumed design dynamic wind pressure may be also determined by the following formulae for the ship classes:

\[
\begin{align*}
M-CP, & \quad p = 171(z_t + 0.6)^{0.34} \quad (2.2.2-2) \\
M-IP, M & \quad p = 151(z_t + 0.6)^{0.37} \quad (2.2.2-3) \\
O-IP, O & \quad p = 121(z_t + 0.6)^{0.44} \quad (2.2.2-4)
\end{align*}
\]

<table>
<thead>
<tr>
<th>Height of the windage center ( z_t ), m</th>
<th>Assumed design dynamic wind pressure ( p ), for the ships of the classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-CP, M-IP, M</td>
<td>O-IP, O</td>
</tr>
<tr>
<td>\leq 0.5</td>
<td>177</td>
</tr>
<tr>
<td>1.0</td>
<td>196</td>
</tr>
<tr>
<td>1.5</td>
<td>216</td>
</tr>
<tr>
<td>2.0</td>
<td>235</td>
</tr>
<tr>
<td>2.5</td>
<td>255</td>
</tr>
<tr>
<td>3.0</td>
<td>265</td>
</tr>
<tr>
<td>4.0</td>
<td>284</td>
</tr>
<tr>
<td>5.0</td>
<td>304</td>
</tr>
<tr>
<td>\geq 6.0</td>
<td>324</td>
</tr>
</tbody>
</table>

2.2.3 The windage area shall include the lateral planes of all continuous surfaces of the hull elements, superstructures and wheelhouses, mast, funnels, ventilators, boats and deck cargoes, as well as awnings which may be arranged in heavy weather.

Windage of discontinued surfaces of the hull elements like guardrails, crane trusses, rigging (except for masts), etc. may be approximately considered by increasing the total lateral area of continuous surfaces calculated for the minimum draught by 5 % and the static moment of this area with respect to the base plane by 10 %.

Windage of discontinued surfaces of the ship components in case of icing is considered by increase of the calculated total areas of the above said continuous surfaces for the minimum draught by 7.5 % and its static moment relative to the baseline of the ship by 15 %.

2.2.4 The approximate allowances for windage of the ship component discontinued surfaces specified in 2.2.3 may be disregarded, if the areas of all such surfaces and their static moments relative to the baseline are calculated individually. In this case, the windage area of discontinued surfaces shall include their overall areas multiplied by respective solidity coefficients, the values of which shall be taken for discontinued surfaces:
guard rails, covered with net, 0.6
not covered with net, 0.2
crane trusses, 0.5
spars and rigging, 0.6

Windage area of discontinued surfaces of the above mentioned elements, when they are calculated individually, shall be taken with a flow coefficient equal to 1.

Projected areas of the hull above the waterline, as well as superstructures and wheelhouses of general (not streamlined) type shall be taken with a flow coefficient equal to 1.

Projected areas of streamlined superstructures and wheelhouses may be taken with the flow coefficient of at least 0.6; however, it shall be proved by corresponding experimental and calculation data.

Projected areas of the ship’s elements located separately and having a streamlined shape (masts, funnels, ventilators, etc.) shall be taken with the flow coefficient equal to 0.6.

2.2.5 Reduced heeling arm due to the dynamic wind pressure, \( m \), is calculated by the formula

\[
\delta = z_c + a_1 a_2 T,
\]

where \( z_c \) — height of the windage center above the actual waterline plane (see 2.2.2), m;

\( a_1, a_2 \) — correction coefficients, see 2.2.6;

\( T \) — average draught of the ship at actual waterline, m.

2.2.6 Coefficient \( a_1 \), considering the influence of water resistance to lateral drift on heeling lever arm \( z \) shall be obtained from Table 2.2.6-1 depending on the ratio \( B/T \) (\( B \) and \( T \) are the breadth and the average draught of a ship at the actual waterline, m) or calculated by the formula:

\[
a_1 = 1.31 - 0.925e^{-0.00025(B/T)^4.33}.
\]

Coefficient \( a_2 \), considering the influence of inertia forces on the heeling lever arm \( z \) shall be obtained from Table 2.2.6-2 depending on the ratio \( z_g/B \) (\( z_g \) is the vertical distance from the centre of gravity to the base plane of the ship, m) or calculated by the formula:

\[
a_2 = \left[\frac{-6.2 + 0.75\left(z_g/B\right)^{-2.64}}{10.7 + \left(z_g/B\right)^{-2.64}}\right].
\]

\begin{table}[h!]
\centering
\begin{tabular}{|c|c|c|c|c|c|}
\hline
\( B/T \) & \( a_1 \) & \( B/T \) & \( a_1 \) \\
\hline
\leq 2.5 & 0.40 & 7.0 & 1.00 \\
3.0 & 0.41 & 8.0 & 1.20 \\
4.0 & 0.46 & 9.0 & 1.28 \\
5.0 & 0.60 & \geq 10 & 1.30 \\
6.0 & 0.81 & & & \\
\hline
\end{tabular}
\caption{Coefficient \( a_1 \)}
\end{table}

\begin{table}[h!]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
\( z_g/B \) & \( a_2 \) & \( z_g/B \) & \( a_2 \) \\
\hline
0.15 & 0.66 & 0.35 & 0.22 \\
0.20 & 0.58 & 0.40 & 0.10 \\
0.25 & 0.46 & \geq 0.45 & 0 \\
0.30 & 0.34 & & & \\
\hline
\end{tabular}
\caption{Coefficient \( a_2 \)}
\end{table}

2.3 MAXIMUM PERMISSIBLE MOMENT FOR ASSESSING STABILITY BY MAIN CRITERION

2.3.1 Maximum permissible moment is determined by the maximum permissible angle of heel.

2.3.2 Maximum permissible angle of heel \( \theta_{perm} \) under dynamic effect of the heeling moment due to wind and waves shall be taken equal to either the angle of capsizing \( \theta_{caps} \) or the angle of downflooding \( \theta_{dnfl.} \), whichever is less.

2.3.3 Maximum permissible moment \( M_{perm} \) may be determined by the dynamic or static stability curves according to the requirements of this Section.

2.3.4 Maximum permissible moment \( M_{perm} \) for the ships of M-СП, M-ПР, M, O-ПР and O classes shall be determined by means of plotting performed with due regard to the roll effect.

When determining moment \( M_{perm} \) on the dynamic stability curve (curve of dynamic stability arms \( d \)) the latter is extended to negative area on a section equal to assumed design roll amplitude \( \theta_m \) calculated according to the requirements in 2.4.
The amplitude of roll is plotted to the left from the point of origin 0 (Fig. 2.3.4-1 and 2.3.4-2), and corresponding point A is fixed on the left leg of the curve; this point is further called the origin point.

When determining the maximum permissible moment using any of the described curves, the following typical cases are possible:

.1 For determination of the maximum permissible moment $M_{perm}$ corresponding to the angle of capsizing $\theta_{caps}$, tangent line $AK$ to the right leg of the curve of arms $d$ is drawn from the origin point $A$ (see Fig. 2.3.4-1). An abscissa of the point of contact $K$ defines, for this case, the angle of capsizing; a line parallel to abscissa axis is drawn via the origin point $A$, and segment $AB$ equal to 1 rad ($57.3^\circ$) is laid. A perpendicular is conducted from point $B$ up to intersecting tangent line $AK$ in a point $E$.

Further, a line parallel to abscissa axis is drawn via the origin point $A$, and segment $AB$ equal to 1 rad ($57.3^\circ$) is laid. A perpendicular is conducted from point $B$ up to intersecting tangent line $AK$ in a point $E$.

Segment $BE$ presents the numerical value of the arm $l_{perm1}$ of the maximum permissible moment corresponding to the angle of capsizing of the ship. In this case, the maximum permissible moment $M_{perm1}$, kN·m, shall be equal to $l_{perm1}$, m, multiplied by the weight of the ship $\Delta$, kN, at the draught, for which the stability curve is plotted, i.e.
For determination of the maximum permissible moment $M_{perm2}$ corresponding to the angle of downflooding $\theta_{dnfl.}$, a value of the angle of downflooding $\theta_{dnfl.}$ is plotted on the curve's X axis (see Fig. 2.3.4-2), and a perpendicular is drawn from the obtained point up to intersecting the curve of arms $d$ in a point $F$.

Further plotting on the curve are performed by the same way as stated above, except that instead of the tangent line to the curve, a secant line $AF$ is conducted to intersecting, in point $E$, perpendicular $BE$ constructed to segment $AB$ equal to 1 radian.

This segment $BE$, in this case, presents a numerical value of the arm $l_{perm2}$ of the sought maximum permissible moment corresponding to the angle of downflooding.

Maximum permissible moment $M_{perm2}$ is calculated by the formula, kN·m:

$$M_{perm2} = \Delta \cdot l_{perm2}, \quad (2.3.4-2)$$

where $l_{perm2}$ — arm of the maximum permissible moment, m;

$\Delta$ — weight of the ship, kN.

The maximum permissible moments $M_{perm1}$ and $M_{perm2}$ shall be determined according to the static stability curve as a result of plottings shown on Figs. 2.3.4-1 and 2.3.4-2.

On the static stability curves (the curve of arms $l$) straight lines $CN$ are chosen parallel to the abscissa axis so that shaded areas $S_1$ and $S_2$ are equal.

Segment $OC$ on the ordinate axis of the curve (see Fig. 2.3.4-1) presents a numerical value of the arm $l_{perm1}$ of the maximum permissible moment corresponding to the angle of capsizing, and the value of the moment $M_{perm1}$, kN·m, shall be calculated by formula (2.3.4-1). Similarly, segment $OC$ (see 2.3.4-2) presents a numerical value of the arm $l_{perm2}$ of the maximum permissible moment corresponding to the angle of downflooding, and the value of the moment $M_{perm2}$, kN·m, shall be calculated by formula (2.3.4-2).

2.3.5 Maximum permissible moment at dynamic inclinations — for the ships of P and I classes when assessing their stability by the main criterion (see 2.1) and for the ships of all the classes when assessing stability by additional requirements (see 3 of this Part) — shall be determined by the dynamic and static stability curves in the same order as specified in 2.3.4 regardless the roll effect (see Figs. 2.3.5-1 and 2.3.5-2), except for the stability assessment of tugboats of O-P1P, M-P1P and M-CIP classes for rope jerk carried out with due regard to rolling (see 3.3.14).
and without bilge keels (or bar keel) shall be taken from Table 2.4.1 depending on frequency \( m, \text{s}^{-1} \), which shall be calculated by the formula

\[
m = m_1 m_2 m_3, \quad (2.4.1-1)
\]

where \( m_1, m_2, m_3 \) are coefficients, see 2.4.3.

Notes. 1. When values \( m \) are greater than those specified in Table 2.4.1, the maximum design roll amplitude for the ships of this class shall be taken.

2. For the ships with bilge keels (or bar keel) the roll amplitude shall be determined according to 2.4.4 to 2.4.7.

<table>
<thead>
<tr>
<th>Roll amplitude</th>
<th>Roll amplitude, ( \theta_m ) for all types of ships</th>
</tr>
</thead>
<tbody>
<tr>
<td>( m, \text{s}^{-1} )</td>
<td>( \text{M-P} \text{-P}, \text{M} )</td>
</tr>
<tr>
<td>0.40</td>
<td>14°</td>
</tr>
<tr>
<td>0.60</td>
<td>18°</td>
</tr>
<tr>
<td>0.80</td>
<td>24°</td>
</tr>
<tr>
<td>1.00</td>
<td>28°</td>
</tr>
<tr>
<td>1.20</td>
<td>30°</td>
</tr>
<tr>
<td>1.40</td>
<td>31°</td>
</tr>
<tr>
<td>1.60</td>
<td>31°</td>
</tr>
<tr>
<td>1.80</td>
<td>31°</td>
</tr>
</tbody>
</table>

The specified assumed design roll amplitude \( \theta_m \), deg., may be also determined by the following expressions for the ship classes:

- \( \text{M, M-P} \) \( \theta_m = 31 - 19.3e^{-1.9m^{2.9}} \) (2.4.1-2)
- \( \text{O, O-P} \) \( \theta_m = 24.4 - 15.9e^{-0.75m^{3.5}} \) (2.4.1-3)

2.4.2 For the ships with sharp bilges and paddle ships, the assumed design roll amplitudes shall be taken equal to 0.75 and 0.80, respectively, of the values taken from Table 2.4.1 or calculated by the formulae (2.4.1-2) and (2.4.1-3).

2.4.3 Coefficient \( m_1 \) that characterizes natural oscillation frequency of a ship (on still water) shall be defined by the formula, \( \text{s}^{-1} \):

\[
m_1 = m_0 / \sqrt{h_0}, \quad (2.4.3-1)
\]

where \( h_0 \) — metacentric height corresponding to the given loading condition of ship calculated regardless of the influence of free surface of liquid cargoes, \( m_0 \) — coefficient to be adopted from Table 2.4.3-1 or calculated by formula (2.4.3-3) depending on the parameter

\[
\eta_i = h_0 B / \left( \zeta_g \sqrt{V} \right), \quad (2.4.3-2)
\]

where \( V \) — volume displacement at mean draught \( T \) corresponding to actual waterline, \( m^3 \);

| Coefficient \( m_0 \) |
|-----------------|--------|--------|--------|
| \( \eta_i \) | \( m_0 \) | \( n_1 \) | \( n_2 \) |
| \leq 0.10 | 0.42 | 1.00 | 2.40 |
| 0.15 | 0.52 | 1.50 | 3.00 |
| 0.25 | 0.78 | 2.00 | 3.30 |
| 0.50 | 1.38 | 2.50 | 3.50 |
| 0.75 | 1.94 | \geq 3.00 | 3.60 |

\( z_g \) — height of centre of gravity above the baseline for the given loading condition, \( m \);

\( B \) — the ship’s breadth at the actual waterline, \( m \).

\[
m_0 = 3.66 - 3.43e^{-0.25}. \quad (2.4.3-3)
\]

Values of dimensionless coefficients \( m_2 \) and \( m_3 \), which consider the hull shape influence on the roll amplitude, shall be taken from Tables 2.4.3-2 and 2.4.3-3 or from expressions (2.4.3-4) and (2.4.3-5) depending on the \( B/T \) ratio and block coefficient \( \delta \).

2.4.3.1 The value of dimensionless coefficients \( m_2 \) and \( m_3 \) shall be taken from Tables 2.4.3-2 and 2.4.3-3 or from expressions (2.4.3-4) and (2.4.3-5) depending on the \( B/T \) ratio and block coefficient \( \delta \).

| Coefficient \( m_2 \) |
|-----------------|--------|--------|
| \( B/T \) | \( m_2 \) | \( B/T \) | \( m_2 \) |
| \leq 2.50 | 1.00 | 6.00 | 0.87 |
| 3.00 | 0.90 | 7.00 | 0.92 |
| 3.50 | 0.81 | 8.00 | 0.96 |
| 4.00 | 0.78 | 9.00 | 0.99 |
| 5.00 | 0.81 | \geq 10.00 | 1.00 |

2.4.3.2 For the ships with sharp bilges and paddle ships, the assumed design roll amplitudes shall be taken equal to 0.75 and 0.80, respectively, of the values taken from Table 2.4.1 or calculated by the formulae (2.4.1-2) and (2.4.1-3).

| Coefficient \( m_3 \) |
|-----------------|--------|--------|
| \( \delta \) | \( m_3 \) | \( \delta \) | \( m_3 \) |
| \leq 0.45 | 1.00 | 0.65 | 0.72 |
| 0.50 | 0.95 | 0.70 | 0.69 |
| 0.55 | 0.86 | 0.75 | 0.67 |
| 0.60 | 0.77 | \geq 0.80 | 0.66 |

\[
m_2 = 0.669 + 10.47(B/T) - 100.74(B/T)^2 + 327.36(B/T)^3 - 339.5(B/T)^4. \quad (2.4.3-4)
\]
$m_i = 1 - 0.358e^{-0.00758^{0.1}}$ \hfill (2.4.3-5)

2.4.4 Assumed design roll amplitudes $\theta_m'$, deg., for the ships with bilge keels (or bar keel)

$$\theta_m' = k \theta_m,$$ \hfill (2.4.4)

where $k$ — correction coefficient, see 2.4.5

$\theta_m$ — roll amplitude for ship without keels, see 2.4.1

2.4.5 Coefficient $k$ specifying the relative decrease of the roll amplitudes due to bilge or bar keels, shall be taken from Table 2.4.5 depending on

$$q = r \alpha \sqrt{B},$$ \hfill (2.4.5-1)

where $B$ — the ship breadth at the actual waterline, m

<table>
<thead>
<tr>
<th>$q$</th>
<th>$k$</th>
<th>$q$</th>
<th>$k$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.00</td>
<td>5.00</td>
<td>0.68</td>
</tr>
<tr>
<td>1.00</td>
<td>0.95</td>
<td>6.00</td>
<td>0.65</td>
</tr>
<tr>
<td>2.00</td>
<td>0.85</td>
<td>7.00</td>
<td>0.63</td>
</tr>
<tr>
<td>3.00</td>
<td>0.77</td>
<td>≥ 8.00</td>
<td>0.62</td>
</tr>
<tr>
<td>4.00</td>
<td>0.72</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The said coefficient $k$ may be also determined by the expression:

$$k = 1 - 0.438q^{0.85} \left( \frac{7}{7 + q^{0.85}} \right).$$ \hfill (2.4.5-2)

2.4.6 Coefficient $r$ considering the increase of water resistance to roll due to bilge or bar keels shall be calculated by the formula:

$$r = (r_1 + r_2) r_3,$$ \hfill (2.4.6)

where $r_1$, $r_2$, $r_3$ are coefficients, see 2.4.7.

2.4.7 Coefficient $r_1$ considering the efficiency of bilge keels with the total area $S_k$, $m^2$, shall be taken from Table 2.4.7-1 depending on ratio $100S_k/(LB)$, % ($L$ and $B$ are the length and the breadth of the ship at actual waterline, m).

The said coefficient $r_1$ may be also determined by the expression:

$$r_1 = 47.8 \frac{S_k}{LB} - 0.241 at \quad r_1 = 1.66 \quad at \quad S_k/(LB) \leq 0.04$$

$$r_1 = 1.66 at \quad S_k/(LB) > 0.04$$ \hfill (2.4.7-1)

Coefficients $r_2$ and $r_3$ considering the influence of the hull shape on the efficiency of bilge keels shall be taken from Tables 2.4.7-2 and 2.4.7-3 accordingly depending on the block coefficient $\delta$ for keel area $S_k$ and ratio $B/T$ ($T$ is the mean draught of the ship at actual waterline, m).

<table>
<thead>
<tr>
<th>$\delta$</th>
<th>$r_2$</th>
<th>$\delta$</th>
<th>$r_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 0.45</td>
<td>0</td>
<td>0.70</td>
<td>0.65</td>
</tr>
<tr>
<td>0.50</td>
<td>0.06</td>
<td>0.75</td>
<td>0.71</td>
</tr>
<tr>
<td>0.55</td>
<td>0.18</td>
<td>0.80</td>
<td>0.68</td>
</tr>
<tr>
<td>0.60</td>
<td>0.35</td>
<td>≥ 0.85</td>
<td>0.64</td>
</tr>
<tr>
<td>0.65</td>
<td>0.51</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\frac{B}{T}$</th>
<th>$r_3$</th>
<th>$\frac{B}{T}$</th>
<th>$r_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 2.50</td>
<td>1.40</td>
<td>7.00</td>
<td>2.13</td>
</tr>
<tr>
<td>3.00</td>
<td>1.48</td>
<td>8.00</td>
<td>2.34</td>
</tr>
<tr>
<td>4.00</td>
<td>1.58</td>
<td>9.00</td>
<td>2.50</td>
</tr>
<tr>
<td>5.00</td>
<td>1.83</td>
<td>≥ 10.0</td>
<td>2.60</td>
</tr>
<tr>
<td>6.00</td>
<td>2.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The requirements specified in 2.4.7 apply to the ships with bar keel too. In this case, $S_k$ is the keel’s lateral projection area, $m^2$.

The said coefficients $r_2$ and $r_3$ may be also determined by the expressions:

$$r_2 = \left(-0.116 + 0.25\delta\right)\left(1 - 2.7\delta + 2\delta^2\right),$$ \hfill (2.4.7-2)

$$r_3 = 1 + 0.166 \frac{B}{T}.$$ \hfill (2.4.7-3)

2.4.8 Roll amplitude $\theta_m$, deg., for the ships of M-CP class (except for passenger ships) with a rounded bilge and without bilge keels shall be calculated by the formula
$\theta_m = m_4 m_5 m_6$, \hspace{1cm} (2.4.8-1)

where $m_4$ — coefficient calculated by the formula:

$$m_4 = \left[ 1.103 - 0.5576 \frac{B}{T} + 0.0764 \left( \frac{B}{T} \right)^2 \right] / \left[ 1 - 0.4971 \frac{B}{T} + 0.0691 \left( \frac{B}{T} \right)^2 \right]$$ \hspace{1cm} (2.4.8-2)

or adopted from Table 2.4.8-1 depending on the ratio of the ship’s breadth $B$ to the draught $T$;

or adopted from Table 2.4.8-2 depending on the block coefficient $\delta$;

$$m_5 = 109.745 - 124.4 \delta + 52.94 \delta^2 - 41.68 \delta + 5.85 \delta^2$$ \hspace{1cm} (2.4.8-3)

or adopted from Table 2.4.8-2 depending on the block coefficient $\delta$;

or adopted from Table 2.4.9 depending on the ratio of the total area of bilge keels $S_k$, m$^2$, to the product $LB$.

2.4.9 If the ship of M-1 class (except passenger ships) has bilge keels, the roll amplitude shall be calculated by the formula

$$\theta_m = k \theta_m$$ \hspace{1cm} (2.4.9-1)

where coefficient $k$ depending on $\tilde{a} = 100 \frac{S_k}{LB}$ is calculated by the formula

$$k = \left[ 1 - 0.8554 \tilde{a} + 0.2522 \tilde{a}^2 - 0.0212 \tilde{a}^3 \right] / \left[ 1 - 0.8432 \tilde{a} + 0.2449 \tilde{a}^2 - 0.0184 \tilde{a}^3 \right]$$ \hspace{1cm} (2.4.9-2)

or adopted from Table 2.4.9 depending on the ratio of the total area of bilge keels $S_k$, m$^2$, to the product $LB$.

2.4.10 Roll amplitude $\theta_m$, deg., of the passenger ship of M-1 class with a rounded bilge shall be calculated by the formula:

$$\theta_m = 109 k x_1 m_5 \sqrt{r s}$$ \hspace{1cm} (2.4.10-1)

where $k$ — coefficient considering the influence of bilge keels taken from Table 2.4.9;

$x_1$ — dimensionless coefficient adopted from Table 2.4.10-1 depending on the breadth-to-draught ($B/T$) ratio or, within the $B/T$ range of 2.4 to 3.5, calculated by the formula:

$$x_1 = \sqrt{1.7645 - 0.3207 \frac{B}{T}}$$ \hspace{1cm} (2.4.10-2)

$m_5$ — dimensionless coefficient adopted from Table 2.4.8-2;

$r$ — parameter calculated by the formula:

$$r = 0.73 + 0.6 \left( \frac{z_g - T}{T} \right) / T \leq 1$$ \hspace{1cm} (2.4.10-3)
s — dimensionless coefficient taken from Table 2.4.10-2 depending on the roll period $\tau$ to be calculated by the formula, $s$:

$$ \tau = 2c \frac{B}{\sqrt{h}}. $$

(2.4.10-4)

<table>
<thead>
<tr>
<th>Table 2.4.10-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensionless coefficient $x_1$</td>
</tr>
<tr>
<td>$B/T$</td>
</tr>
<tr>
<td>2.4</td>
</tr>
<tr>
<td>2.5</td>
</tr>
<tr>
<td>2.6</td>
</tr>
<tr>
<td>2.7</td>
</tr>
<tr>
<td>2.8</td>
</tr>
<tr>
<td>2.9</td>
</tr>
</tbody>
</table>

To determine $s$ within the roll period range from 6 to 20 s, the following formula may be used instead of Table 2.4.10-2:

$$ s = 0.03 + 0.0439 \tau - 0.838 \cdot 10^{-3} \tau^2 + 0.536 \cdot 10^{-3} \tau^3 - 1.1399 \cdot 10^{-5} \tau^4; $$

(2.4.10-5)

<table>
<thead>
<tr>
<th>Table 2.4.10-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roll period $\tau$</td>
</tr>
<tr>
<td>$s$</td>
</tr>
<tr>
<td>0.100</td>
</tr>
<tr>
<td>0.093</td>
</tr>
<tr>
<td>0.083</td>
</tr>
<tr>
<td>0.073</td>
</tr>
</tbody>
</table>

$c$ — correction coefficient depending on the ship's dimensions:

$$ c = 0.373 + 0.023 \frac{B}{T} - 0.043 \cdot 10^{-2} \frac{L}{T}; $$

(2.4.10-6)

$h$ — corrected metacentric height, m (corrected for effect of free surfaces of liquid cargoes);

$L$ — ship's length, m.

The roll amplitude of a sharp-bilge ship shall be taken equal to 70% of the amplitude calculated by the formula (2.4.10-1).

The rated roll amplitude values shall be rounded to integer degrees.

2.4.11 Assumed design roll amplitude for the ships of M class. Roll amplitude $\theta_m$, deg., is calculated by the formula

$$ \theta_m = \frac{1}{2} \left( 0.1306 - 0.2584m + 0.2272m^2 - 0.0674m^3 \right) $$

(2.4.11)

or adopted from Table 2.4.11 depending on the parameter $m$.

<table>
<thead>
<tr>
<th>Table 2.4.11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roll amplitude $\theta_m$</td>
</tr>
<tr>
<td>$m$</td>
</tr>
<tr>
<td>0.40</td>
</tr>
<tr>
<td>0.60</td>
</tr>
<tr>
<td>0.80</td>
</tr>
</tbody>
</table>

2.5 REQUIREMENTS TO STATIC STABILITY CURVE PARAMETERS

2.5.1 For ships of M and M-III classes, the maximum righting arm of the static stability curve shall be at least 0.25 m for ships with a length of 80 m and less and at least 0.20 m for ships with a length of 105 m and more at an angle of heel $\theta \geq 25^\circ$. For ships with a length over 80 m but less than 105 m, righting arm $l_{\max}$ shall be obtained by linear interpolation of the data stated above. The angle of vanishing or the angle of downflooding of the static stability curve shall be at least 50°.

2.5.2 The static stability curve for the ships of M-III class (except for passenger ships) shall comply with the following requirements:

1. The maximum righting arm of the static stability curve shall be at least 0.25 m for ships with a length of 80 m and less and at least 0.20 m for ships with a length of 105 m and more at an angle of heel $\theta \geq 25^\circ$. For ships with a length over 80 m but less than 105 m, righting arm $l_{\max}$ shall be obtained by linear interpolation of the data stated above. For the ships with the $B/T \geq 2.5$, maximum arm may be decreased to 0.15 m if the area under the static stability curve within the angles of heel of $0^\circ$ to $15^\circ$ is at least 0.07 m rad;
2. The angle of vanishing or the angle of downflooding of the static stability curve shall be at least 50°;
3. The area under the righting lever curve shall not be less than, m-rad:
2.5.3 The static stability curve for the ships of M-CII class shall comply with the following requirements:

.1 The maximum righting arm \( l_{\text{max}} \) of the static stability curve shall be at least 0.25 m for ships with a length of 80 m and less and at least 0.20 m for ships with a length of 105 m and more at an angle of heel \( \theta \geq 30^\circ \). For intermediate values of the ship length, value \( l_{\text{max}} \) shall be determined by linear interpolation of the above data.

If the static stability curve has two maxima due to the influence of the superstructures or wheelhouses, the first maximum shall occur at the angle of heel not less than 25\(^\circ\);

.2 The limit of positive static stability (the angle of vanishing stability or the angle of downflooding) shall be at least 60\(^\circ\); however, this limit may be lowered down to 50\(^\circ\) provided that every lowering by 1 degree is accompanied by increase of the maximum arm \( l_{\text{max}} \) of the static stability curve by 0.01 m above the value specified according to 2.5.3.1;

.3 The area under the righting lever curve shall not be less than, m-rad:

<table>
<thead>
<tr>
<th>Angle of Heel</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \leq 30^\circ )</td>
<td>0.055</td>
</tr>
<tr>
<td>( \leq 40^\circ ) or angle of downflooding, whichever is less</td>
<td>0.09</td>
</tr>
<tr>
<td>from 30(^\circ) to 40(^\circ) or the angle of downflooding, whichever is less</td>
<td>0.03</td>
</tr>
</tbody>
</table>
3 ADDITIONAL STABILITY REQUIREMENTS
FOR VARIOUS SHIP TYPES

3.1 PASSENGER AND OTHER SHIPS
CARRYING PEOPLE

3.1.1 Stability of passenger ships by the
main criterion specified in 2.1 shall be as-
sessed for the loading conditions specified in
1.3.

When assessing stability by the main crite-
rion, cabin passengers shall be assumed to be
in their accommodation, deck passengers on
their decks and the cargo stowage in cargo
holds and on decks shall be assumed to com-
ply with the normal operating conditions of
the ship.

For the loading conditions in 1.3.2.1 to
1.3.2.3, stability of the ship shall be also
checked by additional requirements specified
in 3.1.2, 3.1.6, 3.1.10.

N o t e : Stability of a ship by additional re-
quirements shall be assessed also for non-full num-
ber of passengers, if such a loading condition may
be less favourable as regards stability than the worst
one of those listed above.

3.1.2 Stability of passenger ships shall be
sufficient in case of passenger crowding at one
side, i.e. the following condition shall be met:

\[ M_p < M_{perm}, \]  (3.1.2)

where \( M_p \) — heeling moment due to crowding
of passengers to one side, kN-m, see 3.1.3;

\( M_{perm} \) — maximum permissible moment at
static inclinations of the ship, kN-m, see 2.3.

3.1.3 Heeling moment \( M_p \) shall be deter-
mined by from the design scheme of crowding
the passengers at one side corresponding to
their most dangerous disposition possible in
normal operating conditions of the ship. In
this case, the distribution of passengers shall
be taken as at one side on deck areas free
from the equipment and arrangements, with
due regard to restrictions established for pas-
senger access to either part of the deck.

When determining heeling moment \( M_p \), the
passenger distribution density shall be taken as
follows: 4 persons per square meter of free
surface of decks on ships undertaking perma-
nent voyages longer than 24 hours; and 6 per-
sons per square meter on ships undertaking
voyages shorter than 24 hours.

Areas of outer passages in the vicinity of
bulwarks or guard rails shall be assumed with
a coefficient of 0.75, where the passage
breadth is over 0.7 m and with a coefficient of
0.50 where the breadth is \( \leq 0.7 \) m.

Areas of passages between sofas (benches,
armchairs), on which excessive passengers
may crowd in addition to the passengers oc-
cupying their seats, shall be assumed with a
coefficient of 0.5.

Mass of a passenger shall be taken equal to
75 kg and a centre of gravity located 1.1 m
above the deck.

3.1.4 As an ultimate permissible angle of
heel \( \theta_{perm} \), there shall be taken an angle equal
to 0.8\( \theta_{downfl} \), or an angle at which the deck
edge or upper edge of ship fender enters the
water, whichever is less. Value of \( \theta_{perm} \) shall
not exceed 10°, or 12° for ships of up to 30 m
in length.

3.1.5 Moment \( M_{perm} \) shall be defined from
the static stability curve depending on maxi-
mum permissible angles of heel \( \theta_{perm} \), deg.
(see 3.1.4). When assessing stability in case of
crowding passengers on one side, the effect of
free surfaces of liquid cargoes shall be consid-
ered according to 1.4.2.

3.1.6 Stability of passenger ships in case of
crowding passengers on side shall be sufficient
at the greatest dynamic heel arising at the
evolution period of turn, i.e. the following condition shall be met:

\[ M_{\text{turn}} < M'_{\text{perm}}, \] (3.1.6)

where \( M_{\text{turn}} \) — dynamically applied heeling moment, kN·m, arising in evolution period of ship turn and determined as in 3.1.7;

\( M'_{\text{perm}} \) — maximum permissible moment taken as in 3.1.9 when the ship is inclined in the evolution period of turn, having regard to initial heel due to crowding of passengers at one side, kN·m.

Note: If in any real loading condition of a serial passenger ship, condition \( M_{\text{turn}} \leq 0.8M'_{\text{perm}} \) is not met, her stability in the evolution period of turn shall be checked by means of specially conducted full-scale experiment performed on the lead ship of the series.

3.1.7 The dynamical heeling moment applied to ship in the evolution period of turn, kN·m, is:

\[ M_c = v_0^2 \Delta (z_g - a_1 T)/L, \] (3.1.7-1)

where \( c \) — coefficient depending on type of ship propulsor and equal to 0.029 for propeller and waterjet ships and 0.045 for paddle ships;

\( v_0 \) — ship speed before entering the turn, to be taken equal to 0.8 of full ahead speed on a straight course, m/s;

\( \Delta \) — weight of the ship corresponding to the draught up to actual waterline, kN;

\( z_g \) — height of centre of gravity above the baseline, m;

\( a_3 \) — coefficient considering vertical shift of lateral pressure centre when the ship is adrift; it is to be taken from Table 3.1.7 depending on the ratio \( B/T \) (\( B \) is the ship’s breadth at actual waterline);

<table>
<thead>
<tr>
<th>( \frac{B}{T} )</th>
<th>( a_1 )</th>
<th>( \frac{B}{T} )</th>
<th>( a_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>\leq 2.50</td>
<td>0.73</td>
<td>7.00</td>
<td>-3.38</td>
</tr>
<tr>
<td>3.00</td>
<td>0.50</td>
<td>8.00</td>
<td>-4.45</td>
</tr>
<tr>
<td>4.00</td>
<td>-0.27</td>
<td>9.00</td>
<td>-5.40</td>
</tr>
<tr>
<td>5.00</td>
<td>-1.27</td>
<td>\geq 10.00</td>
<td>-6.00</td>
</tr>
<tr>
<td>6.00</td>
<td>-2.33</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( L \) and \( T \) — the ship’s length and the mean draught at actual waterline, respectively, m.

Coefficient \( a_3 \) may be also calculated within the range of \( 2.50 < B/T < 10.0 \) by the formula:

\[ a_3 = 0.015 (B/T)^3 - 0.282 (B/T)^2 + 0.662 B/T + 0.62. \] (3.1.7-2)

Note: Formula (3.1.7-1) is valid for displacement single-hull ships with length-based Froude number \( F_{Ll} = v/L \sqrt{g} \leq 0.36 \).

3.1.8 As the maximum permissible angle of heel \( \theta'_{\text{perm}} \), there shall be taken an angle equal to a deck entrance angle (regardless of fender entering the water) or an entrance angle of waterline being 75 mm below the edge of free-flooding openings, whichever is less.

3.1.9 Moment \( M'_{\text{perm}} \) shall be defined from the static stability curve depending on the maximum permissible angle of heel \( \theta'_{\text{perm}} \) (see 3.1.8) as a result of plotings shown on Fig. 3.1.9, where the point of origin is notionally carried to point \( \theta' \) on curve \( l \) corresponding to the static angle of heel due to crowding of passengers at one side \( \theta' \), arising due to action of static moment \( M_p \) calculated according to 3.1.3.

Moment \( M'_{\text{perm}} \) (or the arm of the permissible moment \( \theta'_{\text{perm}} \)) shall be determined from equality of the areas \( S_1 \) and \( S_2 \).

When assessing stability in the evolution period of turn, the effect of free surfaces of liquid cargoes shall be considered in accordance with 1.4.2.

3.1.10 Stability of passenger ships with the centre of windage located 2 m above the ac-
Additional Stability Requirements for Various Ship Types 239

... shall be sufficient at crowding of passengers at one side in case of static effect of wind, i.e. the following condition shall be met:

\[
\left( M_p + M_w \right) < M_{\text{perm}} ,
\]

where \( M_p \) — heeling moment due to passenger crowding at one side, kN·m, determined according to the instructions in 3.1.3;

\( M_w \) — heeling moment due to static effect of wind, kN·m, see 3.1.11;

\( M_{\text{perm}} \) — maximum permissible moment at static inclinations of a ship, kN·m, defined from the static stability curve depending on the value of angle \( \theta_{\text{perm}} \) (see 3.1.4), the value of angle \( \theta_{\text{perm}} \) being not limited by 10° or 12°.

3.1.11 The heeling moment due to static effect of wind, kN·m, is

\[
M_w = 0.001 p_s S \left( z_w - a_3 T \right) ,
\]

where \( p_s \) — assumed design static wind pressure, Pa, which shall be taken equal to 0.47 of the respective dynamic pressure from Table 2.2.2 depending on the ship class and the height of the windage center above the actual waterline plane;

\( S \) — windage area, m², see 2.2.3 and 2.2.4;

\( z_w \) — height of the centre of gravity above the base plane when the ship is the upright position, m;

\( a_3 \) — coefficient, see Table 3.1.7;

\( T \) — average draught of the ship at actual waterline, m.

3.1.12 Stability of crew boats, special purpose ships and non-passenger ships carrying organized groups of people shall comply with the requirements for stability of passenger ships with due regard to crowding of all people being on the ship (other than the crew members) at one side.

3.1.13 Carriage of people, towing (on a tow line or alongside towing) and industrial operations shall not be performed simultaneously. This fact shall be indicated in the Information on Stability and Floodability.

3.2 CARGO SHIPS

3.2.1 Stability of dry cargo ships shall be assessed by the main criterion specified in 2.1.1 at load according to 1.3.1, 1.3.3, 1.3.5, 1.3.6 and 1.3.8.

Cargo stowage shall correspond to normal conditions of ship’s service.

Stability of the tankers shall be checked at loading conditions according to 1.3.1, 1.3.4, 1.3.8 and, additionally, with 50 % filling of the tanks with full and 10 % stores. Stability of the refueling ships shall be checked at 25 %, 50 % and 75 % filling of the tanks with full and 10 % stores.

3.2.2 For all cargo ships with windage centre of 2 m above the actual waterline, stability at static wind effect shall be checked, i.e. the following condition shall be met:

\[
M_w < M_{\text{perm}} ,
\]

where \( M_w \) — heeling moment due to static effect of wind, kN·m, see 3.1.11;

\( M_{\text{perm}} \) — maximum permissible moment at static inclinations of a ship, kN·m, defined from the static stability curve depending on value of angle \( \theta_{\text{perm}} \) (see 3.2.3).

3.2.3 The maximum permissible angle of heel \( \theta_{\text{perm}} \) shall be taken equal to either 0.80\( \theta_{\text{down}} \) or deck edge entrance angle, whichever is less.

3.2.4 For all cargo ships with specific power capacity, i.e. \( P_e \), kW per unit of displacement \( V \), m³ such that \( P_e / V \geq 0.735 \), stability in the evolution period of turn shall be checked, i.e. the following condition shall be met:

\[
M_c < M_{\text{perm}} ,
\]

where \( M_c \) — dynamical heeling moment, kN·m, applied to a ship in the evolution period of turn, see 3.1.6;

\( M_{\text{perm}} \) — maximum permissible moment, kN·m, determined according to the statical or dynamical stability curves depending on the angle \( \theta'_{\text{perm}} \) (see 3.2.5).

3.2.5 The maximum permissible angle \( \theta'_{\text{perm}} \) shall be taken equal to deck entrance angle or entrance angle of waterline laying...
75 mm below the edges of free-flooding openings, whichever is less.

3.2.6 Stability of the ships of M-CPI class carrying bulk cargoes shall comply with the following requirements:

1. the calculated acceleration due to rolling (in fractions of $g$) $a_{cal}$ shall not exceed 0.3, i.e. the acceleration criterion

$$K^* = 0.3/a_{cal} \geq 1,$$

where $a_{cal} = 1.1 \times 10^{-3} \cdot B m_1 \theta_m$;

$B$ — ship’s breadth at the actual waterline;

$m_1$ — coefficient determined according to 2.4.3;

$\theta_m$ — roll amplitude determined according to 2.4.8 and 2.4.9;

2. when $K^* < 1$, permissible wave height of 3% probability of overtopping is taken from Table 3.2.6.

Table 3.2.6

<table>
<thead>
<tr>
<th>$K^*$</th>
<th>1.0 and more</th>
<th>1.0 to 0.5</th>
<th>0.5 and less</th>
</tr>
</thead>
<tbody>
<tr>
<td>$h_3$</td>
<td>M-CPI 3.5</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>$h_3$</td>
<td>M-CPI 4.5</td>
<td>4.5</td>
<td>4.0</td>
</tr>
</tbody>
</table>

3.2.7 The following additional requirements to stability of the ships of M-CPI class carrying timber cargoes on the deck shall be met:

1. Metacentric height with due regard to free surfaces shall be at least 0.20 m;

2. The maximal righting arm of the static stability curve shall be at least 0.25 m.

3.2.8 The following additional requirements to stability of the ships of M-CPI class carrying containers on the deck shall be met:

1. Metacentric height with due regard to free surfaces shall be at least 0.20 m;

2. The angle of heel on steady turning or under the effect of continuous beam wind as obtained from the stability curve shall not exceed half the angle, at which the freeboard deck immerses; in any case, the angle of heel shall not exceed 15°. Here, the heeling moment on steady turning shall be determined according to 3.1.7, and the heeling moment due to the static wind pressure shall be determined according to 3.1.11.

Where the containers are located only on cargo hatch covers, the angle, at which the hatch coaming edge is immersed, may be adopted instead of the angle, at which the upper deck edge is immersed.

3.2.9 The following additional requirements to the ships of M-IP and M-CPI classes carrying bulk grain shall be met:

1. The angle of heel due to the shift of grain shall not be greater than 12° or the angle, at which the upper deck edge is immersed, whichever is less;

2. In the statical stability diagram (see Fig. 3.2.9.2) the net of residual area between the heeling arm curve and the righting arm curve up to 40° angle of heel (which corresponds to the maximum difference between the ordinates of the two curves), or the angle of downflooding, whichever is the least, shall in all conditions of loading be not less than 0.075 m·rad;

3.2.10 For loading bulk grain, the following requirements shall be met:

1. All necessary trimming shall be performed to level all free grain surfaces and to
Additional Stability Requirements for Various Ship Types

minimize the effect of grain shifting; trimming means grain levelling in cargo holds and/or filling underdeck spaces in order to prevent uncontrolled shift of grain during transportation;

.2 In any filled compartment, trimmed, the bulk grain shall be trimmed so as to fill all spaces under the decks and hatch covers to the maximum extent possible;

.3 In any filled compartment, untrimmed, the bulk grain shall be filled to the maximum extent in way of the hatch opening but may be at its natural angle of repose outside the periphery of the hatch opening.

A filled compartment may comply with this category, if the compartment is considered specially suitable and the requirements to trimming are not applied because the underdeck void space shape resulting from free flowing grain into a compartment is taken into account when calculating the void space depth.

Specially suitable compartment refers to a cargo space, which is constructed with at least two vertical or sloping, longitudinal, grain-tight divisions which are coincident with the hatch side girders or are so positioned as to limit the effect of any transverse shift of grain. If sloping, the divisions shall have an inclination of not less than 30° to the horizontal;

.4 After loading, all free grain surfaces in partly filled compartments shall be leveled;

.5 Unless the account is taken of the adverse heeling effect due to the grain shift according to Appendix 3, free surface of the bulk grain in any partly filled compartment shall be secured by means of special arrangements as to prevent a grain shift;

.6 In filled compartments, trimmed, filled compartments, untrimmed, and partly filled compartments, longitudinal divisions may be installed as a mean to reduce the adverse heeling effect of grain shift provided that:

the division is grain-tight;

the division possesses adequate strength when being affected by pouring grain.

3.2.11 When meeting the requirements in 3.2.9 to 3.2.10, the River Register issues a Certificate of Fitness for Grain Carriage in Bulk.

The Certificate may be issued also if the Addendum to the Information on Stability and Floodbaility is available onboard the ship and includes:

.1 plans of grain stowage;

.2 curves or tables to determine the volume occupied by grain, vertical centre of gravity (height of centre of gravity), and assumed volumetric heeling moments. Such data shall be available for every compartment taking into account the influence of temporary appliances (shifters, shifting boards etc.) used for grain carriage;

.3 tables or curves of maximum permissible heeling moments for varying displacements and varying vertical centre of gravity to allow the master to demonstrate the compliance with the requirements of 3.2.9;

.4 brief loading instructions generalizing the requirements in 3.2.10;

.5 a specific example of calculations.

Note: It is recommended that loading conditions are provided for three representative stowage coefficients, e.g. 1.25, 1.50 and 1.75 m³/t.

3.3 TUGBOATS

3.3.1 Stability of tugboats shall be assessed by the main criterion given in 2.1 and by additional requirements in 3.3.2 to 3.3.11, 3.3.14 for the loading conditions specified in 1.3.1 and 1.3.8.

Note: Stability of the ships of other types fitted with towing arrangement shall be checked for all loading conditions according to 3.3.2 to 3.3.11.

3.3.2 Stability of all the tugboats shall be sufficient at static effect of the tow line, i.e. the following condition shall be met:

\[ M_s < M_{perm}' \]  

(3.3.2)

where \( M_s \) — heeling moment due to effect of statically strained tow line, kN·m, see 3.3.3;

\( M_{perm}' \) — maximum permissible moment at static inclinations of the ship, kN·m, see 3.3.6.

3.3.3 The heeling moment \( M_s \), kN·m, is calculated by the formula:
\[
M_s = F \left[ (z_h / B + f_1) f_2 f_3 + 0.65 h_0' / B \right],
\]

(3.3.3)

where \( F \) — coefficient taken equal to 1.12 \( P_e \) but not less than 0.17 \( V \);

\( z_h \) — vertical distance between a point of application of the tow line force and the base plane, m;

\( B \) — ship's breadth at actual waterline, m;

\( f_1, f_2, f_3 \) — coefficients, see. 3.3.4;

\( h_0' \) — small metacentric height calculated considering the correction to the influence of the liquid cargo's free surfaces (see 1.4.2), m.

Note: If a frame stop of a tow line is fitted, a distance \( z_h \), m, shall be taken equal to the greatest of the following values: elevation of a hook suspension point or elevation of a bottom edge of the frame stop.

3.3.4 Coefficients \( f_1 \) and \( f_2 \) shall be taken from Table 3.3.4 depending on the ratio of the ship breadth \( B \) to the draught \( T \) or by the following formulae, valid for the range of \( 2.25 < B/T < 8.0 \):

\[
f_1 = -0.0209 \left( B/T \right)^3 + 0.3767 \frac{B}{T} + 1.18;
\]

(3.3.4-1)

\[
f_1 = 0.0058 \left( B/T \right)^3 - 0.0904 \left( B/T \right)^2 + 0.3512 B/T + 0.3216.
\]

(3.3.4-2)

Table 3.3.4

<table>
<thead>
<tr>
<th>( B/T )</th>
<th>( f_1 )</th>
<th>( f_2 )</th>
<th>( B/T )</th>
<th>( f_1 )</th>
<th>( f_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \leq 2.25 )</td>
<td>-0.44</td>
<td>0.72</td>
<td>5.00</td>
<td>0.18</td>
<td>0.53</td>
</tr>
<tr>
<td>2.50</td>
<td>-0.37</td>
<td>0.72</td>
<td>5.50</td>
<td>0.26</td>
<td>0.47</td>
</tr>
<tr>
<td>2.75</td>
<td>-0.30</td>
<td>0.72</td>
<td>6.00</td>
<td>0.32</td>
<td>0.42</td>
</tr>
<tr>
<td>3.00</td>
<td>-0.24</td>
<td>0.72</td>
<td>6.50</td>
<td>0.38</td>
<td>0.38</td>
</tr>
<tr>
<td>3.50</td>
<td>-0.12</td>
<td>0.71</td>
<td>7.00</td>
<td>0.43</td>
<td>0.35</td>
</tr>
<tr>
<td>4.00</td>
<td>0.00</td>
<td>0.65</td>
<td>( \geq 8.00 )</td>
<td>0.50</td>
<td>0.30</td>
</tr>
<tr>
<td>4.50</td>
<td>0.10</td>
<td>0.60</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The value of \( f_2 \) shall be taken equal to 1, when the distance between the point of applying the tow line force and the center of gravity, m, measured over a horizontal \( x''_h \leq 0.3L \); when \( x''_h > 0.3L \), then \( f_2 \) shall be taken equal to 0.85.

Note: If a frame stop of tow line is fitted, a value of \( x''_h \), m, shall be taken equal to a distance between the frame stop and the ship's centre of gravity.

3.3.5 Maximum permissible angle \( \theta'_{\text{perm}} \) shall be taken equal to 0.8 \( \theta_{\text{dnnl}} \) or deck edge entrance angle, whichever is less.

3.3.6 The maximum permissible moment \( M'_{\text{perm}} \) is determined by the formula, kN-m:

\[
M'_{\text{perm}} = Dl_{\text{perm}},
\]

(3.3.6)

where \( D \) — weight of the ship corresponding to the draught up to actual waterline, kN;

\( l_{\text{perm}} \) — heeling arm of the maximum permissible moment taken from the static stability curve at an angle of heel \( \theta'_{\text{perm}} \) (see 3.3.5), in m.

3.3.7 Stability of tugboats at \( z_h > 1.2z_g \) (\( z_g \) is the height of the ship’s centre of gravity above the base plane, m) shall be checked at tow line jerk, i.e. the following condition shall be met:

\[
M_p < M'_{\text{perm}},
\]

(3.3.7)

where \( M_p \) — heeling moment, kN-m, due to jerk effect of strained tow line, see 3.3.8;

\( M'_{\text{perm}} \) — maximum permissible moment, kN-m, characterizing the dynamical stability of a ship, see 3.3.10.

3.3.8 The heeling moment \( M_p \), kN-m, shall be calculated by the formula

\[
M_p = 1.85 w D \left( k_1 k_2 \right)^2,
\]

(3.3.8-1)

where \( w \) — coefficient depending on the ship's rated power \( P_e \), in kW, and adopted from Table 3.3.8-1 or calculated by the formula for the range of \( 400 < P_e < 1450 \):

\[
w = 1.31 \cdot 10^{-7} P_e^2 - 4.73 \cdot 10^{-5} P_e + 0.165;
\]

(3.3.8-2)

Table 3.3.8-1

<table>
<thead>
<tr>
<th>( P_e ), kW</th>
<th>( w )</th>
<th>( P_e ), kW</th>
<th>( w )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \leq 400 )</td>
<td>0.168</td>
<td>1200</td>
<td>0.298</td>
</tr>
<tr>
<td>600</td>
<td>0.181</td>
<td></td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>0.210</td>
<td>1400</td>
<td>0.354</td>
</tr>
<tr>
<td>1000</td>
<td>0.249</td>
<td>( \geq 1450 )</td>
<td>0.371</td>
</tr>
</tbody>
</table>

\( D \) — weight of the ship corresponding to the draught up to actual waterline, kN;

\( k_1, k_2 \) — coefficients considering the effect of inertial and damping features of the ship to
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the heeling moment and calculated by the formulae:

\[ k_1 = \sqrt{q_2 \left( \frac{z_{\text{cargo}}}{B} - 1.2 \frac{z_g}{B} \right)} \left[ 0.8 + \left( \frac{x'_{\text{cargo}}}{L} \right)^2 q_1 + \left( \frac{z_h}{B} - 1.2 \frac{z_g}{B} \right)^2 q_2 \right], \]  

\[ k_2 = 1 + q_3 \left[ \left( \frac{z_h}{B} - 1.2 \frac{z_g}{B} \right) \right], \]  

(3.3.8-3)

(3.3.8-4)

where \( q_2 \) — value adopted from Table 3.3.8-2 depending on the \( B/T \) and \( z_g/B \) ratios or calculated by the formulae depending on the \( B/T \) ratio:

\[ \frac{B}{T} \leq 2.5 \quad q_2 = -11.7 \frac{z_g}{B} + 10.325 \]  

(3.3.8-5)

\[ 2.5 < \frac{B}{T} < 8.0 \quad q_2 = -13 \frac{z_g}{B} + 0.56 \frac{B}{T} + 11.56 \]  

(3.3.8-6)

\[ \frac{B}{T} \geq 8.0 \quad q_2 = -9 \frac{z_g}{B} + 7.325 \]  

(3.3.8-7)

\[ \text{Table 3.3.8-2} \]

| Parameter \( q_2 \) | Value \( q_2 \) at \( z_g/B \) |
|---------------------|-----------------|-----------------|-----------------|-----------------|
| \( B/T \)           | 0.30            | 0.35            | 0.40            | 0.45            |
| \( \leq 2.25 \)      | 6.85            | 6.20            | 5.60            | 5.10            |
| 2.5                 | 6.65            | 6.10            | 5.50            | 5.00            |
| 2.75                | 6.55            | 6.00            | 5.40            | 4.90            |
| 3.00                | 6.45            | 5.90            | 5.30            | 4.80            |
| 3.50                | 6.25            | 5.70            | 5.15            | 4.65            |
| 4.00                | 6.05            | 5.50            | 5.00            | 4.50            |
| 4.50                | 5.85            | 5.30            | 4.80            | 4.35            |
| 5.00                | 5.65            | 5.10            | 4.65            | 4.20            |
| 5.50                | 5.45            | 4.95            | 4.50            | 4.05            |
| 6.00                | 5.25            | 4.80            | 4.35            | 3.85            |
| 6.50                | 5.10            | 4.65            | 4.20            | 3.65            |
| 7.00                | 4.90            | 4.50            | 4.05            | 3.45            |
| \( \geq 8.00 \)     | 4.60            | 4.20            | 3.75            | 3.25            |

\( q_1, q_3 \) — coefficients adopted from Table 3.3.8-3 depending on the \( B/T \) ratio,

\[ \text{Table 3.3.8-3} \]

<table>
<thead>
<tr>
<th>Coefficients ( q_1 ) and ( q_3 )</th>
<th>( B/T )</th>
<th>( q_1 )</th>
<th>( q_2 )</th>
<th>( q_3 )</th>
<th>( q_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \leq 2.25 )</td>
<td>15.3</td>
<td>0</td>
<td>5.00</td>
<td>17.2</td>
<td>0.157</td>
</tr>
<tr>
<td>2.5</td>
<td>15.6</td>
<td>0</td>
<td>5.50</td>
<td>17.4</td>
<td>0.208</td>
</tr>
<tr>
<td>2.75</td>
<td>15.9</td>
<td>0.010</td>
<td>6.00</td>
<td>17.5</td>
<td>0.270</td>
</tr>
<tr>
<td>3.00</td>
<td>16.1</td>
<td>0.020</td>
<td>6.50</td>
<td>17.6</td>
<td>0.337</td>
</tr>
<tr>
<td>3.50</td>
<td>16.5</td>
<td>0.045</td>
<td>7.00</td>
<td>17.7</td>
<td>0.407</td>
</tr>
<tr>
<td>4.00</td>
<td>16.8</td>
<td>0.077</td>
<td>( \geq 8.00 )</td>
<td>18.00</td>
<td>0.550</td>
</tr>
<tr>
<td>4.50</td>
<td>17.0</td>
<td>0.115</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ x'_{\text{cargo}}/L \] — ratio, see 3.3.4.

3.3.9 Maximum permissible angle of heel \( \theta_{\text{perm}} \) shall be taken equal to the angle of capsize \( \theta_{\text{caps}} \) or the angle of downflooding \( \theta_{\text{dnfl}} \), whichever is less.

3.3.10 Maximum permissible moment, kN-m,

\[ M_{\text{perm}} = DI_{\text{perm}}, \]  

(3.3.10)

where \( D \) — weight of the ship corresponding to the draught up to actual waterline, kN;

\( I_{\text{perm}} \) — permissible moment arm determined by the dynamic stability curve according to the requirements in 2.3.4 or 2.3.5 at an angle of heel \( \theta_{\text{perm}} \) (cm. 3.3.9), m.

3.3.11 Stability of tugboats during the turning circle shall be checked according to the requirements in 3.2.4.

3.3.12 The Information on Stability and Floodability shall contain data on the flow speed \( v_{\text{flow}} \), above which the manoeuvring of the ship near a still barge without release of the tow line is assumed to be dangerous. A flow speed is calculated by the formula, km/h:

\[ v_{\text{flow}} = 4.8 \sqrt{M_{\text{perm}}/M_s}. \]  

(3.3.12)

The moments \( M_{\text{perm}} \) and \( M_s \) shall be calculated according to requirements given in 3.3.3 to 3.3.6.

3.3.13 Stability of tugboats of high power (over 6.6 kW/m³) shall be checked during trials of the lead ship of the series.

3.3.14 In addition to 3.3.7, stability at dynamic effect of the tow line considering the roll effect, shall be checked for the tugboats of O-P, M-P, M-PP and M-CT classes, if the heeling moment due to dynamic effect of the strained tow line, \( M_r \), determined according to 3.3.8 exceeds the heeling moment due to the dynamic wind pressure \( M_h \), i.e. the following condition shall be met:

\[ M_r < M_{\text{perm}} \]  

(3.3.14)

where \( M_h \) — heeling moment, kN-m, due to the dynamic effect of the strained tow line, determined according to the instructions in 3.3.8.

\( M_{\text{perm}} \) — maximum permissible moment at a dynamic inclination, kN-m, determined
according to 2.3.4 at design roll amplitude, deg, taken according to 2.4.1 to 2.4.7 for the tugboats of O-ПП and М-ПП classes and according to 2.4.8 and 2.4.9 for the tugboats of М-СП class.

To calculate \( M_{\text{perm}} \), the permissible heel angle shall be calculated in the same way as for stability assessment by the main criterion.

### 3.4 FISHING VESSELS

#### 3.4.1
For all the loading conditions, stability during the ship turning circle shall be also checked according to the requirements in 3.2.4.

#### 3.4.2
Where cells formed by filling boards, which prevent transverse and longitudinal shifting of fish, are not available, fish shall be considered as liquid cargo in stability calculations.

### 3.5 FLOATING CRANES, INDUSTRIAL SHIPS, LOADERS

#### 3.5.1
Stability of floating cranes shall be checked in the most unfavourable working condition with 10 % of water and fuel stores under the effect of dynamical wind pressure, i.e. the following condition shall be met:

\[
M_{\text{heel}} < M'_{\text{perm}},
\]

where \( M_{\text{heel}} \) — heeling moment due to dynamical wind pressure effect (see 3.5.2), kN·m;

\( M'_{\text{perm}} \) — maximum permissible moment, kN·m, determined with due regard of the initial heel due to a load on the hook according to 3.5.4.

**Note**: Floating full-turned cranes, in addition to the aforementioned requirement, shall have an angle of static heel at all possible boom lengths not exceeding 3°30’.

#### 3.5.2
The heeling moment due to the dynamic wind pressure when assessing stability of floating cranes in maximum loaded operating condition with a load on the hook shall be determined according to 2.2. The design wind pressure \( p \) for cranes of all classes shall be taken equal to 400 Pa regardless of the height of windage centre above the plane of actual waterline.

A design windage area of a crane with continuous walls shall be taken an area restricted by the crane contour, and for lattice structures — the same area with deduction of spans between the rods.

A design windage area of cranes consisting of several beams (continuous or lattice ones) of the same height located one after another shall be taken as (Fig. 3.5.2):

\[
\begin{align*}
S_{\text{all}} &= S + S_1 + S_2 + S_3 & a > h, \\
S_{\text{all}} &= S + 0.5(S_1 + S_2 + S_3) & h < a < 2h, \\
S_{\text{all}} &= S & a > h,
\end{align*}
\]

Fig. 3.5.2. Determination of the design windage area;

1. an area of the front girder, if a distance between the girders is less than the front beam height;
2. the total front girder area and 50 % of area of each girder, if a distance between the girders is equal to or exceeds the girder eight but less than double girder height;
3. the total girder area, if a distance between the girders is equal to or exceeds its double height.

Area of rear girders not covered by the front girder shall be entirely included to the windage area.

**Note**: Stability of floating cranes with turning boom shall be checked at the position of the boom turned to a side in the frame plane. Herewith, an effect of heeling moment due to gust wind effect shall be taken in the same direction as the heeling moment due to the turned boom and a load on hook.

#### 3.5.3
Maximum permissible angle of heel \( \theta'_{\text{perm}} \) shall be taken equal to one of the following angles, whichever is less, but not more than 6°:

- 1. deck entrance angle
- 2. angle determined at a waterline laying 75 mm bellow the edges of free-flooding openings maximum angle, at which operation of crane equipment is allowed.
3.5.4 When assessing stability of the floating cranes under the dynamic wind pressure at initial static heel due to the turned boom with a load on the hook, the maximum permissible moment is calculated by the formula, kN·m

\[ M_{\text{perm}}' = 0.0087 D \theta'_0 \left( \theta_{\text{perm}}' - \theta'_{\text{cargo}} \right), \]  

(3.5.4)

where \( D \) — weight of the ship corresponding to the draught up to actual waterline, kN;

\( \theta'_0 \) — metacentric height, m, calculated with due regard to correction for the effect of free surfaces of liquid cargoes according to 1.4.2;

\( \theta_{\text{perm}}' \) — maximum permissible angle of heel, deg., see 3.5.3;

\( \theta'_{\text{cargo}} \) — angle of heel due to turned boom with a load on hook, deg.

3.5.5 Design position of the center of gravity of the lifted load shall be taken in its suspension point to the boom.

3.5.6 Stability of the industrial ships (dredges, multi-bucket dredges, hydrographic and buoy vessels, anchor boats) by the main criterion (see 2.1) shall be checked for the following loading conditions:

.1 with full stores and fuel;
.2 with 10% of stores and fuel.

3.5.7 Stability of the loaders in working condition is checked with regard to the dynamic wind pressure, i.e. the following condition shall be met:

\[ M_{\text{heel}} < M_{\text{perm}}', \]  

(3.5.7)

where \( M_{\text{heel}} \) — heeling moment due to dynamic wind pressure, kN·m, determined according to 2.2, here the design wind pressure shall be taken equal to 400 Pa regardless of the ship’s class and the height of windage centre above the plane of actual waterline

\( M_{\text{perm}}' \) — maximum permissible moment, kN·m, determined with due regard to initial inclination \( \theta'_{\text{heel}} \) due to unsymmetrical loading in conveyers and cargo pipes by the formula (3.5.4), in which an angle \( \theta'_{\text{heel}} \) shall be taken instead of angle \( \theta'_{\text{cargo}} \).

3.6 HYDROFOIL CRAFT

3.6.1 This Chapter applies to hydrofoil craft of O-IIIP, O, P and J1 classes.

3.6.2 The requirements specified in 3.1.7, 3.1.10 and 3.1.11 do not apply to hydrofoil craft.

The other requirements of this Part of the Rules apply to hydrofoil craft when in displacement mode.

3.6.3 Stability shall be checked in loading conditions specified in 3.1.1 for the following modes:

.1 displacement mode;
.2 transition mode;
.3 operational mode.

Stability in displacement mode shall be checked by calculation method, and in transitional and operational modes – by model tests. Stability characteristics shall be finely adjusted: for the displacement mode, from the lead ship inclination test results, for the transitional and operational modes, from experimental investigations carried out during commissioning trials of the lead ship.

The test program, the test report, as well the Information on Stability and Floodability made up on the basis of calculations and experiments shall be submitted to the River Register for consideration.

3.6.4 Stability in the displacement mode shall be such that inclination of a ship from a horizontal does not exceed 8° in case of possible uncontrolled movements of passengers (i.e., where all free spaces accessible for passengers have been occupied) and angle of heel resulting from simultaneous effect of heeling moments due to crowding of passengers on one side and due to turn does not exceed 15°.

The heeling moment due to turning, kN·m, is calculated by the formula:

\[ M_w = 0.23 z_g D^2 \bar{D} / L, \]  

(3.6.4)

where \( z_g \) — height of the centre of gravity above the base line, m;
3.6.5 In transitional mode heel of a ship when moving at straight course in loading condition as in 1.3.2.2 and crowding of passengers on one side shall not exceed 15°.

3.6.6 In operational mode in loading condition as in 1.3.2.2, angle of heel when turning toward the heel due to passenger crowding at one side shall not exceed 10°.

3.7 HOVERCRAFT

General requirements

3.7.1 This Chapter applies to all hovercraft of O, P and J classes.

Requirements specified in 2.2.1, 2.2.5, 2.2.6, 2.3.4, 2.3.5, 2.4, 3.1.2, 3.1.5 to 3.1.7, 3.1.9 to 3.1.11, 3.1.13, 3.2.2, 3.2.4, 3.3 to 3.5 are not applicable for stability checking of hovercraft in air cushion mode.

3.7.2 Stability of hovercraft shall be substantiated by design-experiment way using the methods developed by the designer and approved by the River Register.

3.7.3 Experimental studies may be performed not in full or may be omitted, when, together with submitting the calculations to the River Register, the test results of the similar prototype ship prove the compliance with the requirements to stability properties which shall be determined experimentally.

3.7.4 Stability of hovercraft shall be checked for all the loading conditions specified in 1.3.1 for two modes:

1. navigation in displacement mode;

2. air cushion mode.

Stability characteristics shall be finely adjusted for displacement mode on the basis of inclination test, as well as speed and manoeuvring trials of the given hovercraft or the lead ship, and for air cushion mode – on the basis of experimental investigations under the most unfavourable operational conditions held during the commissioning trials of the hovercraft.

Note: Experimental stability testing of full-scale ships may be conducted for the most unfavourable loading condition only; this loading condition shall be determined according to the results of calculations or model tests. If the most unfavourable condition is minimum loading of the ship, the least heeling weights shall be used to induce the corresponding heeling moment.

3.7.5 Values of maximum permissible angles of heel shall be refined from experimental dependences of angle of heel vs. heeling moment, ship speed, and rudder angle.

Basic requirements for stability of skeg hovercraft

3.7.6 Heeling moment due to gust wind effect in air cushion mode, kN·m, is calculated by the formula:

\[ M_{heel} = 0.001kpS(z_w - 0.5T), \]  

(3.7.6)

where

\[ k \] — coefficient, see 3.7.7;

\[ p \] — assumed design dynamic wind pressure, Pa, determined according to 2.2.2;

\[ S \] — windage area of the ship at the draught corresponding to actual waterline, m², determined according to 2.2.3 and 2.2.4;

\[ z_w \] — height of the windage centre above the base plane of the ship at the level of lower skeg edges, m;

\[ T \] — average draught corresponding to actual waterline in air cushion mode, m.

3.7.7 Coefficient \( k \) considering the effect of the ship’s speed in air cushion mode on aerodynamic force is calculated by the formula:

\[ k = 1 + 0.711\sqrt{v}, \]  

(3.7.7)

where \( v \) — ship’s full speed, m/s.

3.7.8 Heeling moment due to gust wind effect in displacement mode shall be determined in accordance with 2.2; coefficient \( a_1 \) (formula (2.2.6-1)) shall be taken equal to unit regardless of the ratio \( B/T \).

3.7.9 Maximum permissible moment \( M_{perm} \) for ships of all classes regardless of values of \( M_{heel} \) shall be determined for air cushion mode according to the dynamic or static stability
Additional Stability Requirements for Various Ship Types

3.7.10 Maximum permissible moment \( M_{\text{perm}} \) for the ships of O-PIP and O classes shall be determined by means of plotting carried out considering roll, the design amplitude of which in air cushion and displacement modes shall be determined by model and full-scale tests.

**Note:** For stability calculations by the main criterion, the stability curve drawn up for air cushion hovering at-rest mode may be used.

3.7.11 Stability of passenger and cargo-and-passenger ships by the main criterion specified in 3.7.6 to 3.7.10 shall be checked for the loading conditions specified in 3.1.1.

3.7.12 Stability of passenger ships shall be sufficient when passengers are crowding at one side in all speed range in both air cushion and displacement modes. In air cushion mode, the following condition shall be met:

\[
\theta_p < \theta_{\text{perm}}, \quad (3.7.12)
\]

where \( \theta_p \) — angle of heel due to crowding of passengers on one side, deg., according to 3.1.3;

\( \theta_{\text{perm}} \) — maximum permissible angle of heel taken according to 3.1.4.

Angle of heel at the corresponding heeling moment and speed shall be taken equal to maximum angle of heel with due regard to experimental dependence of angle of heel upon the ship’s speed and the heeling moment (see 7.1 of Appendix 4).

For displacement mode stability of a hovercraft shall be checked according to 3.1.2 – 3.1.6.

3.7.13 Stability of passenger ships due to crowding of passengers at one side shall be sufficient at the maximum dynamic heel arising in the evolution period of turn in air cushion and displacement modes, i.e. the following condition shall be met:

\[
\theta_c < \theta_{\text{perm}}, \quad (3.7.13)
\]

where \( \theta_c \) — maximum angle of heel, deg., arising during the ship turning circle at passenger crowding at one side and determined experimentally (see 7.2 of Appendix 4)

\( \theta_{\text{perm}} \) — maximum permissible angle of heel, deg., taken according to 3.1.8.

3.7.14 Stability of passenger ships with a centre of windage located over 2 m above an actual waterline plane shall be sufficient at crowding of passengers on one side in case of static wind effect.

For air cushion mode, the following condition shall be met:

\[
\theta_{\text{wp}} < \theta_{\text{perm}} \quad (3.7.14)
\]

where \( \theta_{\text{wp}} \) — angle of heel (see 3.7.12) due to passenger crowding at the heeling moment (3.1.3) with simultaneous static wind pressure (see 3.7.15);

\( \theta_{\text{perm}} \) — maximum permissible angle of heel, determined according to 3.1.4, which is not limited here by 10° or 12°.

For displacement mode, stability shall be checked according to 3.1.10; coefficient \( a_3 \) necessary for determining the heeling moment \( M_w \) (see 3.1.11) shall be taken equal to zero regardless of the B/T ratio.

3.7.15 Heeling moment due to static wind effect in air cushion mode, kN·m:

\[
M_w = 0.001k\rho_pS_w(z_w - 0.5T), \quad (3.7.15)
\]

where \( k \) — coefficient determined according to 3.7.7 with replacing dynamic wind pressure \( \rho \) by static wind pressure \( \rho_p \) equal to 0.47 \( \rho \)

\( \rho_p \) — assumed design static wind pressure, Pa, which shall be taken equal to 0.47 of gust wind pressure adopted from Table 2.2.2 depending on the ship’s class and the height of the windage center above the actual waterline plane

3.7.16 Stability of cargo ships shall be checked by the main criterion according to 3.7.6 to 3.7.10 considering the requirements in 3.2.1.

3.7.17 For all cargo ships with centre of windage located over 2 m above the plane of actual waterline, stability shall be checked at static wind effect.
When a ship is moving on air cushion, the following condition shall be met:

\[ \theta_w < \theta_{perm}, \]  

(3.7.17)

where \( \theta_w \) — angle of heel due to static wind effect, deg., at heeling moment \( M_w \) calculated by the formula (3.7.15)

\[ \theta_{perm} \] — maximum permissible angle of heel, deg., see 3.2.3

For displacement mode, stability shall be checked according to 3.2.2 considering 3.7.14.

3.7.18 For all cargo ships in air cushion and displacement modes, stability shall be checked in the evolution period of turn, i.e. the following condition shall be met:

\[ \theta_{\text{turn}} < \theta_{\text{perm}}^{\text{\text{ turn}}}, \]  

(3.7.18)

where \( \theta_{\text{turn}} \) — maximum angle of heel, deg., arising in the evolution period of turn and obtained by experiment (see 7.2 of Appendix 4);

\[ \theta_{\text{perm}}^{\text{\text{ turn}}} \] — maximum permissible angle of heel, deg., see 3.2.5.

Additional requirements for stability of amphibian hovercraft

3.7.19 Stability in displacement mode shall be checked for all the loading conditions specified in 1.3.1 in the same way as for displacement ships considering the specifics of amphibian hovercraft.

3.7.20 Stability in air cushion mode shall be proved by results of experiments carried out during commissioning trials of the lead ship at the most unfavourable operating conditions according to the program developed by the designer and approved by the River Register.

3.8 HIGH SPEED DISPLACEMENT SHIPS

3.8.1 Stability of high speed displacement ships (with length-based Froude number \( \text{Fr}_L = \sqrt{gL} > 0.36 \)) shall be checked during the trials of the lead ship.

Stability shall be checked at turning in still water at consecutive stepped increase of the rudder angle including the hardover to a side contrary to crowding of passengers (for \( \backslash \) passenger ship), and at consecutive stepped increase of engine rpm up to the maximum one.

3.8.2 When trials of a passenger ship to ensure appropriate displacement, location of centre of gravity and initial angle of heel in case of crowding passengers on one side, a specially taken and lashed solid ballast shall be used.

3.8.3 During the trials, the following shall be contained in the test report:

- displacement;
- forward and aft draught;
- engine rpm and respective ship speed;
- water depth;
- weather conditions;
- initial angles of heel;
- angles of heel for each trial mode;
- rudder angles;
- water level on the ship sides at heel.

3.8.4 Angles of heel obtained during the trials shall be compared with the respective permissible angles of heel as per additional requirements to various types of ships (see 3.1 to 3.4).

3.8.5 On the basis of trials, necessary restrictions shall be entered in the Information on Stability and Flooding with regard to engine rpm and rudder angles.

3.8.6 The test program, the test report, as well the Information on Stability and Flooding made up on the basis of calculations and experiments are subject to special consideration by the River Register.

3.9 CATAMARANS

General requirements

3.9.1 Requirements of the present Chapter apply to catamarans of the M, O, P and \( \backslash \) classes, for which permissible angle of heel does not exceed the angle of coextensive inclination, when a waterline plane touches a bilge of exposed hull in the midship section.

Requirements in 2.2.5, 2.2.6, 2.4, 3.1.7, 3.1.11 do not apply to catamarans. The rest
requirements apply to catamarans as far as they are applicable and do not contradict with requirements of the present Chapter.

**Basic stability requirements for catamarans**

3.9.2 Reduced heeling arm for catamarans due to the dynamic wind pressure applied to the ship is calculated by the formula:

\[ z = z_w - 0.5T, \]  
(3.9.2)

where \( z_w \) — height of the centre of windage above the base plane of ship, m;

\( T \) — average draught of catamaran at actual waterline, m.

3.9.3 Design roll amplitude, deg, for catamarans of the respective class shall be taken from Table 3.9.3 depending on \( q_B \) and \( V/2L \) (where \( B, L \) and \( V \) are breadth, length and volume displacement of the catamaran respectively). Coefficient \( q, \text{s}^{-2} \), shall be calculated by the formula:

\[ q = \left( \frac{z_m - z_g}{i} \right), \]  
(3.9.3-1)

where \( z_m \) — height of transverse metacentre, m;

\( z_g \) — height of centre of gravity above the baseline, m;

\( i \) — relative moment of inertia of a mass including added mass of liquid, m·s²;

\[ i = \frac{z_g^2}{g} \left[ 5.79 B_{\text{hull}}^2 \left( \frac{z_g}{z_g + 0.61} \right)^2 + 1 \right] / (3g), \]  
(3.9.3-2)

\( B_{\text{hull}} \) — breadth of catamaran hull, m, amidships at a level of the actual waterline;

\( g \) — acceleration of gravity, m/s².

3.9.4 Height of transverse metacentre of the catamaran is calculated by the formula, m:

\[ z_m = \alpha B_{\text{hull}} b \left( \frac{\alpha}{11.4 + (\tau + 0.5)^2} + \delta \left[ \frac{b^2 (\alpha + \beta)}{\beta} \right] \right) / \delta, \]  
(3.9.4)

where \( \alpha \) — actual waterplane coefficient for actual waterline of catamaran hulls;

\( b \) — ratio of the hull breadth \( B_{\text{hull}} \) and the draught \( T \);

\( \delta \) — block coefficient of catamaran hulls;

\( \tau = C / (2B_{\text{hull}}) \) — relative horizontal clearance of catamaran hulls;

\( C \) — distance between inner sides of hulls at a level of actual waterline amidships, m.

**Additional stability requirements**

3.9.5 Dynamical heeling moment, kN, applied to a passenger catamaran in the evolution period of turn is calculated by the formula:

\[ M_{\text{turn}} = 0.03 \sqrt{v_0} D \left( \frac{z_g - 0.5T}{L} \right), \]  
(3.9.5)

where \( v_0 \) — catamaran speed before entering the turning taken equal to full straight ahead speed, m/s;

\( D \) — catamaran weight at draught according to actual waterline, kN;

\( z_g \) — see 3.9.3

\( L \) and \( T \) — catamaran’s length and average draught at actual waterline, m, respectively.

### Table 3.9.3

<table>
<thead>
<tr>
<th>Ship class</th>
<th>( q_B, \text{m} \cdot \text{s}^{-2} )</th>
<th>Design roll amplitudes ( \theta_m ) at values of ( V/2L, \text{m}^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>\leq 10</td>
<td>16.0º</td>
<td>15.3º</td>
</tr>
<tr>
<td>20</td>
<td>15.7º</td>
<td>15.1º</td>
</tr>
<tr>
<td>30</td>
<td>18.0º</td>
<td>17.1º</td>
</tr>
<tr>
<td>40</td>
<td>20.0º</td>
<td>19.5º</td>
</tr>
<tr>
<td>\geq 50</td>
<td>22.0º</td>
<td>20.5º</td>
</tr>
<tr>
<td>O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>\leq 10</td>
<td>11.3º</td>
<td>9.3º</td>
</tr>
<tr>
<td>20</td>
<td>12.0º</td>
<td>10.5º</td>
</tr>
<tr>
<td>30</td>
<td>13.2º</td>
<td>11.9º</td>
</tr>
<tr>
<td>40</td>
<td>14.8º</td>
<td>13.9º</td>
</tr>
<tr>
<td>\geq 50</td>
<td>16.5º</td>
<td>15.5º</td>
</tr>
</tbody>
</table>
3.9.6 Heeling moment applied to passenger catamaran due to static wind effect, calculated by the formula, kN-m:

\[ M_w = 0.001 p_w S \left( z_w - 0.5T \right) \quad \text{(3.9.6)} \]

where \( p_w \) — assumed design static wind pressure, in Pa, which shall be taken equal to 0.47 of respective dynamic pressure according to Table 2.2.2 depending on the ship’s class and the height of the windage center above the actual waterline plane;

\( S \) — windage area calculated as per 2.2.3 and 2.2.4, \( m^2 \);

\( z_w \) — height of the centre of the windage area above the base plane when the ship is in upright position, m;

\( T \) — see 3.9.5.

3.9.7 When checking stability of a cargo catamaran by the formula (3.2.4), dynamic heeling moment \( M_t \) applied to the catamaran during the ship turning circle shall be calculated by the formula (3.9.5).

3.9.8 For catamaran tugboats, in formulae (3.3.3), (3.3.8-3), (3.3.8-4) and in Tables 3.3.4, 3.3.8-2 and 3.3.8-3, \( B \) shall be replaced by \( B_{\text{hull}} \), i.e. the total breadth of a catamaran tugboat at a design waterline, m.

3.9.9 When checking stability of catamaran tugboats, the heeling moment shall be calculated by formulae (3.3.3) and (3.3.8-1), and checked by the formula

\[ M_{\text{hull}} = 0.001 p_w S \left( z_w - 0.5T \right) + k \left( z_h - 0.5T \right) P_h \quad \text{(3.9.9)} \]

where \( p_w \) — assumed design dynamic wind pressure, Pa, taken according to the ship class as per Table 2.2.2;

\( S \) — windage area of the ship, \( m^2 \);

\( z_w \) — height of the centre of the windage area above the base plane, m;

\( T \) — average draught of the catamaran at actual waterline, m;

\( k \) — coefficient equal to 1.75 for catamarans of M class and 1.25 for catamarans of O, P and J classes;

\( z_h \) — height of the application point of pull force above the base plane of the ship, m;

\( P_h \) — pull force in the tow line, kN. If a value of the pull force is unknown, it shall be taken equal to 0.0163\( P_e \), \( P_e \) is rated output of main engines, kW.)
4 FLOODABILITY CRITERION

4.1 GENERAL REQUIREMENTS

4.1.1 Forepeak, afterpeak and engine room on all the ships shall be enclosed by watertight bulkheads.

4.1.2 For floodability calculations, the dimensions of the side and bottom damages shall be taken according to 4.1.3 to 4.1.6. A rectangular parallelepiped is assumed as a form of damage.

4.1.3 The dimensions of the hull side damages, except oil tankers and passenger ships of M-CPI class shall be taken as follows:

1. length of damage: 4 % of the ship’s length \( L \);
2. transverse extent measured from the inner surface of the outer plating at right angles to the centre plane: 0.075 \( B \) or 0.9 m whichever is less;
3. vertical extent: from the base line upwards without limit.

4.1.4 The following extent of side damage of oil tankers and passenger ships of M-CPI class shall be assumed:

1. length of damage: \( L^{2/3} / 3 \) for the oil tankers of M-CPI class and \( 3.0 + 0.03 \times L \) for the passenger ships of M-CPI class;
2. transverse extent measured from the inner surface of the outer plating at right angles to the centre plane at the level corresponding to summer freeboard, shall be \( B/5 \);
3. vertical extent: from the base line upwards without limit.

4.1.5 The following extent of bottom damage, except of oil tankers and passenger ships of M-CPI class, shall be assumed:

1. length of damage: 4 % of the ship’s length \( L \);
2. transverse extent: 0.1 \( B \);
3. vertical extent: 0.05 \( B \) or 0.8 m whichever is less.

4.1.6 The following extent of bottom damage of oil tankers and passenger ships of M-CPI class shall be assumed:

1. Longitudinal extent is \( L^{2/3} / 3 \) on the length equal to 0.3 \( L \) from the forward perpendicular and 5 m throughout the rest part of the bottom;
2. Transverse extent is \( B/6 \) or 5 m whichever is less;
3. Vertical extent is \( B/15 \) from the base line.

4.1.7 When ship’s damage of extent less than specified in 4.1.3 to 4.1.6 may worsen damage trim and/or damage stability, this variant of damage shall be considered when making checking calculations of floodability.

4.1.8 If the distance between two adjacent transverse watertight bulkheads is less than the dimensions of the damage specified in 4.1.3 to 4.1.6 or the transverse bulkhead of oil tanker of M-CPI class has a step of a length over 3.05 m within the area of assumed damage, then the respective compartment shall be added to any of the adjacent compartments at the option of the designer during the damage stability check.

Here, for all compartments of the hull the damage mid-length shall be assumed at the compartment mid-length. The forepeak and afterpeak shall be considered as separate compartments.

4.1.9 If there are any pipelines, channels or tunnels located within the area of assumed damage on the oil tanker of M-CPI class, their design shall prevent water from entering the compartments to be assumed to be non-flooded.

4.1.10 In checking calculations of floodability the design volume of flooded compartments shall be taken with due consideration of volume permeability coefficient of
each room of the compartment which shall be taken as equal to ships of all classes, except to passenger ships of M-CPI class:

- for double-side and double-bottom compartments, ballast tanks, empty non-refrigerated holds, free under-deck compartments of flush deck ships: 0.98
- for accommodation and passenger spaces, dry forepeak and afterpeak compartments, spaces occupied by empty vehicles: 0.95
- for empty refrigerated holds: 0.93
- for engine rooms of medium and large ships (L > 40 m): 0.85
- for engine rooms of small ships (L < 40 m): 0.80
- for spaces occupied by general cargoes, ship’s stores: 0.60
- for holds occupied by cargoes in bulk, including coal: 0.55
- for holds occupied by timber cargo: 0.35
- for holds occupied by flour or cement in bags: 0.25

4.1.11 Permeability coefficient of the tanks intended for liquid cargo transportation on oil tankers of M-CPI class shall be taken equal to:

- for the tanks intended for consumable liquids whichever results in more severe requirements: 0 or 0.95
- for the tanks intended for other liquids considering any possible liquid leakage from damaged tanks as well as the possibility of their partial filling: 0 to 0.95

4.1.12 For compartments that include spaces of different purpose, the volume permeability coefficient shall be calculated by the formula:

\[ k_v = \frac{k_{vi}V_i}{\sum V_i}, \]  

(4.1.12)

where \( V_i \) — total theoretical volume of separate rooms in the compartment

\( k_{vi} \) — volume permeability coefficient taken with due regard of the purpose of those rooms

4.1.13 The surface permeability coefficients \( k_s \) used when calculating the areas, static moments and inertia moments of the lost waterline area in flooded compartment for the purpose of taking into account the cargo, machinery, equipment etc., in way of the damaged waterline, shall generally be adopted equal to volume permeability coefficients as in 4.1.10. For rooms not occupied by any substantial quantities of cargo, machinery and equipment in way of the damaged waterline, the surface permeability coefficients shall be adopted equal to the arithmetic mean of unity and the volume permeability coefficient.

4.1.14 Covers of companion and light hatches, manholes, scuttles, glasses and outer doors shall meet the requirements of the national standards.

4.2 REQUIREMENTS FOR DAMAGE TRIM AND STABILITY AT FLOODING THE COMPARTMENTS

4.2.1 The requirements of this Chapter apply to all the ships, except passenger ships of M-CPI class, the requirements to which are specified in 4.3.

4.2.2 The requirements of the Rules to floodability of the ships shall be considered met, if at flooding the compartments specified in 4.2.3:

1. Margin line is not immersed;
2. Lower edges of free-flooding openings through which overboard water may spread to non-damaged compartments are located before righting above the damage waterline for:

- for the passenger ships, crew boats, special purpose ships and non-passenger ships carrying organized groups of people of M-CPI, M-P, M-O-P, O and P classes with a length of \( \geq 25 \text{ m} \) for the ships of M-CPI, M-P and M classes except those specified above, as well as passenger ships, crew boats, special purpose ships and non-passenger ships carrying organized groups of people of M-CPI, M-P, M-O-P and O classes with a length of < 25 m for the passenger ships, crew boats, special purpose ships and non-passenger ships carrying organized groups of people of P class with a length of < 25 m and for other ships

Floodability Criterion

.3 Angles of heel before and after righting do not exceed the values specified in 4.2.8 and 4.2.9;
.4 Damage stability complies with the requirements in 4.2.10 and 4.2.11.

4.2.3 The requirements to floodability shall be provided at flooding:
.1 the forepeak and afterpeak individually, for ships of all types and classes;
.2 each compartment individually, for oil tankers of M-СП class, for passenger ships and ships carrying organized groups of people and specific personnel of М-СП, М-ПП, М, О-ПП, О and Р classes (considering 4.2.1); ice breakers; self-propelled platform ships of M-СП, M-ПП, М, О-ПП and О classes; crewed reinforced concrete ships with a length over 25 m;
.3 the forepeak and afterpeak individually in one hull or both hulls, for catamarans;
.4 the forepeak and afterpeak individually in one skeg and in both skegs simultaneously, for skeg type for skeg type hovercraft;
.5 each two adjacent compartments adjoining to the board or transom, for all non-crewed reinforced concrete ships with a length of 25 m and more;
.6 each compartment individually in the dredge cut area, for bucket dredges of M-СП, М-ПП, М, О-ПП and О classes;
.7 each double bottom and/or double side compartment individually, for dry cargo ships of M-СП class.

Note: The requirement of 4.2.3.2 may be omitted for passenger spaces of hovercraft and hydrofoil craft; those ships shall keep positive buoyancy when these spaces are flooded.

4.2.4 At floodability calculations for the ships of all types and classes, flooding of the machinery space shall be taken into account irrespective of the requirement on providing floodability at flooding the machinery space.

4.2.5 When designing ships of all types and classes, the damage waterline and damage stability shall be checked by calculations at flooding of each compartment individually with submitting the calculations to the River Register. The results of the calculations shall be stated in the Information on Stability and Floodability.

4.2.6 When checking the ship's floodability at flooding the compartments, the parameters of damage trim and stability shall be determined by constant displacement method.

4.2.7 For passenger ships, damage stability shall be checked on the assumption that all the passengers are crowding on the uppermost decks they are permitted to be. The distribution of passengers shall be assumed according to 3.1.3.

4.2.8 In the final stage of unsymmetrical flooding before the righting measures, the angle of heel shall not exceed:
   for passenger ships 15°
   for non-passenger ships 20°

4.2.9 For unsymmetrical flooding after the righting measures, the angle of heel shall not exceed:
   for passenger ships 7°
   for non-passenger ships 12°

4.2.10 Transverse metacentric height determined by the constant displacement method shall be at least 0.05 m in the final stage of flooding for stable equilibrium state at unsymmetrical flooding and for non-inclined position at symmetrical flooding, before appropriate measures to increase metacentric height are taken.

4.2.11 The static stability curve of a damaged ship shall have a sufficient positive lever arm section. In the final stage of flooding and after righting, for all the ships other than flush deck ships, the following shall be provided:
   .1 the maximum lever arm of the static stability curve of not less than + 0.1 m;
   .2 the length of the positive arm section of the damage stability curve to the angle of downflooding is at least 30° at symmetrical flooding and at least 20° at unsymmetrical flooding.

For non-self-propelled flush deck ships, these norms are recommended.

4.2.12 Calculations to conform compliance to the requirements for damage trim and sta-
bility shall be made 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, that, based on these calculations, one could assure that in all other cases the damaged ship would be in a better condition as regards damage trim and stability. Here, the following shall be considered: the actual configuration of damaged compartments, type of covers of openings, presence of longitudinal bulkheads and enclosures watertight sufficiently so that these structures render the flow of water through the ship completely or keep the tightness temporarily.

4.3 REQUIREMENTS TO SUBDIVISION, DAMAGE TRIM AND STABILITY AT FLOODING THE COMPARTMENTS OF THE PASSENGER SHIPS OF M-CII CLASS

Permissible length of compartments in passenger ships

4.3.1 The maximum permissible length of a compartment having its centre at any point in the ship’s length is obtained from the floodable length by multiplying the latter by an appropriate coefficient called the coefficient of subdivision.

When determining the floodable length \( l_{\text{lim}} \), the margin line may be immersed in the area of flooding.

4.3.2 For ship of a given length, appropriate coefficient of subdivision shall be determined by the criterion in service numeral \( C_S \) (hereinafter called the criterion numeral) depending on the parameters \( P \) and \( P_1 \), where \( P \) — the whole volume of the passenger spaces below the margin line, m³;

\[ P = N \times kN \]

\( k \) — passenger capacity

\( N \) — coefficient calculated by the formula:

\[ k = 0.056L \]  

\( L \) — ship’s length, m

The criterion numeral is calculated by the formulae at \( P_1 \):

\[ P_1 > P \quad C_s = \frac{72(M + 2R)}{(V + P_1 - P)} \]  

\[ P_1 \leq P \quad C_s = \frac{72(M + 2P)}{V} \]

where \( M \) — volume of the machinery space with addition of the volume of any permanent oil fuel tanks situated above the inner bottom and forward or abaft the machinery space, m³

\( V \) — whole volume of the ship below the margin line, m³

For ships without continuous bulkhead deck, the volumes of spaces shall be taken up to the actual margin lines used in determining the floodable lengths.

4.3.3 Forepeak or collision bulkhead shall be watertight up to the bulkhead deck; that bulkhead shall be located at least 5 % of the ship’s length clear of the forward perpendicular and not over 3 m with addition of 5 % of the ship’s length.

4.3.4 In ships with a length of 100 m and more, one of main transverse bulkheads abaft the collision bulkhead shall be located apart from the forward perpendicular at the distance not exceeding the permissible length of compartment.

4.3.5 The subdivision abaft the collision bulkhead of the ships with length of less than 131 m, but not less than 79 m having a criterion numeral equal to

\[ S = \left(3574 - 25L\right)/13, \]

shall be governed by the subdivision coefficient equal to 1;

with criterion numeral \( C_s = 123 \) and more — by subdivision coefficient equal to \( B \):

\[ B = 30.3/(L - 42) + 0.18 \]

with an intermediate criterion numeral between \( C_s = S \) and \( C_s = 123 \) — by subdivision coefficient equal to \( F \).
$$F = 1 - (1 - B)\left(C_s - S\right)/(123 - S).$$ \hspace{1cm} (4.3.5-3)

4.3.6 Subdivision abaft the collision bulkhead in ships less than 131 m but not less than 79 m in length, having a criterion numeral less than $S$, as well as ships less than 79 m in length, shall be governed by the subdivision coefficient equal to unit.

4.3.7 Requirement of 4.3.6 is applicable for ships of any length allowed for transportation of more than 12 passengers but not exceeding $L^2/60$ or 50, whichever is less.

4.3.8 Transverse bulkhead may be stepped provided that it meets one of the following conditions:

1. The combined length of the two compartments separated by the bulkhead in question does not exceed either 90% of the floodable length or twice the permissible length, except when in ships having a coefficient of subdivision greater than 0.9 the combined length of the two compartments in question shall not exceed the permissible length;

2. Additional subdivision is provided in way of the step to maintain the same measure of safety as that secured by a plane bulkhead;

3. The compartment, over which the step extends does not exceed, the permissible length corresponding to a margin line taken 76 mm below the step.

**Floodable length**

4.3.9 Calculations of the floodable length shall be made with due regard to the shape, draught and other characteristics of the ship in question.

4.3.10 In determining the floodable length, a uniform average permeability coefficient is applied throughout the whole length of each of the following portions of the ship below the margin line:

- engine room
- ship portion afore the machinery space
- ship portion abaft the machinery space

4.3.11 The average permeability coefficient $\mu$ throughout all machinery spaces shall be determined by the formula:

$$\mu = 0.85 + 0.1(a - c)/V,$$ \hspace{1cm} (4.3.11-1)

where $a$ — volume of the passenger spaces which are situated below the margin line within the limits of the machinery space, $m^3$  
$c$ — volume of between-deck spaces below the margin line within the limits of the engine room, which are intended for cargo or stores, $m^3$  
$V$ — whole volume of the engine room below the margin line, $m^3$

The average permeability coefficient $\mu$ of all the spaces located afore or abaft the machinery spaces shall be calculated by the formula:

$$\mu = 0.63 + 0.35a_1/V_1,$$ \hspace{1cm} (4.3.11-2)

where $a_1$ — volume of the passenger spaces which are situated below the margin line within the limits of forward of or abaft the engine room, $m^3$  
$V_1$ — whole volume of the part of the ship below the margin line within the limits of forward of or abaft the machinery space, $m^3$

**Damage stability**

4.3.12 Calculations confirming compliance of the requirements to damage stability shall be made 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, that, based on these calculations, one could assure that in all other cases the damaged ship would be in a better condition as regards damage trim and stability.

4.3.13 At damage stability calculations, the design volume of the flooded compartments shall be calculated considering volume permeability coefficients of each compartment space, which shall be taken equal to:

- for the spaces occupied by the ship’s machinery and electrical equipment 0.85
- for the spaces occupied by stores and cargo 0.6
- for accommodation and passenger spaces, dry forepeak and afterpeak compartments, and empty cargo compartments 0.95
- for ballast tanks and other empty tanks 0.98
The permeability of tanks with liquid cargo shall be determined with due regard to replacement of cargo by outboard water.

4.3.14 Requirements to the ship’s stability are considered met if:

for the ship intended for carriage of less than 400 persons, at flooding of each separate compartment

or for the ships intended for carriage of 400 persons and more, at flooding a compartment or compartments (the number is determined depending on the damage location in any place along the ship length)

the trim parameters and stability elements of the damaged ship comply with the requirements in 4.3.15 to 4.3.21.

Requirements to trim and damage stability elements

4.3.15 In the final stage of flooding, the metacentric height of a ship determined by the constant displacement method shall be not less than 0.05 m.

4.3.16 The angle of heel at unsymmetrical flooding shall not exceed:

before the righting measures – 15°

after righting – 7° if one compartment is flooded and 12° if two adjacent compartments are flooded.

The righting time shall not exceed 15 minutes.

4.3.17 The margin line shall not be immersed; when closed openings are present through which outboard water may enter non-damaged compartments, the damage waterline shall be at least 0.3 m far apart of lower edges of such openings.

4.3.18 Damage stability curve of the damaged ship shall have a positive arm section to the angle of downflooding of at least 15°, measured from the balance position both before and after the righting measures of the ship or cross-flow actuation.

4.3.19 The area under the curve between the heeling angle corresponding to the equilibrium position of the ship and the least of the following values:

the angle, at which progressive flooding occurs

22° (from the initial point of the curve) if one compartment is flooded or 27° if two adjacent compartments are flooded simultaneously

shall be at least 0.015 m-rad

4.3.20 The residual positive righting arm within the damage stability curve section shall be determined considering the greatest of the following heeling moments:

.1 due to all passengers crowding at one side;

.2 due to launching all lifeboats and liferafts with their full complement of persons and outfit;

.3 due to wind pressure.

In this case, the maximum lever arm shall be equal to

\[ I_{\text{max}} = \frac{M_h}{D}, \]

where \( M_h \) — maximum heeling moment, kN-m

\( D \) — displacement, kN.

In all cases, this lever arm shall be not less than 0.1 m.

4.3.21 The heeling moments required for the determination of the residual righting lever arm shall be assumed on the basis of the following assumptions:

.1 When determining moments due to passengers crowding it is assumed that:

The density of distribution of passengers is assumed to be four persons per square metre.

The mass of each passenger is assumed to be 75 kg.

Passengers are crowing on free deck areas to one side on muster stations so that to provide the greatest heeling moment;

.2 When determining moments due to launching of all lifeboats and liferafts with their full complement of persons and outfit, it is assumed that:

All the lifeboats, rescue boats and liferafts of the one side to which the ship has got a
heel are assumed fully loaded, swung out and ready for launching.

Persons who are not in the life-saving appliances are not considered a source of additional heeling moment or righting moment.

Life-saving appliances at the opposite side are assumed to be stowed for sea;

When determining moments due to the wind pressure, the latter is assumed equal to $120 \text{ N/m}^2$, the design area is assumed equal to the windage area before damage and the lever arm equal to the vertical distance between the centre of effort and the point corresponding to half the mean draught of an intact ship.
5 FREEBOARD AND LOAD LINE

5.1 GENERAL REQUIREMENTS

5.1.1 The requirements of this Section apply to the inland and river-sea navigation ships engaged on coastal voyages.

On river-sea navigation ships engaged on international voyages, in addition to the load line marked according to the requirements of the International Convention on Load Line 66/88, the load line may be marked according to the requirements of this Section. The specified load line marked abaft the load line according to the International Convention on Load Line 66/88 in close proximity to the load line as far as practical.

5.1.2 Compliance with the requirements of the Rules as regards strength, stability and floodability of the ship is a necessary condition for assigning a freeboard.

5.1.3 For the wooden ships, composite ships or GRP ships, the freeboard height is assigned by the River Register if the designer submits the grounds and calculations made using the methods approved by the River Register.

5.1.4 The freeboard height assigned for the ship is fixed by marking a deck line and a load line on each side of the ship. On ships with a length of 10 m and less a freeboard marks may be omitted.

5.2 LOAD LINE MARKING FOR THE INLAND NAVIGATION SHIPS

5.2.1 The load line (Fig. 5.2.1-1) consists of a ring intersected by a horizontal line in the center and lines corresponding to maximum draughts.

A letter indicating the ship navigation area is marked above the horizontal line forward of the ring. Width of lines of the ring and all other load lines is 25 mm, the outer diameter of the ring is 250 mm, the length of the horizontal line which intersects the ring is 400 mm, the size of the letters is 100 × 60 mm with lines 15 mm wide.

If the freeboard height is less than 150 mm, the outer diameter of the ring of the load line may be decreased.

The upper edge of the horizontal line intersecting the ring shall pass through its centre; it is the line of the maximal draught for the class which is assigned to the given ship. The centre of the ring shall be placed on the same vertical with the centre of the deck line.

The deck line is usually applied so that its upper edge passes the intersection point of the outer surface of the freeboard deck and the outer surface of the side plating. The length of the deck line is 300 mm and width is 25 mm (see Fig. 5.2.1-1).

If the lowest side point of the upper surface of the freeboard deck is not located amidships, the deck line is applied amidships along the plane marked horizontally through the specified lowest side point.
If marking the deck line with the specified method is not possible, it may be applied from another fixed point on the side of the ship with respective correction of the freeboard height. The position of the specified point relative to the accepted deck of the freeboard shall be recorded in the load line certificate (see Fig. 5.2.1-2, distance \( a \)).

![Fig. 5.2.1-2 Position of the deck line for the ships with a rounded deck](image)

When a ship is intended for operation in water basins of different categories, then a vertical line and additional lines of maximum draughts 150 mm long shall be applied from the end of the ring’s horizontal line in the fore part of the mark (Figs. 5.2.1-3, 5.2.1-4, 5.2.1-5). The lines of maximum draughts of MC and OC ships on Fig. 5.2.1-5 are related to the inland navigation ships of M and O classes, which may operate in the areas with sea navigation conditions of respective categories.

![Fig. 5.2.1-3 Examples of the load lines of the ships of P and M classes](image)

Fig. 5.2.1-3 Examples of the load lines of the ships of P and M classes

The upper edges of the lines of maximum draughts shall comply with the ship’s freeboard height assigned for water basins of the respective categories.

![Fig. 5.2.1-4 Example of the load lines of the ships of O class](image)

**5.2.2** The load line and the deck line shall be applied on the plating amidships on each side.

On ships with side paddle wheels, two marks shall be placed on each side approximately 1/3 of the ship’s length apart from her extremities.

When the load lines are placed not amidships, the deck sheer shall be taken into account.

For sheered ships with the lowest deck point of the freeboard deck (zero ordinate of sheer) shifted abaft or ahead from the midship plane, the distance between the upper edge of the deck line and the upper edge of the maximum draught line which shall be placed amidships, shall be extended to the sheer ordinate in the midship section.

**5.2.3** Where the load line mark and subdivision load lines are places under the fender guard, the latter shall be cut so that its ends are clear of the load line mark and subdivision load lines for 100 mm.

**5.2.4** The load line shall be applied white or yellow on dark background or black on light background.

On steel ships, the load line shall be made of a steel sheet and welded or made by building-up fillets and painted according to the requirements of this Para.

On ships made of light alloys, horizontal lines of the load line shall be made of welded
or riveted strips of the same material as the hull; all the rest lines may be only punched and painted.

On ships with the hull made of GRP, the load line mark shall be made of plastic and glued.

On ships with wooden planking, the load line mark may be either cut and painted or only painted depending on the planking thickness.

5.2.5 For checking draughts and loading, in the fore and aft sections of the ship and for the ships with a length of more than 40 m and amidships, the draught marks (scales) shall be applied. When applying the draught scales amidships, they shall be located abaft the load line in close proximity to it. The manufacture, application and painting of the marks are made according to 5.2.4. For the ships with a length of less than 25 m, it is not required to meet this requirement.

5.3 LOAD LINE FOR THE RIVER-SEA NAVIGATION SHIPS

5.3.1 The load line, the general view and dimensions of which are specified on Fig. 5.3.1 shall be applied on board the ships of M-Ñ class.

5.3.2 The load line for the ships of M-Ñ class with a greater than minimum freeboard shall be applied according to Fig. 5.3.2.

The upper edge of the horizontal line intersecting the ring of the load mark shall be placed at a distance corresponding to a greater than minimum freeboard assigned measured downwards from the upper edge of the deck line.

Forward of the load line ring, the Fresh Water Load Line shall be applied at a distance calculated by the formula (5.3.2) considering actual salt water density in the sea navigation area:

\[ \Delta T = V (\gamma - 1)/q, \]

(5.3.2)

where \( \Delta T \) — distance between salt water and sea water load lines

\( \gamma \) — actual density of salt water in the navigation area, t/m³

\( V \) — volume displacement of the ship in salt water at a draught corresponding to the assigned freeboard, m³

\( q \) — weight of cargo, the acceptance or removal of which changes the ship draught by 1 cm in salt water with density \( \gamma \), t/cm

Forward of the load mark ring, the Fresh Water Load Line shall be applied at the distance corresponding to 1/48 of the draught above the centre of the ring. The distance may be specified taking into account the actual density of salt water in the area of navigation using the formula (5.3.2).

Abaft the load mark ring, the load lines shall be applied for navigation in inland water basins of categories M and O and in coastal sea areas with salt water where ships of classes M-ÏÐ and O-ÏÐ are allowed to operate.

5.3.3 Load line in ships of class M-Ñ with minimum freeboard assigned shall be applied according to Fig. 5.3.3.
Freeboard and Load Line

Fig. 5.3.3 Load line in ships of class M-ΠП assigned the minimum freeboard

The upper edge of the horizontal line of the ring shall be placed at a distance corresponding to the minimum summer freeboard measured downwards from the upper edge of the deck line.

Forward of the ring the following load lines shall be applied: the Summer Load Line (at the level of the load mark centre), the Fresh Water Load Line and the Winter Load Line for ships operating in the Baltic Sea, the Caspian Sea, the Black Sea and the Asov Sea.

For ships with a length over 100 m the Winter Load Line is omitted.

The Winter Load Line shall be applied under the Summer Load Line at the distance corresponding to 1/48 of the summer draught.

Abaft the ring, load lines shall be applied for navigation in basins of categories М and О and in coastal sea areas with salt water where ships of classes M-ΠП and O-ΠП are allowed to operate.

5.3.4 Periods, during which the Summer or Winter Load Lines are used for the ships of M-СП class with a length of up to 100 m, are specified in Table 5.3.4.

<table>
<thead>
<tr>
<th>Area of navigation</th>
<th>Period of use of the Load Line:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Winter</td>
</tr>
<tr>
<td>The Baltic Sea</td>
<td>from 01 Nov till 31 Mar</td>
</tr>
<tr>
<td>The Caspian Sea</td>
<td>from 1 Dec till 15 Mar</td>
</tr>
<tr>
<td>The Black Sea</td>
<td>from 1 Dec till 28/29 Feb</td>
</tr>
</tbody>
</table>

5.3.5 Load line for ships of class M-ΠП having an assigned freeboard (minimum or a greater than minimum) shall be applied as in Fig. 5.3.5.

The upper edge of the horizontal of the load mark ring shall be placed at a distance corresponding to the freeboard assigned measured downwards from the upper edge of the deck line.

Forward of the load mark ring, the Fresh Water Load Line shall be applied at the distance corresponding to 1/48 of the draught above the centre of the ring. This distance may be set by the formula (5.3.2) with due consideration of the water density in the sea navigation area.

Abaft the load mark ring, the load lines shall be applied for navigation in inland water basins of categories M, O and P and in coastal sea areas with salt water, where ships of class O-ΠП are allowed to operate.

The dimensions of the load line are taken according to Fig. 5.3.1.

5.3.6 Load line in ships of class O-ΠП with freeboard assigned shall be applied according to Fig. 5.3.6.

The upper edge of the horizontal of the load mark ring shall be placed at a distance corresponding to a greater than minimum freeboard assigned measured downwards from the upper edge of the deck line.

Forward of the load mark ring, the Fresh Water Load Line shall be applied at the distance corresponding to 1/48 of the draught above the centre of the ring. This distance may be calculated by formula (5.3.2) with due
Fig. 5.3.6 Load line in O-ΠP class ships

consideration of the water density in the navigation area.

Abaft the load mark ring, the load lines for navigation in inland water basins of categories O and P shall be applied.

The dimensions of the load line are taken according to Fig. 5.3.1.

5.4 MINIMUM FREEBOARD HEIGHT

5.4.1 Freeboard height for the ships with sheer taken according to Tables 5.5.2 and 5.5.4 and coaming heights taken according to Table 5.6.1 shall be set as follows:

.1 for the closed inland navigation ships according to Table 5.4.1-1 and Table 5.4.1-2.

<table>
<thead>
<tr>
<th>Ship length, m</th>
<th>Freeboard height ( H_{fb} ), mm, for the ships of class O</th>
<th>P</th>
<th>( \geq 130 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \leq 30 )</td>
<td>35</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>40</td>
<td>40</td>
<td>70</td>
<td>115</td>
</tr>
<tr>
<td>50</td>
<td>45</td>
<td>80</td>
<td>130</td>
</tr>
<tr>
<td>60</td>
<td>50</td>
<td>90</td>
<td>150</td>
</tr>
<tr>
<td>70</td>
<td>55</td>
<td>100</td>
<td>170</td>
</tr>
<tr>
<td>80</td>
<td>60</td>
<td>110</td>
<td>190</td>
</tr>
<tr>
<td>90</td>
<td>65</td>
<td>120</td>
<td>210</td>
</tr>
<tr>
<td>100</td>
<td>70</td>
<td>135</td>
<td>230</td>
</tr>
<tr>
<td>110</td>
<td>75</td>
<td>150</td>
<td>260</td>
</tr>
<tr>
<td>120</td>
<td>80</td>
<td>170</td>
<td>290</td>
</tr>
<tr>
<td>( \geq 130 )</td>
<td>85</td>
<td>170</td>
<td>450</td>
</tr>
</tbody>
</table>

.2 for the open inland navigation ships, freeboard height of their length: for the ships of O class – 1000 mm, of P class – 600 mm, of \( \mathcal{L} \) class – 450 mm.

<table>
<thead>
<tr>
<th>Ship length, m</th>
<th>Freeboard height ( H_{fb} ), mm, for the ships of class</th>
<th>( \mathcal{L} )</th>
<th>P</th>
<th>O</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \leq 30 )</td>
<td>15</td>
<td>30</td>
<td>60</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>20</td>
<td>35</td>
<td>70</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>25</td>
<td>40</td>
<td>80</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>30</td>
<td>45</td>
<td>90</td>
<td>155</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>35</td>
<td>50</td>
<td>100</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>40</td>
<td>60</td>
<td>120</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>45</td>
<td>70</td>
<td>140</td>
<td>230</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>50</td>
<td>80</td>
<td>160</td>
<td>260</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>55</td>
<td>90</td>
<td>180</td>
<td>290</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>60</td>
<td>100</td>
<td>200</td>
<td>325</td>
<td></td>
</tr>
<tr>
<td>( \geq 130 )</td>
<td>65</td>
<td>110</td>
<td>220</td>
<td>360</td>
<td></td>
</tr>
</tbody>
</table>

The total height of freeboard and coaming for the open ships of O class shall be not less than 1900 mm, of P class – not less than 1200 mm, of \( \mathcal{L} \) class – not less than 600 mm;

.3 for the ships M-ΠP and O-ΠP classes – from Table 5.4.1-1 and 5.4.1-2. Here, the tabular values are increased by 1/48 of the respective draught in fresh water;

.4 for the M-ΣΠ class ships – from Table 5.4.1-3.

<table>
<thead>
<tr>
<th>Ship length, m</th>
<th>Freeboard height ( H_{fb} ), mm, for the ships of M-ΣΠ class:</th>
<th>( \mathcal{L} ) dry cargo ships, tugboats, ice breakers, industrial ships, passenger ships</th>
<th>tankers</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \leq 30 )</td>
<td>285</td>
<td>235</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>380</td>
<td>320</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>485</td>
<td>405</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>625</td>
<td>525</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>785</td>
<td>660</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>960</td>
<td>780</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>1070</td>
<td>910</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>1250</td>
<td>1060</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>1460</td>
<td>1210</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>1640</td>
<td>1380</td>
<td></td>
</tr>
<tr>
<td>130</td>
<td>1820</td>
<td>1550</td>
<td></td>
</tr>
<tr>
<td>( \geq 140 )</td>
<td>2000</td>
<td>1710</td>
<td></td>
</tr>
</tbody>
</table>

For the passenger ships with a length of 100 m and more with enclosed first tier superstructure, the freeboard, \( m \), specified in Table 5.4.1-3 may be decreased by value \( \Delta F \) calculated by the formula:
\[
\Delta F = h_k l_a b_a / \left( 0.88 L_s B_s \right),
\]  
(5.4.1.4)

where \( h_k \) — the least of the following compared vertical dimensions, m:
- distances between the bulkhead deck and the lower edges of closed openings in outer walls of enclosed first tier superstructure;
- heights of coamings enclosing hatches in the freeboard deck

\( l_a, b_a \) — length and breadth, respectively, of the first tier superstructure, m

\( L_s \) — maximum length of the part of the ship below the margin line

\( B_s \) — maximum breadth of the part of the ship below the margin line

5.4.2 Minimum freeboard is determined by increasing the tabular freeboard determined according to 5.4.1 by the following corrections:

- For the closed inland navigation ships of Ë, Ð, Î and Ì classes and for the river-sea navigation ships of Î-ÏÐ and Ì-ÏÐ classes — according to the maximum values specified in 5.4.3;
- For the open inland navigation ships of Ë, Ð and Î classes and for the river-sea navigation ships of Ì-ÑÏ class — allowances determined according to 5.4.4 and 5.4.5 and considering deviation of the actual dimensions of the sheer, or the forecastle and poop, and coaming height from the dimensions specified in 5.5 and 5.6.

5.4.3 The freeboard height for the Ë, Ð, Î, Ì, Î-ÏÐ and Ì-ÏÐ class ships as obtained from Table 5.4.1-1 and 5.4.1-2 shall be corrected as follows:

- For the ships with the \( B/T < 4.5 \), the tabular freeboard height shall be increased by the correction value calculated by the formula, mm:

\[
\Delta H_{B/T} = 0.49 L (4.5 - B/T);
\]  
(5.4.3.1)

- For the ships with block coefficient \( \delta > 0.75 \), the freeboard height shall be increased by the correction value calculated by the formula, mm:

\[
\Delta H_{\delta} = \left[ 18.2 L + 17 \left( 4.5 - B/T \right) \right] \cdot (\delta - 0.75) .
\]  
(5.4.3.2)

If \( B/T \geq 4.5 \), in the formula (5.4.3.2) the \( B/T \) ratio shall be taken equal to 4.5;

- For the ships with the length to breadth ratio \( L/B < 5.5 \), the tabular freeboard height shall be increased by the correction value calculated by the formula, mm:

\[
\Delta H_{L/B} = 6.7 L (5.5 - L/B) .
\]  
(5.4.3.3)

5.4.4 If the sheer or dimensions of the forecastle and poop are different from the values specified in 5.5, the freeboard height shall be increased by a value that provides the two following conditions met:

- Buoyancy reserve shall be not less than one determined for the ships with the sheer specified according to 5.5 or with the forecastle and poop;

- The static moments of the volumes, which result from the extended freeboard height relative to the midship plane, shall be not less than the static moments of the volumes for the ships with the sheer determined according to 5.5 or with forecastle and poop.

5.4.5 If the coaming height is less than that specified in the requirements in 5.6, the minimum freeboard height shall be increased by the difference between the tabular and the actual coaming heights.

The minimum height of coaming of hatches located on the open decks shall be at least 100 mm for ships of all classes.

Decrease of the freeboard height as compared with the value stated in Table 5.4.2 due to the increase of the coaming height is not allowed.
The coaming’s heights of other hatches may be less than tabular heights without correction of the freeboard height, if the hatch covers comply with the requirements in 1.2.1.10.

5.4.6 The minimum freeboard height of the closed inland navigation ships of Ë and Ð classes shall be not less than:
   For all the ships, except the tankers and platform ships:
   Ë class — 150 mm;
   Ð class — 250 mm;
   For tankers and platform ships:
   Ë class — 90 mm;
   Ð class — 160 mm.

5.4.7 The cargo platform guard of the platform ship shall be designed to prevent washing of the bulk cargo. The sum of the guard height and the freeboard height shall be at least one half of the wave height corresponding to the basin category where the ship operates.

5.4.8 For the awning barges of O, P and Ë classes carrying cargo in the holds, the minimum freeboard height may be assigned same as for the dry cargo decked ships (see Table 5.4.1-1) provided that the awning and its gates are weathertight and the gate coaming height is not less than that provided for cargo holds (see 5.6.1).

Note: Awning is a light structure on the freeboard deck for cargo and passenger protection in bad weather conditions. Awnings gates are enclosure of an opening in the awning wall for cargo handling.

When these conditions are not met, the minimum freeboard height shall be assigned the same as for open ships.

5.4.9 For the dredgers, landing stages, guard ships and floating docks, the freeboard height shall be taken same as for the closed ships.

5.4.10 For the cargo ships loaded by hydromechanization means, the freeboard height shall be calculated in the same manner as for the tankers. While substantiating the possibility of transporting other types of cargo on these ships the freeboard height shall be assigned as for the open ships.

5.4.11 The freeboard height for skeg-type hovercraft shall be calculated as for the displacement ships.

Here, the freeboard is the distance to the upper edge of the deck line and, in the absence of the freeboard deck, the distance to the lower edge of openings, through which water may come inside the ship but not above the lower edge of window openings.

5.4.12 The freeboard of amphibian-type hovercraft with such design and shape of the hull, which differ from ordinary displacement ships, shall be assigned on condition that buoyancy reserve corresponding to at least 100 % of maximal mass displacement is provided.

5.5 SHEER, FORECASTLE AND POOP

5.5.1 On the ships of M-СІІ, M-ПП and M classes with the freeboard height to the forecastle deck in the fore perpendicular area (and in absence of the forecastle, to the freeboard deck) less than the sum of the minimum freeboard height amidships and sheer, the ordinate values of which are specified in this Section, it is recommended to fit the bulkwark in the bow.

5.5.2 For sheer line of ships without forecastle and poop shall be taken a broken line with ordinates on fore and aft perpendiculars taken according to Table 5.5.2 (except the ships of M-СІІ class) and ordinates at points located 0.15 of the ship’s length apart from the fore perpendicular and 0.07 of the ship’s length apart from the aft perpendicular being equal to 0.
Sheer ordinate values

<table>
<thead>
<tr>
<th>Ship length, m</th>
<th>Sheer ordinate, mm</th>
<th>Ship length, m</th>
<th>Sheer ordinate, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bow</td>
<td>Stern</td>
<td>Bow</td>
</tr>
<tr>
<td>≤30</td>
<td>1000</td>
<td>500</td>
<td>550</td>
</tr>
<tr>
<td>40</td>
<td>1000</td>
<td>500</td>
<td>600</td>
</tr>
<tr>
<td>60</td>
<td>1000</td>
<td>500</td>
<td>700</td>
</tr>
<tr>
<td>80</td>
<td>1000</td>
<td>500</td>
<td>800</td>
</tr>
<tr>
<td>100</td>
<td>1100</td>
<td>550</td>
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</tr>
<tr>
<td>120</td>
<td>1200</td>
<td>600</td>
<td>1050</td>
</tr>
<tr>
<td>130</td>
<td>1300</td>
<td>650</td>
<td>1100</td>
</tr>
</tbody>
</table>

Notes.
1. Sheer ordinates for the tankers are taken according to this Table with lowering the class, i.e. for the ships of M class, ordinates of the ships of O class are taken, for the ships of O class – ordinates of the ships of P class.
2. The sheer is not required for all the ships of Л class and for the tankers of P class.

The sheer ordinates shall be measured from a horizontal line coinciding with the upper edge of the deck line marked according to 5.2.

5.5.3 The sheer specified in 5.5.2 is not required for the ships of M-ПП, М, О-ПП, О and П classes, if the following conditions are met:

1. The forecastle height above the deck shall be at least: for the ships of М-ПП and М classes – 1000 mm, for the ships of О-ПП and О classes – 900 mm and for the ships of П class – 500 mm;

2. The forecastle length not less than 0.07 of the ship’s length for the ships of all classes;

3. The poop height above the deck not less than one half of the forecastle height for the ships of all classes;

4. The poop length not less than 0.03 of the ship’s length but not less than 2 m for the ships of all classes.

The ships of М-ПП and М classes with the sheer without the forecastle, in the bow extremity there shall be fitted with a bulwark with a length equal to the length of the forecastle determined according to 5.5.3.2.

Ships of М, О and П classes without sheer and the poop in the aft shall be fitted with a bulwark of the same length, but not less than 2 m.

5.5.4 The sheer ordinates $S$ for the closed ships of М-ПП class are regulated in Table 5.5.4.

<table>
<thead>
<tr>
<th>Ship length, m</th>
<th>Sheer ordinate, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bow</td>
</tr>
<tr>
<td>≤30</td>
<td>1000</td>
</tr>
<tr>
<td>40</td>
<td>1170</td>
</tr>
<tr>
<td>50</td>
<td>1280</td>
</tr>
<tr>
<td>60</td>
<td>1360</td>
</tr>
<tr>
<td>70</td>
<td>1410</td>
</tr>
<tr>
<td>80</td>
<td>1460</td>
</tr>
</tbody>
</table>

They may be also calculated by the formulae:

for the bow
$$S = 1695 - 0.711L + 0.0127L^2 - 20595/L;$$

(5.5.4-1)

for the stern
$$S = 766 + 0.6L + 0.305 \cdot 10^{-2} L^2 - 8639/L,$$

(5.5.4-2)

where $L$ — ship length, m.

The sheer ordinates for the tankers of М-ПП class are determined according to Table 5.5.2 as for the tankers of М class.

5.5.5 The forecastle and poop dimensions for the ships of М-ПП class shall comply with the following requirements:

The forecastle height above the deck at least 1500 mm.

The forecastle length at least 0.07 of the ship’s length and at least half the ship breadth.

The poop height above the deck shall be at least half the forecastle height.

The poop length shall be at least 0.03 of the ship’s length but not less than 2 m.

5.6 ARRANGEMENT OF OPENINGS AND COAMINGS

5.6.1 For all the ships, except the ships of М-ПП class, the height of coamings from the upper edge of the deck plating of cargo and other hatches located on the freeboard deck and not protected by the superstructures or wheelhouses shall be not less than specified in Table 5.1.6.
Table 5.6.1

<table>
<thead>
<tr>
<th>Ship class</th>
<th>Cargo</th>
<th>Other*</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-IP, M</td>
<td>400</td>
<td>300</td>
</tr>
<tr>
<td>O-IP, O</td>
<td>300</td>
<td>250</td>
</tr>
<tr>
<td>P</td>
<td>250</td>
<td>200</td>
</tr>
<tr>
<td>J</td>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>

* Other hatches include trunks, access holes, non-cargo holds, outer exits to the superstructures and wheelhouses, awnings.

For the ships of M-CP class, the height of the cargo hatch coamings shall be not less than 450 mm and for other hatches according to the requirements in 5.6.1 for the ships of M and M-IP classes.

5.6.2 The height of the cargo hatch coamings for the open ships of O, P and J classes shall be assigned according to the requirements in 5.4.1.2.

The coaming’s height of hatches in passenger ships where passengers are located in the hull’s compartments not closed by a deck or superstructure, shall be not less than the coaming’s height on open cargo ships.

5.6.3 Where the hatches are located inside the superstructures fitted with the closures as specified in this Chapter, the height of the hatch coamings may be taken as 75 mm for the ships of all classes.

5.6.4 Coamings of companion hatchways of M-CP class ships shall be at least 450 mm high when located on the open deck and at least 380 mm high when located on decks of the superstructures.

5.6.5 For the ships of M-CP class, coamings of doors leading to the open deck shall be at least 380 mm high, and coamings of doors leading to the superstructure deck at least 280 mm high.

5.6.6 The thickness of vertical plating of the companion hatchway coamings specified in 5.6.4 shall be equal to the thickness of the deck where the companion hatchways are located but not more than 8 mm.

5.6.7 The companion hatchway covers and all the outer doors of the superstructures, wheelhouses and lobbies for the ships of M-CP class shall be permanently attached and watertight. They shall be made of steel or material with fire-retardant properties not lower than wood impregnated with fire-proof substance (see 1.2.1.20, Part III of the Rules). Quick-action arrangements shall be provided for opening, closing and tightening the covers and doors which shall be capable of being used from both sides.

For passenger ships the requirements of the present paragraph apply only to covers of companion hatchways and outer doors of superstructures, wheelhouses and lobbies located on the freeboard deck.

5.6.8 The thickness of flat steel companion hatchway covers for the ships of M-CP class shall be not less than that of the shell or plating, on which they are fitted, but not more than 10 mm.

5.6.9 Cargo and other hatches located on the open areas of the freeboard deck for the closed ships of M-CP, M-IP, M, O-IP and O classes shall be fitted with watertight closures, and for the ships of P and J classes with weathertight closures.

Cargo hatches of class O ships may be fitted with weathertight closures, when the sum of the assigned freeboard height and the cargo hatch coaming is not less than 1200 mm.

Closures of the cargo hatches for the ships of M, O, P and J classes shall be rated for loading by the cargo weight which is assumed to be stowed on those closures, but the design load shall not be less than 2.45 kPa.

5.6.10 The requirements in 5.6.11 to 5.6.17 related to the closures are specified for steel machine-driven closures on the ships of M-CP class with weather-tightness secured by means of gaskets and batten-down devices.

5.6.11 The closures shall be rated for the weight loads from the cargo which is assumed to be stowed on those closures. However, in all the cases the minimum load depending on the ship’s length shall be assumed as linearly increased from 7.35 kPa at the ship’s length of 24 m up to 12.15 kPa at the ship’s length of 100 m. For the ships less than 24 m and more
100 m in length the weight load shall be taken as not dependent on the ship’s length and equal to the above limit values of 7.35 kPa and 12.15 kPa accordingly.

For the ships of M-Ç II 4.5 class, the minimum loads on hatch covers (except for the area at a distance of 25 % of the ship’s length abaft the bow perpendicular) are taken as equally distributed along the length and equal to 7.84 kPa at the ship’s length of 24 m and equal to 13.37 kPa at the ship’s length of 100 m. For the area at a distance of 25 % of the ship’s length abaft the fore perpendicular, the minimum load on hatch covers is taken changing by linear dependence from 8.33 kPa at the ship’s length of 24 m and from 14.59 kPa at the ship’s length of 100 m on bow perpendicular to 7.84 kPa at the ship’s length of 24 m and to 13.37 kPa at the ship’s length of 100 m on the aft border of the area. At the ship’s length above 24 m but less 100 m, the minimum loads on hatch covers are determined by means of linear interpolation.

5.6.12 When the rated load (see 5.6.11) is applied to closures, the stress in the closure components shall not exceed 0.4 of the yield point or 0.235 of the ultimate strength of the material, whichever is less.

5.6.13 A deflection of hatchway covers shall not exceed 0.0028/l (l — span of beams or bearing stiffeners of the cover).

5.6.14 Thickness of steel plating of hatchway covers shall not be less than 0.01 of the spacing of stiffeners or 6 mm, whichever is greater.

5.6.15 Parts of a driving unit of hatchway covers shall ensure the normal operation at ambient temperatures from −25 °C to +50 °C, heel up to 5° and the maximum trim by bow or stern due to full loading of one of the end holds.

5.6.16 Hatchway covers of cargo compartments in oil tankers shall be permanently attached and, when battened down, be water/gas-tight under inner carried liquid vapour pressure at least 24.5 kPa.

5.6.17 The steel plates of hatchway covers of cargo compartments in oil tankers shall be at least 8 mm thick and covers made of light alloys at least 10 mm thick. At every 400 mm of the cover length stiffeners made of strip of thickness equal to that of the cover and with a height of at least 80 mm shall be provided.

5.6.18 Cargo hatchway covers in ships of class M-Ç II shall be rated for the weight loads from the cargo, which is assumed to be stowed on those covers. The specific minimum load on the cargo hatch covers depending on the ship’s length shall be assumed as linearly increased from 4.90 kPa at the ship’s length of 24 m up to 9.81 kPa at the ship’s length of 100 m. For the ships less than 24 m and more 100 m in length the specific weight load shall be taken as not dependent on the ship’s length and equal to the above limit values of 4.90 kPa and 9.81 kPa accordingly.

5.6.19 Cargo hatchway covers and closures of other hatches and openings on open parts on the weather deck, lobbies, entrances and other openings in the superstructure on the main deck of class O-Ç ships as regards strength and weathertightness shall meet the requirements for class M ships; here, cargo hatchway covers shall be rated for the weight loads from the cargo which is assumed to be stowed on those covers. The minimum specific load on the cargo hatch covers depending on the ship’s length shall be assumed as linearly increased from 2.45 kPa at the ship’s length of 24 m up to 5.40 kPa at the ship’s length of 100 m. For the ships less than 24 m and more 100 m in length the specific weight load shall be taken as not dependent on the ship’s length and equal to the above limit values of 2.45 kPa and 5.40 kPa accordingly.

5.6.20 Ventilation heads located on the open parts of the freeboard deck shall have strong steel coaming with the height for the ships of M-Ç II class being not less than 760 mm and for the ships of other classes being not less than that required for coamings of the cargo hatches. Ventilation openings on all the ships, except P and JI classes shall be fitted with tight closures. Coamings of portable ven-
tilation heads shall be fitted with covers or similar closing means.

5.6.21 Outlet openings of piping when located in sides below the freeboard deck shall be arranged according to the requirements of Section 10.4 Part IV of the Rules.

5.6.22 All outer doors and windows of the superstructures, wheelhouses and lobbies located on the freeboard deck shall be watertight for the ships of all classes, except for the cases specified in 5.6.23.

5.6.23 Outer doors may be weathertight when its lower edge is clear of the maximum draught plane on at least a length stated in Table 5.6.23.

<table>
<thead>
<tr>
<th>Ship class</th>
<th>Distance, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>3500</td>
</tr>
<tr>
<td>O</td>
<td>1900</td>
</tr>
<tr>
<td>P</td>
<td>1200</td>
</tr>
<tr>
<td>I</td>
<td>600</td>
</tr>
</tbody>
</table>

Doors of the closed spaces (e.g., store-rooms, boatswain's stores) located on the freeboard, forecastle and poop decks, may be weathertight.

5.6.24 Scuttles in the outer shell plating below the freeboard deck, in frontal bulkheads of closed superstructures and wheelhouses of the first level as well as in frontal bulkheads of closed superstructures and wheelhouses of the second level on 0.25 of the ship’s length from the forward perpendicular shall be supplied with storm shutters permanently attached to the hull structures. The thickness of the scuttle glasses shall comply with the requirements in 2.7.24, Part III of the Rules.

5.6.25 Scuttles in superstructures of the first and the second levels, located outside the areas and structures stated in 5.6.24, shall be supplied with permanently attached storm shutters and the thickness of glass shall be at least 8 mm at clear diameter of 250 mm or less and at least 12 mm at clear diameter of 350 mm or more. Clear diameter shall not exceed 400 mm.

5.6.26 On the class M and O ships, the side scuttles located in spaces below the freeboard deck shall be fitted with permanently attached storm shutters; here, the scuttle glass thickness shall be at least 8 mm at a clear diameter up to 250 mm inclusive and at least 12 mm at a clear diameter of 350 mm and more. However, the clear diameter shall not exceed 450 mm. For intermediate clear diameters the glass thickness is determined by linear interpolation.

On the class P and I ships, the glass thickness for scuttles may be at least 6 mm at a clear diameter of 250 mm and below and at least 10 mm at a clear diameter of 400 mm and more.

The lower edge of side scuttles of ships of all classes shall be clear of the maximum draught line on at least 150 mm. On the class P ships, where the storm shutters are not available on the scuttles, the specified distance shall be not less than the freeboard height according to Tables 5.4.1.

Side scuttles of class M-PIP and M passenger ships located less than 2.5 % of the ship’s breadth apart from the maximum draught line shall be dead.

On the class M-PIP and M ships, in the superstructures located on the freeboard deck and extended from side to side, the scuttles shall be fitted with storm shutters. In superstructure spaces located on the freeboard deck and not being extended to the sides may be fitted with watertight with heavy glass (at least 10 mm).

On the passenger ships of M-CPI, M-PIP, O-PIP, M, O and P classes, the side scuttles located in the spaces below the freeboard deck, except rescue scuttles, shall be non-opening or to have a structure allowing to open them only by the crew members. The scuttles, except for the non-opening ones, located below the freeboard deck, including rescue scuttles, shall be equipped with automatic alarm on their opening led to the wheelhouse.

5.6.27 Side scuttles of M-CPI class passenger ships shall be so located that no scuttle sill is below a line parallel to the freeboard deck.
at side and having its lowest point \(0.025B\) above the summer load line or 500 mm, whichever is greater.

5.6.28 Covers on outboard water inlet and ice boxes shall be watertight.

The upper edge of openings shall be above the maximum draught line by at least 150 mm.

5.6.29 On oil tankers and flush deck ships, the following requirements shall be met:

1. All openings in the freeboard deck shall be fitted with strong watertight closures;
2. Manholes, doors of lobbies and other openings of ships of O, P and \(\Omega\) classes located on the forecastle or poop may be weathertight.
6 MANOEUVRABILITY OF SHIPS

6.1 SCOPE OF APPLICATION

6.1.1 This Section contains the manoeuvrability requirements to the displacement ships and convoys, which apply to:

.1 self-propelled cargo ships with a length of 40 m or more;
.2 displacement passenger ships, special purpose ships and crew boats with a length of 20 m or more.

6.1.2 The requirements of this Section do not apply to pushed convoys, ship formations, catamarans or ships with waterjets, rotating-blade propulsors or paddle wheels.

6.2 DEFINITIONS AND EXPLANATIONS

6.2.1 The following terms are used in this Section:

.1 propulsion and steering unit (PSU) means propulsor and its steering devices (rudders and/or nozzles);
.2 ship propulsion and steering system (PSS) means all the PSUs that are present on the ship and ensure its longitudinal movement and manoeuvrability;
.3 turning capability means the ship’s ability to turn within a minimum radius of curvature;
.4 directional stability means the ship’s ability to maintain the chosen straight course in deep\(^1\) still water;
.5 manoeuvrability under wind conditions means ship’s ability to:
   maintain any chosen straight course while all propulsors are rotating at rated speed and
   turn on the spot in the chosen direction under wind conditions by simultaneously operating the main controls and the bow steering device;
.6 manoeuvrability with propulsors not in operation means ship’s ability to mechanically maintain a straight course under her own momentum, to turn in the chosen direction and to invert the direction of the turn;
.7 emergency stopping means quickly changing the operating mode of all the propulsors from full speed ahead to full speed astern in deep still water, when loaded as indicated in 6.3.2.

6.3 GENERAL REQUIREMENTS TO SETTING MANOEUVRABILITY STANDARDS

6.3.1 A ship is considered to meet the manoeuvrability requirements specified in this Section if, when loaded according to 6.3.2, the following requirements are met:

.1 turning capability (see 6.5);
.2 directional stability (see 6.6);
.3 manoeuvrability with propulsors not in operation (see 6.7);
.4 emergency stopping (see 6.8);
.5 manoeuvrability under wind conditions (see 6.9).

6.3.2 The manoeuvrability test shall be conducted when the ship is in fully loaded condition, with an even keel trim and with the full stores and fuel.

Manoeuvrability tests for cargo ships under wind conditions in accordance with 6.9 shall be conducted only for ships in ballast, without cargo, and with 10% of stores and fuel.

Manoeuvrability tests for passenger ships under wind conditions in accordance with 6.9

\(^{1}\) Deep water means that depth \(H\) of a water body does not affect propulsion performance of the ship and complies with condition \(H \geq 4T + 3V^2/g\), where \(T\) — ship draught, m; \(V\) — ship velocity, m/s; \(g\) — acceleration of gravity, m/s\(^2\).
shall be conducted only for ships without cargo or passengers, and with 10 % of stores and fuel.

6.3.3 The ship manoeuvrability criteria specified in 6.3.1 apply to the ships with the following types of ship propulsion and steering systems:

.1 propellers in steering nozzles;
.2 propellers in steering nozzles with a centre rudder;
.3 rudders behind open propellers;
.4 rudders behind nozzle propellers including independent nozzles.

Manoeuvrability criteria values for the ships with the above types of the PSSs are calculated according to the instructions of Appendix 5.

6.3.4 For the ships with the PSS types not specified in 6.3.3, the manoeuvrability criteria determination methods are specified according to the methods developed by the designer and approved by the River Register.

6.3.5 The criteria for assessing ship’s turning capability, directional stability and manoeuvrability with propulsors not in operation may also be determined by:

.1 testing an autonomous self-propelled ship model which is geometrically similar to the ship;
.2 full-scale tests.

In these cases, the criteria values do not have to be calculated.

6.4 TABLE OF MANOEUVRABILITY CHARACTERISTICS

6.4.1 To facilitate speedy reference, a table of each ship’s manoeuvrability characteristics shall be posted in a visible place in the wheelhouse.

6.4.2 The table shall be drawn up by the design organization and the results of the calculations shall be supplemented or corrected on the basis of data from full-scale tests and tests with self-propelled models.

6.4.3 For the form of the table, see Appendix 5.

6.5 TURNING CAPABILITY

6.5.1 The criterion for measuring turning capability is the minimum relative mean steady turning diameter \((D/L)_m\), measured from the centre of gravity, that is, the ratio between the diameter \(D\) of the smallest possible turn which the ship can make in deep still water and the length \(L\) of the ship at the design waterline, where the speed of rotation of all the propellers is the same prior to the commencement of the manoeuvre and is not subsequently regulated.

\[ \frac{D_t}{L} \leq 2. \] (6.5.2)

6.6 DIRECTIONAL STABILITY

6.6.1 The criterion for measuring directional stability is the minimum relative mean steady turning diameter, measured from the center of gravity of the ship in deep still water with the rudder angle at zero and all the propellers rotating at the same speed.

6.6.2 The ship’s directional stability is considered to satisfy the requirements of in the Rules if the steady turning diameter is 10 or more times the ship’s length, and also if the ship continues to move on a straight course without turning, with the rudder angle at zero.

6.7 MANOEUVRABILITY WITH PROPULSORS NOT IN OPERATION

6.7.1 The criterion for measuring manoeuvrability with propulsors not in operation is the ship’s capacity to come out of a steady turn, made with the rudder at a 20° angle, after the main propellers have stopped, without using the side thruster.

6.7.2 The ship is considered to meet the requirements of these Rules if it can be taken out of a steady turn, made with the rudder at a 20° angle, after the main propellers have stopped, by operating the main controls, without using the side thruster.
6.8 EMERGENCY STOPPING CAPACITY

6.8.1 The criterion for measuring emergency stopping capacity is the ship’s stopping course $S_{AT}$ the distance, m, which the ship travels relative to the water from the moment when the order to make an emergency stop is given to the moment when the ship has come to a complete stop relative to the water.

6.8.2 The ship is considered to meet the requirements of the present Rules, if the stopping course $S_{AT}$ does not exceed the value calculated by the formula, m,

$$S_{AT} = 30.7 \sqrt{V} + 1.28 L,$$  \hspace{1cm} (6.8.2)

where $V$ — displacement of the ship, m$^3$;
$L$ — ship’s length, m.

6.9 MANOEUVRABILITY UNDER WIND CONDITIONS

6.9.1 The criteria for measuring manoeuvrability under wind conditions are:

.1 Wind velocity in navigational zone, m/s, which allows the ship to move along any chosen straight course with all propulsors rotating at the rated speed;

.2 The specific thrust of the side thruster, kN/m$^2$, required for the ship to turn on the spot using the main controls and the side thruster.

The specific thrust of the side thruster of a cargo ship is the ratio between the thrust of the side thruster $T_T$, kN, and the product of the length of the ship at the design waterline $L$ and the full load draught $T$. The specific thrust of the side thruster of a passenger ship is the ratio $T_T/S$ between the thrust of the side thruster $T_T$, kN, and the windage area $S$, m$^2$.

6.9.2 The ship’s manoeuvrability under wind conditions (criterion 6.9.1.1) is considered to meet the requirements of the Rules if the wind velocity in the navigation area which still allows the ship to move on any chosen straight course with all the propulsors rotating at rated speed is:

- for class M and O ships — no less than 19 m/s;
- for class P and J ships — no less than 14 m/s.

6.9.3 Specific thrust of the bow thruster (criterion 6.9.1.2) meets the requirements of the Rules, if it is not less than:

$$T_T/(LT) = 0.03 \text{ for cargo ships; }$$
$$T_T/S = 0.04 \text{ for passenger ships with } SL \geq 20\,000\,m^3.$$  \hspace{1cm} (6.9.3)

6.10 FULL-SCALE TRIALS

6.10.1 Full-scale trials of the ships and convoys intended to determine the ship’s manoeuvrability compliance with the requirements of the Rules, confirmation of the calculation or full-scale trial results, as well as additions and corrections to the table of manoeuvrability characteristics, shall be carried out together with commissioning trials in the following cases:

.1 on the lead ships in the series;
.2 on the single built ships;
.3 on ships after repair, refitting or modernization, if their manoeuvrability is affected.

6.10.2 The full-scale trials are carried out at ship loading according to 6.3.2. Deviations with regard to draught shall not exceed 10%.

6.10.3 Full-scale manoeuvrability trials are carried out in deep still water, with waves no greater than 1 to 2 points according to the scale of the Central Hydrometeorological Department of the Russian Federation, and wind velocity no greater than 3 to 4 m/s.

6.10.4 Full-scale manoeuvrability trials shall be carried out using the program drawn up according to the requirements in Appendix 5 and RTSC.
INSTRUCTION ON DRAWING UP INFORMATION ON STABILITY AND FLOODABILITY OF SHIP

1 This Appendix contains general instructions on drawing up the Information on Stability and Floodability (hereinafter referred to as the Information). The Information shall include all the ship features determining its stability and floodability.

2 The Information is intended to assist the master in preparing and introducing measures to provide adequate stability and floodability of the ship in operation.

3 The Information shall contain references to the documents used for its drawing up.

4 The system of physical units shall be the same for the entire document. Symbolic notations of the units shall be accompanied with explanations.

5 The Information shall contain the general particulars of the ship including the following:
   .1 name of the ship, design No. and the year of construction;
   .2 registry number;
   .3 type of ship;
   .4 purpose of the ship (kinds of cargoes, which the ship is intended for);
   .5 ship class;
   .6 navigation areas of the ship and restrictions imposed;
   .7 main dimensions of the ship (length, breadth, depth, draught up to summer load line and the relevant displacement and deadweight);
   .8 speed of the ship in deep still water;
   .9 bilge keel area, if any;

10 inclining test data including the place of tests, the date, the test results (weight displacement in lightship condition, abscissa and applicata of the ship's centre of gravity), the Inspection office of the River Register who has approved the inclining test results;

11 other data at the option of the Information developer.

6 The Information shall contain the data proving that the ship meets the stability criteria which are developed for typical loading conditions and include:
   .1 plan of location of tanks with stores and ballast, cargo spaces, engine room;
   .2 tables showing the distribution of stores and ballast among the tanks in typical loading conditions with the indication of weight and coordinates of the centre of gravity and the relevant moments.

The calculations for typical loading conditions shall contain the following data:
   a text description of the loading condition; a drawing of the ship showing the location of the main loading components to be included in the displacement, a plan of the deck cargo stowage;
   tables for calculation of the ship’s weight, position of the centre of gravity, moments of separate loading components and of the light ship, and, in the event of icing of the ship, with due regard to the ice weight;
   corrections for the free surface effect of liquid cargoes and ballast;
   the value of initial metacentric height and the static stability curve with due regard to the free surface effect;
values of the stability criteria required by the Rules for the given loading condition and the results of checking how these requirements are met;

.3 a summary table of typical loading conditions including:
  denomination of the loading condition;
  displacement;
  ship trim parameters;
  vertical centre of gravity and longitudinal centre of gravity;
  corrections for the free surface effect;
  the initial metacentric height of the ship with due regard to the free surface effect;
  permissible values of the initial metacentric height or position of the centre of gravity;
  values of normed parameters, stability criteria and their permissible values;
  the angle of downflooding.

7 The Information shall contain materials for the stability estimation when the loading conditions vary from the typical ones. Those materials shall enable the master to determine, with sufficient accuracy and without undue loss of time, whether the ship stability meets the Rules.

The materials under consideration shall include:

.1 stability check diagrams containing the curves of permissible heights of the centre of gravity depending on the ship’s displacement. The diagram may comprise several curves for different loading conditions (i.e., for the ship without deck cargo, with timber cargo, in conditions of icing etc.);

.2 data for determining the weight and position of the centre of gravity of liquid cargoes;

.3 tables for determining corrections for the free surface effect;

.4 data for determining the weight and position of the centre of gravity of cargoes carried by the ship.

For carriage of containers and timber cargoes recommended plans of its stowage on the deck shall be provided;

.5 data for calculation of the trim and heel;

.6 a diagram (or a table) enabling to determine the mean draught of the ship by her displacement (the displacement curve);

.7 method of using the contents of .1 to .6 for estimating the ship’s stability at calculations of a loading condition other than the typical ones. An example of the calculations shall be also given on the form used for typical loading conditions of the ship;

.8 blank forms on which the master could make independent calculations.

8 The Information shall contain also the data on the ship’s floodability including the description of floodability requirements as applied to the ship concerned, as well as results of floodability calculations and damage stability criteria. Calculations for symmetrical and unsymmetrical flooding shall be given on separate sheets where the following shall be provided:

a sketch of the ship’s inboard profile with the indication of flooded compartment and position of the emergency waterline;

static stability curve of a damaged ship.

Floodability calculation results shall be presented in a tabular form that shall contain the data on emergency trim and heel, transverse metacentric height and normed parameters of damage stability. The table shall contain also the similar data on intact stability.

On the basis of the floodability calculation results for the river-sea navigation ships, a curve on the permissible position of the ship’s center of gravity considering the requirements to damage stability shall be provided.

9 The Information shall also contain the materials required to enable more precise estimation of the ship stability when any of the criteria are met without any reserve being ensured. Such materials include:

.1 a diagram of permissible moments including resultant curves for each criterion;

.2 curves or tables of the form-stability arms which allow plotting of precise static and dynamic stability curves for each non-typical loading conditions;

.3 materials necessary for calculation of stability criteria using the static stability curve;
dependence of the angle of downflooding on the draught or displacement of the ship;
other materials at the designer's option and the information for the determination of the limiting criterion;
the method of using the materials specified in 9.1 to 9.5 with a numerical example of the stability calculation.

A separate section of the Information shall contain the directions for the master on restrictions which follow from the provisions of the Rules, and the recommendations for ensuring stability in service with due regard to the ship's particulars including:

the information on the criteria limiting the ship's stability;

an indication that the stability criteria do not take into account the possible shifting of cargo and, in order to prevent the shifting one should be guided by the documents stating the cargo securing and stowage;
the information on restrictions imposed on the ship's loading, the information of stowage of the deck cargo;
instructions on the order of consumption of liquid cargoes and ship's ballasting during the voyage;
the list of openings which shall be closed during the operation to prevent flooding. At the option of the designer, the plan of location of these openings may be included;
recommendations on checking the ship stability during handling operations;
other information at the designer's option.

This Section may also contain the roll calculation results in the wave height range corresponding to the navigation area at different direction towards the ship's course with the respective recommendations for the master.
INSTRUCTION ON DETERMINING THE LOCATION OF SHIP’S CENTRE OF GRAVITY FROM EXPERIMENT (INSTRUCTION ON INCLINING TEST OF SHIPS)

1 GENERAL PROVISIONS

1.1 The inclining test of ships is required for final checking of the loading and initial stability calculation results by experimental determination of position of the centre of gravity. Inclining test is carried out according to the present Instructions and is attended by the expert.

1.2 A group of specialists headed by the inclining test manager is appointed for carrying out the inclining test.

1.3 The inclining test manager is responsible for the quality and reliability of the test results. His demands are obligatory for all specialists involved in carrying out and supporting the inclining test.

1.4 All deviations from the Instructions occurred at the inclining test shall be indicated and grounded in the inclining test report drawn up on the spot during the test.

2 PLACE OF CONDUCTING THE TEST (WATER AREA) AND WEATHER CONDITIONS

2.1 The inclining test shall be conducted in the still water area protected against current, waves and wind.

2.2 The water depth on the spot of test shall be such as to provide at least 1 m depth under the bottom (or under the hydrofoil for hydrofoil craft) at the maximal inclination of the ship.

2.3 The water area shall be free of objects hindering free inclination of the ship and movements around the ship while measuring operations. Water area shall be sufficiently distant away from passing ships or protected against waves created by passing ships.

3 PREPARATION

3.1 Ship

3.1.1 The ship shall be oriented towards the direction of the wind or current.

3.1.2 The ship shall be fixed in the center plane by longitudinal mooring ropes of maximum possible length connected together below the anchor hawseholes. The number of mooring ropes to be used shall be not more than four. Special devices for ship holding during inclining test having the River Register’s Compliance Certificate may be used.

3.1.3 The initial angle of ship heel shall be not more than 0.5°.

3.1.4 Loading condition shall be as close as possible to light ship displacement. The mass of missing loads is permitted to be not more than 2 % of light ship displacement, the mass of excessive loads including the test weight — not more than 5 % without regard to the ballast as per 3.1.9 of this Instruction.

3.1.5 All objects shall be secured in their proper locations. Movable objects shall be also secured.
3.1.6 Liquid loads shall be removed excepting liquid media in engines, systems and pipelines to ensure their operational condition.

The following liquids may not be removed:
.1 fresh water and lubricating oil stores;
.2 residuals of liquid cargoes and stores in daily tanks not influencing the quality of the test. The tanks containing stores other than daily tanks shall be pressurized until the liquid appears in the air pipes subject to measures preventing air pockets, the valves of service lines shall be shut off and sealed. Plots or tables for determining the weight and coordinates of the centre of gravity of the remaining cargoes shall be available.

3.1.7 On refrigerating ships, it shall be assured that no water is present under insulation in the holds.

3.1.8 Foreign objects, cargo residuals, scaffolding, garbage, snow shall be removed from the ship.

No icing of external and internal surfaces including the underwater part of the ship is allowed.

3.1.9 Metacentric height shall be not less than 0.2\text{m}. The necessary ballast may be taken onboard to provide this value.

3.1.10 The only persons present onboard shall be the personnel carrying out the inclining test.

3.1.11 Machinery and equipment which are in operation shall be stopped. In particular cases operation of the machinery or equipment not affecting the inclining test quality may be allowed.

3.1.12 It is necessary to establish the signals “Prepare for measurements”, “Start measurements”, “Finish measurements”, to instruct the participants of the inclining test and to establish method of communication.

3.1.13 Immediately prior to the inclining test it is necessary to check the presence of liquid loads and excessive cargoes, correspondence of missing loads to the record, stowage and securing of removable loads. It is necessary to prepare test weight, inclinographs, fittings, tools, reporting and technical documentation. Condition of the ship shall undergo random inspection after the test has been finished.

3.1.14 For ships less than 12\text{m} in length the ship prepared for the test shall be weighed prior to the test.

3.2 Test weights

3.2.1 Solid test weights shall be used for the inclining test. The inclining test may be carried out using a method whereby groups of persons move from side to side.

3.2.2 If all the test weight is located on one side, the ship's heel shall be provided: 2 - 4° – by solid test weight or 1.5 - 2° – by moving groups of persons from side to side. For catamarans and floating cranes a heel of at least 1° shall be ensured.

3.2.3 The test weights shall be of such design and shape as to ensure its precise fixation and determination of its center of gravity.

3.2.4 The test weights shall be divided into equal groups. When using solid test weights, the number of groups shall be two or more, the number of groups of persons – one or more.

3.2.5 The weight of the test weights shall be determined using weigh scales.

Weigh scales and weights which have not undergone the certification according to the laws of Russian Federation cannot be used. All solid test weights shall be marked.

It is not allowed to determine the mass of the whole group by mass of one or several weights.

3.2.6 The test weights shall be placed on the weather deck in the places easily accessible for its moving and changing the arms. The places where the test weights are located shall be fixed.

3.3 INSTRUMENTS

3.3.1 The following instruments shall be used for measuring the heeling angles:
.1 pendulums, water levels, inclinographs – if heeled by the solid test weights;
.2 inclinographs – if heeled by moving groups of persons from side to side.

3.3.2 One of the three following variants shall be used for measuring the heeling angles:
.1 pendulums (water levels) – three off and more;
.2 inclinographs – two off and more;
.3 inclinographs and pendulums (water levels) – two off.
For ships less than 30 m in length two pendulums (water levels) or one measuring device and one pendulum may be used.

3.3.3 Pendulums (water levels) shall be placed in different places along the ship length and prepared for operation according to the Instruction for use.

3.3.4 Length of pendulum thread shall be sufficient to provide a deflection of at least 150 mm across the measuring scale with the test weight at one side.

Pendulums with a thread length less than 3 m on ships having a length of 30 m and more, and pendulums with a thread length less than 2 m on ships less than 30 m in length, are not allowed.

3.3.5 The pendulum shall be made of flexible wire up to 0.3 mm in diameter and a billet (weight). For fast oscillation damping, two mutually perpendicular plates shall be attached to the weight and immersed into the receptacle filled with water or lube oil.

For measuring the weight deflection a measuring rod with a paper strip or measuring scale firmly attached to the hull shall be provided. Prior to beginning the test the weight thread shall be stretched by hanging the weight.

3.3.6 When determining the ship’s heeling angles by means of water levels (communicating vessels), two glass tubes with a length of approximately 1 to 1.2 m and diameter of 10 to 20 mm shall be connected with a rubber hose.

The tubes shall be mounted at the sides in the same framing plane at equal distance from the deck. After the tubes are fixed, one of them shall be filled with coloured water in a such amount that the water level reaches approximately half a length of the tubes. When determining the ship’s heel angle, the distance between the tubes is taken as the pendulum length and changes of the water level in the tubes as regarding the initial water level as the deflections.

It is necessary to check during the test that the rubber hose is filled with water along the whole length and is free of air bubbles which may impair the test results.

3.3.7 Calibration data of inclinographs to be used for the inclining test shall be submitted.

4 INCLINING TEST

4.1 Measurements

4.1.1 The heel angles shall be measured since the moment of “Start measurement” signal till the moment of “Finish measurement” signal.

4.1.2 A steel tape is required for measuring distances up to 20 m.

4.1.3 The measurements shall be performed with the following accuracy:
.1 the length of pendulums – 5 mm;
.2 the draught and freeboard height – 10 mm;
.3 test weight transfer arms – 10 mm;
.4 the pendulum deflections – 1 mm;
.5 deflections of inclinograms – 0.2 mm;
.6 mass of the test weights – 1 %;
.7 time – 0.1 s.

4.2 Draught

4.2.1 The draught shall be measured at the beginning and at the end of the inclining test by the draught marks and measurements of the freeboard height at three points along the ship’s length, as a minimum.

For the purpose of on-line measurements quality, specially prepared Profile Views scaled up by the height, Bonjean diagram, or lines drawing with indicated draft marks shall be used. Waterlines shall be drawn by draught
and freeboard height measurement points. In case of significant deviations of some points additional measurements shall be made.

4.2.2 The measurements shall be made on both sides. In order to measure draught values at waves it is recommended to use a glass tube open at the both ends with a hose of 1 to 2 m in length; one end of the tube with the hose attached shall be immersed in water at the depth of 0.1 m or below a plywood sheet freely floating on the water surface.

4.2.3 Draught of tugboats and ships less than 30 m in length may be measured also by means of a wooden frame consisting of a horizontal bar with a length exceeding the maximal ship breadth by 1 to 1.5 m and two vertical struts scaled in centimeters. The frame may be of swing-up type, where the bar and the struts are connected by steel hinges and crossbeams. For better immersing of the frame into the water it is recommended to bind the bar at the bottom by a steel strip 8 to 10 mm thick.

For measuring the ship’s draught the frame shall be placed from the bow or stern and pulled to the plane of one of the frames in a such manner as the water level at the struts corresponds to the same scales.

When performing measurements in the flat bottom area of ships with initial heel angle the draught is determined as a half-sum of the scales fixed at port and starboard struts provided that the struts are symmetric as regards the centre plane of the ship.

After the draught measurements in that frame plane are finished, the frame shall be moved using the struts aftward or forward, and the draught is measured in other frame plane in the same manner.

4.3 Test weight transfer

4.3.1 Procedure and sequence of transfer of the test weight groups is determined by the inclining test manager according to recommended type diagrams (Table A2.4.3.1).

4.3.2 The arm of solid test weight transfer shall be measured from the transfer of its center of gravity.

<table>
<thead>
<tr>
<th>Measurement No.</th>
<th>Procedure of test weight transfer with the quantity of its groups for side</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>port side</td>
</tr>
<tr>
<td>0</td>
<td>020406</td>
</tr>
<tr>
<td>1</td>
<td>000406</td>
</tr>
<tr>
<td>2</td>
<td>000006</td>
</tr>
<tr>
<td>3</td>
<td>000000</td>
</tr>
<tr>
<td>4</td>
<td>100000</td>
</tr>
<tr>
<td>5</td>
<td>010000</td>
</tr>
<tr>
<td>6</td>
<td>0103050</td>
</tr>
<tr>
<td>7</td>
<td>123050</td>
</tr>
<tr>
<td>8</td>
<td>123450</td>
</tr>
<tr>
<td>9</td>
<td>123450</td>
</tr>
<tr>
<td>10</td>
<td>023456</td>
</tr>
<tr>
<td>11</td>
<td>020456</td>
</tr>
<tr>
<td>12</td>
<td>020406</td>
</tr>
</tbody>
</table>

Note: Figures 1 to 6 specify the test weight group number, 0 means empty space where the symmetric test weight group may be transferred from the other side; the number of the test weight group transferred at the given measurement is underlined.

The arm of the groups of persons transfer is the distance between the guide lines along which the persons are lined up, reduced by 20 cm.

If indirect measuring of the arms is applied, the reason for this and the used measuring method shall be indicated.

4.3.3 The persons shall transfer according to the designated signal, stand in alignment, without bending or resting on something, faced towards the centre plane, with the heels touching the guide lines.

4.3.4 The number of transfers of the test weight and measurements shall be not less than eight.

4.3.5 The center of gravity of the group of persons over the height shall be assumed at the deck level.

4.4 Angle of heel

4.4.1 One measurement of the heeling angle and one value of the metacentric height correspond to each transfer of the test weight.
4.4.2 At each measurement the following shall be taken into account:

1. A deflection of the pendulum shall be measured for at least 5 sequential swings (distances between extreme positions of the pendulums) after the swing becomes less than 15 mm;

2. If determining the heeling angle by water levels, the procedure of measuring the water level in the tubes is the same as for pendulum method;

3. The inclinograms shall be recorded by the inclinograph for at least five full free inclinations of the ship according to the Instructions for inclinograph use. The device recording scale shall be at least 15 mm/degree.

4.5 Period of rolling

4.5.1 If the inclining test is performed using the inclinographs allowing to measure free inclination period of the ship, the period of rolling shall be determined for all ships of M-III, M-IIP, M, O-IIP and O classes (see also 4.5.2 of this Appendix).

At each transfer of the test weights the total time required for five or six free sequential inclinations of the ship shall be measured by a stop-watch timer. Here, for the reference points shall be taken the most clearly expressed inclinogram peaks. The period of rolling shall be determined with due regard to the inclinograph time scale coefficient.

4.5.2 In cases not stipulated in 4.5.1 of this Appendix and for ships with excessive stability the inclining test manager decides whether it is necessary to determine the period of rolling. The swinging of the ship is performed by means of transferring the solid weights or by moving of the group of people from side to side at least three times; at each swinging, the time required for five or six free sequential inclinations of the ship shall be measured by at least two stop-watch timers.

5 INCLINING TEST REPORT

5.1 The results of the inclining test are fixed in the inclining test report and the reports 1–5 which are integral parts of the inclining test report (see Section 8 of the present Appendix). The inclining test report is signed by all participants of the inclining test, and the reports — by responsible performers appointed by the inclining test manager.

5.2 The expert who attends the inclining test signs the following documents:

1. inclining experiment report;

2. the inclinogram or records of the pendulum deflections.

6 PROCESSING OF INCLINING TEST RESULTS

6.1 Input data

6.1.1 The inclining test report and the ship’s report documents documentation are assumed as the initial data in the processing of the inclining test results. These materials shall be processed according to the requirements given in 6.2 – 6.8 of the present Appendix.

6.2 The inclining test materials

6.2.1 The inclining materials shall comprise the calculations of the displacement, coordinates of the ship’s center of gravity in lightship condition and the ship’s inertial coefficient at inclining (if the period of rolling has been determined, see 4.5 of the present Appendix).

6.2.2 The inclining test materials are drawn up by the designer as the report documents.

6.2.3 The inclining test materials are submitted in three copies to the River Register for approval.

6.3 Sagging

6.3.1 The ship’s sagging shall be taken into account at the calculations of the displacement and the Z-coordinate of the ship’s center of gravity using any reasonably precise method.

6.4 Displacement and coordinates of the ship’s center of gravity
6.4.1 The weight of the ship $D$, kN, and coordinates of the centre of gravity $z_c$, $x_c$, m, shall be determined using the following formula:

1. at trim < 0.005$L$, m:

$$D = pgV; \quad (A2.6.4.1.1-1)$$

$$z_g = r + z_c - h_t; \quad (A2.6.4.1.1-2)$$

$$x_g = x_c - R \psi \varphi. \quad (A2.6.4.1.1-3)$$

Theoretical elements $V$, $z$, $r$, $x$, and $R$ shall be determined using the curves of the lines drawing;

2. at trim ≥ 0.005$L$, m:

$$D = pgV; \quad (A2.6.4.1.2-1)$$

$$z_g = z_c + (r - h_t) \cos \psi; \quad (A2.6.4.1.2-2)$$

$$x_g = x_c - (r - h_t) \sin \psi. \quad (A2.6.4.1.2-3)$$

Theoretical elements $V$, $z$, $r$, and $x$ are determined using any reasonably precise method at corresponding bow and stern draughts.

6.5 Metacentric height

6.5.1 The metacentric height according to the results of particular measurements shall be calculated in the Table A2.6.5.1.

6.5.2 The metacentric height at the inclining test $h_t$ shall be determined using the formula (see also 6.6.4), m,

$$h_t = \Sigma i/n, \quad (A2.6.5.2)$$

where $n$ — number of observations (measurements).

6.6 Inclining test quality

6.6.1 Quality of the inclining test is considered satisfactory, if the relative confidence accuracy of the test calculated according to 6.6.2 at the confidence coefficient of 0.98 does not exceed 5%.

6.6.2 Quality of the inclining test shall be assessed as the following:

1. the root mean square deviation of the metacentric height values, m,

$$\sigma_h = \sqrt{\frac{\sum (h_i - h_\bar{h})^2}{n(n-1)}} = \sqrt{\frac{\Sigma_6}{n(n-1)}}, \quad (A2.6.6.2.1)$$

2. the confidence accuracy of the test, m,

$$\varepsilon = t_{0.98} \sigma_h, \quad (A2.6.6.2.2)$$

where $t_{0.98}$ — coefficient to be determined as regards the number of considered measurements according to the Table A2.6.6.2.2.

<table>
<thead>
<tr>
<th>Coefficient $t_{0.98}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of observations less 1 ($n-1$)</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
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<td>12</td>
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<tr>
<td>13</td>
</tr>
<tr>
<td>14</td>
</tr>
</tbody>
</table>

3 Relative confidence accuracy of the test, %

$$\tau = 100\varepsilon/h_t. \quad (A2.6.6.2.3)$$

6.6.3 On-line control of the inclining procedure shall be performed for each pendulum (water level, inclinograph) by the plots (Fig. A2.6.6.3-1) or the type of inclinograms (Fig. A2.6.6.3-2).

Determination of the metacentric height

<table>
<thead>
<tr>
<th>Measure</th>
<th>Transfer moment, kN·m</th>
<th>Increment of angle $\Delta \Theta_m$, rad</th>
<th>$h_i = \text{col.2}/(\text{col.3} \cdot \Delta 1)$, m</th>
<th>$\Delta h = h_i - h_\bar{h}$, m</th>
<th>$\Delta h^2 = (h_i - h_\bar{h})^2 = (\text{col. 5})^2$, m$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>col.1</td>
<td>$\Sigma_4$</td>
<td>$\Sigma_5$</td>
<td>$\Sigma_6$</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
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<td>..........</td>
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<tr>
<td>$n$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Sigma$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The total ship’s heeling angle (or its tangent) calculated from the initial position (before moving test weights) is plotted along the abscissa axis (see Fig. A2.6.6.3-1), the total heeling moment induced by all test weight transferred since the beginning of the inclining procedure is plotted along the ordinate axis. Each measurement corresponds to a particular point on the plot. All points marked on the plot shall be approximately on the same straight line passing through the origin of coordinates. The points distant from this line are assumed as uncertain, they shall be controlled during the inclining procedure and the relevant inclining shall be repeated.

6.6.4 If it is discovered from a single measurement result that value of metacentric height \( h \) could be obtained only as a result of an accidental error (e.g., the person carrying out observations has made a mistake while recording the readings, the ship has touched an obstacle, etc.), this individual measurement may be discarded.

6.7 Inertial coefficient

6.7.1 The ship’s inertial coefficient at inclining shall be determined using the formula, \( m^{1.5} \): \[
C = \tau \sqrt{h_g / B},
\]

(A2.6.7.1)

where \( \tau \) — period of ship’s rolling, s.

6.8 Light ship

6.8.1 The displacement of the light ship include the weight of a ship in full ready condition without deadweight and liquid ballast.

6.8.2 The deadweight includes the following loads:

1. the loads transported by the ship, other than “dead” liquid loads;
2. the crew and passengers with their luggage, food stores including packing and fresh water;
3. fuel, water and lubricating oil stores for ship operation, other than liquid loads;
4. consumables;
variable set of changeable fishery equipment of fishing vessels;
fishery production and components for its treatment, packing and packaging materials on fishing vessels.

Note: “Dead” liquid loads mean residuals of liquid loads in the hull, which cannot be removed by ordinary onboard facilities from the tanks, draining bilges, bilge sumps etc.

6.8.3 The deadweight does not include the following loads:
1 supply and belongings;
2 spare parts;
3 liquids media in engines, apparatus, installations, systems and pipelines to ensure their operational condition;
4 water in swimming pools;
5 solid and liquid ballast.

6.8.4 Weight and coordinates of the center of gravity of the light ship shall be determined according to Table A2.6.8.4.

7 CALCULATION RESULTS
7.1 The light ship elements obtained from the inclining data shall be presented in comparison with the design data (Table A2.7.1).

8 EXAMPLE OF DRAWING UP THE INCLINING TEST REPORT

SHIP INCLINING TEST REPORT

<table>
<thead>
<tr>
<th>Main dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length ( L ) = 224.7 m</td>
</tr>
<tr>
<td>Breadth ( B ) = 4.5 m</td>
</tr>
<tr>
<td>Depth (amidships) ( H ) = 3.2 m</td>
</tr>
</tbody>
</table>

**Time of conducting the inclining test**

Date  
Beginning of the test \( h \) \( \min \)  
End of the test \( h \) \( \min \)

**Determination of the weight and location of the center of gravity in lightship condition**

<table>
<thead>
<tr>
<th>Type of loading</th>
<th>Weight, kN</th>
<th>Arms, m</th>
<th>Moments, kN ( \cdot ) m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( x ) along the ship's length from amidships, “+” means forward, “–” means aftward ( \left( x = \Sigma x / \Sigma 2 \right) )</td>
<td>( z ) along the ship's height from the base plane ( \left( z = \Sigma z / \Sigma 2 \right) )</td>
<td>( M_x )</td>
</tr>
<tr>
<td>1 Ship in inclining test</td>
<td>( \Sigma 1 )</td>
<td>( \Sigma x )</td>
<td>( \Sigma x )</td>
</tr>
<tr>
<td>2 Missing loads</td>
<td>( \Sigma 2 )</td>
<td>( \Sigma 2 )</td>
<td>( \Sigma 2 )</td>
</tr>
<tr>
<td>3 Excessive loads</td>
<td>( \Sigma 3 )</td>
<td>( \Sigma 3 )</td>
<td>( \Sigma 3 )</td>
</tr>
</tbody>
</table>

**Comparison of the ship’s design and experimental data**

<table>
<thead>
<tr>
<th>Ship’s particular</th>
<th>Design values</th>
</tr>
</thead>
<tbody>
<tr>
<td>from the inclining test data</td>
<td>by the design (or from the effective Information on Stability and Floodability)</td>
</tr>
</tbody>
</table>

| \( D \), kN | \( x \) \( m \) | \( z \) \( m \) | \( T_h \) \( m \) | \( T_o \) \( m \) | \( C \), \( m^{-0.5} \) \( s^{-1} \) |
Place of the test
Under-keel depth m

Weather conditions
Wind 1 to 1.5 m/s
Waves calm, calm weather
Ambient air temperature + 10 °C

List of the test committee
Inclining test manager

(name and surname, position, organization)
Members of the committee:

The test was attended by the representative of Branch Office of the River Register.

Notes
(The ship’s position relatively to the wind and waves, initial heeling angle, the water level in boilers etc.)

Ship’s draught during the test (from the base plane)
At the fore perpendicular \(T_f = 2.42\) m
At the aft perpendicular \(T_a = 2.62\) m
Average \(T_{av} = 2.52\) m
Trim \(\varphi = (T_f - T_a)/L = - 0.0081\)
Draught measurement error \(\Delta T = \pm 0.005\) m

The diagram indicating the ship position, mooring, the direction of the wind and waves etc.

The draughts were measured according to the draught marks from the boat and according to the freeboard height (see Draught Measurement Report).

Initial trim — 0°.

Ship’s loading condition
The ship was brought to a loading condition equal to the lightship displacement with tolerance given in 3.1.4 of the present Appendix.

The forepeak and afterpeak tanks are drained and stripped. The lubricating oil tank is pressurized.

Missing loads are given in Table 1, excessive loads — in Table 2 and in records of loads which are missing or excessive as regards the lightship condition.

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo type</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>1 Wire rope</td>
</tr>
<tr>
<td>2 Starboard anchor chain</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo type</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>1 Charcoal in bunkers</td>
</tr>
<tr>
<td>2 Lubricating oil</td>
</tr>
<tr>
<td>3 Crew</td>
</tr>
<tr>
<td>4 Members of the committee</td>
</tr>
<tr>
<td>5 Test weights</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

Test weight and transfer arms
Iron castings were used as test weights. Prior to the test the ballast weights were weighed, marked, divided into four groups and stowed on the deck.

Weight of test weight groups and their transfer arms are specified in Table 3.

The total weight of the test weights is 1544 kN.
The weight error of test weight groups does not exceed 1 %.

The transfer arms were measured by the metal tape.

### Table 3

<table>
<thead>
<tr>
<th>Test weight group No.</th>
<th>Location</th>
<th>Weight, kN</th>
<th>Transfer arm, m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>On the deck: 8 to 10 fr.</td>
<td>3860</td>
<td>3.56</td>
</tr>
<tr>
<td>2</td>
<td>48 to 50 fr.</td>
<td>3750</td>
<td>3.56</td>
</tr>
<tr>
<td>Starboard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>On the deck: 8 to 10 fr.</td>
<td>3930</td>
<td>3.56</td>
</tr>
<tr>
<td>4</td>
<td>48 to 50 fr.</td>
<td>3910</td>
<td>3.56</td>
</tr>
</tbody>
</table>

The present report is accompanied by Reports 1 – 4 and Report 5 or inclinograms.

Signatures:

Inclining test manager _____________________________
Members of the committee ___________________________
expert of _______________________________________
Branch Office of the River Register_________________________

### Statement No. 1

**Ship draughts measurement**

The ship draughts measured by the draught marks from the boat and freeboard height measured by wooden gauge rod from the upper deck are specified below. Given below:

<table>
<thead>
<tr>
<th>Draught by the draught marks, m:</th>
<th>Starboard</th>
<th>Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>forward</td>
<td>2.51</td>
<td>2.53</td>
</tr>
<tr>
<td>aft</td>
<td>2.71</td>
<td>2.73</td>
</tr>
<tr>
<td>Freeboard height, m:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At the fore perpendicular</td>
<td>1.25</td>
<td>1.31</td>
</tr>
<tr>
<td>at the aft perpendicular</td>
<td>0.78</td>
<td>0.78</td>
</tr>
<tr>
<td>Amidships</td>
<td>0.59</td>
<td>0.57</td>
</tr>
<tr>
<td>Average measured draught, m:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>at the fore perpendicular</td>
<td>2.52</td>
<td></td>
</tr>
<tr>
<td>at the aft perpendicular</td>
<td>2.72</td>
<td></td>
</tr>
<tr>
<td>Draught reduced by the bar keel height h = 10 cm, m:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fore $T_f$</td>
<td>2.42</td>
<td></td>
</tr>
<tr>
<td>aft $T_a$</td>
<td>2.62</td>
<td></td>
</tr>
<tr>
<td>average $T_w$</td>
<td>2.52</td>
<td></td>
</tr>
<tr>
<td>Draught measurement error due to condition of the water surface T, m</td>
<td>±0.005</td>
<td></td>
</tr>
</tbody>
</table>

### Statement No. 2

**Missing loads (as regards the light ship condition)**

Loads missing as regards the light ship condition were determined according to the drawings and records ____ by visual examination of the ship. The examination results are specified in the table.

<table>
<thead>
<tr>
<th>Cargo type</th>
<th>Cargo location</th>
<th>Weight, kN</th>
<th>Arms, m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$X$ along the ship’s length from amidships</td>
<td>$Z$ along the ship’s height from the base plane</td>
</tr>
<tr>
<td>1 Wire rope</td>
<td>On the deck: frame</td>
<td>4.6</td>
<td>0</td>
</tr>
<tr>
<td>2 Starboard anchor chain</td>
<td>Cable locker frame</td>
<td>8.7</td>
<td>9.95</td>
</tr>
</tbody>
</table>

### Statement No. 3

**Excessive loads (as regards the light ship condition)**

Loads excessive as regards the light ship condition were determined by visual examination of the ship. The examination results are specified in the table.

<table>
<thead>
<tr>
<th>Cargo type</th>
<th>Cargo location</th>
<th>Weight, kN</th>
<th>Arms, m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$X$ along the ship’s length from amidships</td>
<td>$Z$ along the ship’s height from the base plane</td>
</tr>
<tr>
<td>1 Charcoal</td>
<td>Port bunker frame</td>
<td>23.0</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>Starboard bunker frame</td>
<td>20.0</td>
<td>1.2</td>
</tr>
</tbody>
</table>
have drawn up this report regarding the fact that we had determined the mass of the test weight intended for conducting inclining test of the ship ____________________

The mass was determined using the weighing scales ____________________ that had undergone the last state calibration ____________________, at ______________. The accuracy _______% according to the Certificate ____________________, dated _________________. After the mass had been determined, the test weight was divided into four groups and marked, the results are shown in the table.

<table>
<thead>
<tr>
<th>Group No.</th>
<th>Weight, kN</th>
<th>Quantity, pieces</th>
<th>Test weight type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3850</td>
<td></td>
<td>Cast iron</td>
</tr>
<tr>
<td>2</td>
<td>3750</td>
<td></td>
<td>ditto</td>
</tr>
<tr>
<td>3</td>
<td>3930</td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>4</td>
<td>3910</td>
<td></td>
<td>&quot;</td>
</tr>
</tbody>
</table>

Signatures:
______________________________
______________________________
______________________________
______________________________

Statement No 5
Records of pendulum deflection measurements

Deflection of pendulums, mm, were measured by a wooden gauge rod. Steel wire 0.3 mm in diameter was used as pendulums. Measurements of pendulum deflections, the length and location of the pendulums are specified in the table.

<table>
<thead>
<tr>
<th>Measurement No.</th>
<th>Extreme pendulum deflections at all stages of the inclining test</th>
<th>Average value of measurements according to 6 stages</th>
<th>Pendulum deflection at measurements at 6 stages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>195 205 197 193 202 199 201 199 202 202 200 200 200</td>
<td>200</td>
<td>—</td>
</tr>
<tr>
<td>1</td>
<td>260 276 262 274 265 271 266 270 267 269 268 268 268</td>
<td>268</td>
<td>+68</td>
</tr>
<tr>
<td>2</td>
<td>333 339 333 339 334 338 335 337 325 337 336 336 336</td>
<td>336</td>
<td>+68</td>
</tr>
<tr>
<td>3</td>
<td>326 271 265 270 266 270 267 270 267 269 268 268 268</td>
<td>268</td>
<td>—68</td>
</tr>
<tr>
<td>4</td>
<td>194 198 195 197 195 197 196 196 196 196 196 196 196</td>
<td>196</td>
<td>—72</td>
</tr>
<tr>
<td>5</td>
<td>128 132 128 132 129 131 129 131 131 130 130 130 130</td>
<td>130</td>
<td>—66</td>
</tr>
<tr>
<td>6</td>
<td>64 70 65 70 65 69 65 68 66 69 67 67 67</td>
<td>67</td>
<td>—63</td>
</tr>
<tr>
<td>7</td>
<td>131 135 132 136 133 134 132 133 133 133 133 133 133</td>
<td>133</td>
<td>+66</td>
</tr>
<tr>
<td>8</td>
<td>201 205 202 205 203 204 204 204 203 203 203 203 203</td>
<td>203</td>
<td>+70</td>
</tr>
</tbody>
</table>
Appendix 2

Pendulum No. 1 with a length $\lambda_1=2960$ mm Location $\lambda$ on the bridge

Observer

(Surname, name)

Expert of _________________________ Branch Office of the River Register____________

9 EXAMPLE OF PROCESSING THE RESULTS OF DETERMINING THE LOCATION OF SHIP’S CENTRE OF GRAVITY FROM THE INCLINING TEST

Calculation of the ship’s displacement and coordinates of the centre of gravity in test conditions (Table A2.9-1)

Calculation data

The ship’s draught at the perpendiculars from the base plane during in test conditions:

$T_f = 2.42$ m; $T_a = 2.62$ m.

Station spacing $\Delta L = 1.234$ m.

Displacement volume regardless of protruding parts

$V = \Delta L \Sigma_2 = 1.234 \cdot 123.7 = 152.5$ m$^3$.

The ship’s weight in test conditions including protruding parts

$D = KpgV = 1 \cdot 1.006 \cdot 9.81 \cdot 152.5 = 1504.5$ kN.

X-coordinate of the centre of buoyancy

$x_{cv} = \Delta L \Sigma_4 / \Sigma_2 = -1.234 \cdot 14.58 / 123.7 = -0.15$ m.

Z-coordinate of the centre of buoyancy

$z_{cv} = \Sigma_5 / \Sigma_2 = 195.3 / 123.7 = 1.58$ m.

Metacentric radius

$r = 2 \Sigma_7 / (3 \Sigma_2) = 2 \cdot 234.0 / (3 \cdot 123.7) = 1.26$ m.

Calculation of metacentric height in test conditions A2.9-2 – A2.9-4)

Metacentric height in test conditions

$h_{it} = \Sigma_4 / 8 = 2.944 / 8 = 0.368$ m.

<table>
<thead>
<tr>
<th>Frame No.</th>
<th>Frame area, m$^2$</th>
<th>Multiplier</th>
<th>Product col.2+3</th>
<th>Frame area moment $M_y$, m$^4$</th>
<th>Y-coordinate of the waterline $y$, m</th>
<th>y$^3$, m$^4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1.77</td>
<td>9</td>
<td>15.90</td>
<td>4.3</td>
<td>1.80</td>
<td>5.80</td>
</tr>
<tr>
<td>3</td>
<td>3.36</td>
<td>8</td>
<td>26.85</td>
<td>7.8</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>4</td>
<td>4.78</td>
<td>7</td>
<td>33.42</td>
<td>9.0</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>5</td>
<td>5.97</td>
<td>6</td>
<td>35.80</td>
<td>10.2</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>6</td>
<td>6.94</td>
<td>5</td>
<td>35.69</td>
<td>12.1</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>7</td>
<td>7.65</td>
<td>4</td>
<td>30.60</td>
<td>12.7</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>8</td>
<td>8.24</td>
<td>3</td>
<td>24.70</td>
<td>13.2</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>9</td>
<td>8.62</td>
<td>2</td>
<td>17.24</td>
<td>13.4</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>10</td>
<td>8.85</td>
<td>1</td>
<td>8.84</td>
<td>13.4</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>11</td>
<td>8.85</td>
<td>–1</td>
<td>–8.85</td>
<td>13.4</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>12</td>
<td>8.81</td>
<td>–2</td>
<td>–17.65</td>
<td>13.4</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>13</td>
<td>8.50</td>
<td>–3</td>
<td>–25.50</td>
<td>13.4</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>14</td>
<td>8.06</td>
<td>–4</td>
<td>–32.37</td>
<td>13.4</td>
<td>2.25</td>
<td>11.40</td>
</tr>
<tr>
<td>15</td>
<td>7.26</td>
<td>–5</td>
<td>–36.32</td>
<td>12.5</td>
<td>2.25</td>
<td>11.40</td>
</tr>
</tbody>
</table>

1 When using the example of processing the results as calculation template, here and further the substring "A2.9-" shall be excluded from the numbers of tables.
### Table A2.9-1

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>6.24</td>
<td>-6</td>
<td>37.40</td>
<td>14.70</td>
<td>2.25</td>
<td>11.40</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>5.09</td>
<td>-7</td>
<td>35.60</td>
<td>10.80</td>
<td>2.25</td>
<td>11.40</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>3.81</td>
<td>-8</td>
<td>30.37</td>
<td>10.00</td>
<td>2.25</td>
<td>11.40</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>2.68</td>
<td>-9</td>
<td>18.79</td>
<td>6.00</td>
<td>2.10</td>
<td>9.20</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>0</td>
<td>-10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

### Table A2.9-2

<table>
<thead>
<tr>
<th>Measurement No.</th>
<th>Ballast location and weight, kN</th>
<th>Weight of transferred ballast, kN</th>
<th>Transfer arm (&quot;+&quot; from port to starboard, &quot;−&quot; from starboard to port), m</th>
<th>Transfer moment (M = col.4 \times col.5), kN·m</th>
<th>Moment, kN·m, col. 6, summation from the top</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.85 3.75</td>
<td>3.93 3.91</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>3.75 3.85</td>
<td>3.93 3.91</td>
<td>3.75 3.56</td>
<td>+13.3</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>3.75 3.85</td>
<td>3.93 3.91</td>
<td>3.75 -3.56</td>
<td>-13.3</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>3.85 3.75</td>
<td>3.93 3.91</td>
<td>3.85 -3.56</td>
<td>-13.7</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>3.93 3.75</td>
<td>3.91 3.93</td>
<td>3.93 -3.56</td>
<td>-14.0</td>
<td>-14.0</td>
</tr>
<tr>
<td>6</td>
<td>3.91 3.93</td>
<td>3.85 -3.75</td>
<td>3.91 -3.56</td>
<td>-13.9</td>
<td>-27.9</td>
</tr>
<tr>
<td>7</td>
<td>3.93 3.91</td>
<td>3.91 3.93</td>
<td>3.91 -3.56</td>
<td>+13.9</td>
<td>-14.0</td>
</tr>
<tr>
<td>8</td>
<td>3.85 3.75</td>
<td>3.93 -3.75</td>
<td>3.93 -3.56</td>
<td>+14.0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table A2.9-3

| Measurement No. | Pendulum No. 1 with length \(\lambda_1 = 2960\) mm | Heeling angle increment \(\Delta \theta_i = \Delta \theta_i / \lambda_1\) | Pendulum No. 2 with length \(\lambda_2 = 3060\) mm | Heeling angle increment \(\Delta \theta_i = \Delta \theta_i / \lambda_2\) | \(\Delta \theta_{av}\) |
|-----------------|--------------------------------------------------|--------------------------------IMITER |--------------------------------------------------|--------------------------------------------------|-----------------|
| 0               | 0                                                | 0.0230                         | 80                                               | 0.0262                                           | 0.0264          |
| 1               | +68                                              | 0.0230                         | 77                                               | 0.0252                                           | 0.0241          |
| 2               | +68                                              | -0.0230                        | -77                                              | -0.0252                                          | -0.0241         |
| 3               | -68                                              | -0.0243                        | -80                                              | -0.0262                                          | -0.0252         |
| 4               | -72                                              | -0.0223                        | -81                                              | -0.0264                                          | -0.0244         |
| 5               | -66                                              | -0.0213                        | -73                                              | -0.0249                                          | -0.0231         |
| 6               | -63                                              | +0.0223                        | +80                                              | +0.0262                                          | +0.0242         |
| 7               | +66                                              | -0.0236                        | +80                                              | +0.0262                                          | +0.0249         |
| 8               | +70                                              | -0.0236                        | +80                                              | +0.0262                                          | +0.0249         |

### Table A2.9-4

<table>
<thead>
<tr>
<th>Measurement No.</th>
<th>Transfer moment (M_i), kN·m</th>
<th>(\Delta \theta_{av}), 10⁻²</th>
<th>(h_i) (=) (M_i / (D \Delta \theta_{av})), m</th>
<th>(\Delta h), 10⁻² (=) (h_{av} - h_i), 10⁻², m</th>
<th>(\Delta h), 10⁻⁸, m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>+13.7</td>
<td>+2.46</td>
<td>0.363</td>
<td>-0.5</td>
<td>0.25</td>
</tr>
</tbody>
</table>
### Calculation of coordinates of the ship's centre of gravity in test conditions

X-coordinate of the centre of gravity (from amidship):

\[ x_g = x_{cv} - \left( r_{yy} - h_c \right) \sin \psi = -0.15 -\]
\[ - \left( 1.26 - 0.368 \right) \cdot 0.008 = -0.16 \text{ m}. \]

Z-coordinate of the center of gravity (from the base plane):

\[ z_g = z_{cv} + \left( r_{yy} - h_c \right) \cos \psi =\]
\[ = 1.58 + \left( 1.26 - 0.368 \right) \cdot 1 = 2.47 \text{ m}. \]

### Root mean square deviation

\[ \sigma_h = \sqrt{\sum \left( h_i - h_b \right)^2 / (n(n-1))} =\]
\[ = \sqrt{\sum h_i \cdot 10^{-4} / (n(n-1))} =\]
\[ = \sqrt{10.14 \cdot 10^{-4} / (8 \cdot 7)} = 0.00426 \text{ m}. \]

### Calculation results of ship's particulars in lightship condition

#### Table A2.9-5

<table>
<thead>
<tr>
<th>Type of loading</th>
<th>Weight, kN</th>
<th>Arms, m</th>
<th>Moments, kN-m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ship in test conditions</td>
<td>1534.0</td>
<td>-0.16</td>
<td>-245.0</td>
</tr>
<tr>
<td>2 Missing loads from Table 8-1</td>
<td>13.3</td>
<td>6.24</td>
<td>1.76</td>
</tr>
<tr>
<td>3 Excessive loads from Table 8-2</td>
<td>-64.10</td>
<td>0.66</td>
<td>2.52</td>
</tr>
<tr>
<td>Light ship</td>
<td>( \Sigma 3 = 1481.0 )</td>
<td>-0.14</td>
<td>2.47</td>
</tr>
</tbody>
</table>

#### Table A2.9-6

<table>
<thead>
<tr>
<th>Ship’s particular</th>
<th>Values</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>from the inclining test data</td>
<td>from the design (Information on Stability and Floodability)</td>
</tr>
<tr>
<td>( D, \ t )</td>
<td>148.1</td>
<td>( T_{\rho} ), m</td>
</tr>
<tr>
<td>( x_g, \ m )</td>
<td>-0.13</td>
<td>( T_{\rho}^\prime ), m</td>
</tr>
<tr>
<td>( z_g, \ m )</td>
<td>2.47</td>
<td>( C, \ m^{0.5} ), s</td>
</tr>
</tbody>
</table>

Signatures of the members of committee

Inclining test manager

(signature)
CALCULATION OF ASSUMED HEELING MOMENT
FOR BULK GRAIN CARRIAGE

1 General assumptions

1.1 When calculating the adverse heeling moment due to a shift of cargo surface in ships carrying bulk grain it shall be assumed that:

.1 In filled compartments, which have been trimmed according to 3.2.10 of the present part of the Rules, a void exists under all boundary surfaces having an inclination to the horizontal less than 30° and that the void is parallel to the boundary surface having an average depth \( h_v \), mm, calculated by the formula:

\[
h_v = h_{sv} + 0.75 \left( h - 600 \right),
\]

where \( h_{sv} \) — standard void depth taken from Table A3.1.1.1, mm;

<table>
<thead>
<tr>
<th>Distance from the hatch end or hatch side to boundary of compartment, m</th>
<th>Standard void depth ( h_{sv} ), mm</th>
<th>Distance from the hatch end or hatch side to boundary of compartment, m</th>
<th>Standard void depth ( h_{sv} ), mm</th>
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<tr>
<td>0.5</td>
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<td>1.0</td>
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<td>6.5</td>
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<td>550</td>
</tr>
<tr>
<td>4.0</td>
<td>430</td>
<td>8.0</td>
<td>590</td>
</tr>
</tbody>
</table>

\( h \) — depth of the hatch girder (under-deck section of coaming) mm, which is taken equal to the depth of longitudinal girder of the hatch or hatch-end beam, whichever is less.

Value of \( h_v \) shall be taken not less than 100 mm;

.2 Within filled hatchways and in addition to any open void within the hatch cover, there is a void of average depth of 150 mm measured down to the surface of the grain from the lowest part of the hatch cover or the top of the hatch-side coaming, if it is located below the indicated part of the hatch cover;

.3 In a filled compartment which is exempted from trimming outside the hatchway according to 3.2.10.3 of the present Part of the Rules, it shall be assumed that the surface of grain after loading will slope into the void space underdeck, in all directions, at the angle of 30° to the horizontal from the edge of the opening which establishes the void;

**Note**: A distance from the hatch end or hatch side to boundary of the compartment (i.e. boundary surfaces) in the corner area shall be taken equal to the perpendicular distance from the line of the longitudinal hatch girder or the line of the hatch-end beam up to the boundary surfaces of the compartment, whichever is greater;

.4 In a filled compartment which is exempted from trimming in the ends of compartment and being considered as specially suitable according to 3.2.10.3 of the present Part of the Rules, it shall be assumed that the surface of grain after loading will slope in all directions away from the filling area at the angle of 30° to the horizontal from the lower edge of the hatch-end beam.
1.2 For ensuring the stability characteristics according to 3.2.9 of the present Part of the Rules the stability calculations shall be based upon the assumption that the center of gravity of cargo in a filled compartment, trimmed, is at the volumetric center of the whole cargo space. When it is permitted to take into account the effect of assumed underdeck voids on the vertical position of the center of gravity of the cargo in filled compartments, trimmed, it will be necessary to compensate for the adverse effect of the vertical shift of the surface of grain by increasing the assumed transverse heeling moment due to the transverse shift of grain according to 2.2 of the present Appendix.

In all cases the weight of cargo in a filled compartment, trimmed, shall be the volume of the whole cargo space divided by the stowage coefficient of grain.

1.3 The centre of gravity of grain in a filled compartment, untrimmed, shall be taken to be the volumetric centre of the whole cargo compartment without regard to voids. In all cases the weight of cargo shall be the volume of the cargo (resulting from the assumptions stated in 1.1.3 or 1.1.4) divided by the specific stowage coefficient of grain.

1.4 In partly filled compartments the adverse effect of the vertical shift of grain surfaces shall be taken into account by means of increasing the assumed volumetric heeling moment according to 2.2 of the present Appendix.

1.5 In calculating the maximum void area that can be formed against a longitudinal structural member, the effects of any horizontal surfaces, e.g. flanges or faces, shall be ignored.

1.6 The total areas of the initial and final voids shall be equal.

1.7 Longitudinal structural members, which are grain-tight, may be considered effective over their full depth except where they are provided as a device to reduce the adverse effect of grain shift. In the latter case the provisions of 3.2.10.6 of the present Part of the Rules shall apply.

1.8 After the assumed shift of grain the final void pattern in cross-sectional plane of the compartments shall be:

1 according to Fig. A3.1.8-1 when the compartment section within the length of hatch openings has no longitudinal division;

![Fig. A3.1.8-1](image1)

Notes. 1. If the maximum void area which can be formed under \(AB\) after grain shifting is less than the initial void area under \(AB\), i.e. the area \(AB\ h\), than the excess area \(AB\ h\) shall be added to the area of void formed under \(CD\) in the hatchway opening.

2. If the maximum void area which can be formed under \(CD\) after grain shifting is less than the initial void area under \(CD\), than the excess initial void area under \(CD\) shall be added to the area of void formed at the elevated side;

2 according to Fig. A3.1.8-2, if longitudinal bulkhead is present.

![Fig. A3.1.8-2](image2)

Notes. 1. If the maximum void area, which can be formed under \(AB\) after grain shifting, is less than the initial void area \(AB\ h\), than the excess area \(AB\ h\) shall be added to the area of void formed in the low half of the hatchway opening, i.e. under \(CD\).

2. If a centreline division is the division mentioned in 3.2.10.6 of the present Part of the Rules,
it shall extend to at least 0.6 m downwards the edge of point H or J, whichever gives the greater depth.

1.9 For filled compartments which are exempted from trimming outside the periphery of the hatchway according to 3.2.10.3 of the present Part of the Rules the following shall be assumed:

1. The resulting grain surface after shifting is sloped at an angle of 25° to the horizontal. However, if in any section of the compartment, forward, aft or abreast of the hatchway the mean transverse cross sectional area of that part of the compartment not filled with grain is equal to or less than the area which could be obtained by application of 1.1, then the angle of grain surface after shifting in that section shall be assumed to be 15° to the horizontal;

2. The cross sectional area of any part of the compartment the void area not filled with grain shall be assumed to be the same both before and after the grain shift.

1.10 For specially suitable filled compartments which are exempted from trimming forward and aft of the hatchway according to 3.2.10.3 of the present Part of the Rules the following shall be assumed:

1. The resulting grain surface after shifting is sloped at an angle of 15° to the horizontal;

2. The resulting grain surface forward and aft of the hatchway after shifting shall be assumed to be at an angle of 25° to the horizontal.

1.11 For partly filled compartments the resulting grain surface after shifting shall be assumed to be at an angle of 25° to the horizontal.

1.12 Bulkhead fitted in partly filled compartment shall be raised above the surface of the grain for 1/8 of the maximum breadth of the compartment and extended downwards the surface of the grain for the same distance.

1.13 When the longitudinal divisions fitted in the compartment do not reach its transverse boundaries or are made of several parts separated from each other by free spans, then such divisions or their parts may be considered as the effective means to prevent full width shifts of grain surfaces only for the length equal to the actual length of the division or its continuous portion less 2/7 of the greater of the transverse distances between the division and ship’s side.

2 Calculation of the heeling moment arms due to transverse shift of grain

2.1 The design heeling moment arm \( l_0 \) shall be determined by the formula, m:

\[
l_0 = \frac{M_{qy}}{\mu \Delta},
\]

where \( M_{qy} \) — assumed volumetric heeling moment, m^4;

\( \mu \) — volume of unit of the cargo (grain) weight, m^3/t;

\( \Delta \) — ship displacement, t.

2.2 Assumed volumetric heeling moment \( M_{qy} \) is calculated by the formula, m^4:

\[
M_{qy} = C_{vsc} M_{qyi}^L,
\]

where \( S_{vsc} \) — coefficient taking into account the adverse effect of vertical shift of the grain surface on the stability:

for filled compartments, trimmed 1.06
for partly filled compartments 1.12

\( M_{qyi}^L \) — total design volumetric heeling moment, m^4:

\[
M_{qyi}^L = \sum_{i=1}^{n} M_{qyi}^L,
\]

where \( n \) — number of compartments;

\( M_{qyi}^L \) — design heeling moment due to horizontal shift of cargo (grain) in \( i \)-th compartment \((i=1, 2...n)\), m^4:

\[
M_{qyi}^L = F_i y_i L_i,
\]

\( F_i \) — cross-sectional area of the compartment, m^2, filled with cargo; it is assumed that at the grain shift the area \( F_i \) is not changed, the trace of the resulting grain surface on the cross-section area of the compartment after
shift is a straight line inclined at 15° to the horizontal for filled compartments, trimmed and 25° for filled compartments, untrimmed and partly filled compartments;

\( y_i \) — value of horizontal shift, m, of the centre of gravity of the compartment cross-section area \( F_i \) at the grain shift (changing of the section configuration);

\( l_i \) — length of \( i \)-th hold.

2.3 Design heeling moment arm \( l_40 \), m:

\[ l_{40} = 0,8l_0. \]
REQUIREMENTS FOR FULL-SCALE TRIALS AND EXPERIMENTAL DATA TO CONFIRM STABILITY OF HOVERCRAFT

1. Trials shall be carried out on the lead ships which have undergone the inclining test according to the Instructions for Finding the Location of Ship’s Center of Gravity from Experiment given in Appendix 2.

2. The purpose of the trials is full-scale determination of heeling angles at inclining loads provided by 3.7 of the present Part of the Rules and different speed values.

3. When checking stability in hovering mode, the trials are carried out with the main blowers operating in full-load mode regardless of the ship’s speed.

4. The trials are conducted in the water area free of current, waves and wind. In case of current with permanent velocity and direction, the trials shall be conducted twice at each running mode, upstream and downstream.

5. For a single-propeller ship, the load required for inducing the design inclining moment shall be located to the side opposite to the direction of the propeller rotation.

6. Cargo shifting along the ship during the trials is prohibited.

7. The following shall be checked during the trials:
   .1 running the straight course at five or six values of the running speed from zero to the maximal speed at design inclining moments provided by 3.7 of the present Part of the Rules with continuous recording of the heeling angles;
   .2 turning at the maximum speed and speeds corresponding to the maximal heel on the straight course, at three values of rudder shifting angle including hardover positions, from zero position to port and starboard with continuous recording of the heeling angles. The rudder shall be reversed as quick as possible. Initial trim due to crowding of passengers shall be to the side external relatively to the turning centre.

8. The following shall be submitted to the River Register:
   .1 inclining test report;
   .2 trials report containing the data on the ship’s weight during the trials, forward and aft draught, position of the centre of gravity along the ship’s height and length, initial metacentric height, water depth, presence of current and weather conditions during the trials, data on records and measurements done according to the program;
   .3 processed measurement results as the heeling angle versus straight ahead speed graph at inclining moments provided by 3.7 of the present Part of the Rules and the maximum heeling angle at turning versus the rudder angle and initial turning speed graph at inclining moments provided by 3.7 of the present Part of the Rules.
MANEUVRABILITY CALCULATIONS AND FULLSCALE MANEUVRABILITY TRIALS OF INLAND AND RIVER-SEA NAVIGATION SHIPS

1 General provisions

1.1 The present Appendix shall be used for calculation of criteria regulating the ships manoeuvrability and for full-scale manoeuvrability trials according to requirements given in 6 of the present Part of the Rules.

2 Terms and definitions

2.1 The following designations have been adopted in the present Appendix:

- $A_0$ — propeller disc area, m$^2$; $A_0 = \pi D^2/4$;
- $A_e$ — propeller disc expanded area, m$^2$;
- $A_r$ — rudder blade area, m$^2$;
- $A'_r$ — part of the rudder blade area located within the propeller jet, m$^2$;
- $A''_r$ — part of the rudder blade area located outside the propeller jet, m$^2$;
- $B$ — ship’s breadth, m;
- $C_b$ — block coefficient of the ship hull;
- $C_{TT0}$, $C_{T0}$ — load coefficients at nominal running mode (at $v_0$ and $n_0$);
- $C_k$ — the characteristic of the hull;
- $D$ — propeller diameter, mm;
- $D_1$ — steady turning diameter, m;
- $D/L = 2/\Omega$: relative steady turning diameter;
- $k_v$ — speed increasing coefficient near the PSU at a nonlinear motion of the ship;
- $L$ — ship length, m;
- $l_a$ — nozzle length, m;
- $l'_a$ — relative nozzle length: $l'_a = l_a/D$;
- $m$ — ship mass, t;
- $n$ and $n_m$ — rotation frequency of the propeller, s$^{-1}$ and min$^{-1}$, respectively;
- $n_0$ — rated rotation frequency of the propeller, s$^{-1}$;
- $R$ — water resistance to the ship’s motion, N;
- $R_0$ — water resistance to the ship’s motion at $v_0$, N;
- $P$ — propeller pitch, m;
- $S$ — windage area, m$^2$;
- $T$ — ship draught, m;
- $t$ — time, s;
- $v$ and $v_s$ — ship speed, m/s and km/h, respectively;
- $v'$ — ship speed droop at a nonlinear motion;
- $v_0$ — ship speed at rated rotation frequency of all propellers, m/s;
- $V_a$ — wind velocity in navigational zone, m/s;
- $v_a$ — PSU inflow velocity, m/s;
- $w$ — wake coefficient at the straight course motion of the ship;
- $w'$ — wake coefficient at a nonlinear motion of the ship;
- $x_r$, $x'_r = x_r/D$ — distance, m, and a relative distance of rudder profile leading edge from the plane of open propeller disc, or from nozzle trailing edge, measured along the propeller axis;
- $z$ — number of PSUs in the ship PSS;
- $\delta$ — propeller jet angle at a nozzle angle $\delta$, degrees;
- $\lambda$ — aspect ratio of a rudder blade;
\( \lambda'_r \) — aspect ratio of a rudder blade located within the propeller jet;
\( \lambda''_r \) — aspect ratio of a rudder blade located outside the propeller jet;
\( \rho \) — water density, kg/m³.

2.2 The terms used in this Appendix should be understood as follows:

1. Non-dimensional lateral force of the PSU \( C_y \) means lateral force of the PSU \( Y_r, N \), related to \( \rho v_a^2 A_0/2 \);
2. Non-dimensional rate of turn of the ship \( \Omega \) means ratio between the ship's rate of turn, \( \omega, \) degree/s, and the value 57,3 \( \times v/L \);
3. Damping force means an anti-rotation force dependent on the ship's rate of turn;
4. Propeller thrust loading coefficient \( C_{\ominus} \) means propeller thrust \( \Theta, N \), related to \( \rho v_a^2 A_0/2 \);
5. PSU "propeller in nozzle" loading coefficient \( \Psi \) means thrust \( T_e, N \), related to \( \rho v_a^2 A_0/2 \);
6. Advance ratio \( J_p \) of propeller (PSU "propeller in nozzle") means ratio between the PSU water inflow speed \( v_a, m/s \) and the product of propeller rotation frequency \( n, s^{-1} \), with the propeller diameter \( D, m \);
7. Aspect ratio of a rudder blade (a part of a rudder blade) means ratio between the depth of the rudder or its part (nozzle stabilizer or its part) to the relevant chord; for the complex planeform means ratio between the planeform area and the squared chord, or ratio between the squared depth and the planeform area;
8. Positional force means force dependent on a drift angle (ship), a rudder angle (steering equipment);
9. Ship's rate of turn \( \alpha \) means ratio of the course angle deviation to its deviation time, degree/s;
10. Drift angle \( \beta \) means angle between the centre line and speed direction in the center of gravity of the ship, degrees;
11. Drift angle \( \beta_{\text{ash}} \) means drift angle in aft part of the ship (angle of PSU water inflow), degrees;
12. Rudder angle \( \delta \) means steering equipment angle as related to the centre line, degrees;
13. Propeller thrust \( T_p \) means force generated by the propeller along the centre line and applied to thrust bearing, N;
14. PSU "propeller in nozzle" thrust \( T_e \) means total force generated by the nozzle propeller along the centre line, N.

3 General instructions on manoeuvrability calculation

3.1 The present Appendix provides for calculation of manoeuvrability criteria values for the following types of the PSSs:
1. propellers in steering nozzles;
2. propellers in steering nozzles with a centre rudder;
3. rudders behind open propellers;
4. rudders behind nozzle propellers.

3.2 When using tables, diagrams and charts of the present Appendix, intermediate values of initial characteristics shall be determined by means of linear interpolation.

4 Turning capability

4.1 Minimum relative steady turning diameter \( (D_1/L)_{\text{min}} = 2/\Omega_{\text{max}} \) shall be determined by finding \( \Omega_{\text{max}} \) x-coordinate of intersection of curves \( C_{\Theta}(\Omega) \) and \( C_{\Theta}(\Omega) \), built on the same diagram as a function of non-dimensional rate of turn of the ship \( \Omega \) (Fig. A5.4.1).

4.2 Characteristics of the hull \( C_{\Theta}(\Omega) \) and characteristics of hull/PSU interaction (wake coefficient \( w', \) speed droop \( v'' \), coefficient of increasing PSU inflow speed \( k_v \)) shall be calculated according to Table A5.4.2:
1. for each drift angle specified in Table A5.4.2, values \( \Omega \) and \( C_{\Theta} \) shall be determined by using known values \( \beta B/T, T/L \) (and \( C_{\Theta} — \) for passenger ships) and basing on a chosen diagram (Fig. A5.4.2-1 – A5.4.2-4). The dia-
grams shown on Fig. A5.4.2-1 – A5.4.2-4, shall be used for tracing hull performance curve $C_{yk}(\Omega)$ when calculating turning capability, directional stability and manoeuvrability with propulsors not in operation. Each diagram (Fig. A5.4.2-1 for cargo ships, Fig. A5.4.2-2 – A5.4.2-4 for passenger ships with various block coefficients $C_b$) is subdivided into five subdiagrams conforming to values $B/T$: 3.5; 4.5; 5.5; 6.5; 7.5. Each diagram has a grid of curves $T/L$ within the range of values from 0.02 to 0.04 and that of curves within the range of values from 5° to 40°.

Calculation of characteristics of the hull $C_{yk}(\Omega)$ provides that a necessary diagram is selected basing on the ship type and block coefficient $C_b$, a subdiagram and a relevant curve thereof are selected basing on the ratio $B/T$. Non-dimensional rate of turn of the ship $\Omega (X$-axis) and characteristics of the hull $C_{yk}(\Omega)$ (Y-axis) shall be determined by given values of drift angles $\beta$ (subdiagram curves). It shall be noted that each subdiagram has its own Y-axis;

2 angle PSU water inflow $\beta_{stem}$ at the stern, degrees, shall be calculated by the formula:

$$\beta_{stem} = \chi \arctan (\tan \beta + 0.475 \Omega / \cos \beta),$$  

(A5.4.2.2)

where $\chi = 1.0$ for stern PSU; $\chi = 0.8$ for center line PSU;

3 wake coefficient $w'$ for single- and double-propeller ships shall be calculated by the formula:

$$w' = \begin{cases} w_p \left[ 1 - \left( \frac{\beta}{45} \right)^6 \right] & \text{if } \beta < 45^\circ \\ w_p & \text{if } \beta \geq 45^\circ \end{cases}$$  

(A5.4.2.3-1)

where $w_p$ — wake coefficient by calculation of the ship's propulsion performance.

4 the ship speed droop $v'$ on steady turning shall be calculated by the formula:

$$v' = \Omega + 2.61 - 0.70 \tan \Omega,$$  

(A5.4.2.4)

5 coefficient of increase of PSU water inflow $k_v$ shall be calculated by the formula:

$$k_v = \frac{\cos \beta}{\cos \beta_{stem}}.$$  

(A5.4.2.5)

6 auxiliary coefficient $\varphi$ shall be calculated by the formula:

$$\varphi = \pi \rho D^2 (1 - w')^2 / (4LT).$$  

(A5.4.2.6)

Table A5.4.2  Manoeuvrability calculation performances

<table>
<thead>
<tr>
<th>Values to be calculated</th>
<th>$\beta$</th>
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<tr>
<td>$\Omega$ – Fig. A5.4.2-1 – A5.4.2-4</td>
<td>$5^\circ$</td>
</tr>
<tr>
<td>$C_{yk}$ - Fig. A5.4.2-1 – A5.4.2-4</td>
<td>$\beta_{stem}$ – formula (A5.4.2.2)</td>
</tr>
</tbody>
</table>

Fig. A5.4.1. Diagram for calculating the maximum nondimensional rate of turn $\Omega_{max}$.
Fig. A5.4.2-1. Diagram $\Omega$ vs. $C_{\delta}$ for cargo ships

Fig. A5.4.2-2. Diagram $\Omega$ vs. $C_{\delta}$ for passenger ships at $0.55 > C_{\delta} \geq 0.45$
Fig. A5.4.2-3. Diagram $\Omega$ vs. $C_{yi}$ for passenger ships at $0.65 > C_b \geq 0.55$

Fig. A5.4.2-4. Diagram $\Omega$ vs. $C_{yi}$ for passenger ships at $0.75 \geq C_b \geq 0.65$
4.3 Nondimensional lateral force of the PSS of any type shall be calculated using Tables A5.4.4, A5.4.7, A5.4.9, A5.5.4, A5.5.7, A5.5.9.

4.4 Nondimensional lateral force of PSS "propellers in steerable nozzles" and "propellers in steerable nozzles + center rudder" shall be calculated according to Table A5.4.4. Angle $\delta_m = 32^\circ$ shall be taken as the maximum nozzle angle. Propeller thrust increasing coefficient $q_t$ at nozzle deflection shall be taken equal to 1.40.

Calculation at drift angles $\beta = 5^\circ$, $10^\circ$, $15^\circ$ may be omitted.

<table>
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<tr>
<th>Table A5.4.4</th>
<th>For calculating nondimensional lateral force of PSS</th>
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<tbody>
<tr>
<td>Values to be calculated</td>
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<tr>
<td>$J_p$ – formula (A5.4.6.1)</td>
<td>$5^\circ$</td>
</tr>
<tr>
<td>$C_{TT}$ – Fig. A5.4.6.2</td>
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<tr>
<td>$C_1$ – Fig. A5.4.6.3</td>
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<td>$A_y$ – formula (A5.4.6.4)</td>
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<td>$k_\delta$ from Table A5.4.6.5</td>
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<td>$B_y$ – formula (A5.4.6.6)</td>
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<td>$k_\beta$ from Table A5.4.6.7</td>
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<td>$D_y$ – formula (A5.4.6.8)</td>
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<td>$\Delta C_y$ – formula (A5.4.6.9)</td>
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<td>$C_y$ – formula (A5.4.6.10)</td>
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<tr>
<td>$C_{yr}$ – formula (A5.4.6.11)</td>
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</table>

4.5 Initial values for calculation of PSU "propeller in nozzle" performance according to Table A5.4.4, shall be calculated by the following formulas and Tables:

1. Angle of propeller jet deflection by steerable nozzle $\delta^*$ – by the formula for nozzles:
   - without stabilizer $\delta^* = 28.0 - 30.5(\ell_0 - 0.6)$
   - with stabilizer $\delta^* = 32.0 - 15.0(\ell_0 - 0.6)$
   (A5.4.5.1);

2. PSU thrust decreasing coefficient $q_{TT}$ by the formula for nozzles:
   - without stabilizer $q_{TT} = 0.75 - 0.25(\ell_0 - 0.6)$
   - with stabilizer $q_{TT} = 0.70 - 0.07(\ell_0 - 0.6)$
   (A5.4.5.2);

3. Coefficient of lift force of steerable nozzle as foil ring – by the formula:
   $$\mu = 1.67 + 4.11\ell_0' - 1.11(\ell_0')^2.$$
   (A5.4.5.3)

4.6 The values included in Table A5.4.4, shall be calculated using data of Table A5.4.2 by the following formulas, tables and diagrams:

1. Propeller advance ratio $J_p$ – by the formula:
   $$J_p = v_0v'(1 - \varphi)k_c/(D\ell_0);$$
   (II5.4.6.1)

2. PSU "propeller in nozzle" thrust loading coefficient $C_{TT}$ – from diagram (Fig. A5.4.6.2);

3. Propeller thrust loading coefficient $C_T$ – by the diagram (Fig. A5.4.6.3);

4. Auxiliary value $A_y$ – by the formula:
Fig. A5.4.6.3. Propeller in nozzle thrust loading coefficient

\[ A_y = q_{TT} C_{TT} \left( \sqrt{1 + q_T C_T \cos \delta^* - \cos \beta_{stem}} \right), \]

where \( \beta_{stem} \) shall be calculated by the formula (A5.4.6.4);

5 auxilary coefficient \( k_{\delta} \) – from Table A5.4.6.5;

6 positional component of non-dimensional lateral force of the PSU \( B_y \) – by the formula:

\[ B_y = \left( A_y \sqrt{1 + q_T C_T^2 + \mu \cos \beta_{stem}} \right) \cdot k_{\delta} \sin \delta^*; \]

(A5.4.6.6)

7 auxiliary coefficient \( k_{\beta} \) – from Table A5.4.6.7;

8 damping component of nondimensional lateral force of the PSU \( D_y \) – by the formula:

\[ D_y = \left( A_y + \mu \cos \delta^* \right) \cdot k_{\beta} \sin \beta_{stem}; \]

(A5.4.6.8)

9 if the nozzle stabilizer has a section with area \( A_{stab}' \), m², and aspect ratio (ratio of the average depth of this stabilizer section to its length) \( \lambda_{stab}' \), which is projected upward from the propeller jet, an additional nondimensional damping lateral force \( \Delta C_{stab} \) by the formula:

\[ \Delta C_{stab} = 0.143 \lambda_{stab}' A_{stab}^* \left( 32 - \beta_{stem} \right) \cos \beta_{stem} / \left( 1 + \lambda_{stab}' \cdot D^2 \right) ; \]

(A5.4.6.9)

Table A5.4.6.5

<table>
<thead>
<tr>
<th>( C_{TT} )</th>
<th>( k_{\delta} ) at ( \lambda_{stab}' )</th>
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<tr>
<td>35.0</td>
<td>0.93 1.07 1.20 1.24</td>
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Table A5.4.6.7

<table>
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<td>8.0</td>
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<td>0.55 0.72 0.82 0.90</td>
</tr>
<tr>
<td>35.0</td>
<td>0.55 0.73 0.84 0.90</td>
</tr>
</tbody>
</table>
if a double-propeller ship fitted with propellers in nozzles has an additional centre rudder with area $A_r$ and aspect ratio $\lambda_r$, which is deflected at angle $\kappa$ times more than the nozzle angle, an additional non-dimensional lateral force $C_y$ shall be calculated by the formula:

$$
C_p = \begin{cases} 
0.140 \lambda_p A_p \left( \frac{32 \kappa - \beta_{stem}}{2 + \lambda_p} \right) & \text{if } \kappa < 1.5 \\
0 & \text{if } \kappa \geq 1.5
\end{cases}
$$

(A5.4.6.10)

where $\beta_{stem}$ shall be calculated by the formula (A5.4.2.2) for centerline PSU.

If the PSS does not include a centre rudder, $C_y = 0$;

11 non-dimensional lateral force $C_y$ of PSU "propeller in steerable nozzles" and "propellers in steerable nozzles + centre rudder" shall be calculated by the formula:

$$
C_y = \phi \left[ 0.81 \left( B_y + D_y \right) + \Delta C_{stab} + 0.5 C_{pr} \right].
$$

(A5.4.6.11)

4.7 Nondimensional lateral force of PSS "rudders behind open propellers" shall be calculated according to Table A5.4.7. Angle $\delta_{m} = 35^\circ$ shall be taken as the maximum possible rudder angle $\delta$.

Calculation at drift angles $\beta = 5^\circ$, $10^\circ$, $15^\circ$ may be omitted.

4.8 The values included in Table A5.4.7, shall be calculated using data given in respective columns of Table A5.4.2 by the following formulas, tables and diagrams:

1. propeller advance ratio $J_p$ by the formula (A5.4.6.1);
2. propeller thrust loading coefficient $C_T$ by the diagram on Fig. A5.4.8;
3. lateral force PSU loading coefficient derivative with respect to deflection angle $C_y$ – from Table A5.4.8.3;
4. upwash coefficient $k_\beta$ – from Table A5.4.8.4;
5. coefficient $k_p$ – from Table A5.4.8.5 in relation to $C_T$.

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<tr>
<th>$\beta$</th>
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<th>15°</th>
<th>20°</th>
<th>25°</th>
<th>30°</th>
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<td></td>
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<td></td>
</tr>
<tr>
<td>$C_y$</td>
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<td></td>
</tr>
<tr>
<td>$k_\beta$</td>
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<td></td>
</tr>
<tr>
<td>$k_p$</td>
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Table A5.4.7

For calculating nondimensional lateral force of PSS "rudders behind open propellers"
Table A5.4.8.3
Lateral force PSU loading coefficient derivative
with respect to deflection angle $C_T y$

<table>
<thead>
<tr>
<th>$C_T$</th>
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<th>$C_T$</th>
<th>$C_T^y$</th>
</tr>
</thead>
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<td>14.0</td>
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</tr>
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</tr>
<tr>
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<td>7.11</td>
<td>4.0</td>
<td>25.0</td>
</tr>
<tr>
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<td>4.5</td>
<td>28.9</td>
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<td>8.09</td>
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Table A5.4.8.4
Upwash coefficient $k_\beta$

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<td>0.27</td>
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Table A5.4.8.5
Coefficient $k_\sigma$

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<tr>
<td>9.0</td>
<td>1.18</td>
<td>9.0</td>
<td>1.04</td>
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Note: $x_p'=x_p/D$ — relative distance of the rudder profile leading edge from the plane of the propeller disc measured along the propeller axis.

If the rudder section projected from the propeller jet has aspect ratio $\lambda_\sigma^* \leq 0.1$, $k_\sigma = 1.0$ shall be taken;

Coefficient $a_\sigma$ for a value correction $\lambda_\sigma^*$ from 1.0, – by the formula:

$$ a_\sigma = (2\lambda_\sigma^* + \lambda_\sigma^* - 1)(4\lambda_\sigma^* k_{\lambda_\sigma} - 3\lambda_\sigma^* - 4k_{\lambda_\sigma} + 6)/\left[\lambda_\sigma^*(\lambda_\sigma^* + 1)(\lambda_\sigma^* + 2)\right]; $$

(A5.4.8.6)

Coefficient $b_\sigma$ for an effect of the rudder section projected from the propeller jet – by the formula:

$$ b_\sigma = 8\lambda_\sigma^* A_y \left[ (1 + \lambda_\sigma^*) D^2 \right]; $$

(A5.4.8.7)

Non-dimensional lateral force $A_y$ generated by the rudder section located within the propeller jet – by the formula:

$$ A_y = 0.0175 a_\sigma C_T \left( \delta - k_{\lambda_\sigma} \beta_{\text{stern}} \right); $$

(A5.4.8.8)

Non-dimensional lateral force $B_y$ generated by the rudder section located within the propeller jet – by the formula:

$$ B_y = 0.0175 b_\sigma \left( \delta - \beta_{\text{stern}} \right); $$

(A5.4.8.9)

Non-dimensional damping force $C_{pr}$ generated on the propeller – by the formula:

$$ C_{pr} = -0.0175 \left( k_{\lambda_\sigma} + k_{2y} \sqrt{C_T} \right) \beta_{\text{stern}}; $$

(A5.4.8.10)

where $k_{\lambda_\sigma} = 0.177 P/D + 0.087 \left( A_y / A_0 - 0.55 \right)$

$K_{2y} = \left[ 0.257 + 0.233 \left( A_y / A_0 - 0.55 \right) \right] \cdot (P/D)^2 +$

$\left[ 0.067 - 0.018 \left( A_y / A_0 - 0.55 \right) \right];$

(A5.4.8.11)

Coefficient of PSU/hull dynamic interaction $k_y$ – by the formula:

$$ k_y = 1 - a \left( \delta - 11.5 \right), $$

where $a$ is taken as follows for the following ships:
double-propeller 0.022
single- and three-propeller 0

.12 nondimensional lateral force $C_y$ of PSS "rudders behind open propellers" – by the formula:

$$C_y = \varphi \left( A_y + B_y \right) + k_y + C_{pr}$$  \hspace{1cm} (A5.4.8.12)

4.9 Nondimensional lateral force of PSS "rudders behind propellers in nozzles" shall be calculated using Table A5.4.9. Angle $\delta_m = 35^\circ$ shall be taken as the maximum possible rudder angle $\delta$.

<table>
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<th>Values to be calculated</th>
<th>$5^\circ$</th>
<th>$10^\circ$</th>
<th>$15^\circ$</th>
<th>$20^\circ$</th>
<th>$25^\circ$</th>
<th>$30^\circ$</th>
<th>$35^\circ$</th>
<th>$40^\circ$</th>
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<td>$C_T$ – Fig. A5.4.6.3</td>
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</tr>
<tr>
<td>$C_T$ – from Table A5.4.10.4</td>
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<td>$B_y$ – formula (A5.4.8.9)</td>
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<td>$C_{pr}$ – formula (A5.4.8.12)</td>
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</table>

Calculation at drift angles $\beta = 5^\circ$, $10^\circ$, $15^\circ$ may be omitted.

4.10 The values included in Table A5.4.9, shall be calculated using data of Table A5.4.2 by the following formulas, tables and diagrams:

.1 propeller advance ratio $J_p$ – by the formula (A5.4.6.1);
.
.2 PSU "propeller in nozzle" thrust loading coefficient $C_T$ – by the diagram on Fig. A5.4.6-1;
.
.3 propeller thrust loading coefficient $C_t$ – by the diagram on Fig. A5.4.6-2;
.
.4 PSU loading derivative with respect to lateral force $C_y^\delta$ – from Table A5.4.10.4;
.
.5 upwash $\Delta \beta$ – from Table A5.4.10.5;

| Values of PSU loading derivative with respect to lateral force $C_y^\delta$ |
|-----------------------------|----------|----------|----------|----------|
| $C_T$ | $C_y^\delta$ | $C_T$ | $C_y^\delta$ |
| 1.0 | 3.60 | 10 | 10.2 |
| 1.5 | 4.03 | 12 | 11.4 |
| 2.0 | 4.60 | 14 | 12.7 |
| 2.5 | 5.00 | 16 | 14.0 |
| 3.0 | 5.33 | 18 | 15.2 |
| 3.5 | 5.73 | 20 | 16.8 |
| 4.0 | 6.14 | 25 | 20.0 |
| 4.5 | 6.50 | 30 | 23.4 |
| 5.0 | 6.86 | 35 | 27.0 |
| 6.0 | 7.50 | 40 | 30.5 |
| 8.0 | 8.86 | 45 | 34.0 |
| 9.0 | 9.48 | 50 | 37.5 |

.6 coefficient $k_\alpha$ – from Table A5.4.8.5 in relation to $C_{TT}$;
.
.7 coefficient $a_t$ for a value correction $\lambda'_t$ from 1.0, – by the formula (A5.4.8.6);
.
.8 coefficient $b_t$ for an effect of the rudder section projected from the propeller jet – by the formula (A5.4.8.7);
.
.9 non-dimensional lateral force $A_y$ generated by the rudder section located within the propeller jet – by the formula:

$$A_y = 0.0175 a_t C_y \left( \delta - \Delta \beta \right); \hspace{1cm} (A5.4.10.9)$$
.
.10 non-dimensional lateral force $B_y$ generated by the rudder section projected from the propulsors jet – by the formula (A5.4.8.9);
.
.11 auxiliary coefficient $k_\beta$ – from Table A5.4.6.7;
.
.12 non-dimensional damping force $C_{pr}$ generated on the PSU "propeller in nozzle" – by the formula:
Table A5.4.10.5

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<th>( \Delta \beta ) at ( C_T ) if ( x_p' \leq 0.5 )</th>
<th>( \Delta \beta ) at ( C_T ) if ( x_p' &gt; 0.5 )</th>
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</thead>
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<tr>
<td>10°</td>
<td>3°</td>
<td>2°</td>
</tr>
<tr>
<td>20°</td>
<td>4°</td>
<td>2.5°</td>
</tr>
<tr>
<td>30°</td>
<td>7.5°</td>
<td>4°</td>
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<tr>
<td>40°</td>
<td>10°</td>
<td>11°</td>
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<tr>
<td>45°</td>
<td>17.5°</td>
<td>13°</td>
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<tr>
<td>50°</td>
<td>21°</td>
<td>16°</td>
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<tr>
<td>55°</td>
<td>26°</td>
<td>19°</td>
</tr>
<tr>
<td>60°</td>
<td>30°</td>
<td>24°</td>
</tr>
</tbody>
</table>

Note: \( x_p' = x_p / D \) — a relative distance of the rudder profile leading edge from the nozzle trailing edge, measured along the propeller axis.

\[
C_{pr} = -k_y \left( C_{TT} / \left( \sqrt{1 + C_T} - \cos \beta_{\text{stern}} \right) + \mu \right) \times \sin \beta_{\text{stern}},
\]

(A5.4.10.12)

where coefficient \( \mu \) shall be calculated by the formula (A5.4.5.3);

.13 coefficient of PSU/hull dynamic interaction \( k_y \) by the formula:

\[
k_y = 1 - 0.011(\delta - 11.5); \quad (A5.4.10.13)
\]

.14 non-dimensional lateral force \( C_{yr} \) of PSS "rudders behind propellers in nozzle" shall be calculated by the formula (A5.4.8.12).

5 Directional stability

5.1 Relative steady turning diameter with the rudders angle \( D_{\text{turn}} / L \) at zero shall be determined by finding a zero x-coordinate \( \Omega_0 \) of intersection of curves \( C_{ik}(\Omega) \) and \( C_{yr}(\Omega) \), built on the same diagram as a function of nondimensional rate of turn of the ship \( \Omega \)(see Fig. A5.5.1). If curves \( C_{ik}(\Omega) \) and \( C_{yr}(\Omega) \) do not intersect, the ship is considered as straight course stable, relative diameter of her steady turning with the rudders angle at zero \( D_{\text{turn}} / L \) = \( \infty \), nondimensional rate of turn \( \Omega_0 = 0 \).

5.2 Characteristics of the hull \( C_{ik}(\Omega) \) calculated according to A5.4.2 may be used as characteristics of the hull \( C_{ik}(\Omega) \), for calculating directional stability.

5.3 Nondimensional lateral force of PSS of any type shall be calculated using Tables A5.5.4, A5.5.7, A5.5.9. The rudder angle \( \beta \) is taken equal to zero. Calculations only at drift angles \( \beta = 5°, 10°, 15° \) will be sufficient.

5.4 Non-dimensional lateral force of PSS "propellers in steerable nozzles" and "propellers in steerable nozzle + centre rudder" shall be calculated according to Table A5.5.4.

5.5 Values \( \mu \) for calculation of non-dimensional lateral force of PSS "propellers in steerable nozzles" according to Table A5.5.4 shall be calculated by the formula (A5.4.5.3).
For calculating nondimensional lateral force of PSS "propellers in steerable nozzles" and "propellers in steerable nozzle + centre rudder".

<table>
<thead>
<tr>
<th>Values to be calculated</th>
<th>( J_p ) - formula (A.5.4.6.1)</th>
<th>( C_T ) - Fig. A.5.4.6.2</th>
<th>( C_T ) - Fig. A.5.4.6.3</th>
<th>( A_y ) - formula (A.5.5.6.4)</th>
<th>( k_\beta ) - from Table A.5.4.6.7</th>
<th>( D_y ) - formula (A.5.5.6.6)</th>
<th>( C_\alpha ) - formula (A.5.5.6.8)</th>
<th>( C_\eta ) - formula (A.5.5.6.9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( 5^\circ )</td>
<td>100°</td>
<td>150°</td>
<td>200°</td>
<td>250°</td>
<td>300°</td>
<td>350°</td>
<td>400°</td>
<td></td>
</tr>
</tbody>
</table>

\[ J_p \]

\[ C_T \]

\[ A_y \]

\[ k_\beta \]

\[ D_y \]

\[ C_\alpha \]

\[ C_\eta \]

5.6 The values included in Table A.5.5.4 shall be calculated using data of Table A.5.4.2 by the following formulas, tables and diagrams:

1. Propeller advance ratio \( J_p \) - by the formula (A.5.4.6.1);

2. PSU "propeller in nozzle" thrust loading coefficient \( C_T \) - by the diagram on Fig. A.5.4.6.1;

3. Propeller thrust loading coefficient \( C_T \) - by the diagram on Fig. A.5.4.6.2;

4. Auxiliary value \( A_y \) - by the formula:

\[ A_y = C_{TT} \left( \sqrt{1 + C_{TT}} - \cos \beta_{stern} \right) \]  \hspace{2cm} (A.5.5.6.4)

where \( \beta_{stern} \) shall be calculated by the formula (A.4.2.2);

5. Auxiliary coefficient \( k_\beta \) - from Table A.5.4.6.7;

6. Damping component of nondimensional lateral force of the PSU \( D_y \) - by the formula:

\[ D_y = -\left( A_y + \mu \right) k_\beta \sin \beta_{stern} \]  \hspace{2cm} (A.5.5.6.6)

If the nozzle stabilizer has a section with area \( A_{stab} \), \( m^2 \), and aspect ratio (ratio of the average depth of this stabilizer section to its length) \( \lambda_{stab} \), which is projected upward from the propeller jet, an additional nondimensional damping lateral force \( \Delta C_{stab} \) shall be calculated by the formula:

\[ \Delta C_{stab} = -0.14 \lambda_{stab} A_{stab} \cos \beta_{stern} \int \left( 1 + \lambda_{stab} \right)^{-2} \right] \]  \hspace{2cm} (A.5.5.6.7)

8. If a double-propeller ship fitted with nozzle propellers has an additional centre rudder with area \( A_r \) and aspect ratio \( \lambda_r \), an additional non-dimensional damping lateral force \( C_r \) shall be calculated by the formula:

\[ C_r = -0.14 \lambda_r A_r \cos \beta_{stern} \int \left( 2 + \lambda_r \right)^{-2} \right] \]  \hspace{2cm} (A.5.5.6.8)

where \( \beta_r \) shall be calculated by the formula (A.4.2.2) for centerline PSU.

If the PSS does not include the centre rudder, \( C_r = 0 \);  

9. Non-dimensional lateral force \( C_\eta \) of PSS "rudders behind open propellers" shall be found from Table A.5.5.7. The rudder angle \( \delta \) shall be taken \( \delta = 0^\circ \). Calculation at drift angles \( \beta = 20^\circ, 25^\circ, 30^\circ, 35^\circ, 40^\circ \) may be omitted.

5.8 The values included in Table A.5.5.7 shall be calculated using data of Table A.5.4.2 by the following formulas, tables and diagrams:

1. Propeller advance ratio \( J_p \) - by the formula (A.5.4.6.1);

2. Propeller thrust loading coefficient \( C_T \) - by the diagram on Fig. A.5.4.8;

3. PSU loading derivative with respect to lateral force \( C_\eta \) - from Table A.5.4.8.3;

4. Upwash coefficient \( k_\beta \) - from Table A.5.4.8.4;

5. Coefficient \( k_\alpha \) - from Table A.5.4.8.5;

6. Coefficient \( a_r \) for a value correction \( \lambda_r \) from 1.0. - by the formula (A.5.4.8.6);
For calculating nondimensional lateral force of PSS "rudders behind open propellers"

<table>
<thead>
<tr>
<th>β (°)</th>
<th>5°</th>
<th>10°</th>
<th>15°</th>
<th>20°</th>
<th>25°</th>
<th>30°</th>
<th>35°</th>
<th>40°</th>
</tr>
</thead>
<tbody>
<tr>
<td>( J_p ) – formula (A5.4.6.1)</td>
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<tr>
<td>( C_T ) – Fig. A5.4.8</td>
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<tr>
<td>( C_{TP} ) – from Table A5.4.8.3</td>
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<tr>
<td>( k_{\beta} ) – from Table A5.4.8.4</td>
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<tr>
<td>( k_a ) – from Table A5.4.8.5</td>
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<tr>
<td>( a_{a_{\gamma}} ) – formula (A5.4.8.6)</td>
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<tr>
<td>( b_{a_{\gamma}} ) – formula (A5.4.8.7)</td>
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<tr>
<td>( A_{\gamma} ) – formula (A5.5.8.8)</td>
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<tr>
<td>( B_{\gamma} ) – formula (A5.5.8.9)</td>
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<tr>
<td>( C_{\gamma} ) – from Table A5.5.8.10</td>
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<tr>
<td>( C_{\gamma} ) – formula (A5.5.8.11)</td>
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</tbody>
</table>

5.7 Coefficient \( h \) for an effect of the rudder section projected from the propeller jet – by the formula (A5.4.8.7);

5.8 Non-dimension damping force \( A_{\gamma} \) generated by the rudder section located within the propeller jet – by the formula:

\[
A_{\gamma} = -0.0175a_{\gamma}C_{\gamma}k_{\beta}B_{\text{stem}}; \quad (A5.5.8.8)
\]

5.9 Non-dimension damping lateral force \( B_{\gamma} \) generated by the rudder section projected from the propeller jet – by the formula:

\[
B_{\gamma} = -0.0175h_{\beta}B_{\text{stem}}; \quad (A5.5.8.9)
\]

5.10 The values included in Table A5.5.9 shall be calculated using data of Table A5.4.2 by the following formulas, tables and diagrams:

5.4 PSU loading derivative with respect to lateral force \( C_{\gamma} \) – from Table A5.4.10.4;

5.5 Upwash coefficient \( k_{\beta} \) – from Table A5.5.10.5;

5.6 Coefficient \( k_a \) – from Table A5.4.8.5 in relation to \( C_{\gamma} \);

5.7 Coefficient \( a_{a_{\gamma}} \) for a value correction \( \lambda_1 \) from 1.0 – by the formula (A5.4.8.6);

Calculation at drift angles \( \beta = 20°, 25°, 30°, 35°, 40° \) may be omitted.

For calculating nondimensional lateral force of PSS "rudders behind propellers in nozzles"

<table>
<thead>
<tr>
<th>β (°)</th>
<th>5°</th>
<th>10°</th>
<th>15°</th>
<th>20°</th>
<th>25°</th>
<th>30°</th>
<th>35°</th>
<th>40°</th>
</tr>
</thead>
<tbody>
<tr>
<td>( J_p ) – formula (A5.4.6.1)</td>
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<tr>
<td>( C_{TT} ) – Fig. A5.4.6.2</td>
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</tr>
<tr>
<td>( C_T ) – Fig. A5.4.6.3</td>
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<tr>
<td>( C_{\beta} ) – from Table A5.5.10.4</td>
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<tr>
<td>( k_{\beta} ) – from Table A5.5.10.5</td>
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<tr>
<td>( k_a ) – from Table A5.5.10.9</td>
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<tr>
<td>( A_{\gamma} ) – formula (A5.5.10.11)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>( B_{\gamma} ) – formula (A5.5.10.12)</td>
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</tr>
</tbody>
</table>

5.9 Nondimensional lateral force of PSS "rudders behind propellers in nozzles" shall be calculated using Table A5.5.9. The rudder angle shall be taken \( \delta = 0° \).
Table A5.5.10.5  

<table>
<thead>
<tr>
<th>$C_T$</th>
<th>$x_p$</th>
<th>$k_\beta$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$&lt; 0.7$</td>
<td>$1.2$</td>
<td>$1.7$</td>
</tr>
<tr>
<td>2.0</td>
<td>0.18</td>
<td>0.23</td>
<td>0.27</td>
</tr>
<tr>
<td>3.0</td>
<td>0.15</td>
<td>0.18</td>
<td>0.22</td>
</tr>
<tr>
<td>4.0</td>
<td>0.12</td>
<td>0.15</td>
<td>0.18</td>
</tr>
<tr>
<td>6.0</td>
<td>0.10</td>
<td>0.12</td>
<td>0.15</td>
</tr>
<tr>
<td>8.0</td>
<td>0.08</td>
<td>0.10</td>
<td>0.12</td>
</tr>
<tr>
<td>12.0</td>
<td>0.06</td>
<td>0.08</td>
<td>0.10</td>
</tr>
<tr>
<td>16.0</td>
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<td>0.07</td>
<td>0.09</td>
</tr>
<tr>
<td>20.0</td>
<td>0.04</td>
<td>0.06</td>
<td>0.08</td>
</tr>
<tr>
<td>30.0</td>
<td>0.03</td>
<td>0.05</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Note: $x_p = x_p/D$ — relative distance of rudder profile leading edge from nozzle trailing edge measured along the propeller axis.

0.8 coefficient $h_i$ for an effect of the rudder section projected from the propeller jet – by the formula (A5.4.8.7);

0.9 non-dimensional lateral force $A_y$ generated by the rudder section located within the propeller jet – by the formula:

$$A_y = -0.0175a_i k_\beta \beta_{\text{stern}},$$  (A5.5.10.9)

10 non-dimensional lateral force $B_y$ generated by the rudder section projected from the propeller jet – by the formula:

$$B_y = -0.0175b_i \beta_{\text{stern}},$$  (A5.5.10.10)

11 non-dimensional damping lateral force $C_{py}$ generated on the PSU “propeller in nozzle” – by the formula:

$$C_{py} = -0.0175k_\beta \left[C_T \left(\frac{1}{1+C_T} - 1\right) + \mu \right] \beta_{\text{stern}},$$  (A5.5.10.11)

where the coefficient $k_\beta$ shall be taken from Table A5.5.10.5;

coefficient $\mu$ – by the formula (A5.4.5.3);

12 non-dimensional lateral force $C_{yr}$ of PSS “rudders behind propellers in nozzles” – by the formula:

$$C_{yr} = \phi \left(A_y + B_y + C_{py}\right).$$  (A5.5.10.12)

6 Manoeuvrability with propulsors not in operation

6.1 The ship’s capacity to come out of any steady turn, after the main engines have stopped, shall be determined by comparing the maximum absolute negative value $\left(C_{yr}\right)_{\text{min}}$ of hull performance curve $C_{y\alpha}(\Omega)$, plotted according to 4.2 of the present Appendix, and values of nondimensional lateral force $\left(C_{yr}\right)_{\text{min}}$, generated by main steering equipment of the ship with propulsors not in operation (see Fig. A5.6.1). The ship is considered as capable to come out of any steady turn with propulsors not in operation, if $\left|\left(C_{yr}\right)_{\text{min}}\right| \geq \left|\left(C_{yr}\right)_{\text{min}}\right|$, i.e. if the value $\left(C_{yr}\right)_{\text{min}}$ lies below the minimum point of hull performance curve $C_{y\alpha}(\Omega)$.

Fig. A5.6.1. Diagram for calculating the ship’s capacity to come out of any steady turn after the main engines have stopped

6.2 Nondimensional lateral force $\left(C_{yr}\right)_{\text{min}}$ generated by main steering equipment of the ship with main engines not in operation shall be taken as follows:

- with single steering nozzle $-1.1$
- for single rudder behind open propeller $-0.75a_i A_i/A_0$
- for single rudder behind propeller in nozzle $-0.65a_i A_i/A_0$
- for centre rudder of the double-propeller ship $-\phi A_i(z_{pr} A_0)$

7 Emergency stopping capacity

7.1 When determining stopway the procedure of emergency stopping is considered to include two phases:

1 The first phase – from the moment when the order to make an emergency stop is
given to the moment when all propulsors start running at full astern;

7.2 The second phase – from the moment when all propulsors start running at full astern to the moment when the ship has come to a complete stop.

7.2 Emergency stopway $S_{st}$, m, shall be calculated by the formula

$$S_{st} = S_1 + S_2,$$  \hspace{1cm} (A5.7.2.1)

where $S_1$ — way, which the ship travels within the first phase, m, to be determined according to 7.3 of the present Appendix.

$S_2$ — way, which the ship travels within the second phase, m, to be determined according to 7.6 of the present Appendix.

7.3 The way $S_1$, m, which the ship travels within the first phase of emergency stopping, shall be calculated by the formula:

$$S_1 = \ln \left(1 + C v_1 t_1 \right)/C,$$  \hspace{1cm} (A5.7.3.1)

where $t_1$ — time of the first phase at emergency stopping, s, to be determined according to 7.4 of the present Appendix.

The value $C$, m$^{-1}$, included in the expression (A5.7.3.1), shall be calculated by the formula:

$$C = (R_0 - \sum T_{el} \right)/\left(1.05m v_0^2 \right),$$  \hspace{1cm} (A5.7.3.2)

where $m$ — ship mass, t.

$R_0$ — water resistance to the ship’s motion at $v_0$, kN, to be determined by calculation of propulsion performance.

$\sum T_{el}$ — average total thrust of the PSS within the first phase of emergency stopping, kN, to be calculated by the formula:

$$\sum T_{el} = 0.5pv_0^2 \times \sum_{i=1}^{z_p} \left[k_{Ki}D_i^2 \left(1 - w_i \right)^2 + C_{hi}D_iP_i \right],$$  \hspace{1cm} (A5.7.3.3)

where $z_p$ — number of PSUs

$i$ — number of PSU within PSS;

$K_{Ki}$ — coefficient taken equal to:

0.4 — for open propellers;

0.5 — for propellers in nozzles;

$w_i$ — wake coefficient for the $i$-th PSU by calculation of propulsion performance;

$D_i$ — diameter of the $i$-th propeller, m;

$P_i$ — pitch of the $i$-th propeller, m;

$C_{hi}$ — correction coefficient, m$^{-1}$, to be calculated by formula:

$$C_{hi} = \left(1 - w_i \right)(\lambda_i - \Delta\lambda_i) / \left[P_i\sqrt{1 - (\lambda_i - \Delta\lambda_i)^2} \right],$$  \hspace{1cm} (A5.7.3.4)

where $i$ — shall be taken as:

for open propellers 0.675

for propellers in nozzles 0.70

$\Delta\lambda_i$ shall be taken as:

if reversible gear is available 0.5

when the engine directly drives the propeller 0.3

7.4 Unless otherwise noted, time of the first phase of emergency stopping $t_1$ shall be taken equal to 25 s according to 6 of the present Part of the Rules. Time of the first phase of emergency stopping less than 25 s shall be approved by the engine manufacturer.

7.5 The ship speed $v_1$ at the end of the first phase of emergency stopping, m/s, shall be calculated by the formula:

$$v_1 = v_0 / \left(1 + C v_0 t_1 \right),$$  \hspace{1cm} (A5.7.5)

where $C$ — coefficient, m$^{-1}$, to be calculated by the formula (A5.7.3.2);

$t_1$ — time of the first phase of emergency stopping, s, to be determined according to 7.4 of the present Appendix.

7.6 The way, which the ship travels within the second phase of emergency stopping, m, shall be calculated by the formula:

$$S_2 = 0.5 v_1 \ln \left(1 + a^2 \right)/\left(ab \right),$$  \hspace{1cm} (A5.7.6.1)

where $v_1$ — ship speed at the end of the first phase of active stopping to be determined according to 7.5 of the present Appendix.

The values $a$ and $b$ shall be calculated by formulas, s$^{-1}$:

$$a = (v_1 / v_0) \sqrt{R_0 / \sum T_{el} \right},$$  \hspace{1cm} (A5.7.6.2)

$$b = \sqrt{R_0 \sum T_{el} / \left(1,05m v_0 \right) \right},$$  \hspace{1cm} (A5.7.6.3)
where \( \sum T_{e2} \) — average total thrust of the PSS within the second phase of emergency stopping, kN, to be calculated by formula:

\[
\sum T_{e2} = 0.5 \sum_{i=1}^{z} \left[ m_i k_{K2} P_{d_i}/(\pi n_{i0} P_i) \right],
\]

(A5.7.6.4)

where \( m_i \) — capacity ratio of the \( i \)-th engine at astern running, to be taken equal to 0.85 for reversing engines. In installations with reverse gear \( m_z \) shall be taken equal to reverse gear ratio at ahead and astern running;

\( K_{K2} \) — coefficient taken equal to:
- for open propellers 6.00
- for PSU "propeller in nozzle" 6.25

\( P_{d_i} \) — power to the \( i \)-th propulsor at ahead running, kW;

\( n_{i0} \) — rotation speed of the \( i \)-th propeller at ahead running, s\(^{-1}\);

\( D_n, P_r \) — see 7.3 of the present Appendix;

\( m \) — see 2.2 of the present Appendix.

8 Maneuverability under wind conditions

8.1 Wind velocity \( V_a \), m/s, which the ship move along any chosen straight course with all propellers rotating at the rated speed of all propulsors, shall be calculated by the formula:

\[
V_a = 0.75 V_0 \times \sqrt{[0.35 (a_i + 2.10 b_i)/c + 0.12 a_2/c^2]} / P_{a_2} + 1.0,
\]

(A5.8.1)

where \( c \) — coefficient to be determined according to 8.8.2.

The values \( P_{a_2}, a_i, b_i, a_2 \) included in the formula (A5.8.1), shall be calculated by the following formulas:

.1 auxiliary coefficient \( P_{a_2} \) — by the formula:

\[
P_{a_2} = 0.001225 S/\left( LT \right).
\]

(A5.8.1.1)

.2 coefficient of positional force on hull \( a_i \) — by the formula for:

- cargo ships \( a_i = 3.7 T / L \)
- passenger ships \( a_i = 4.2 T / L \)

(A5.8.1.2)

.3 coefficient of positional force on hull \( a_2 \) for cargo ships — from Table A5.8.1.3:

Table A5.8.1.3

<table>
<thead>
<tr>
<th>( B/T )</th>
<th>( 0.018 )</th>
<th>0.022</th>
<th>0.026</th>
<th>0.030</th>
<th>0.034</th>
<th>0.038</th>
<th>0.044</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.920</td>
<td>0.798</td>
<td>0.712</td>
<td>0.661</td>
<td>0.625</td>
<td>0.602</td>
<td>0.578</td>
</tr>
<tr>
<td>4</td>
<td>0.841</td>
<td>0.720</td>
<td>0.623</td>
<td>0.559</td>
<td>0.520</td>
<td>0.490</td>
<td>0.473</td>
</tr>
<tr>
<td>5</td>
<td>0.794</td>
<td>0.673</td>
<td>0.575</td>
<td>0.508</td>
<td>0.465</td>
<td>0.437</td>
<td>0.416</td>
</tr>
<tr>
<td>6</td>
<td>0.771</td>
<td>0.649</td>
<td>0.551</td>
<td>0.480</td>
<td>0.441</td>
<td>0.414</td>
<td>0.393</td>
</tr>
<tr>
<td>7</td>
<td>0.759</td>
<td>0.637</td>
<td>0.535</td>
<td>0.469</td>
<td>0.429</td>
<td>0.402</td>
<td>0.380</td>
</tr>
<tr>
<td>8</td>
<td>0.755</td>
<td>0.633</td>
<td>0.534</td>
<td>0.465</td>
<td>0.425</td>
<td>0.398</td>
<td>0.375</td>
</tr>
</tbody>
</table>

.4 coefficient of positional force on hull \( a_2 \) for passenger ships — from Table A5.8.1.4;

Table A5.8.1.4

<table>
<thead>
<tr>
<th>( B/T )</th>
<th>( 0.044 )</th>
<th>0.038</th>
<th>0.034</th>
<th>0.030</th>
<th>0.026</th>
<th>0.022</th>
<th>0.018</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.486</td>
<td>0.507</td>
<td>0.533</td>
<td>0.564</td>
<td>0.618</td>
<td>0.703</td>
<td>0.823</td>
</tr>
<tr>
<td>4</td>
<td>0.374</td>
<td>0.393</td>
<td>0.424</td>
<td>0.463</td>
<td>0.525</td>
<td>0.626</td>
<td>0.742</td>
</tr>
<tr>
<td>5</td>
<td>0.318</td>
<td>0.339</td>
<td>0.369</td>
<td>0.409</td>
<td>0.475</td>
<td>0.575</td>
<td>0.695</td>
</tr>
<tr>
<td>6</td>
<td>0.293</td>
<td>0.312</td>
<td>0.339</td>
<td>0.382</td>
<td>0.449</td>
<td>0.548</td>
<td>0.668</td>
</tr>
<tr>
<td>7</td>
<td>0.281</td>
<td>0.302</td>
<td>0.328</td>
<td>0.370</td>
<td>0.436</td>
<td>0.537</td>
<td>0.657</td>
</tr>
<tr>
<td>8</td>
<td>0.277</td>
<td>0.297</td>
<td>0.324</td>
<td>0.364</td>
<td>0.432</td>
<td>0.533</td>
<td>0.657</td>
</tr>
</tbody>
</table>

.5 coefficient of positional moment on hull \( b_1 \) shall be calculated by the formula:

for cargo ships

\[
b_1 = \left[ 0.101 + 0.00174 (L/B - 8.17) \right] \times \left( 21.07T/L + 0.285 \right),
\]

(A5.8.1.5-1)

for passenger ships:

\[
b_1 = \left[ 0.109 + 0.00189 (L/B - 8.17) \right] \times \left( 22.05T/L + 0.299 \right).
\]

(A5.8.1.5-2)

8.2 The coefficient included in the formula (A5.8.1) shall be calculated by the formula:

\[
c = (\rho D^5 + 0.037 h)/\left( \rho B^5 \right),
\]

(A15.8.2)

where values \( B^5, D^5 \) for various types of PSU shall be determined according to 8.3 and 8.4 of the present Appendix, value \( \rho \) shall be determined by the formula (A5.4.2.6), value \( w' \) included in this formula shall be determined by formulas (A5.4.2.3-1), (A5.4.2.3-2) at \( \beta_{stern} = 10^\circ \).
8.3 Values $B_y^\delta$, $D_y^\delta$ included in formula (A5.8.2) for PSS "propellers in steerable nozzles" and "propellers in steerable nozzles + centre rudder" shall be calculated by the following formulas:

$$B_y^\delta = 0.0175k_\delta \times$$
$$\left[ q_{TT}C_{CT0}\sqrt{1 + q_{TT}C_{CT0}/(1 + q_{TT}C_{CT0} - 1) + \mu} \right].$$

$$D_y^\delta = -0.0175k_\delta \left[ q_{TT}C_{CT0}/(1 + q_{TT}C_{CT0} - 1) + \mu \right] -$$
$$-0.14 \left[ \lambda_u^* A_u^*/(1 + \lambda_u^*) + \lambda_p A_p/(2 + \lambda_p) \right]/D_t.$$  

(A5.8.3.1)

(A5.8.3.2)

The values included in the formulas (A5.8.3.1) and (A5.8.3.2) shall be determined by formulas and tables given in 4.4 and 4.6 of the present Appendix. If no section of nozzle stabilizers is projected from the propeller jet, $A_u^* = 0$. If the PSS does not include the centre rudder, $A_p = 0$.

8.4 The values $B_y^\delta$, $D_y^\delta$ included in the formula (A5.8.2) for PSS "rudders behind open propellers" shall be calculated by the following formulas:

$$B_y^\delta = 0.0175 \left( a_\gamma C_y^\delta + b_1 \right),$$

$$D_y^\delta = -0.0175 \left( a_\gamma C_y^\delta k_\beta + b_1 \right).$$

(A5.8.4.1)

(A5.8.4.2)

where values, included in formulas (A5.8.4.1) and (A5.8.4.2), shall be determined by formulas and tables given in 4.8 of the present Appendix.

8.5 Values $B_y^\delta$, $D_y^\delta$ included in formula (A5.8.2) for PSS "rudders behind propellers in nozzles" shall be calculated by the following formulas:

$$B_y^\delta = 0.0175 \left( a_\gamma C_y^\delta + b_1 \right),$$

$$D_y^\delta = -0.0175 \left( a_\gamma C_y^\delta k_\beta + b_1 \right).$$

(A5.8.5.1)

(A5.8.5.2)

where values, included in formulas (A5.8.5.1) and (A5.8.5.2), shall be determined by formulas and tables given in 4.10 of the present Appendix.

9 Instructions on full-scale trials

9.1 The program of full-scale manoeuvrability trials shall be developed by the designer and shall include turning-circle trial, spiral trial, $10^\circ/10^\circ$, $20^\circ/20^\circ$, $30^\circ/30^\circ$, zigzag trial, stop-inertia trial, ship’s emergency stopping and astern steering trial.

9.2 Turning circle trials shall be carried out by circling at rudder angles $\delta = 10^\circ, 20^\circ, 35^\circ$ on either side, for ships with the maximum rudder angles exceeding $35^\circ$, and at high rudder angles. Turns shall be carried out in deep still water, where all propellers turn at any rotation speed, which is the same prior to the commencement of the manoeuvre and is not subsequently adjusted. The trials include measurements of steady-turning diameters $D_t$. The trials shall result in plotting the diagram of $\Omega = 2L/D_t$ or $D_t/L$ against the rudder angle (diagram of ship manoeuvrability). The section of the ship manoeuvrability diagram within the range of rudder angles $-5^\circ \leq \delta \leq +5^\circ$ shall be plotted upon results of spiral manoeuvre according to 9.3 of the present Appendix. The average value of $2L/D_t$ on either side at the maximum rudder angles shall be considered as a criterion of the ship's turning capability according to 6.5.2 of the present Part of the Rules.

9.3 The spiral manoeuvre shall be carried out as a continuous sequence of steady turns at rudder angles $\delta$ within the range of $+5^\circ$ to $-5^\circ$. To carry out this manoeuvre the ship shall enter into the turn at the rudder angle $\delta = +5^\circ$ at any fixed motion speed $v_0$, where the speed of rotation of all propellers is the same prior to the commencement of the manoeuvre and is not subsequently regulated. After a steady rate of turn is obtained, a rudder angle shall be gradually decreased to $+3^\circ$, $+2^\circ$, $+1^\circ$, $+0^\circ$. A steady rate of turn shall be obtained on each phase. If at $\delta = 0^\circ$ the ship stops turning and gets on a straight course, the manoeuvre is over. If at $\delta = 0^\circ$ the ship keeps turning to starboard, the rudder shall be sequentially moved aport at small angles ($\delta = -0.5^\circ, -1^\circ, -1.5^\circ, -2^\circ$) to set such rudder angle to port, at
which the ship starts turning to port after achieving a steady rate of turn (critical rudder angle \( \delta_{cr} \)). After steady rates of turn are obtained, the rudder shall be sequentially moved to \(-3^\circ\) and \(-5^\circ\). Here the whole procedure shall be carried out again from \( \delta = -5^\circ \) to \( \delta = +5^\circ \). The ship's rate of turn \( \omega \), deg/s, shall be measured on each area after steady turning is obtained.

The manoeuvre results shall be processed by the formula:

\[
\Omega = \omega L / (57.3 v' v') = 2L / D_{\text{turn}}, \quad (A5.9.3.1)
\]

where \( v' \) shall be calculated by the formula (A5.4.2.4) using the method of successive approximations, starting at \( v' = 1.0 \). Processing results shall be applied on the ship manoeuvrability diagram obtained in 9.2 of the present Appendix.

9.4 If the ship manoeuvrability diagram, plotted according to 9.2 and 9.3 of the present Appendix, is symmetric with respect to axis \( \delta = 0^\circ \), this axis represents the true zero rudder angle, and the average value on this axis on either side \( \Omega = \Omega_{0} \) or the value \( D_{\text{turn}} / L = 2 / \Omega_{0} \) shall be considered as a criterion of straight course stability according to 6 of the present Part of the Rules.

If the ship manoeuvrability diagram, plotted according to 9.2 and 9.3 of the present Appendix, is not symmetric with respect to axis \( \delta = 0^\circ \), the axis of true zero rudder angle shall be drawn through the point \( \delta_{0} = 0.5 (\delta_{cr\text{,abs}} + \delta_{cr\text{,port}}) \) on this axis. In this case the criterion of straight course stability according to 6.6.1 of the present Part of the Rules shall be the average value \( \Omega_{0} \) \( \Omega \) on either side on the axis of true zero rudder angle or the value \( D_{\text{turn}} / L = 2 / \Omega_{0} \).

9.5 The \( 10^\circ/10^\circ, 20^\circ/20^\circ, 30^\circ/30^\circ \) zigzag trials shall be carried out by gradual deflection of the rudder at the same angle \( \delta \) on either side at the moments, when the ship sets off a straight course to the opposite side at the angle \( \Theta = -\delta \) (Fig. A5.9.5). Zigzag trials shall be carried out at the ship speed on the initial straight course \( v = 0.8v_{0} \). The following shall be tested: ship's overshoot angle \( \Theta_{1} \) (angle of ship's turn from the beginning of rudder moving to pullout to the moment of rotation stop) and pullout time \( t_{1} \) (from the beginning of rudder moving for pullout to the moment of rotation stop). Each manoeuvre shall consist of three semi-periods to measure respectively \( \Theta_{11}, \Theta_{12}, \Theta_{13} \) and \( t_{11}, t_{12}, t_{13} \).

9.6 Stop-inertia trials shall be carried out by entering into a steady turning at the rudder angle \( \delta = 20^\circ \) with stopping the ship's propulsors and subsequent rudder moving at the angle \( \delta = 30^\circ \) to the opposite side. The trials shall include recording of the ship's rotation stop and transition to its rotation to the opposite side or her failure to pull out of turn.

9.7 Emergency stopping shall be carried out at the straight course motion of the ship at a speed conforming to a rated rotation speed of propellers by quickly changing the operating mode of propulsors to full speed astern. The following shall be recorded during trials:

1. The ship's stopway path from the moment when the command "stop - full astern" is given to the moment when the ship has come to a complete stop relative to the water;
2. Time from the moment when the command "stop - full astern" is given to the moment when propellers start running astern;
3. Ratio of the course angle deviation to the initial one at the end of manoeuvre.
9.8 Astern steering trials shall be carried out at the ship moving astern by her straight course keeping without manoeuvring on main engines.

10 Table of manoeuvrability characteristics

10.1 Table of manoeuvrability characteristics shall be placed in a conspicuous position in the wheelhouse. The recommended form of Table of manoeuvrability characteristics is given on Fig. A5.10.1.

Table of manoeuvrability characteristics

10.2 Table of manoeuvrability characteristics shall be developed by the ship’s designer basing on calculations with subsequent supplementing and correction upon full-scale trial results.

10.3 Table of manoeuvrability characteristics shall include the following components:

1. Table of characteristics of ship, ship power installation and steering equipment main dimensions, load and ballast draught; main engine capacity, rated and critical rotation speed of main engines; type and sizes of rudders (parameters of steerable nozzles and steerable pods), thruster capacity and thrust.

2. Table of characteristics of ship, ship power installation and steering equipment may be developed in any form;

3. The ship speed performance as a diagram of the ship speed \( v \), km/h, on a straight course in deep still water against propellers rotation speed \( n_p \), min\(^{-1}\), in fully loaded and ballast conditions (Fig. A5.10.3-1).

4. Performance of fully loaded ship turning quality as a board presenting time-dependent motion path at different rudder angles \( \delta \) (Fig. A5.10.3-2).

5. Inertial properties of the ship as a diagram of motion speed \( v \), km/h, and way, which she travels \( S_n \), m, against time and initial speed \( v_0 \), km/h (initial rotation speed of
propellers $n_0$, min$^{-1}$), at emergency stopping (Fig. A5.10.3-3);

Fig. A5.10.3-3. Diagram of ship speed and the way, which she travels, against time and initial motion speed at emergency;

.5 pullout performances according to Table A5.10.3.5, which contains pullout time $t_1$, s, and overshoot angle $\theta_1$ at pullout of a steady turn of a fully loaded ship moving fully ahead at the rudder angle $\delta_0$ by moving rudders at the maximum angle to the opposite side;

For determining pullout characteristics

<table>
<thead>
<tr>
<th>Rudder angle on turn, $^\circ$</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Время одерживания, $t_1$, c</td>
<td>27</td>
<td>31</td>
<td>34</td>
<td>42</td>
</tr>
<tr>
<td>Overshoot angle $\theta_1$</td>
<td>17</td>
<td>23</td>
<td>26</td>
<td>29</td>
</tr>
</tbody>
</table>

.6 table of wind speed limits in the navigational zone $V_a$, m/s, which the ballasted ship can withstand when moving on a straight course with a speed $v$, m/s, according to Table A5.10.3.6;

For drawing up the table of wind speed limits

<table>
<thead>
<tr>
<th>Ship speed in still water, km/h</th>
<th>10.0</th>
<th>12.5</th>
<th>15.0</th>
<th>17.5</th>
<th>20.0</th>
<th>22.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship speed in the navigational zone, m/s</td>
<td>10.5</td>
<td>13.1</td>
<td>15.7</td>
<td>18.4</td>
<td>21.0</td>
<td>22.4</td>
</tr>
</tbody>
</table>

.7 table of the fully-loaded ship sinkage $\Delta T_b$ when moving on a straight course with a speed $v$, km/h, in shallow water for the depth range $H$, m, according to Table A5.10.3.7;

For drawing up the table of the fully-loaded ship sinkage

<table>
<thead>
<tr>
<th>Water depth (m)</th>
<th>12.0</th>
<th>14.0</th>
<th>16.0</th>
<th>18.0</th>
<th>20.0</th>
<th>22.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta T_b$ at the ship speed $v$, km/h</td>
<td>0.11</td>
<td>0.15</td>
<td>0.19</td>
<td>0.25</td>
<td>0.3</td>
<td>0.37</td>
</tr>
<tr>
<td>7.0</td>
<td>0.14</td>
<td>0.19</td>
<td>0.24</td>
<td>0.31</td>
<td>0.38</td>
<td>–</td>
</tr>
<tr>
<td>5.0</td>
<td>0.17</td>
<td>0.24</td>
<td>0.31</td>
<td>0.39</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4.0</td>
<td>0.21</td>
<td>0.28</td>
<td>0.36</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

.8 visibility zones diagram;

.9 diagram of man-overboard manœuvre.

Note: Numerals of parameters on Fig. A5.10.1 and A5.10.3-1 – A5.10.3-3 and in Table A5.10.3.5 – A5.10.3.7 are given for reference only and do not apply to a particular ship.
Part III

FIRE PROTECTION
1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION

1.1.1 This Part of the Rules establishes requirements for structural fire protection of ships, fire extinguishing systems and stations, fire protection outfit, fire safety of domestic and general service systems, fire alarm system, spare parts and tools for fire extinguishing systems.

1.1.2 Elements of structural fire protection, fire extinguishing systems and fire alarm system shall comply with the requirements of the corresponding Parts of the Rules.

Fire extinguishing means (fire extinguishing medium, fire-fighting equipment, fire extinguishers, fire-fighting tools included in fire protection outfit, spare parts, tools, etc.) and personal protective equipment (fireman’s outfit included in fire protection outfit, emergency escape breathing devices), regarding fire safety requirements, shall comply with the requirements established by the Federal Law No. 123-ФЗ dated 22 July 2008 “Technical Regulations on Fire Safety Requirements” that shall be approved by declarations or certificates confirming the production compliance with the specified Federal Law requirements, drawn by the bodies, accredited according to the legislation of the Russian Federation on accreditation in the national accreditation system.

1.1.3 Requirements of this Part are not applied to fire extinguishing systems and equipment fitted on special fire-fighting ships, as well as to their fire protection outfit, spare parts and tools.

1.1.4 Tugboats and pushboats intended for operation with oil tankers are covered by the requirements related to oil tankers.

1.2 TERMS AND DEFINITIONS

1.2.1 Terms related to the Rules common terminology and their definitions are stated in 2.1 and 2.2 Part 0 of the Rules. The following terms are used in these Rules:

- **Cargo zone** means a totality of spaces and areas connected with cargo storage and transportation.

Cargo zone of ships intended for storage and transportation of inflammable liquids in bulk and liquefied gases consists of the following spaces and areas:

- compartments and tanks for inflammable liquids and gases and adjacent spaces;
- rooms containing pumps and compressors for pumping inflammable liquids and gases;
- storage rooms for cargo hoses;
- spaces in which cargo system pipelines are led;
- spaces above the pump rooms and vertical cofferdams adjacent to the compartments and tanks for inflammable liquids and gases;
- spaces above the cargo tank deck at the distance of less than 2.4 m in the vertical and less than 3 m in the horizontal directions from the cargo tanks;
- spaces located less than 3 m in any horizontal direction and less than 2.4 m in the vertical direction from closed tanks, receptacles, measuring tanks;
- spaces located less than 3 m in any direction from gas ventilation outlets and similar arrangements;
- spaces in which pipelines for inflammable liquids and gases are led, within 3 m from those pipelines in any direction;
- spaces connected with the above-mentioned spaces by openings or exits.

Cargo zone of other ships consists of the following spaces and areas:

- holds and spaces for cargo stowage;
spaces at the distance less than 3 m in any direction from the gas ventilation outlets of the cargo hold intended for any kind of stowage of inflammable and highly inflammable materials and substances as well as other spaces connected with the above-mentioned spaces by openings or exits;

2 Cargo spaces means the spaces which include:
   cargo tanks intended for cargo carriage including discharge tanks;
   spaces for dry goods not being ship stores, dry cargo and refrigerated holds and spaces between decks intended also for carriage of containers and removable tanks as well as motor vehicles without fuel in their tanks;
   closed ro-ro cargo spaces extending to 1/3 length or the entire length of the ship;
   open ro-ro cargo spaces extending to 1/3 length or the entire length of the ship, opened on both sides or on the one side and having ventilation providing the absence of trapped zones over the entire length of the space through permanent openings distributed in the side plating or deckhead or from above, having a total area of at least 10% of the total area of the space sides;
   weather deck is a deck that is totally exposed to environment from above and at least from two sides;

3 Length of a ship means the overall length of a ship;

4 Inflammable liquids — see the definition in 2.2.14 Part 0 of the Rules;

5 Confined space means the space having any of the characteristics mentioned below:
   confined entry and exit openings;
   insufficient ventilation and;
   not intended for continuous operation;
   and includes (but it is not limited to the listed), cargo spaces, double bottom, fuel tanks, ballast tanks, cargo pump rooms, compressor rooms, cofferdams, chain lockers, empty spaces, box-shaped keels, separating spaces, boilers, engine crankcases, engine air inlets, fecal tanks and adjacent rooms. The list is not exhaustive and for confined spaces it shall be made with regard to features of particular ships;

6 Closed method of loading and unloading oil products means a method of performing cargo handling operations by both coastal and onboard facilities by means of sealed piping system ensuring communication of the oil compartments with the atmosphere only through the gas outlet system;

7 Structural fire protection means a set of passive structural protection means aimed at:
   prevention of fire risk;
   restriction of spreading fire and smoke along the ship;
   arrangement of conditions for safe evacuation of people out of the ship spaces and from the ship as well as for fire extinguishing;

8 Vertical fire-resistant zones means the hull, superstructure and deckhouse spaces formed by transverse fire-proof or fire-retardant divisions;

9 Divisions of type A, or fireproof divisions means those divisions formed by bulkheads or decks which shall be:
   made of steel or equivalent fire resistant material;
   constructed to prevent the passage of smoke and flame to the end of the one-hour standard fire test (see 1.2.1.35).

The divisions have the following designations depending on the time t within which the surface 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:

\[
\begin{array}{c|c}
 t \text{ (min)} & \text{Division}\n \hline
 0 & A-0 \\
 15 & A-15 \\
 30 & A-30 \\
 60 & A-60 \\
\end{array}
\]

10 Divisions of type B or fire-retardant divisions means

---

1 According to GOST 1062.
2 The definition was given by the IMO Resolution A.1050 (27).
those divisions formed by bulkheads, decks, ceilings or linings made of non-combustible materials and being flame-tight within the 30-minute standard fire test. The divisions have the following designations depending on the time $t$ within which the surface 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 225 °C above the original temperature:

<table>
<thead>
<tr>
<th>$t$ (min)</th>
<th>B-15</th>
<th>0</th>
<th>B-0</th>
</tr>
</thead>
</table>

11 Divisions of type C means those divisions made of non-combustible materials for which the requirements for smoke and fire penetration prevention as well as observance of the temperature rise are not applied;

12 Foam expansion ratio means the ratio of the volume of foam produced to the volume of foaming agent aqueous solution supplied;

13 Material equivalent to steel means a 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 exposure to the standard fire test;

14 Machinery spaces – see the definition in 2.2.25 Part 0 of the Rules;

15 Machinery spaces of A category means the spaces, containing internal combustion engines, boilers or other power plants working on liquid fuel, as well as trunks of these spaces;

16 Low flame spread means that the surface will adequately restrict the spread of flame, this being determined in accordance with national standards;

17 Stairways means inner ladders, elevators and moving stairways;

18 Continuous B type ceilings and linings means B class ceilings and linings of terminating either at an A or B type divisions or at outer surfaces of a ship;

19 Standard fire test specimen means a bulkhead (a deck) specimen with the heating area of at least 4.65 m² and the height (the deck length) of 2.44 m, which corresponds with the intended structure and comprises insulation joints, if they are present on the intended structure;

20 Fire-resistant material means a material keeping sufficient heat-insulating capacity in the event of fire or by fire heat, that is determined according to national standards;

21 Protected space means a space equipped with one of fire-fighting systems and automatic fire detection system;

22 Accommodation spaces means cabins for the crew, passengers, special personnel, lounges, mess-rooms, restaurants, canteens, sport halls, offices, hair-dressing saloons, sanitary compartments, as well as corridors, lobbies and companions adjoining to these compartments;

23 Pump rooms means cargo pump rooms in tankers;

24 Semi-closed spaces means partially closed spaces with natural ventilation, which are located on ships in the explosive zone at distance up to 3 m from cargo tanks, tanks for combustible liquids with flash point of max. 60 °C or spaces with cargo pumps, pipelines of combustible liquids, hoses;

25 Adjacent spaces means spaces separated from each other with a bulkhead, deck or similar fixed structure without openings or with permanently closed openings.

Spaces separated from each other with detachable structures or having non-closing openings in separating bulkhead or deck shall be considered as one common space;

26 Service spaces means utility spaces; boatswain stores, paint stores; machine and electric shops, not being a part of machinery spaces, radio room;

27 Utility spaces means galleys, dishwashing, preparation rooms; rooms for

1 GOST 12.1.044, GOST 53327, GOST R 51032, GOST 30444.

2 GOST 53299, GOST 30247.0, GOST 53310, GOST R 56076.
water heaters, ironing rooms, saunas and similar spaces intended for household needs which contain oil fuel, solid fuel or gaseous fuel burning units or are fitted with electrical heaters; storerooms for ship’s stores; adjacent corridors;

28 **Fire station** means the place where start-up devices of fire extinguishing systems, fire appliances or fire alarm detectors for a particular part of a ship (a compartment or separate spaces) are located;

29 **Central fire control station** means a fire control station, where fire detection stations and remote starting devices of fire-fighting systems, if any, are centralized. The room in which the central fire control station is located and which is not a wheelhouse, shall have direct communication with the wheelhouse or round-the-clock watch while the ship is under way;

30 **Fixed fire-fighting systems** means systems intended to supply fire extinguishing agent to protected spaces or directly into them and structurally connected with the hull;

31 **Discharge tank** means a tank intended for collecting water used for washing cargo tanks and contaminated ballast water;

32 **Fire protection outfit** means portable active fire-fighting means (apparatuses, appliances and expenditure materials) intended for:

- fire suppression;
- provision of actions of the crew while extinguishing a fire;

provision of fire extinguishing systems with substances required for their operation when extinguishing a fire;

33 **Method of spaces’ protection** 1C means that all inner division bulkheads are of classes B or C and that the fixed alarm fire detection system is fitted and meets the requirements of the Rules. Automatic smoke detectors and manual detectors of this system shall be located so as to provide fire detection throughout all corridors, all ladders and escape routes within accommodation spaces;

34 **Combustible mediums** means inflammable liquids, gases, solid combustible materials and substances;

35 **A standard fire test** means the determination of the specimen’s resistance to heating from any of the sides depending on the time of heating in a test furnace up to the following temperatures counted off from the initial furnace temperature, °C:

<table>
<thead>
<tr>
<th>end of minute</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>30</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature</td>
<td>556</td>
<td>659</td>
<td>718</td>
<td>821</td>
<td>925</td>
</tr>
</tbody>
</table>

36 **Fixed deck coatings** means all deck coatings applied directly to metal deck including anti-corrosion coating and glue, but not including finish coatings (linoleum, carpet, etc.);

37 **Passenger ship** – see the definition in 2.2.40 Part 0 of the Rules. Coastal ships intended for accommodation of more than 12 passengers are considered in the present Part of the Rules as passenger vessels;

38 **Crude oil** means any oil occurring naturally in the earth whether or not treated to render it suitable for transportation and includes crude oil where certain distillate fractions may have been removed from or added to;

39 **Flash point** means the minimum temperature at which vapour formed on the surface of inflammable liquid forms a mixture with the ambient air capable of igniting when an open flame has been brought to it. Flash point shall be determined using the closed cup test;

40 **Fire smothering** means a method of fighting a fire by filling the protected space with vapours of non-inflammable liquids or non-inflammable gases which form the environment which does not sustain combustion;

41 **Surface fire-fighting** means a method of fighting a fire by cooling, damping or restricting access of oxygen to burning surfaces, e.g. by water or foam;

42 **Fuel oil and lubricating oil storages** means main storage tanks, daily service tanks, discharge, settling, sediment and other tanks;

43 **Crew** – see the definition in 2.2.76 Part 0 of the Rules.
1.3 FIRE PROTECTION PLANS

1.3.1 On every self-propelled ship with a length of 25 m or more the diagrams shall be arranged in the central control station, the wheelhouse or at visible places in corridors, indicating the following:

1. location of control stations;
2. location of the spaces protected by fixed fire extinguishing systems with the indication of their control devices and arrangements;
3. location of fire-retardant and fire-resistant divisions;
4. location of fire protection outfit;
5. means of access to compartments, on decks etc. with the indication of escape routes, corridors and doors (for ships fitted with cabins);
6. location of fire hydrants;
7. the ventilation system diagram including the central control of fans, with the indication of fan shutters and fans servicing all the ship zones;
8. locations for remote closing of fuel tank pipelines.

1.4 CLASSIFICATION OF EXPLOSION-HAZARDOUS ZONES AND SPACES

1.4.1 For classification of explosion-hazardous zones, see Table 1.4.1.

1.4.2 Fire-risk rooms and spaces are the following:

first category:

1. tanks and cargo tanks for inflammable liquids and liquefied gases;
2. cofferdams separating the tanks stated in 1.4.2.1 from adjacent spaces, and spaces adjacent to them which are not separated by cofferdams and not having forced ventilation;
3. cargo holds intended for transportation of inflammable liquids and liquefied gases;

second category:

4. pump rooms for inflammable liquids and compressor rooms for liquefied gases;
5. closed / semi-closed spaces for storing cargo hoses used for pumping inflammable liquids and liquefied gases;
6. closed / semi-closed spaces in which pipelines for inflammable liquids and liquefied gases are led;
7. spaces adjacent to the tanks stated in 1.4.2.1, not separated by cofferdams but having forced ventilation;
8. spaces above the pump rooms and vertical cofferdams adjacent to the tanks stated in 1.4.2.1;
9. spaces above the cargo tank decks and cofferdams at the distance of less than 2.4 m in the vertical and less than 3 m in the horizontal directions from the cargo tanks;
10. spaces located closer than 3 m in any horizontal direction and no less than 2.4 m in the vertical direction above closed tanks, receptacles, measuring tanks and similar capacities;
11. spaces located closer than 3 m in any direction from gas ventilation outlets and similar arrangements;
12. semi-closed spaces adjacent to the tanks stated in 1.4.2.1, as well as spaces, through which spaces in which pipelines for inflammable liquids and liquefied gases are led, within 3 m from those pipelines in any direction.

1.4.3 Rooms and spaces onboard the oil tankers designed for carrying inflammable liquids and liquefied gases with flash point up to 60 °C inclusive or for operating with them are subdivided into explosive (see 1.4.1) and explosion-proof ones, and with vapor flash point more than 60 °C — fire-hazardous (see 1.4.2) and fire-proof ones.
### Classification of explosion-hazardous zones

<table>
<thead>
<tr>
<th>Designation of hazardous zone</th>
<th>Classification of explosion-hazardous zones</th>
<th>Rooms and spaces included in this zone</th>
</tr>
</thead>
</table>
| 0                            | Zone, where explosive mixture of air and gas may be present permanently or for long periods of time | 1. Inner spaces of cargo compartments and tanks, tanks for combustible liquids; cargo holds for transportation of combustible liquids in containers; cargo pipelines.  
2. Open spaces up to 1 m high from the water surface covered with oil products. |
| 1                            | Zone, where explosive mixture of air and gas may be present under normal operating conditions | 1. Pump and compressor rooms for pumping inflammable liquids.  
2. Cofferdams separating compartments and tanks belonging to zone 0 from adjacent spaces and spaces adjacent to those belonging to zone 0, not separated by cofferdams and not having forced ventilation.  
3. Storage rooms for cargo hoses for pumping inflammable liquids.  
4. Spaces above the cargo tank deck at the distance of less than 2.4 m in the vertical and less than 3 m in the horizontal directions from the cargo tanks.  
5. Spaces and semi-closed rooms on the open deck in a radius of 3 m from the openings which are not ventilating, filling openings and hatches of cargo tanks, pump rooms and cofferdams adjacent to cargo tanks.  
6. Laying areas for pipelines with combustible liquids on the open deck – up to 3 m in any direction.  
7. Spaces located closer than 3 m in any direction from gas ventilation outlets.  
8. Open spaces located within 3 m vertically and horizontally from devices for emission from safety and breathing valves of containers with inflammable liquids and combustible gases. |
| 2                            | Zone with low chance of presence of explosive mixture of air and gas, and in case if this mixture appears it is present for short periods of time | 1. Closed / semi-closed spaces in which pipelines for combustible liquids and liquefied gases are led.  
2. Spaces adjacent to those in zone 0, not separated by cofferdams but having forced ventilation.  
3. Inner spaces of cargo compartments and tanks, cargo pipelines, for combustible liquids with flash point of max. 60 °C and their ventilation system. |
2 STRUCTURAL FIRE PROTECTION

2.1 SUBDIVISION OF MATERIALS DUE TO COMBUSTIBILITY, FLAME SPREADING AND INFLAMMABILITY

2.1.1 Materials used for ships construction shall undergo tests for assessing combustibility, flame spreading, inflammability of deck coverings, degree of integrity and inflammability of textiles.

For the test methods established by normative documents on fire safety, see Appendices 1 to 5 Part X of the Rules.

Proceeding from the test results the grades of materials are determined according to 2.1.2–2.1.4.

2.1.2 Materials, except for textiles, are divided into:

1. non-combustible materials – materials, whose combustibility parameters at 30 minute-tests in the furnace are the following:
   - temperature increase – max. 50 ºC;
   - sample weight loss – max. 50 %;
   - steady flame burning – max. 10 s;

2. combustible materials – materials not complying with at least one of the parameters stated in 2.1.2.1.

2.1.3 Classifications of materials according to flame spreading are based on flame spreading index value $I$ – dimensionless reference indicator, characterizing the capability of materials or substances to inflame, to spread flame on the surface and to release heat. Combustible materials and compositions undergo tests for flame spreading and are assessed as follows:

1. low flame-spreading materials – materials and compositions which are relatively high resistant to flame spreading along the surface and are characterized by flame spreading index $I \leq 20$;

2. rapid flame-spreading materials are the materials and compositions which spread flame along the surface and are characterized by flame spreading index $I > 20$.

2.1.4 Fixed deck coverings with a thickness 5 mm and more are subject to ignitability tests and are assessed according to Appendix 3 Part X of the Rules or according to GOST 30402 as follows:

1. hardly inflammable deck coverings – fixed deck coverings with critical surface density of heat flow exceeding 35 kW/m²;

2. medium inflammable deck coverings – fixed deck coverings with critical surface density of heat flow in range from 20 to 35 kW/m²;

3. highly inflammable deck coverings – fixed deck coverings with critical surface density of heat flow exceeding 20 kW/m².

2.2 REQUIREMENTS FOR MATERIALS

2.2.1 Structural bulkheads, decks and trunks of machinery spaces shall be made of steel; otherwise their structure shall be equivalent to steel structure due to the fire safety.

2.2.2 No combustible materials for structure elements in the machinery spaces are allowed.

2.2.3 Insulation of the ship spaces shall be as follows:

1. For the ship's sides, decks, bulkheads, partitions and other divisions it shall be made of non-combustible materials;
2. Heat and noise insulation of the ship’s sides, bulkheads, decks and trunks off machinery spaces and boiler rooms shall be made of non-combustible materials. The insulation surface shall be protected against ingress of fuel, oil and their vapours.

Bulkheads and decks separating machinery spaces from adjacent accommodation and household spaces shall be made of at least A-30 type divisions.

If spaces adjacent to the machinery spaces are completely free from combustible materials, their divisions may be of A-0 type.

2.2.4 At control stations, in accommodation and household spaces including related corridors, fixed deck coverings of a thickness 5 mm and more shall be hardly inflammable as per 2.1.4.1 and shall not release toxic or explosive gases.

Outer surfaces of corridors and partitions of the ladders from the control stations, accommodation and household spaces as well as concealed or non-accessible surfaces in those spaces (beyond panels, linings, etc.) shall be made of low flame-spreading materials.

Facing of outer surfaces in accommodation and household spaces may be made of combustible materials with a thickness not exceeding 2 mm, when the latter are not adjacent to the machinery spaces. If low flame-spreading materials are used, facing may be more than 2 mm thick.

2.2.5 Mass of combustible materials used for inner bulkheads, furring, insulation, lining, finishing, furniture and other equipment of control stations, accommodation and household spaces excepting cooled spaces, where this Part of the Rules allows its application, shall be not more than 45 kg per 1 m² of the deck area where the given space is located.

The area of a space formed by non-vertical structures is calculated on the basis of plan area of this space at the middle of its height between the floor and the top ceiling.

Wood for furring, covering of inner decks and platforms, bulkheads, insulation lining shall be impregnated by fireproof composition or treated in other equivalent way.

In case of fire or heating the materials shall not release toxic or explosive gases in hazardous concentrations.

In all cases surface of the material shall be low flame-spreading.

2.2.6 No varnishes, paints on nitrate base or any other combustible base shall be used for inner finishing of the ship’s spaces.

Finishing coatings shall not release toxic substances in dangerous concentrations when burning (class of hazard — not higher than moderately hazardous according to GOST 12.1.044).

No aluminium paints shall be used on oil tankers in cargo compartments, cofferdams, pump rooms, cargo deck area and other spaces where explosive vapours may be present.

2.2.7 Textiles for draperies, curtains etc., as well as furniture covers and mattresses shall not spread flame more rapidly than woollen cloth of relative mass 0.8 kg/m².

Carpets and similar coverings shall not spread flame more rapidly than woollen products used for the same purpose.

No combustible materials with rapid flame propagation shall be used as padding for mattresses and pillows.

2.2.8 All capacities intended for collection of combustible wastes shall be made of non-combustible materials and shall have no openings in walls or the bottom.

2.2.9 Materials used for equipment included in fire extinguishing systems shall be non-combustible and resistant to fire extinguishing agents. Gaskets and flexible hoses (see 10.2.22 Part IV of the Rules) used in joints of fire extinguishing systems shall be made of materials resistant to fire extinguishing agents, water (sea water for M-СП, М-ПП and О-ПП class ships) and moist air.

2.2.10 Deck coverings inside explosive rooms and spaces shall prevent the risk of spark formation.

1 GOST R 50810.
2.3 USE OF COMBUSTIBLE MATERIALS

General provisions

2.3.1 On passenger ships, A, B or C type divisions in accommodation and service spaces which are faced with combustible materials, facings, moldings, decorations and veneers shall comply with the provisions of 2.2.4, 2.2.6, 2.3.4 – 2.3.6.

2.3.2 On non-passenger ships, non-combustible bulkheads, ceilings and linings fitted in accommodation and service spaces may be faced with combustible materials, facings, moldings, decorations and veneers provided such spaces are bounded by non-combustible bulkheads, ceilings and linings in accordance with the provisions of 2.2.4, 2.2.6, 2.3.4 – 2.3.6.

2.3.3 Structures of combustible materials near galley ovens shall be covered with heat insulation of non-combustible material, faced with steel plates which shall be extended over the overall oven dimensions for at least 500 mm.

Maximum heat of combustion for combustible materials

2.3.4 Combustible materials used on the surfaces and linings shall have a heat of combustion not exceeding 45 MJ/m², with regard to their thickness. The requirements of this paragraph are not applicable to the surfaces of furniture fixed to linings or bulkheads.

Heat of combustion with regard to facing material is determined by the following formula (MJ/m²):

$$ Q = q_s ps $$

(2.3.4)

where $q_s$ – specific heat of combustion for the material, determined according to GOST R 56025 (MJ/kg);

$p$ – material density (kg/m³);

$s$ – material thickness (m).

2.3.5 The total volume of combustible facings, moldings, decorations and veneers meeting the requirements of 2.3.1 and 2.3.2 in accommodation and service spaces shall not exceed a volume equivalent to 2.5 millimeters veneer on the combined area of the walls and ceiling linings. Furniture fixed to linings, bulkheads or decks need not be included in the calculation of the total volume of combustible materials.

2.3.6 The following surfaces shall have low flame-spread characteristics;

1. on passenger ships:
   - outer surfaces in corridors and ladder enclosures, and bulkhead and ceiling linings in accommodation and service spaces (except saunas) and control stations;
   - surfaces and grounds in concealed or inaccessible spaces in accommodation and service spaces and control stations;

2. for non-passenger ships:
   - outer surfaces in corridors and ladder enclosures and of ceilings in accommodation and service spaces (except saunas) and control stations;
   - surfaces and grounds in concealed or inaccessible spaces in accommodation and service spaces and control stations.

2.4 LADDERS, TRUNKS. REQUIREMENTS FOR DRAUGHT RESTRICTION AND PENETRATION OF SMOKE AND FLAME

2.4.1 Exits from spaces, ladders, doors and rescue scuttles shall be made according to the requirements of 1.8 Part IV and 9 – 10 Part I of the Rules. In addition to the requirement of 1.8.4 Part IV of the Rules for ships of 85 m in length, light hatch may be used as a second exit. It shall be opened from inside.

2.4.2 Ladders shall be made of steel or other equivalent material. Ladders passing through a single deck shall be enclosed on either of two decks by fire-retardant divisions and self-closing doors.

Ladders passing through more than one deck shall be enclosed on all decks by fire-retardant divisions and self-closing doors; exits shall be provided from ladder enclosures to the open deck or to the corridors giving access to the open deck.

2.4.3 In ladder enclosures of passenger ships, each deck shall be provided with max.
six seats. Seats shall be fixed and shall not restrict the passenger escape route. Furniture shall not be permitted in passenger and crew corridors forming escape routes in cabin areas.

2.4.4 Elevators and lifts shall be located within trunks made of steel or equivalent material which shall prevent smoke and flame penetration from one space between decks to another one. Closing arrangements restricting draught and smoke penetration shall be provided.

2.4.5 Air spaces located beyond the lining of ladders, trunks and similar vertical enclosures as well as deck penetrations for pipes and cables shall be sealed with a non-combustible material at every deck.

2.4.6 Protection of ladders and elevator trunks in the accommodation, service spaces and control stations of M-CTI class ships shall be provided as follows:

.1 Ladders passing through one deck only shall be protected at least at one level by at least B-0 type divisions and self-closing doors. Elevators passing through one deck only shall be enclosed by A-0 type divisions with steel doors at both levels. Ladders and elevator trunks which penetrate more than a single deck shall be surrounded by at least A-0 type divisions and be protected by self-closing doors at all levels;

.2 Ladders and elevator trunks may be protected by B-0 type divisions on ships with the accommodation spaces intended for 12 passengers or less, ladders passing through more than one deck and at least two exits to an open deck available at each accommodation spaces’ level;

.3 One of the ladders of the machinery spaces which comply with the requirements of 1.8.3 Part IV of the Rules, throughout the escape route shall have continuous fire protection by means of separation by A-15 type divisions;

.4 Elevator trunks shall be so arranged that to prevent from penetration of smoke and flame from one tween-deck space to another;

.5 Where hold-back arrangement is provided, it shall comply with the requirements of 2.6.3.

2.5 FIRE-HAZARDOUS MATERIAL STORAGE, WELDING ROOMS AND SAUNAS

Storerooms for highly inflammable materials and substances

2.5.1 Storerooms for highly inflammable materials and substances as well as combustible materials shall not be adjacent to the accommodation spaces, machinery spaces, fuel and lubricating oil storages. Structures of bulkheads and decks of the storerooms shall be made of steel or another equivalent material.

Where the hull, superstructures and deck-houses are made of other materials, structures of bulkheads and decks of the storerooms shall be of type B-15.

2.5.2 Storerooms for highly inflammable materials and substances shall comply with the following requirements:

.1 Storerooms shall have separated exits to an open deck. One exit to an open deck may be arranged from the lamp rooms and paint stores located in adjacent spaces through a common lobby isolated from other spaces provided that each store room has individual closable exit to that lobby;

.2 Equipment shall be made of non-combustible materials;

.3 Stores shall be provided with natural plenum-exhaust ventilation. Outlet openings of vent pipes from the mentioned spaces shall be fitted with flame arresting fittings;

.4 Inflammable liquids of ship supply with a flash point lower than 43 °C inside the storerooms shall be stored in special steel tanks with air ducts led to the outside and fitted with flame arresting fittings;

.5 Storeroom doors shall open toward the open deck and be provided with an inscription “Fire danger!”

2.5.3 Where a separate storeroom for easily inflammable liquids is impracticable, they may be stored in steel lockers or boxes complying with the following requirements:

.1 The lockers and boxes shall be fitted with tightly closing doors or covers with locks and vent ducts fitted with flame arresting fittings. The lockers and boxes shall not be adja-
cent to the accommodation spaces. Doors or cover in places of contact with the case shall be faced with materials preventing spark formation. Where the lockers or boxes are fitted on the deck made of combustible material, the latter shall be insulated by steel above non-combustible heat-insulating material 5 mm thick along the locker or box surfaces. Instead of deck insulation the locker or the box may be fitted on legs at least 50 mm high.

2. Inside the lockers or boxes inflammable liquids may be stored in not more than two tightly closed cans. Steel cans shall be secured in pockets faced with non-combustible material preventing spark formation. The can capacity for inflammable liquids shall not exceed 20 L. No cans made of synthetic materials may be used.

2.5.4 Store of rags and used rags shall be kept in storerooms outside the machinery spaces. Service store of rugs is allowed to be kept in the machinery spaces in individual closed steel boxes.

Ship’s pyrotechnical means

2.5.5 Ship pyrotechnic means other than those for lifeboats and liferafts shall be kept in tightly closed metal lockers.

2.5.6 Lockers for storing pyrotechnic signal means shall be impenetrable and made of steel or its equivalent fire-resistant material, fitted with tight doors, located on the open deck, at least 100 mm above the deck and at minimum distance of 100 mm from external bulkheads of the superstructure / wheelhouse, next to which they are mounted, or integrated in the wheelhouse. In the latter case, their doors shall be arranged to open outwards (to the deck).

Lockers shall be provided with shelves excluding friction and shocks of rockets, their displacement under heel conditions.

If the locker is subject to direct sunlight, it shall be provided with a sun visor.

The following inscriptions shall be applied on the lockers (boxes):

“Pyrotechnics
No open flame”.

Storage rooms for oxygen and acetylene cylinders

2.5.7 Storage rooms for oxygen and acetylene cylinders shall be at least 2 m clear of the accommodation spaces and control stations and at least 4 m clear of spaces containing inflammable substances and fuel or essential onboard equipment.

2.5.8 The storage room for acetylene cylinders shall be separate from the storage room for oxygen cylinders.

2.5.9 Rooms for storing cylinders shall be separated from adjacent rooms by A-60 type divisions and have an entrance directly from the open deck.

2.5.10 Storage spaces for oxygen and acetylene cylinders shall be equipped with regard to the following requirements:

1. Oxygen and acetylene cylinders shall be kept in vertical position in special closed spaces with natural ventilation or on open decks;

2. Storage spaces for the cylinders shall be fitted with uprights with sockets, clamps or other devices which provide reliable fastening and release of the cylinders;

3. Storage spaces for the cylinders on the open deck shall be selected to avoid accidental mechanical damage of the cylinders and access of unauthorized personnel;

4. Cylinders shall be protected against direct sunlight;

5. Warning inscriptions “Acetylene” “Explosive” and “No smoking” shall be provided on the fence of the area with acetylene cylinders; warning inscriptions “Oxygen”, “No oil inside” and “No smoking” shall be provided on the fence of the area with oxygen cylinders;

6. Cylinders shall not be fastened on bulkheads of accommodation spaces;
.7 Laying and placement of foreign equipment, cables and pipelines in cylinder rooms is not allowed.

2.5.11 Doors of spaces shall open outward, shall have locks and inscriptions as stated in 2.5.10.5.

**Spaces for electric-gas-welding operations**

2.5.12 Space for electric-gas-welding operations shall comply with the following requirements:

1. The space shall be located to the aft from cargo tanks (in oil tankers), discharge tanks and cofferdams protecting them, shall be separated from adjacent rooms by A-60 type divisions and have an exit to the open deck;

2. The space shall not be located in machinery spaces of A category, as well as at distance less than 5 m from the rooms intended for storing and transporting explosive and fire-risk materials;

3. The distance from the room to gas ports of cargo compartments and discharge tanks shall be min. 9 m;

4. The space shall be fitted with forced ventilation which provides 20 air exchanges per hour;

5. The welding current source shall be fitted with a blocking device preventing from its activation when entrance door is open and forced ventilation is not in operation;

6. The door shall have a lock, the outer door shall be provided with lighting panel “Keep out! Welding in progress!”.

**Saunas**

2.5.13 Saunas shall comply with the requirements of 9.9 Part I of the Rules and with the following requirements:

1. The sauna perimeter shall be fitted with A-60 type divisions, except those inside the perimeter;

2. Saunas shall include changing rooms, showers and toilets. If there is an entrance from the bathroom to the sauna, then the door between them may not comply with fire safety requirements, but in this case the bathroom shall comply with the requirements for saunas according to the present Rules;

3. Wooden benches and wooden linings on bulkheads and ceilings are permitted in saunas and in this case the requirements of 2.3.4, 2.3.5 are not applied. 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., non-combustible plate with an air gap of at least 30 mm).

2.6 **REQUIREMENTS FOR STRUCTURAL FIRE PROTECTION OF VARIOUS SHIP TYPES**

**Passenger ships**

2.6.1 On passenger ships the following structural elements shall be fireproof inside the hull and superstructures:

- trunks of machinery spaces and boiler rooms
- enclosures of ladders
- bulkheads and decks separating the control stations from adjacent spaces
- bulkheads and decks separating the accommodation spaces from the household, machinery spaces and boiler rooms as well as the cargo holds and fuel storerooms
- bulkheads and decks of storerooms for highly inflammable and combustible materials as well as galleys and all other spaces where fuel is stored or used
- bulkheads and deck of the passages used as escape routes for passengers and crew

The stated structural elements shall be designed as per Tables 2.6.1-1 and 2.6.1-2.

When using Tables 2.6.1-1 and 2.6.1-2, the following shall be considered:

1. Bulkheads between cabins, between cabins and corridors, vertical bulkheads
- bulkheads separating lounges according to 2.6.2, bulkheads of spaces with pressure sprinkler system shall comply with B-0 type;
### Table 2.6.1-1

**Type of bulkheads between spaces without pressure sprinklers**

<table>
<thead>
<tr>
<th>Space</th>
<th>control station</th>
<th>stairwell</th>
<th>mustering station</th>
<th>lounge</th>
<th>engine space</th>
<th>galley space</th>
<th>storeroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control station</td>
<td>—</td>
<td>A-0</td>
<td>A-0/B-15</td>
<td>A-30</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
</tr>
<tr>
<td>Stairwell</td>
<td>—</td>
<td>—</td>
<td>A-0</td>
<td>A-30</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
</tr>
<tr>
<td>Mustering station</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Lounge</td>
<td>—</td>
<td>—</td>
<td>B-15</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
</tr>
<tr>
<td>Engine space</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>A-60/A-0</td>
<td>—</td>
<td>A-0</td>
<td>A-60/B-15</td>
</tr>
<tr>
<td>Galley space</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Storeroom</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

1. The type of bulkheads for mustering stations is specified as follows: in the numerator – inside the ship, in the denominator – in open spaces.
2. The type of bulkheads between lounges and mustering stations is specified as follows: in the numerator – inside the ship, in the denominator – in open spaces.
3, 4 Type of bulkhead shall be selected with regard to the requirements of 2.6.1.1 and 2.6.1.2, respectively.
5 The type of bulkheads is specified as follows: in the denominator – bulkheads separating galleys and refrigerated chambers or provision rooms, in the numerator – other bulkheads.

### Table 2.6.1-2

**Type of bulkheads between spaces with pressure sprinklers**

<table>
<thead>
<tr>
<th>Space</th>
<th>control station</th>
<th>stairwell</th>
<th>mustering station</th>
<th>lounge</th>
<th>engine space</th>
<th>galley space</th>
<th>storeroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control station</td>
<td>—</td>
<td>A-0</td>
<td>A-0/B-15</td>
<td>A-0</td>
<td>A-60</td>
<td>A-60</td>
<td>A-30</td>
</tr>
<tr>
<td>Stairwell</td>
<td>—</td>
<td>—</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td>A-60</td>
<td>A-0</td>
</tr>
<tr>
<td>Lounge</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>B-0</td>
<td>A-60</td>
<td>A-60</td>
<td>A-0</td>
</tr>
<tr>
<td>Engine space</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>A-60/A-0</td>
<td>A-60</td>
<td>A-60</td>
</tr>
<tr>
<td>Galley space</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>B-15</td>
</tr>
<tr>
<td>Storeroom</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

1–4 See the corresponding footnotes for Tables 2.6.1-1.

...
tor of the door position (“O p e n” – “C l o s e d ”).

Self-closing doors, which remain open during the normal operation, shall be closed from the place permanently manned by crew members. After the door is closed, it shall remain available for local closing and opening.

Other openings in the bulkhead shall be sealed by non-combustible material in a such way that the bulkhead integrity is not disturbed.

Closing devices of the openings in other fire-retardant divisions shall be so sealed that to retain the integrity.

2.6.4 Air spaces beyond the ceiling, panels or lining shall be separated by tightly fit sealings without gaps made of non-combustible materials preventing from draught and located at the distance not exceeding 14 m apart.

2.6.5 Structural fire protection of passenger ferries shall be executed in the same way as on passenger ships.

Ships and ferries intended for transportation of motor vehicles and other vehicles with filled fuel tanks shall comply with the following requirements:

1. Accommodation, service and machinery spaces shall be separated from cargo decks and holds by fireproof divisions of type A;
2. Closed spaces (holds) shall be fitted with forced ventilation.

Oil tankers. General requirements

2.6.6 Portholes and windows in bulkheads of superstructures and deckhouses faced to the cargo tanks or measuring tanks as well as in outer bulkheads adjacent to a superstructure at the distance within 3 m shall be of blind (non-opening) type. No doors are allowed in the mentioned areas.

This requirement does not apply to cargo handling control stations having no direct connections with the accommodation and service spaces, and the wheelhouse.

In addition to the above mentioned, the requirements of 5.6.2 Part IX of the Rules shall be met.

2.6.7 For heating the ship’s cargo or spaces, the machinery space or special compartment from the deck or from the machinery space, boilers working on liquid fuel with flash point of over 60 °C, may be fitted. The doors in machinery space trucks shall be of self-closing type. The doors shall be closed in normal position.

2.6.8 No wood or other combustible materials may be used in bulk cargo tanks, cofferdams and pump rooms.

2.6.9 Bulk cargo / discharge tanks shall be separated from the machinery spaces by cofferdams.

2.6.10 Cofferdams shall be of a length equal to one spacing but not less than 0.5 m. By-pass gate valves in cofferdam bulkheads are not allowed.

2.6.11 When the pump room is adjacent to the machinery space, no cofferdam is required.

2.6.12 Pump rooms shall be separated from the machinery spaces and cofferdams by gastight bulkheads.

Pump rooms shall have separate exits to the open deck fitted with gas-tight closures.

Direct connection between the pump rooms and the machinery spaces is not allowed.

2.6.13 On the deck of bulk cargo tanks hollow (tubular) details in the structure of ladders, enclosures and other structures are permitted, if natural ventilation of their inner cavities is provided. No hollow details are permitted in bulk cargo tanks and pump rooms of oil tankers.

The requirement does not cover pipelines of the cargo heating system.

2.6.14 Structure of hatch covers fitted in spaces and areas with risk of explosion shall prevent spark formation when they are being opened or closed. Hatch covers shall be gastight.

2.6.15 Accommodation spaces shall be located in the superstructures of the after part of a ship made of steel or other equivalent
material. Where the accommodation spaces are located above the pump rooms, cofferdams or cargo compartments, the deck of the mentioned spaces shall be raised for 0.5 m above the ship’s deck.

2.6.16 The space between the ship’s deck and the raised superstructure shall be open. The raised deck shall be gas-tight and be made of steel or other equivalent material.

2.6.17 The superstructure containing the accommodation spaces shall have two exits on the open deck, one from each side.

2.6.18 On self-propelled oil tankers a smoking room shall be provided in the superstructure, with equipment and lining made of non-combustible materials. Exit from the smoking room shall lead to a corridor, the portholes shall be of blind (non-opening) type.

2.6.19 On oil tankers and ships carrying hazardous chemicals in bulk, cofferdams, ballast tanks, cargo reservoirs and other spaces in the cargo zone shall be accessed directly from the open parts of the deck. Double bottom space may be accessed through other spaces.

2.6.20 Ships stated in 2.6.19, shall be provided with two independent exits in the cargo zone which are located as far as possible from each other. Minimum free dimensions of exits shall be the following:

- \((600 \times 600)\) mm – for exits through horizontal openings, manholes, hatches
- \((600 \times 800)\) mm – for exits through vertical openings, manholes and hatches. If the lower edge of an exit is located 600 mm above the floor level, it shall be provided with steps.

Requirements for oil tankers intended for transportation, pumping and storage of liquids with a flash point of max. 60 °C.

2.6.21 Peaks shall be separated from cargo zone and fuel tanks by cofferdams. Machinery spaces shall be separated from cargo zone by cofferdams, cargo pump rooms or isolated ballast tanks. The cofferdams shall be fitted with water or inert gas filling system.

Accommodation spaces shall be located above dry compartments in superstructures of the after part of a ship made of steel or other equivalent material. The first tier of the aft superstructure shall extend from side to side. The fore bulkhead of that tier shall be tight and have no doors, necks and opening portholes.

Placement or overhanging of accommodation spaces and the wheelhouse above the pump room and cargo tanks on self-propelled tankers is not permitted. On non-self-propelled ships those spaces may be located amidships above the cofferdams, pump rooms and cargo compartments, when the deck of those spaces is raised above the ship’s deck by 2 m; here, the requirement of 2.6.16 shall be complied with.

2.6.22 In the pump room (see 2.6.11 and 2.6.12), the first floor from the machinery space bulkhead shall be gas-tight.

2.6.23 The structure and material of the deck machinery elements (locking devices, brake blocks etc.) fitted in spaces and areas with risk of explosion, shall prevent spark formation.

Chain lockers (if located in the mentioned spaces and areas) shall be gas-tight and fitted with arrangements for water filling.

2.6.24 Mooring and towing bollards shall be arranged on foundations which design shall provide for free air circulation beneath the bollards.

In spaces and areas with risk of explosion no steel towing or mooring ropes may be used or stored.

2.6.25 The structure and material of guard rails located in explosive cargo zone shall prevent formation of sparks as a result of impact.

2.6.26 Working spaces decks (near the onboard arrangements and the deck machinery) shall be covered with wooden grating or insulated by non-slip mastic. Grating shall have no steel fastenings.

Requirements for oil stations

2.6.27 On oil stations working with inflammable liquids with a flash point of max.
60 °C no accommodation or other spaces may be located except for pump rooms, machinery spaces, control stations and service spaces (offices, washrooms, shower rooms and lavatories).

2.6.28 No control stations or service spaces may be located in the ship’s hull.

2.6.29 Machinery spaces of all stations as well as boiler rooms of stripping stations working with inflammable liquids with a flash point below 60 °C, shall comply with the following requirements:
- The deck of machinery spaces located above the cargo tanks shall be raised over the cargo tank deck by at least 0.7 m;
- Machinery spaces located inside the hull shall be separated from the cargo tanks by cofferdams of at least 0.5 m width.

2.6.30 In oil stations working with inflammable liquids with a flash point of over 60 °C, the machinery spaces may be located either inside the hull or above the cargo tank deck.

- The deck of machinery spaces located above the cargo tanks shall be raised over the cargo tank deck by at least 0.5 m.
- Machinery spaces located inside the hull shall be separated from cargo tanks by a cofferdam.

- In oil stations intended for operation with inflammable liquids with a vapour flash point above 120 °C, no raise of the machinery space deck over the cargo tank deck is required.

2.6.31 In oil stations working with inflammable liquids with a vapour flash point below 60 °C entries to the machinery spaces shall be arranged from the deck of superstructure or entrance deckhouse arranged at the height of at least 2 m from the main deck.

2.6.32 Pump rooms, machinery spaces and entrance deckhouses shall have blank (non-opening) side scuttles, tight bulkheads and divisions and separate exits to open decks with tight closures.

Requirements for oil tanker service ships

2.6.33 Port ships, which service oil tankers carrying oil goods with vapour flash point of max. 60 °C, including auxiliary ships, fuelers, floating stores shall comply with the requirements of 2.1 – 2.5, and with the following:
1. Fender guards shall be either made of materials preventing spark formation or faced with such materials. Guard rails shall not be fastened to the hull by driftbolts;
2. Fenders with outer surfaces made of spark-forming materials are not permitted;
3. Detachable elements of guard rails, mooring and towing ropes, closures of bulwarks and fender suspensions shall be made of materials preventing spark formation;
4. Design of the doors and hatch covers located in the cargo zone of an oil tanker during mooring operations, shall prevent spark formation when they are being opened (closed);
5. Fuelers being oil tankers shall also comply with the requirements of 2.6.6 – 2.6.32 with due regard of the vapour flash point of the cargo being transported.

Requirements for ships less than 25 m in length

2.6.34 The requirements of 2.1 – 2.5 apply to ships less than 25 m in length, unless specified otherwise in 2.6.35 – 2.6.37.

2.6.35 On wooden and composite ships wood may be used without fireproof impregnation for inner bulkheads, divisions, decks except for wooden divisions in spaces containing internal combustion engines.

- Ceilings, sides and bulkheads of the machinery space shall be either impregnated with fireproof composition or plated with steel above the layer of non-combustible material not less than 5 mm thick.

2.6.36 Heat insulation of the deck above the fuel tank compartment shall be made of non-combustible material.

2.6.37 On ships without continuous deck tight bulkheads are not required for enclosing spaces of engines.

Requirements for floating objects with wooden superstructures

2.6.38 Wood may be used as structural material for superstructures of inland navigation
floating objects with the reinforced concrete hull, operated in close proximity to the coast and moored to it, if the requirements of 2.1 – 2.5 and the following requirements are complied with:

1. Superstructures shall be made of timber impregnated by fireproof composition;
2. There shall be maximum three superstructure tiers;
3. It is necessary to take measures to minimize the amount of combustible materials onboard the floating object (non-combustible materials shall be used for isolation, finishing and furniture);
4. All spaces shall be protected by a fire detection and alarm system;
5. When selecting and fitting ship’s technical facilities, elements of systems and electric equipment, the fire risk arising from superstructure material properties shall be considered;
6. Floating object shall be equipped with fire extinguishers, whose number shall exceed that stated in 6.1.8 at least by two times;
7. Smoking shall be forbidden on board the floating object;
8. At least two (main and reserve) evacuation routes from each room and from the floating object shall be provided. The reserve route may be provided by means of portable (folding or rope) ladders through windows and portholes.

2.7 STRUCTURAL FIRE PROTECTION OF M-CII CLASS SHIPS

General requirements

2.7.1 In places where A type metal divisions are adjacent to metal decks, bulkheads and sides as well as in places where piping, cables and air ducts penetrate through A type metal divisions, those structures adjacent to as well as penetrating through A type divisions shall be insulated by non-combustible materials. The total length of the insulated section shall be at least 500 mm regardless of the insulation availability at one side or both sides from the A type division. The length of the insulated section may be reduced if the reduced insulation length is proved sufficient by the standard fire testing (see 1.2.1.35).

2.7.2 The A type divisions separating two adjacent rooms, one of which is completely free from combustible medium (inflammable liquids, inflammable compressed, liquefied gases and gases dissolved under pressure, inflammable solid combustible materials and substances), or being the outer surfaces of superstructures and deckhouses, due to their fire resistance properties shall meet the requirements for A-0 type divisions.

2.7.3 Continuous B type ceilings and linings (ceilings and linings terminating either at an A or B type division or at outer surfaces of a ship) together with related decks and bulkheads may be approved as completely or partially complying with the requirements to insulation and fire resistance of A type divisions stated in relevant fire resistance tables (see Tables 2.7.18-1, 2.7.18-2, 2.7.22-1, 2.7.22-2).

2.7.4 B type bulkheads shall extend from deck to deck and to outer plating or other boundaries. However, when such a boundary is protected by a continuous B type ceiling or lining extending to both sides from the bulkhead, the latter may terminate near such continuous ceiling or lining.

2.7.5 Closures of openings in A and B type divisions shall be of the same type as the divisions themselves.

Closures of openings in A type divisions shall be smoke- and fire-tight within 60 min of standard fire resistance test and be made of steel or equivalent material.

Closures of openings in B type divisions shall be fire-tight within 30 min of standard fire resistance test and be made of non-combustible material.

B type doors may be used in corridor A-0 type bulkheads.

All windows and portholes in bulkheads inside the accommodation and service spaces shall be arranged in such a way that they do to impose the fire-resistance properties of the bulkhead. This requirement does not apply to glassed bulkheads, windows and portholes in the outer plating of the hull, bulkheads and deckhouses, and outer doors in superstructures and deckhouses.
2.7.6 Fire-fighting doors in bulkheads of vertical fire zones and in ladder enclosures as well as doors leading to machinery spaces of A category, except for mechanically driven watertight doors, outer and normally locked doors, shall be self-closing. Those doors shall close at the inclination angle up to 3.5° to the side opposite to the closing direction. The doors shall be supplied with a hold-back arrangement keeping them in the open position and releasing them either by the remote control or directly from the places arranged on both sides of the door. The hold-back arrangement shall be designed in such a way that the doors could be closed automatically if the remote control system is damaged.

2.7.7 In the lower corner of the doors located in fire-resistant bulkheads (except for doors in the main fire-resistant bulkheads) there may be an opening with self-closing device for fire hose. The diameter of the opening shall allow free pass of fire hose connections used onboard the ship and provide the doors with possibility to close with a fire hose passing through them.

2.7.8 No air ducts or gratings may be arranged in A type doors.

2.7.9 Air ducts may be arranged either in the lower half of doors of corridor bulkheads, cabins or public spaces or under doors except for the doors in ladder enclosures. The total net area of such openings shall not exceed 0.05 m²; they shall be fitted with a mesh made of non-combustible material.

2.7.10 Upper parts of B type doors may be glassed by special heat-resistant glass or glass wired with reinforcing wire mesh. Frames for glass fixation shall be made of steel or other non-combustible material. Construction of glassed doors shall comply with all requirements to B type divisions; this shall be proved by the results of testing specimens of such doors for fire resistance.

2.7.11 Hinges of A and B class doors shall be made of materials with melting point not less than 950 °C.

2.7.12 Where openings for cables, piping, trunks, air ducts or ventilation system assemblies, lightning fixtures etc. are arranged in A and B type divisions, the measures shall be taken against loss of fire resistance properties of the latter.

2.7.13 Doorways of all doors, air ducts, ring spaces around smoke pipes, light hatchways of machinery spaces, boiler and pump rooms shall be supplied with closing devices. Those devices shall be manufactured in such a way that they could be controlled from the open deck in the event of fire. The requirement for the control of closing devices from the open deck does not apply to doors that can be closed from outside the spaces listed above.

2.7.14 In light hatchways of machinery spaces and boiler rooms no glass panels shall be fitted. Portholes arranged in the light hatchways shall have glass wired with reinforcing wire mesh.

Requirements for passenger ships

2.7.15 Structural fire protection of passenger vessels regardless of the voyage patterns shall correspond with the requirements of the International Convention for the Safety of Life at Sea, 1974, as amended. The requirement applies to passenger ships of M-IIP and O-IIP classes.

Requirements for cargo ships

2.7.16 The requirements of 2.7.17 – 2.7.20 are additional to the requirements of 2.7.1 – 2.7.14 and apply to cargo ships of gross tonnage 500 and over.

2.7.17 Accommodation and service spaces shall be protected by 1C protection method which specifies that all inner bulkheads shall be made of non-combustible B and C type divisions.

2.7.18 The minimum fire resistance of bulkheads and decks separating adjacent spaces shall comply with the requirements of 2.7.18-1 and 2.7.18-2 respectively, which divide those spaces into the following categories proceeding from the risk of fire:
### Table 2.7.18-1

**Minimum fire integrity of bulkheads separating adjacent spaces**

<table>
<thead>
<tr>
<th>Rooms and their fire risk category</th>
<th>Room fire risk category</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control stations</td>
<td>1 A-0 1</td>
<td>A-0 1</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-15</td>
<td>A-60</td>
<td>A-15</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
<td>*</td>
</tr>
<tr>
<td>Corridors, lobbies and companions</td>
<td>2 —</td>
<td>C</td>
<td>B-0</td>
<td>A-0 3, B-0</td>
<td>B-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
</tr>
<tr>
<td>Accommodation spaces</td>
<td>3 —</td>
<td>—</td>
<td>C</td>
<td>A-0 3, B-0</td>
<td>B-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
</tr>
<tr>
<td>Enclosures of stairways</td>
<td>4 —</td>
<td>—</td>
<td>—</td>
<td>A-0 3, B-0</td>
<td>A-0 3, B-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-30</td>
</tr>
<tr>
<td>Service spaces (low risk of fire)</td>
<td>5 —</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>C</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-0</td>
</tr>
<tr>
<td>Machinery spaces of category A</td>
<td>6 —</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td>A-60</td>
<td>*</td>
<td>A-60</td>
</tr>
<tr>
<td>Other machinery spaces</td>
<td>7 —</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-0</td>
</tr>
<tr>
<td>Cargo spaces</td>
<td>8 —</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
</tr>
<tr>
<td>Service spaces (high risk of fire)</td>
<td>9 —</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
</tr>
<tr>
<td>Open decks</td>
<td>10 —</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>A-0</td>
</tr>
<tr>
<td>Ro-ro cargo spaces</td>
<td>11 —</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

1. Bulkheads which separate wheelhouse, chart house and radio room, may be of B-0 type.
2. To determine the type of bulkheads see 2.4.6 and 2.7.20.
3. Doors from cabins to inner individual lavatories may be made of combustible materials.
4. Where transport of hazardous goods is not provided, A-0 type bulkheads may be used.
5. When spaces are used for the same purpose, bulkheads between them may be dispensed with.

**Note.** “*” — divisions made of steel or other equivalent material, which may be not of A type.

### Table 2.7.18-2

**Minimum fire integrity of decks separating adjacent spaces**

<table>
<thead>
<tr>
<th>Lower spaces and their fire risk category</th>
<th>Fire risk category of upper spaces</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control stations</td>
<td>1 A-0 1</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-60</td>
<td></td>
</tr>
<tr>
<td>Corridors, lobbies and companions</td>
<td>2 A-0 2</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-30</td>
<td></td>
</tr>
<tr>
<td>Accommodation spaces</td>
<td>3 A-60 3</td>
<td>A-0</td>
<td>*</td>
<td>A-0</td>
<td>*</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-30</td>
<td></td>
</tr>
<tr>
<td>Enclosures of stairways</td>
<td>4 A-0 4</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-30</td>
<td></td>
</tr>
<tr>
<td>Service spaces (low risk of fire)</td>
<td>5 A-15 5</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-0</td>
<td></td>
</tr>
<tr>
<td>Machinery spaces of category A</td>
<td>6 A-60 6</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
<td>A-60</td>
<td>*</td>
<td>A-60</td>
<td>A-30</td>
<td>A-60</td>
<td>*</td>
<td>A-60</td>
<td></td>
</tr>
<tr>
<td>Other machinery spaces</td>
<td>7 A-15 7</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-0</td>
<td></td>
</tr>
<tr>
<td>Cargo spaces</td>
<td>8 A-60 8</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>*</td>
<td>A-0</td>
<td></td>
</tr>
<tr>
<td>Service spaces (high risk of fire)</td>
<td>9 A-60 9</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-0</td>
<td>A-30</td>
<td></td>
</tr>
<tr>
<td>Open decks</td>
<td>10 * 10</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Ro-ro cargo spaces</td>
<td>11 A-60 11</td>
<td>A-30</td>
<td>A-30</td>
<td>A-30</td>
<td>A-30</td>
<td>A-0</td>
<td>A-60</td>
<td>A-0</td>
<td>A-0</td>
<td>A-30</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

**Note.** See footnotes and Note to Table 2.7.18-1.

1 – control stations;
2 – corridors, lobbies and companions;
3 – accommodation spaces according to 1.2.1.22 except for corridors, lobbies and companions;
4 – inner ladders and elevators except for those entirely located within the machinery spaces as well as their enclosures. A ladder enclosed only in one tween-deck space is to be considered as a part of the space from which it is not separated by fire-fighting door;
5 – service spaces (with low risk of fire): storerooms of combustible materials with area less than 2 m², storerooms of non-combustible materials, drying rooms and laundries;
6 – machinery spaces of A category;
7 – other machinery spaces: machinery spaces except for those of category 6, and special electrical spaces;
8 – cargo spaces according to 1.2.1.2;
9 – service spaces (with high risk of fire) according to 1.2.1.26 except for those listed in category 5;
10 – open decks: open deck spaces and closed promenade decks having no risk of fire as well as air spaces outside the superstructures and deckhouses;
11 – ro-ro cargo spaces according to 1.2.1.2.

Openings in bulkheads and decks between ro-ro cargo spaces shall have fire- and smoke-tight covers.

Where a deck marked with * in Table 2.7.18-2, is penetrated for the passage of electric cables, pipes and vent ducts, such penetrations should be made tight to prevent the passage of flame and smoke.

2.7.19 At the control stations, in accommodation and service spaces all ceilings and linings, draught stops and relevant framing shall be made of non-combustible material.

2.7.20 Bulkheads in accommodation and service spaces, which are not required to be made as A or B type divisions, shall be made as at least C type divisions.

Requirements for oil tankers

2.7.21 The requirements of 2.7.22 – 2.7.33 are additional to those stated in 2.7.1 – 2.7.14 and apply to oil tankers of gross tonnage 500 and over, which are intended for transportation of crude oil and oil products with a flash point of max. 60 °C. Ships intended for transportation of oil products with a flash point exceeding 60 °C shall comply with the requirements of 2.7.16 – 2.7.20.

Ships of gross tonnage up to 500 shall comply with the requirements of 2.6.6 – 2.6.26.

2.7.22 The minimum fire resistance of bulkheads and decks separating adjacent spaces shall comply with the requirements of 2.7.22-1 and 2.7.22-2, which divide those spaces into the following categories proceeding from the risk of fire:

<table>
<thead>
<tr>
<th>Minimum fire integrity of bulkheads separating adjacent spaces</th>
<th>Room fire risk category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table 2.7.22-1</strong></td>
<td><strong>Room fire risk category</strong></td>
</tr>
<tr>
<td><strong>Rooms and their fire risk category</strong></td>
<td>1</td>
</tr>
<tr>
<td>Control stations</td>
<td>1</td>
</tr>
<tr>
<td>Corridors, lobbies and companion</td>
<td>2</td>
</tr>
<tr>
<td>Accommodation spaces</td>
<td>3</td>
</tr>
<tr>
<td>Stairways</td>
<td>4</td>
</tr>
<tr>
<td>Service spaces (low risk of fire)</td>
<td>5</td>
</tr>
<tr>
<td>Machinery spaces of category A</td>
<td>6</td>
</tr>
<tr>
<td>Other machinery spaces</td>
<td>7</td>
</tr>
<tr>
<td>Pump rooms</td>
<td>8</td>
</tr>
<tr>
<td>Service spaces (high risk of fire)</td>
<td>9</td>
</tr>
<tr>
<td>Open decks</td>
<td>10</td>
</tr>
</tbody>
</table>

1 Bulkheads which separate wheelhouse, chart house and radio room, may be of B-0 type.
2 To determine the type of bulkheads see 2.4.6 and 2.7.20.
3 Doors from cabins to inner individual lavatories may be made of combustible materials.
4 When spaces are used for the same purpose, divisions between them may be dispensed with.

**Note.** **“*” – divisions made of steel or other equivalent material, which may be not of A type.**
### Table 2.7.22-2

<table>
<thead>
<tr>
<th>Lower spaces and their fire risk category</th>
<th>Fire risk category of upper spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Control stations</td>
<td>A-0</td>
</tr>
<tr>
<td>Corridors, lobbies and companions</td>
<td>A-0</td>
</tr>
<tr>
<td>Accommodation spaces</td>
<td>A-60</td>
</tr>
<tr>
<td>Stairways</td>
<td>A-0</td>
</tr>
<tr>
<td>Service spaces (low risk of fire)</td>
<td>A-15</td>
</tr>
<tr>
<td>Machinery spaces of category A</td>
<td>A-60</td>
</tr>
<tr>
<td>Other machinery spaces</td>
<td>A-15</td>
</tr>
<tr>
<td>Pump rooms</td>
<td>—</td>
</tr>
<tr>
<td>Service spaces (high risk of fire)</td>
<td>A-60</td>
</tr>
<tr>
<td>Open decks</td>
<td>*</td>
</tr>
</tbody>
</table>

**Note.** See footnotes to Table 2.7.22-1.

1 — control stations
2 — lobbies, corridors and companions
3 — accommodation spaces excepting lobbies, corridors and companions
4 — stairways (inner ladders and elevators)
5 — service spaces (with low risk of fire): storerooms of combustible materials with area less than 2 m², storerooms of non-combustible materials, drying rooms and laundries
6 — machinery spaces of A category
7 — other machinery spaces
8 — cargo pump rooms
9 — service spaces (with high risk of fire) according to 1.2.1.26 excepting those stated in category 5 as well as control stations of cargo operations and incinerator rooms
10 — open decks means open deck areas without any risk of fire and air spaces outside the superstructures and deckhouses

Sealings of shafting and cables piercing the bulkhead between the machinery spaces of A category and other machinery spaces shall not disturb the bulkhead integrity.

Where a deck, except for an open deck, marked with * in Table 2.7.22-2, is penetrated for the passage of electric cables, pipes and vent ducts, such penetrations should be made tight to prevent the passage of flame and smoke.

However, where a deck, except for an open deck, is penetrated for the passage of electric cables, pipes and vent ducts, such penetrations should be made tight to prevent the passage of flame and smoke.

2.7.23 External boundaries of superstructures and deckhouses which enclose the accommodation spaces (including shelter decks on which these spaces are situated), facing cargo zone along the full height, as well as adjacent side boundaries along 3 m at the height of three levels from the deck shall have insulation which corresponds to A-60 type divisions.

2.7.24 Windows and portholes in external boundaries facing cargo zone as well as in the adjacent side boundaries of superstructures and deckhouses, at the height of three levels from the deck along the distance of 4 % of the ship’s length, but not less than 3 m, and not over 5 m from the end of the superstructure or deckhouse facing cargo zone, shall be of closed (non-opening) type.

The requirement does not apply to wheelhouse windows which may allow opening, but they shall provide tightness in closed position.

The mentioned portholes in frontal bulkheads of the first level shall be supplied with...
dead covers permanently attached to their casings. Casing, frame, dead cover and glass-fixing ring shall be made of steel or other equivalent material. Porthole glass shall be tempered and have the following minimum thickness (mm):

<table>
<thead>
<tr>
<th>clear diameter (mm)</th>
<th>thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 and less</td>
<td>10</td>
</tr>
<tr>
<td>300 to 350</td>
<td>15</td>
</tr>
<tr>
<td>400</td>
<td>19</td>
</tr>
</tbody>
</table>

Clear diameter shall not exceed 400 mm. For intermediate clear diameters (from 200 to 300 mm and from 350 to 400 mm) the glass thickness shall be determined by means of linear interpolation.

2.7.25 In boundaries mentioned in 2.7.24 no doors are permitted excepting for doors to control stations of cargo operations, provision and other stores not connected with other spaces. Bulkheads separating such stations and stores shall be of class À-60.

This requirement does not apply to wheelhouse doors. These doors shall provide the wheelhouse tightness when closed.

In boundaries mentioned in 2.7.24 detachable plates may be attached by bolts to close openings for transportation of dismantled equipment.

2.7.26 Machinery spaces, control stations, cargo operations control stations, accommodation and household spaces (excluding isolated cargo handling gear lockers) shall be situated aft of cargo tanks, discharge tanks, pump rooms and cofferdams.

Machinery spaces other than category A, control stations, accommodation and service spaces may be situated to the bow from cargo zone provided that they are separated from cargo tanks and discharge tanks by cofferdams, pump rooms or isolated ballast tanks and the adequate safety level is reached if compared with location of those spaces aft from cargo tanks, discharge tanks, pump rooms and cofferdams.

2.7.27 In the accommodation area closed spaces for smoking (smoking rooms) shall be provided. Those spaces shall be formed by B-15 type divisions, and their finishing shall be made of low-flame-spread materials.

2.7.28 Cargo pumps shall be located in separate rooms enclosed by gas-tight bulkheads. Openings in boundaries separating pump rooms from the machinery spaces for pass of cargo pump shafts, electric cables, etc. shall be equipped with sealings which do not disturb the bulkhead integrity.

In bulkheads and decks which separate the pump rooms from other spaces, fixed gas-tight light enclosures may be allowed, provided that they do not impose fire integrity of those divisions.

The bearing structures of deck light hatches for cargo pump compartments shall be made of steel. These hatches shall close from the outside of the pump room.

Pump room bulkhead may be designed with a recess which butts into the machinery space with the height not exceeding one-half of the design depth.

2.7.29 Machinery spaces shall be separated from cargo tanks and discharge tanks by cofferdams, cargo pump rooms, fuel tanks or isolated ballast tanks.

Cargo tank or discharge tank adjacent to the machinery space by their corner shall be separated by a corner cofferdam.

Corner cofferdams not accessible for visual examination are to be filled with a composition suitable for this purpose.

Spaces for pumps and related equipment for ballasting compartments adjacent to cargo tanks and discharge tanks as well as spaces for fuel pumps may be used for separation of the machinery spaces from cargo tanks and discharge tanks provided those spaces have the fire safety level required for cargo pump rooms.

2.7.30 On the upper deck a continuous coaming extending from side to side with the height of at least 150 mm shall be provided at a distance about 2 m from the superstructure where accommodation and service spaces are located.

2.7.31 No coal-fueled cooking ranges or any other coal-fueled equipment are permitted.
2.7.32 Intake ventilation openings of accommodation and service spaces as well as control stations shall be located either on the outer walls of superstructures or deckhouses not facing cargo zone or on the side wall of a superstructure or a deckhouse at a distance of at least 4% of the ship length but not less than 3 m and not exceeding 5 m from the end of the superstructure or the deckhouse facing cargo tanks.

Air duct openings of the machinery spaces shall be located as far as possible from the cargo zone.

2.7.33 In combination carriers the following requirements shall be also complied with:

1. Discharge tanks shall be surrounded with cofferdams except for cases when shell plating, deck plating, pump room bulkhead or fuel tank wall performs function of a discharge tank boundary. Those cofferdams shall be separated from all enclosed (closed) spaces including double bottom space and trunks for pump room piping by tight structures. Means shall be provided for filling the cofferdams with water and for draining them.

When bulkhead of the cargo pump room serves as a boundary of the discharge tank, the latter shall be separated from double bottom space, pump room piping or other enclosed (closed) spaces by tight divisions. Openings with gas-tight bolted covers are permitted.

2. Means shall be provided for isolating the piping connecting the pump room with discharge tanks. The means of isolation shall consist of a valve followed by a spectacle flange or a spool piece with blank flanges. The means of piping isolation shall be located near discharge tanks. Such means may be arranged in the pump room directly at the bulkhead in the place where the pumps penetrates it.

In addition to existing onboard cargo and drainage systems, independent pumps and piping shall be provided on the open deck for discharging the contents of discharge tanks;

3. Access for discharge tank cleaning is allowed only from the open deck. Hatches shall be provided with gas-tight covers. Those covers shall be provided with locking arrangements preventing their unauthorised opening;

4. All cargo spaces and adjacent spaces shall be provided with forced ventilation. Forced ventilation may be provided by portable fans.

Cargo pump rooms, pumping trunks and cofferdams adjacent to discharge tanks stated in 2.7.33.1 shall be fitted with an alarm and monitoring system for inflammable vapours.

Provision shall be made for measuring vapour concentration in all other spaces located within cargo zone, which allows measuring from the open deck or accessible places;

5. Precaution instructions for operations with dry goods when oil residue is present in discharge tanks shall be provided in a visible place.
3 FIRE-EXTINGUISHING SYSTEMS

3.1 GENERAL PROVISIONS

General requirements

3.1.1 Requirements of the present Section apply to fire extinguishing systems and stations intended for fire protection of ships.

3.1.2 If a ship is equipped with fire extinguishing equipment and systems in addition to those stated in this Section, they shall comply with the requirements of the present Section of the Rules.

3.1.3 Fire extinguishing systems and stations shall be intended to ensure their reliability and readiness for use under all conditions of operation.

3.1.4 In addition to the requirements of this Section, elements of fire alarm systems (pumps, filters, pipelines, fittings, etc.) shall comply with the applicable requirements of 7, 8, 10 and 11 Part IV of the Rules.

3.1.5 Storage reservoirs for extinguishing medium, pneumohydraulic tanks, vessels for compressed gases used in fire extinguishing systems shall comply with the requirements for pressure vessels stated in 8 Part IV of the Rules.

Fire-extinguishing systems.

General requirements

3.1.6 On ships with the main engines of total capacity exceeding 220 kW as well as in floating workshops, passenger ships, crew boats, special purpose ships, loaders of inflammable substances or liquids and pump stations regardless of the engines capacity spaces proceeding from their purpose shall be equipped with fixed fire extinguishing systems according to Table 3.1.6 with regard to the following:

1. Automatic sprinkler or water spray system shall be fitted:

   In passenger ships carrying more than 36 passengers in control stations, accommodation and service spaces, including corridors and ladders. Control stations, where water may cause damage to essential equipment, may be fitted with fixed fire-extinguishing system of another type. Spaces having little or no fire risk such as voids, public toilets, carbon dioxide rooms and similar spaces need not be fitted with this system.

   In passenger ships carrying not more than 36 passengers, where fixed smoke detection and alarm system shall be fitted only in corridors, ladders and escape routes within accommodation spaces, in accommodation and service spaces and in control stations, except those containing no significant fire risk, such as voids, lavatories, etc.

   In cargo ships in accommodation spaces, galleys and other spaces (except those containing no significant fire risk) equipped with fire detection and alarm system where restrictions to types of bulkhead structure are not applied;

2. Lamp rooms, paint stores, storerooms for inflammable liquids, liquefied and compressed gases may be not fitted with fixed fire extinguishing system if the volume of each storeroom does not exceed 3 m³ or if the deck area of the storeroom without access to accommodation spaces is less than 4 m²;

3. Fire extinguishing systems for protection of cargo container spaces in ships of gross tonnage 2000 and more;

4. Dry cargo spaces (10 of Table 3.1.6) are not fitted with fire extinguishing systems in the following cases:

   In cargo ships with gross tonnage less than 2000 not suitable for transportation of hazardous goods.
### Table 3.16

<table>
<thead>
<tr>
<th>Name of the space</th>
<th>Fire-extinguishing system</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>water</td>
</tr>
<tr>
<td>1. Control stations excepting those in emergency power source rooms</td>
<td>O</td>
</tr>
<tr>
<td>2. Emergency power source rooms</td>
<td>—</td>
</tr>
<tr>
<td>3. Accommodation spaces and ladder enclosures</td>
<td>O</td>
</tr>
<tr>
<td>4. Household spaces</td>
<td>O</td>
</tr>
<tr>
<td>5. Stores for explosives</td>
<td>O</td>
</tr>
<tr>
<td>6. Stores for highly inflammable and combustible materials</td>
<td>O</td>
</tr>
<tr>
<td>7. Ro-ro cargo spaces normally not subdivided and extending to either a substantial length or the entire length of the ship</td>
<td>O</td>
</tr>
<tr>
<td>8. Oil tanks</td>
<td>—</td>
</tr>
<tr>
<td>9. Cargo tanks intended for cargo carriage including discharge tanks</td>
<td>O</td>
</tr>
<tr>
<td>10. Spaces for dry goods not being ship stores</td>
<td>O</td>
</tr>
<tr>
<td>11. Machinery spaces of A category and attended machinery spaces</td>
<td>O</td>
</tr>
<tr>
<td>12. Not permanently attended machinery spaces containing propulsion electric motors with total capacity exceeding 220 kW, machinery spaces with generators, main and emergency switchboards</td>
<td>O</td>
</tr>
<tr>
<td>13. Cargo pump spaces in oil tankers</td>
<td>O</td>
</tr>
</tbody>
</table>

1 Medium expansion foam extinguishing system shall be used.
2 The system is used on ships intended for special purposes, such as automobile or railroad car ferries, where the provision of vertical fire zone bulkheads would defeat the purpose for which the ship is intended, in addition to water-sprinkling, foam fire extinguishing and gas fire extinguishing.
3 High expansion foam extinguishing system shall be used.
4 They shall be fitted only in the rooms, which may be closed from outside the rooms.
5 See 3.1.7.
6 Dry cargo and refrigerated holds and spaces between decks intended also for carriage of containers and removable tanks as well as motor vehicles without fuel in their tanks.
7 See 3.1.6.3 to 3.1.6.4.
8 It shall not be used to protect cargo container spaces.
9 See 3.8.25.

**Note.** Symbols: O – rooms are protected by the stated system; + – spaces are protected by one of the systems marked with this symbol.

If holds are intended only for transportation of ore, coal, grain, non-dried timber, non-combustible goods and goods with low fire risk; the holds shall be fitted with steel hatch covers and means of covering vent outlets and other openings leading to the holds.

Dry cargo spaces (10 of Table 3.1.6) of passenger ships with gross tonnage 1000 and more shall be protected with fixed gas fire extinguishing system or fixed foam fire extinguishing system with foam expansion ratio 1000:1.

6 Gas fire extinguishing system shall be fitted in rooms for muffler spark arresters of internal combustion engines, waste-heat boilers, flues and steam boilers onboard the ships: carrying inflammable liquids and their tenders;

carrying dry goods, regardless of their gross tonnage;
carrying highly inflammable dry goods, regardless of their gross tonnage;
with the total capacity of the main and auxiliary engines exceeding 350 kW;
7 If machinery spaces of A category and attended machinery spaces are protected with foam extinguishing system, the portable foam generator shall be provided;
8 Floating objects with wooden bulkheads shall be equipped with water, foam and carbon dioxide extinguishing systems.

3.1.7 Inert gas fire extinguishing system may be used for oil tankers during unloading operations to prevent the fire by creating and maintaining the medium not sustaining combustion in the cargo tanks by means of inert gas;
On oil tankers of gross tonnage 5000 and more the system is fitted at the ship owner's discretion.

3.1.8 Tugboats and pushboats intended for service ships carrying inflammable substances and liquids as well as motor transport having fuel in tanks shall be equipped with foam or water extinguishing system.

3.1.9 On ships with crew consisting of less than three persons (see 3.1.8), fixed water / foam extinguishing system may be dispensed with.

3.1.10 On non-self-propelled ships operating without a crew, fire-fighting equipment and fire extinguishing systems are not required. Tugboats and pushboats intended for operation with these ships shall be equipped with fixed fire extinguishing systems with manifolds with quick-closing nuts located on the open deck and intended for delivering water or water solution of foam-forming agent to the ships being towed or pushed.

3.1.11 If in the space protected by gas or aerosol fire extinguishing system air receivers with a capacity of 30% of this space are provided, the quantity of fire extinguishing agent is determined according to the design volume of the space to be protected and according to the excess of compressed air free volume. Such increase in quantity of fire extinguishing agent may be not provided, if the air is discharged outside the protected space by safety valves and safety fusions of air receivers.

3.1.12 Overpressure or depression as a result of extinguishing medium dispersion shall not cause damage to structural elements of the protected room. It shall be possible to provide safe pressure equalizing.

3.1.13 Protected rooms shall be provided with possibility to remove fire extinguishing agent. If corresponding suction devices are fitted for this purpose, they shall not operate during fire extinguishing.

3.1.14 Divisions which separate the spaces protected by fire smothering system from the adjacent spaces shall be water-tight.

3.1.15 Air ventilation openings of the spaces protected by fire smothering systems shall be fitted with closing devices from outside of the spaces.

3.1.16 Fire extinguishing systems shall be subject to hydraulic tests according to 6.2.58 RTSC.

Additional requirements for fire extinguishing systems of M-CII class ships

3.1.17 Where two or several adjacent ship spaces with risk of fire are not separated from each other by gas- or water-tight bulkheads or decks, fire extinguishing agent and corresponding fire extinguishing system are chosen proceeding from the space possessing the highest risk of fire, and the necessary amount of fire extinguishing agent and its flow rate are calculated using the corresponding total area or volume of all spaces connected with each other. Total number of extinguishing aerosol generators for these rooms shall be determined by summing the number of generators, intended individually for each room.

If protected spaces are not connected with each other, the necessary quantity of fire extinguishing agent shall be calculated for one space which is the largest.

3.1.18 Water- and gas-tight doors may be considered as enclosures in a bulkhead sepa-
rating adjacent machinery spaces only if they are remotely driven and fire stations which can release the fire-extinguishing agent are fitted with alarm reporting the full closing of these doors. If such alarm is not available, the amount of fire extinguishing agent is calculated and delivered proceeding from the necessity to provide fire extinguishing means for the total volume (area) of adjacent spaces.

In order to prevent excessive pressure in spaces fitted with fire smothering systems during release of fire extinguishing agent either valves shall be provided or the available means shall be used (e.g. air ducts or ventilation pipes).

3.1.19 When calculating the amount and the flow rate of fire extinguishing agent, the total net volume (area) of storage tanks for substances with fire risk located in that space shall be added to the design volume (or the intended area accordingly) of the protected space, excepting the volume (the area) of tanks contained in double bottom.

If protected space is a machinery space of A category, then volume of fuel and oil tanks located inside the space or adjacent to it shall be added to the design volume, excepting tanks contained in the double bottom. Here, the volume of the largest tank of separate tanks or two adjacent tanks shall be added to the design volume (the greatest volume shall be chosen).

3.1.20 Fire extinguishing systems shall be so designed that fire extinguishing agent shall be delivered to all areas of the protected space including enclosed sections therein (e.g. control stations, workshops in the machinery spaces, etc.).

Piping and valves

3.1.21 When laying pipelines the following requirements shall be met:

.1 Fire smothering systems extinguishing agent shall be delivered to each of protected spaces by a separate pipe; check valves shall be fitted in the space of the fire extinguishing station.

This requirement is not applied to foam extinguishing systems intended for delivering foam outside the cargo tanks by means of high-pressure monitors and portable air-foam hoses or by means of medium-expansion foam generators.

One delivery pipeline is permitted for a group of small spaces of the same type (e.g. lamp room and paint store room);

.2 Piping of fire extinguishing systems shall not be led in fuel and lubricating oil stores and cooled spaces for all ships and in pump rooms for tankers. Pressure piping of fire extinguishing systems shall not be led in accommodation spaces;

.3 Piping of gas fire extinguishing systems may be laid via accommodation and service spaces, when piping throughout its length inside those spaces has no plug connections and is designed for pressure stated in Table 6.2.58 RTSC;

.4 All fire extinguishing systems shall be so designed that to ensure periodical inspections in process of operation. For checking pipes of gas fire extinguishing systems, compressed air shall be supplied to the manifold. Compressed air line shall be fitted with a stop-check valve.

Systems equipped with pipelines and nozzles for supplying extinguishing media, shall have devices for their operation testing by compressed air.

Aerosol fire extinguishing systems shall be so designed that to ensure periodical inspections by starting them with the help of simulators of fire extinguishing aerosol generators, whose electric characteristics shall comply with characteristics of generators starting devices.

3.1.22 In fire extinguishing system seamless steel pipes shall be used. Copper, copper-nickel and bimetallic tubes (where one layer is made of steel or copper) may be used as equivalent to steel tubes and pipes.

Steel tubes shall have anti-corrosion coating on the inner and the outer surfaces.

Hydrants, other equipment and fittings of fire extinguishing systems which provide working and safe condition of those systems,
shall be made of materials resistant to fire extinguishing agents and water (sea water for ships of Р-П, Р-ПП and О-ПП classes).

3.1.23 The system shall be activated without additional switches at the station, shall operate under any working conditions of the ship, including at temperatures below 0 °C and in case of fire.

3.1.24 The fire extinguishing system shall be activated at the control station located outside the protected space.

3.1.25 If the fire extinguishing system is intended for protection of several rooms, it shall be equipped with a separate marked activation device for each room.

3.1.26 In the immediate proximity to each activation device, there shall be operating instructions written with non-erasable text and hanged in a visible place. It shall contain the instructions on:

1. activating the fire-extinguishing system;
2. ensuring that no persons are present in the protected space;
3. the crew’s actions for activating the system;
4. the crew’s actions in case of fire extinguishing system failure.

3.1.27 In any service conditions the systems shall be prevented from spontaneous start-up, except for the sprinkler and aerosol fire extinguishing systems in case of temperature increase in the protected space up to the values stated in 3.4.15 and 3.9.11, respectively. All devices shall be protected from mechanical damage. Start-up handles of foam extinguishing and fire smothering systems shall be sealed.

3.1.28 Regardless of the availability of remote activation the system shall be provided with local control directly from the fire extinguishing station and that for the pump – from the place of its location.

For aerosol fire extinguishing systems local control may be dispensed with.

3.1.29 Remote activation systems (using air, nitrogen, carbon dioxide etc.) shall have two starting reservoirs, each of them capable of performing a single full start of extinguishing system.

3.1.30 Remote activation devices shall be controlled by means of handwheels or levers rigidly connected with rods or rollers.

3.2 FIRE EXTINGUISHING STATIONS

General requirements

3.2.1 Equipment of all fire extinguishing systems except for water and aerosol extinguishing systems shall be located outside the spaces protected by the system and at fire extinguishing stations, with regard to 3.2.3.

If those systems operate in conjunction with the fire pumps, on passenger vessels more than 65 m long, self-propelled dry cargo ships and oil tankers with cargo-carrying capacity over 1500 t, fire pumps, driving motors as well as their controls shall be located outside protected spaces.

Fixed emergency fire pump shall comply with the requirements of 3.3.17.

3.2.2 Foam extinguishing stations and fire smothering stations shall comply with the following:

1. All fire extinguishing stations excepting that for machinery spaces shall be located on open deck or directly under it with direct access to the decks.

Fire extinguishing station for machinery spaces may have no direct access to open deck only if remote extinguishing medium release device is accessible from the wheelhouse or other space having direct access to the open deck;

2. Stations shall be located in tight enclosures or lockers. Bulkheads and decks separating the station from protected spaces shall be type A divisions (see 1.2.1.9);

3. If the station requires temperatures above zero for operation, the station room shall be fitted with heat insulation and heating;

4. To monitor the ambient temperature the station room shall be fitted with a ther-
mometer visible from inside the station and from outside via a porthole. The ambient temperature in the space shall not exceed 40 °C.

Readings of press-gauges on air reservoirs shall be visible from inside the station and from outside via a porthole.

The station shall have natural or artificial illumination; electric power to lamps shall be supplied from both the main network and the emergency lighting network.

The station shall be permanently locked by a lock with two keys, one of which shall be kept in a locked box with a glassed wall near the lock, and the other – in the wheelhouse.

The diagram of the fire extinguishing station showing activation devices and protected spaces as well as brief manual on starting the system shall be located in the station room in a visible place.

All valves and devices shall be supplied with nameplates bearing inscriptions and indications: “Open”, “Closed”;

Stations shall be fitted with independent exhaust ventilation which provides 12 air exchanges per hour.

3.2.3 If the amount of fire extinguishing agent supplied to the protected space does not exceed 125 kg, local fire extinguishing stations may be provided with max. 5 vessels.

Inside the machinery spaces, reservoirs with fire extinguishing agent may be fitted for the protection of crank cases, mufflers of internal combustion engines, smoke pipes and other closed volumes located within the machinery space.

Additional requirements for fire extinguishing stations of M-CII class ships

3.2.4 On M-CII class ships with a gross tonnage less than 150, where the location of fire extinguishing station outside the protected space is impracticable, as well as in particular cases in other ships where the total volume of protected spaces does not exceed 100 m³, reservoirs with fire extinguishing agent and pressure vessels may be located inside the protected spaces provided that they are fitted by remote activation device for immediate system actuation from the outside of the protected space; here, the location of remote activation drive shall be indicated and illuminated from both the ship’s general network and the emergency network.

Reservoirs containing fire extinguishing agent with toxic properties which are located inside permanently attended spaces, shall be enclosed in steel gas-tight partitions fitted with independent ventilation.

3.3 WATER EXTINGUISHING SYSTEM

Fire pumps

3.3.1 Pumps of water extinguishing systems shall be operated by electric power. The number of fixed main and emergency fire pumps shall be not less than stated in Table 3.3.1. The total capacity of the main fire pumps shall be the maximum one of those specified according to the requirements of 3.3.3 and 3.3.4.

<table>
<thead>
<tr>
<th>Types of ships</th>
<th>Number of fixed pumps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fire pumps</td>
<td></td>
</tr>
<tr>
<td>Passenger ships length (m):</td>
<td></td>
</tr>
<tr>
<td>65 and less</td>
<td>1</td>
</tr>
<tr>
<td>65 to 100</td>
<td>1</td>
</tr>
<tr>
<td>over 100</td>
<td>2</td>
</tr>
<tr>
<td>Oil tankers and carriers of motor transport with filled tanks and inflammable fluids in containers with a length, (m):</td>
<td></td>
</tr>
<tr>
<td>100 and less</td>
<td>1</td>
</tr>
<tr>
<td>over 100</td>
<td>1</td>
</tr>
<tr>
<td>Ships of M-CII class with a gross tonnage:</td>
<td></td>
</tr>
<tr>
<td>less than 300</td>
<td>1</td>
</tr>
<tr>
<td>300 to 1000</td>
<td>1</td>
</tr>
<tr>
<td>1000 to 4000</td>
<td>2</td>
</tr>
<tr>
<td>4000 and more</td>
<td>2</td>
</tr>
<tr>
<td>Other ships</td>
<td>1</td>
</tr>
</tbody>
</table>

Fire pumps may be driven from the main engine provided that the structure “engine – shafting – propeller” enables the operation of the fire pump when the ship is at anchorage and provides for switching-off the pump when the ship is in motion.

3.3.2 Emergency fire pump may be dispensed with, if fire pumps and power sources
for their drive are located in different compartments having not more than one adjacent steel decks or bulkheads so that in the event of fire pumps located in another (other) compartment (compartments) shall provide the water delivery to the fire main.

3.3.3 The total capacity of the main fire pumps shall be determined proceeding from the condition of simultaneous supply of 15% of all hydrants available on a ship but not less than three of them, and for ships with total engine capacity of 220 kW and less — not less than two pumps capable of feeding jets of maximal capacity used on a ship. Here, the requirements of 3.3.19 shall be complied with.

Every fixed fire pump shall be rated for a supply of at least two water jets by the maximal diameter of nozzles used in a ship. Every fixed fire pump excepting emergency pump shall additionally have supply of not less than 80% of the total required supply divided by required number of fire pumps, but at least 25 m³/h.

3.3.4 The total supply of fixed fire pumps shall be at least (m³/h):

\[ Q = K \left(1.68 \sqrt{L(B+H)} + 25\right)^2, \quad (3.3.4) \]

where \( K \) — coefficient: for passenger ships \( K = 0.012 \) and \( K = 0.008 \) for cargo ships;

\( L, B, H \) — main dimensions of a ship (m).

The supply \( Q \) may not exceed 180 m³/h, if greater supply is not required for proper simultaneous functioning of other water consuming systems.

When determining the total supply of fire pumps neither pumps fitted in the fore part of oil tankers nor the emergency pump shall be taken into account.

3.3.5 Head in the system shall be sufficient to provide for simultaneous operation of systems stated in 3.3.3; pressure at hydrants shall be at least 0.25 MPa.

3.3.6 If a ship is fitted with alternative systems which consume water from fixed fire pumps, the latter shall supply water in quantity sufficient for operation of water extinguishing system with a supply of min. 50% of that stated in 3.3.3 and 3.3.4 and parallel operation of one of other systems consuming the greatest amount of water. In this case, the water supply for water extinguishing system shall be sufficient for at least two water jets by the greatest nozzles. Possible increase of water supply should be considered due to the pressure rise in the pipelines necessary for operation of other fire extinguishing systems; the requirement of 3.3.5 shall also be considered.

3.3.7 Water quantity for fire extinguishing systems, except for water fire extinguishing system, shall be determined according to the requirements of 3.4, 3.5 and 3.7.

3.3.8 As fixed fire pumps sanitary, ballast, drainage and other outboard water pumps may be used provided that its supply and head comply with the requirements of 3.3.5, 3.3.6. They shall also meet the requirements of 3.3.9.

3.3.9 Fire pumps located outside the machinery spaces of A category shall have a separate sea valve in each compartment containing them.

3.3.10 All fire pumps including the emergency pump shall be located in spaces with temperature above zero.

3.3.11 In cargo and passenger ships with not permanently attended spaces of fire pumps or permanently attended with one person, remote start-up of one of the pumps shall be provided from the wheelhouse and the area permanently attended when the ship is at anchor; water shall be supplied to the fire main without opening of valves in the pump room. The location of the pump remote start-up device shall be fitted with an indicator of the water pressure in the fire main.

3.3.12 Onboard energy sources shall provide for operation of fire pumps in any service conditions including the anchorage.

3.3.13 Fixed fire pumps may be used for other ship purposes when the ship is fitted with at least two independently driven pumps, one of which is permanently ready for immediate operation according to the main pur-
pose. If a ship is fitted with one fire pump, its short-term use is allowed for other purposes (e.g. for washing a deck, hawses etc.).

3.3.14 Fire pumps and pipelines shall be used neither for pumping of oil products, lubricating oil and other inflammable fluids nor as ballast pumps for tanks filled in turn by fuel and ballast.

3.3.15 On discharge line a pressure gauge shall be fitted prior to isolating valve.

Pumps charging pressure in fire piping over the permissible value shall be supplied with overflow valves for removing water from a discharge line to a filling line.

Overflow valves shall be adjusted on a pressure exceeding the working pressure by not more than 10%.

3.3.16 Fixed fire pumps and relevant outboard valves shall be fitted below the light-draft water-line. If a pump is located above the mentioned water-line, self-suction devices shall be provided.

Provision should be made for the delivery of water by fire pumps from two outboard valves located on both sides of a ship. On ships with ice strengthening, one of the sea inlets shall be further equipped for efficient ice removal, air removal and shall be heated.

3.3.17 Emergency fixed fire pump shall comply with the following:

1. The pump shall be driven from a diesel engine or an electrical motor supplied with power both by main or emergency diesel generator. If a diesel engine is fitted to drive the pump, the emergency fire pump room shall be fitted with a daily fuel tank of capacity sufficient to enable operation of the pump for at least 3 hours; and for M-СП, M-ПП and M class ships – for at least 6 hours;

2. The pump shall be connected to water extinguishing system of a ship;

3. The pump supply shall be sufficient for simultaneous operation of two hand fire nozzles with maximal jet diameter applied on a ship at the design pressure. If the pump may be used also for other water or foam extinguishing systems, its supply shall be increased accordingly to comply with the requirements of 3.3.3;

4. The pump, power sources for its drive and outboard water intake valves shall be so located as in the event of fire in the main fire pump room, they cannot be out of operation;

5. The entrance to the emergency pump room shall be independent of the main fire pump room. The pump shall not be located forward of the fore peak bulkhead;

6. The pump shall comply with the requirements of 3.3.15, 3.3.16; any of the outboard valves required by 3.3.16 may be used as the second outboard valve, if a slide gate on filling pipeline from that outboard valve is located in the emergency pump room.

3.3.18 On non-self-propelled ships with a minimum crew of 3 persons, fitted with electric power sources, portable diesel-pump set may be used as a fire pump and shall meet the following requirements of 3.15.2.

Piping

3.3.19 Diameter of fire main of water extinguishing system and water service pipes shall be sufficient for supplying the maximum required discharge from two fire pumps working simultaneously. In this case, the water velocity in all areas shall not exceed 4 m/s as per 3.3.4.

Pressure in the fire main shall not exceed 1 MPa.

3.3.20 Fire piping led via non-heated spaces and open decks shall be fitted with check valves to disconnect it from piping led via heated spaces, and with drainage arrangements.

3.3.21 Filling and discharge lines of each fire pump shall be fitted with check valves; filling pipes may be fitted with slide valves; if there are two or more rotary pumps, discharge lines of each of them shall be fitted with check stop valves.

3.3.22 Fire main piping shall be fitted with drainage arrangements.

The arrangement of pipes and hydrants shall be such as to avoid the possibility of freezing.
3.3.23 On ships carrying deck cargo, the pipelines shall be arranged as far as practicable to avoid risk of damage by such cargo.

3.3.24 On ships with a length of 50 m and more fire mains with linear piping shall be fitted with check valves on at least each section 30 m long in accessible places.

Hydrants

3.3.25 Each hydrant shall be provided with fire hose coupling, providing fast, tight and reliable connection of the hydrant with fire hose, as well as connection of fire hoses between them and with other fire-fighting equipment.

Hydrants located on the open deck shall be also provided with blank cap.

3.3.26 Hydrants shall be so located to provide two water jets by two hydrants simultaneously, one of which shall be supplied to the hose of length stated in 3.3.33 to any place of the ship.

3.3.27 Hydrants shall be located:
1. on the open deck – in the exit area of superstructures and trunks as well as near cargo hatches;
2. inside the spaces – in corridors and lobbies, in the machinery spaces.

Hydrants shall be located at the distance not more than 1.35 m from the deck or planking.

Hydrants in the inside spaces shall be located not more than 20 m far apart from each other.

Outer hydrants (on decks) shall be located not more than 40 m far apart from each other.

Between two nearby stop valves double hydrants shall be fitted.

3.3.28 On ships carrying deck goods hydrants shall be protected from damage by cargo and located in easily accessible places.

3.3.29 Machinery spaces, where engines and boilers working on fuel oil are fitted, shall provide at least two hydrants located at the port and starboard; on ships with capacity up to 750 kW for this purpose the hydrant located directly near the fire pump (between the pump and the stop valve) may be used.

Machinery spaces of ships with total capacity less than 220 kW may be fitted with one hydrant located directly near the fire pump (between the pump and the check valve).

3.3.30 On passenger ships, the number and arrangement of hydrants in accommodation, service and machinery spaces shall comply with the requirements of 3.3.26 with all watertight doors closed and all doors in bulkheads of vertical fire zones closed.

3.3.31 Tugboats, push-tugboats, icebreakers, rescue boats and floating docks shall be fitted with manifolds with quick-closing nuts located on the open deck and intended for water delivery to other vessels.

3.3.32 All onboard hydrants shall be painted red and numbered.

Fire hoses and nozzles

3.3.33 Fire hoses shall satisfy the following:
1. A hose length for hydrants located on the open deck shall be not less than 10 m and not more than 20 m; for hydrants located in the ship spaces – at least 10 m, but not more than 15 m;
2. Hoses shall be made of low-flame-spread materials.

3.3.34 The number of fire hoses used for the purposes of extinguishing fires or testing the fire-extinguishing apparatus at fire drills and surveys shall be at least equal to the number of onboard hydrants.

3.3.35 Each fire hose assembled with a nozzle shall be located near the relevant hydrant. In interior locations in passenger ships carrying more than 36 passengers fire hoses shall be connected to the hydrants at all times.

Fire hoses shall be stored in separate non-locking cabinets or on hose reels; cabinets shall be marked with subscription ПР (FH – “fire hose”) or with corresponding pictograph.

3.3.36 Nozzles shall be of a dual purpose type, i.e. jet/spray type.
3.3.37 Standard nozzle diameters shall be 12, 16 and 19 mm.

For accommodation and service spaces, a nozzle size shall be max. 12 mm.

In machinery spaces and on open decks of ships with carrying capacity of 1000 t and over, on passenger ships 50 m long and over, technical fleet vessels and on floating docks, nozzle diameter of hand hoses shall be such as to obtain the maximum discharge possible from two jets at the pressure stated in Table 3.3.1 from the smallest pump, provided that the nozzle diameter is 16 to 19 mm.

In tugboats and pushboats with total capacity of the main engines less than 900 kW hand hoses with nozzle diameter of 12 mm may be used on the open deck, if operation of a foam extinguishing system is provided by means of a fire pump.

In tugboats and pushboats with minimum total capacity of the main engines 900 kW, nozzle diameter of 16 and 19 mm may be used.

Isolating valves and relief valves

3.3.38 Shut-off valves shall be provided to separate the fire main within the machinery space containing the main fire pump or pump(s) from the rest of the fire main. These valves are to be fitted in accessible place outside the machinery space. The fire main shall be so arranged that all the hydrants on the ship, except those in the machinery space referred to above, can be supplied with water by another fire pump, including an emergency fire pump, provided that the isolating valves are shut.

3.4 SPRINKLER SYSTEM

General provisions

3.4.1 Sprinkler system shall spray the water of 5 L/min per 1 m² of the largest protected space.

The system tubes shall be constantly filled with water, except for small outer sections, which may not be filled, if it is necessary preventive measure. In the sprinkler system part filled with water, the necessary pressure shall be maintained. Any system parts subjected to low temperatures shall be adequately protected from freezing.

3.4.2 Sprinklers shall be activated automatically in case of increase in temperature in the protected space up to the values stated in 3.4.15.

3.4.3 Sprinkler system shall be equipped with pneumohydraulic tank, alarm control valves, automatically activated pump and air compressor and cylinder maintaining the working pressure in the system and immediate water supply to opening sprinklers.

3.4.4 The air cylinder, compressor, pump and pipes of the sprinkler system, except for the pipeline connecting the sprinkler system with water extinguishing system, shall be independent from other systems.

3.4.5 The sprinkler pump and pneumohydraulic tank shall be fitted outside the machinery spaces as per 3.2. The central control station shall be fitted with pressure gauge connected to the fire main piping.

Sprinkler system pumps

3.4.6 The pump shall be activated automatically in case of the system pressure drop and shall supply the water before all the water in the pneumohydraulic tank is used.

Automatic activation means shall be provided for the pump in case of the pressure drop.

3.4.7 The pipeline pump and system shall maintain the necessary pressure at the level of the highest sprinkler to supply the maximum discharge for simultaneous operation area of the greatest protected space for the parameter stated in 3.4.14.

3.4.8 The delivery side of the pump shall be fitted with a sampling cock with a open-ended discharge tube. The cross-sectional area of the valve and tube shall be sufficient for passing the water in the amount equal to the pump supply with the pressure stated in 3.4.7.

3.4.9 The pump shall have a sea valve located in the pump room and arranged in such
a way to preclude the need for shutting off
the seawater delivered to the pump for any
reason, except for the pump inspection and
repair.

3.4.10 The feed line shall be connected to
the suction line of the water extinguishing
system of a ship. The connecting pipeline
shall be fitted with lockable stop-check valve.

Pneumohydraulic tank

3.4.11 The pneumohydraulic tank shall be
fitted with the following instruments and de-
vices:

1 device for automatic pressure mainte-
nance;
2 device for water level check and alarm
warning on the water/pressure level in the
tank lower than the specified one, led to a
permanently attended place: to the wheel-
house; to the central control station (if any);
in the machinery space (permanently at-
tended) or near the attendant’s place (if any);
3 pressure relief valve;
4 pressure gauge.

3.4.12 The pneumohydraulic tank shall
permanently store the fresh water in amount
equal to the sprinkler pump supply per 1 min.
Tank capacity shall be minimum doubled
water-supply stated above.
The tank shall maintain the air pressure to
have the pressure not lower than the working
one of the sprinkler plus hydrostatic pressure
from the tank bottom to the highest sprinkler
after using the full reserve of the fresh water.

3.4.13 Structure of pneumohydraulic tanks
shall comply with 8.17 and 8.18 Part IV of the
Rules for pressure vessels.

Sprinklers

3.4.14 Sprinklers shall be fitted in the up-
per part of the protected space and spaced to
supply the medium discharge of min. 5 L/min
per 1 m² of the protected space area.

3.4.15 Sprinklers in accommodation and
service spaces shall be actuated within the
temperature range of 68 to 79 °C. On passen-
ger ships they shall be actuated within the
temperature range of 57 to 68 °C. For sprin-
klers fitted in drying rooms and galleys, the
response temperature shall be max. 30 °C
higher than the air temperature near the ceil-
ing.

3.4.16 Sprinklers shall be made of material
resistant to corrosion. The sprinklers of galva-
nized steel shall not be used.

Alarm and monitoring device

3.4.17 Alarm and monitoring device sen-
sors shall be fitted on the feed line of each
section of the sprinkler system and:

1 supply the signal to activate the water
supply sources when opening any sprinkler
fitted in the section;
2 give visual and audible alarm when
opening any sprinkler fitted in the section;
3 transmit the information on the fire
break-out in the group of spaces served by the
system.

3.4.18 Alarm and monitoring devices shall
be fitted in metal lockers outside machinery
spaces in permanently attended places and in
other places, where the crew can receive the
fire alarm.

Places of alarm and monitoring devices in-
stallation shall be accessible, lighted and
closed with glassed doors for monitoring con-
dition of the devices and pressure gauges.

Each alarm and monitoring device shall
provide the list of protected spaces or plan of
the protected spaces served by each section.
The ship shall provide the instructions for
checking and maintaining the system.

3.4.19 One of the alarm and monitoring
devices shall have switches, allowing to check
the alarm response and operation of indicators
of each section for sprinklers.

Piping

3.4.20 Sprinkler systems shall be separated
by sections. One section shall provide for
max. 50 sprinklers. One section may not be
located in different vertical fire zones. One
section shall service maximum two decks.
Each section shall provide for devices to blow the pipelines with compressed air or to wash them with water.

3.4.21 Each section shall be deactivated by only one stop valve with a pressure gauge behind it.

The stop valve of each section shall be available, and its location shall be marked.

To verify correct operation of the system, a sampling cock shall be fitted near the stop valve of each section with cross sectional area equal to that of the sprinkler.

3.4.22 Diameters of the sprinkler system pipelines shall provide the operation of sprinklers with pressure and water consumption stated in 3.4.1 and 3.4.14.

The sprinkler system pipelines shall be fitted with stop-check valves, preventing the ingress of outboard water inside the tank and water leakage from the tank and system.

The intake of the pump feeding the sprinkler system shall be fitted with a filter.

3.5 WATER-SPRAYING SYSTEM

3.5.1 The water-spraying system in machinery spaces of A category and in pump rooms shall be constantly filled with water and shall be pressurized. This system shall be supplied from the water extinguishing system line and from the independent pump, activating automatically in case of the system pressure drop. The pipeline providing connection with the fire main of water extinguishing system shall be fitted with stop-check valve.

In other protected spaces the system may be supplied only from the water extinguishing system line.

Pump and its controls shall be located outside the spaces protected by the system.

3.5.2 The pump supply and head shall be determined with regard to features and number of sprayers fitted in the largest protected space and intensity of water supply, which shall be at least:

- 0.85 L/min per 1 m² of the deck area on ships intended for carriage of hazardous goods in bulk;
- 5 L/min per 1 m² of the fuel spillage area, or of the cargo space area;
- 20 L/min per 1 m² for front parts and surfaces of boilers, fuel oil units, centrifugal separators (but not bilge water separators) and fuel purifiers;
- 10 L/min per 1 m² for heated fuel pipelines, located near exhaust pipes or similar hot surfaces of main and auxiliary engines.

3.5.3 The intake of the pump feeding the system, and the pipeline providing connection with the fire main of water extinguishing system shall be fitted with filters, preventing the blockage of the system and sprayers.

3.5.4 The distribution valves shall be located in accessible places outside the protected space.

Permanently attended spaces shall provide for remote control of the distribution valves from these spaces.

3.5.5 Sprayers in the protected spaces shall be located in the following places:

- 1 under the space ceiling;
- 2 above the equipment and facilities, whose operation is connected with using fuel oil or other inflammable liquids;
- 3 above the surfaces for possible spillage of fuel oil or inflammable liquids.

Sprayers in the protected spaces shall be located in such a way that the working area of any sprayer could overlap the working area of adjacent sprayers.

3.6 DRENCHING AND WATER SCREEN SYSTEM

3.6.1 The drenching system shall be supplied from the pump located outside the protected spaces.

3.6.2 The system shall be started outside the protected space.

Automatic systems actuated in case of inadmissible increase of the room temperature may be fitted.

3.6.3 The capacity of pumps serving the drenching system shall be at least 24 L/min per 1 m² of the total area of the protected space.
3.6.4 The drenching system may be used to protect the superstructures of the ship extinguishing the fire on other ships. In this case, intensity of water supply on the protected surface shall be min. 10 L/min on 1 m² of the tier length and can be reduced to 5 L/min provided that the protected surfaces have isolation of A-60 type. System sections shall be located on each tier, and the nozzle location shall provide for even water supply on the protected outer surface.

3.6.5 Water screen system shall be supplied from the water extinguishing system main. The calculated capacity of pumps serving the water screen system is min. 70 L/min per 1 m of the screen length.

3.6.6 Screens for protection of doorways shall be located and controlled from the side of the corridor.

3.7 FOAM EXTINGUISHING SYSTEM

General provisions

3.7.1 In a foam extinguishing system foam of the following expansion ratios may be produced as an extinguishing medium:
.1 low expansion – around 20:1;
.2 medium expansion – from 20:1 to 200:1;
.3 high expansion – around 200:1.

3.7.2 Foam-forming medium for producing low and medium expansion foam for M-СП, M-ПР and О-ПР class ships shall be capable of working both on fresh water and sea water.

3.7.3 Output of foam extinguishing system and the quantity of foam-forming medium shall be calculated proceeding from the foam expansion ratio, the flow rate of the medium and the working period of the system stated in Table 3.7.3.

When using the data in Table 3.7.3, the following shall be considered:
.1 Output of foam extinguishing system in the case marked with footnote 1 in Table 3.7.3 is selected when multiplying the relative feeding values specified under the footnote sign by the area specified below:
   for relative feeding of 0.36 m³/h per 1 m² of the greatest horizontal cross-section area of a tank;
   for relative feeding of 0.036 m³/h per 1 m² of the area of cargo tank deck which is determined as the product of the maximal ship breadth and the length of cargo tank deck;

<table>
<thead>
<tr>
<th>Relative feeding of the solution and continuous operation period of the foam extinguishing system</th>
<th>Relative feeding (m³/h) of the solution per 1 m², at the expansion ratio of foam-forming medium</th>
<th>Rated period of continuous operation (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the space</td>
<td>less than 20:1</td>
<td>20:1 to 200:1</td>
</tr>
<tr>
<td>Cargo tanks for inflammable liquids with flash point of 60 °С and lower and decks where they are located</td>
<td>(0.36 or 0.036 or 0.18)¹</td>
<td>0.36²</td>
</tr>
<tr>
<td>Cargo tanks for inflammable liquids with flash point above 60 °С and fuel tanks</td>
<td>0.36³</td>
<td>0.27³</td>
</tr>
<tr>
<td>Holds for dry hazardous goods</td>
<td>—</td>
<td>0.24³</td>
</tr>
<tr>
<td>Machinery spaces and other spaces containing liquid fuel equipment</td>
<td>—</td>
<td>0.27³</td>
</tr>
<tr>
<td>Storerooms for inflammable liquids, materials and substances, liquefied and compressed gases</td>
<td>—</td>
<td>0.27³</td>
</tr>
</tbody>
</table>

¹ See 3.7.3.1.  
² Horizontal cross-section area of the largest protected space shall be taken for a rated area.  
³ See 3.7.3.3.
for relative feeding of \(0.18 \text{ m}^3/\text{h per 1 m}^2\) of the area protected by high-pressure monitor of the maximal supply and fully located forwards to it, but not less than \(75 \text{ m}^3/\text{h}\).

The output of foam extinguishing system is the maximum calculated value;

2. The minimum quantity of foam-forming medium shall be calculated by multiplying the system capacity by the design time of its continuous operation stated in Table 3.7.3;

3. For oil tankers equipped with inert gas system, in cargo tank spaces for inflammable liquids with vapour flash point of max. 60°C and decks for these tanks, the design time of continuous operation shall be 20 min.

3.7.4 Foam-forming medium reservoirs shall be fitted with filling and discharging facilities, liquid level detector and cleaning facilities. Capacity of the reservoirs shall be sufficient for storage of the entire reserve of foam-forming medium.

Where excessive pressure is not allowed when the system is in operation, non-return valves shall be provided between the reservoirs and the main pipeline.

Where in ships intended for operation entering areas of salt water a foam-forming medium for fresh water is provided in high expansion foam extinguishing system, foam reserve shall be provided in a reservoir of foam extinguishing station which is sufficient for at least single filling of a space to be protected. The rest water may be supplied from the ship store.

3.7.5 The calculation of foam extinguishing system output shall include technical evaluation of the mixer type selection for obtaining water solution of foam-forming medium of the required concentration, steam generators and air-foam hoses.

Rated discharge of foam-forming medium of the mixer shall be sufficient for operation of nozzles / foam generators working simultaneously.

3.7.6 The foam extinguishing system main control station shall be located at the fire extinguishing station located outside the cargo area, near the accommodation spaces, be accessible and provide control over the system in case of fire in the protected areas and spaces. A sampling device for determining the foam-forming medium percentage in the solution shall be provided at the fire extinguishing station on the main at the maximum distance from the mixers, the pipeline feeding the system with water shall be fitted with a pressure gauge.

The main equipment of the system (tanks with foam-forming medium, pumps, mixers, etc.) may be located in the machinery space, if the system does not serve it.

**Low / medium foam extinguishing system**

3.7.7 Low-expansion foam fire extinguishing system shall produce foam with expansion ratio not exceeding 20:1. If actual expansion ratio is more than 20:1, the quantity of foam-forming medium is calculated as for the system with expansion ratio 20:1. If actual expansion ratio is less than 20:1, the amount of foam-forming medium shall be proportionally increased.

3.7.8 Foam extinguishing system shall be able to deliver foam to any tank located on the deck which is opened, and to any area of the cargo tanks. Foam thereto shall be delivered by high-pressure monitors and portable arrangements (air-foam hoses or foam generators).

3.7.9 Air-foam nozzle used in ship spaces shall provide foam supply of not less than \(120 \text{ m}^3/\text{h}\).

3.7.10 The number and location of monitors shall comply with the requirements of 3.7.8, 3.7.12. Each high-pressure monitor shall supply foam solution with intensity at least 50% of that stated in footnote 1 of Table 3.7.3.

3.7.11 High-pressure monitor shall be fitted with switchover device for alternate delivery of water and foam. Branches of the water main and the foam solution main shall be connected to this device.

Check valves may be provided instead of switchover device, if their interlock is provided.
3.7.12 A distance from high-pressure moni-
tor to the most distant boundary of the pro-
tected area located forward to the monitor
shall not exceed 75 % of monitor jet length
under conditions of calm weather.

3.7.13 To provide the integrity of the fire
main in case of fire or explosion on the foam
main in accessible and protected places at
poop front and on the deck of cargo tanks
shut-off valves shall be fitted approximately
in each 30-40 m of the length. Each valve
shall be fitted with a plate with inscription
notifying that in normal operating conditions
it shall be permanently open.

In front of each shut-off valve, the main
shall be fitted with doubled fire nozzles of
diameter 70 mm for connection of air-foam
hoses at the distance which provides fulfill-
ment of the requirements of 3.3.25 and
3.3.27.

Branches of the water and foam mains for
high-pressure monitors connection shall be
also located in front of shut-off valves.

In ships where medium expansion foam is
applied, instead of doubled fire nozzles valve
boxes shall be fitted with the number of fire
nozzles equal to 50 % of the design number of
foam generators.

3.7.14 Portable medium-expansion air-
mecanical foam generator shall comply with
the following requirements:

.1 design flow on foam-forming medium
solution at pressure about 0.6 MPa in front of
the foam generator shall be not less than
21.6 m³/h;

.2 length of the foam jet shall be at least
8 m;

.3 design number of the foam generators
or combined foam units shall be:

\[ N = \frac{Q}{q} \]  (3.7.14.3)

where \( Q \) – the system productivity regarding
the solution (m³/h);

\( q \) – foam generator or combined foam
unit productivity regarding the solution
(m³/h).

3.7.15 Fixed foam extinguishing system of
spaces for dry hazardous goods shall comply
with the following requirements:

.1 Check valve shall be fitted in front of
the place where system main crosses the open
deck;

.2 The main shall be fitted with a valve
box with hydrants at both port and starboard
sides. The distance between the valve boxes at
both sides shall be not more than 40 m. The
number of hydrants in each valve box shall be
equal to 50 % of the design number of foam
generators.

3.7.16 Foam extinguishing system in tug-
boats and pushboats intended for operation
with non-self-propelled ships carrying in-
flammable liquids or dry hazardous goods
shall be designed for fire extinguishing on the
ships being under service. The system produc-
tivity and store of foam-forming medium are
defined according to 3.7.3; here, cargo tanks
and holds of a non-self-propelled ship are
taken as cargo tanks and holds.

Foam extinguishing unit shall be fitted with
flow-line hoses, foam nozzles with foam
pourers or foam generators with extenders.

For fire protection of tugboats and
pushboats other fire extinguishing systems
may be used.

3.7.17 When a ship is equipped with low /
medium expansion foam extinguishing system,
the solution main lines shall be arranged to
the entrance area of the machinery spaces
from the upper deck as well as to the areas of
the fuel delivery to the ship. Each of those
lines shall be fitted with two hydrants for the
connection to fire hoses with air-foam nozzles
or foam generators.

3.7.18 On ships using the medium-
expansion air- mechanical foam, the solution
pipeline shall be connected to the water ex-
tinguishing system main for using foam from
this main for extinguishing fires in accommo-
dation and service spaces. For this purpose,
hydrants in accommodation, service and ma-
chinery spaces shall provide for corresponding
number of foam generators.

3.7.19 Instead of monitors and foam gen-
erators, fixed or portable combined foam units
may be used.
High expansion foam extinguishing system

3.7.20 Spaces protected by high expansion foam system shall be fitted with air outlets in the upper part of a side opposite to foam entrance which shall comply with the requirements of 10.4, 10.12 Part IV and 4.2.2.2 Part II of the Rules.

3.7.21 Cross-sectional area of foam lines shall be not less than that of foam generator outlets. Foam lines shall be so arranged that to reduce the head loss to a minimum and the outlets shall be so located as to avoid any obstacles to free delivery of foam to a protected space.

3.7.22 Foam generator or foam line outlets in places where they go outside the boundaries of the station shall be fitted with a closing device. That device shall be opened automatically simultaneously with the start of the system.

The device shall be controlled manually and fitted with the “Open” and “Closed” positions indicators.

3.7.23 A switchover device shall be provided for supplying the foam to the protected space or to the open deck during the test of the system. The device shall be sealed in a position which ensure delivery of the foam to a protected space.

3.7.24 Equipment ensuring generators operation shall be fed by the main and emergency power sources.

3.8 GAS FIRE EXTINGUISHING SYSTEM

General requirements

3.8.1 The gas fire extinguishing system may use the following fire extinguishing agents:

- CO₂ – carbon dioxide;
- inergen (IG-541) – gas containing 52 % of nitrogen, 40 % of argon, 8 % of carbon dioxide;
- gas fire-extinguishing media, complying with the requirements of the Russian Federation legislation in fire safety area.

3.8.2 The total open flow area of mains as well as the open flow area of the supply manifold shall not exceed the total open flow area of valves of reservoirs opened simultaneously for the largest protected space.

3.8.3 The open flow area of supply manifolds for protected spaces shall not exceed the total open flow area of valves of reservoirs opened simultaneously for the given space. The total open flow area of outlet discharge pipelines shall not exceed the open flow area of the supply manifold.

3.8.4 The amount of 85 % of the design quantity of carbon dioxide shall be delivered within at least (min):

- for machinery spaces, emergency diesel generator rooms, fire pump rooms and other spaces where liquid fuel or other flammable liquids are applied 2
- for spaces where no liquid fuel or other inflammable liquids are transported or applied. 10

3.8.5 For gas delivery to the protected spaces the upper part of the latter shall be fitted with nozzles.

Where floor plating of the machinery spaces is located at the height over 1 m from the bottom (inner bottom), then the part of nozzles (min. 15 %) shall be located at the upper part of the space under the plating.

3.8.6 The total area of nozzle outlets of this space shall not exceed 85 % of the total open flow area of the supply manifold.

3.8.7 In silencers, exhaust gas boilers and funnels perforated pipes may be used instead of the nozzles.

The total area of the pipe perforations shall be 10 % less than its cross-sectional area.

3.8.8 Gas fire extinguishing station shall be fitted with a device for weighing reservoirs or measuring their liquid level.

Carbon dioxide fire extinguishing system

3.8.9 Amount of carbon dioxide shall be determined by the formula (kg):

\[ G = 1.79V\varphi \]  

(3.8.9)

where \( V \) – the design volume of the largest protected space (m³)

\( \varphi \) – the factor equal to:
for dry cargo holds and other spaces excepting those stated below for machinery spaces which design volume is calculated taking into account the overall volume of trunks; for machinery spaces which design volume is calculated without taking into account the volume of trunks from the level where horizontal cross-sectional area of trunks is max. 40 % of the machinery spaces area

The factor $\varphi$ for which the $G$ value is greater is taken for machinery spaces.

On ships with gross tonnage less than 2000 register tons, excepting passenger ships, factors 0.35 and 0.4 may be reduced to 0.3 and 0.35 accordingly.

3.8.10 The number of carbon dioxide storage reservoirs is determined proceeding from the extent of filling (the amount of carbon dioxide per 1 m$^3$ of the capacity) which shall not exceed either 675 kg/m$^3$ at the design pressure of carbon dioxide in the reservoir of 12.5 MPa and more or 750 kg/m$^3$ at the design pressure of carbon dioxide in the reservoir of 15 MPa and more. Specific volume of unpressurized CO$\text{2}$ is 0.56 m$^3$/kg.

When filling the reservoirs, the amount of carbon dioxide may deviate for not more than 0.5 kg per one reservoir from the design value.

In case specified in 3.2.3, the extent of filling shall be decreased for 75 kg/m$^3$ compared with the limits stated above.

3.8.11 CO$\text{2}$ vessels shall be arranged outside the protected spaces, in gastight enclosures or locker, hermetically separated from the other spaces. Doors of these enclosures or lockers shall be intended to open outwards, be lockable and have hazard warnings on the outside, as well as CO$\text{2}$ marking.

3.8.12 The reservoirs shall be fitted in vertical position by rows on supports which may be made of wood. The reservoirs shall be accessible for examination and determination of their gas quantity. Each vessel shall be marked with the following data: charge type, charge weight (kg), vessel No.

The starting reservoirs shall be kept on the fire extinguishing station and have a color different from that of carbon dioxide storage reservoirs.

3.8.13 If the enclosures of CO$\text{2}$ vessels are located in the below-deck section, they shall have a direct access outside. These enclosures shall be equipped with artificial ventilation, independent from other ventilation systems.

Inergen fire extinguishing system

3.8.14 To protect several spaces, each space shall be equipped with individual fire-extinguishing system.

3.8.15 Vessels with inergen fitted in the protected space shall be fitted with safety valves preventing the rise of pressure above the rated value. The valve shall ensure the relief of the vessel content to the protected space.

3.8.16 Vessel filling pressure shall not exceed 20 MPa at +15 °C;

3.8.17 The inergen volume necessary for protection of spaces shall be min. 44 % and max. 50 % of the total volume of these spaces.

Piping and valves

3.8.18 Pipeline connecting a reservoir with the supply manifold shall be seamless and made of tough-pitch copper.

Special flexible hoses made of low-flame-spread materials may be used.

The pipeline shall be fitted with check valve.

3.8.19 Gas fire extinguishing station main shall be fitted with pressure gauge which has a scale with the upper-range value exceeding hydraulic test pressure of the reservoirs on at least 1 MPa. Scaling factor shall not exceed 0.5 MPa.

3.8.20 Reservoir valves of the carbon dioxide fire extinguishing system shall comply with the following requirements:

1. To be fitted with safety devices.

Safety diaphragms shall break down when the pressure in a reservoir reaches the value $(1.3 \pm 0.1)p$ (MPa), where $p$ is the design pressure in the reservoir. For valves with slot
diaphragms fitted additionally with safety dia-
phragms the breakdown pressure of slot dia-
phragm shall exceed the upper limit breakdown
pressure of safety diaphragm by at least 1 MPa.

A checking device shall be also arranged
to monitor the actuation of a safety device;

2 A valve opening device shall be of lever
type and provide for the complete opening
of the valve by turning the lever on the angle not
exceeding 90°. The device shall permit the
valves to be opened both individually and in
group;

3 To have pipes with bevel cut not ex-
tended to the bottom of reservoirs on the dis-
tance 5 to 15 mm. Clear inner diameter of the
pipes as well as pipes connecting the reservoir
valves with the supply main, shall be at least
10 mm;

4 Where valves of starting reservoirs differ
from valves of other reservoirs in the design,
they shall be marked by distinct color and its
casing shall have the “starting” marking.

3.8.21 Gas from the safety devices of valves
of the carbon dioxide fire extinguishing system
shall be withdrawn outside the station
boundaries to the atmosphere either by a
separate pipe which outlet branch shall be
fitted with audible alarm or to the supply
main fitted with:

two pipes, one of which is fitted with check
valve and open end and the second – with
safety diaphragm;

an alarm device on the presence of pres-
sure in the supply main which is led to per-
manently attended spaces.

In this case no checking device monitoring
the actuation of a safety device for valves is
required.

3.8.22 Pipelines which deliver gas from
starting reservoirs to servomotors shall be fit-
ted with check valves interlocked with open-
ing device of starting reservoirs.

Starting devices

3.8.23 Spaces listed in 3.8.4.1 should be
provided with remote start-up from the cen-
tral fire control station or from the place lo-
cated near the entrance to those spaces.

Start-up devices of the system at the fire
control station shall provide for simultaneous
opening of valves of the reservoirs intended
for the above-mentioned spaces.

3.8.24 System remote start-up station shall
be fitted with a device which provides signal-
ing when the gas is delivered to the protected
space.

3.8.25 When fitting the gas extinguishing
system in cargo pump spaces of oil tankers, a
notice shall be exhibited at the controls stat-
ing that due to the electrostatic ignition haz-
ard, the system is to be used only for fire ex-
tinguishing and not for inerting purposes.

3.9 AEROSOL FIRE EXTINGUISHING
SYSTEM

General requirements

3.9.1 Aerosol fire extinguishing system shall
comprise of:

extinguishing aerosol generators;
control and alarm board;
warning detectors about start-up of aerosol
fire extinguishing system;
cable runs.

3.9.2 The design weight of aerosol-forming
composition, in kg, shall be determined by
formula (kg):

\[
G = V + \sum_{i=1}^{n} \left( V_{in_i} P_{in_i} / P_a \right) k \varphi ,
\]  (3.9.2)

where

- \( V \) - design free volume of protected
  space (m³)
- \( V_{in_i} \) - volume of \( i \)th air receiver, (m³)
- \( n \) - number of air receivers in protected
  space
- \( i \) - consecutive number of air receiver
- \( P_{in_i} \) - working pressure in \( i \)th air receiver
  (MPa)
- \( P_a \) - atmospheric pressure (MPa)
- \( \varphi \) - rated fire extinguishing concentration
  of aerosol (kg/m³)
- \( k \) - safety factor equal to 1.5

3.9.3 During the system start-up the fol-
lowing shall be provided:
automatic actuation of warning detector in the protected space and in adjacent spaces, if a single exit leads to the protected space, as per 5 of this Part of the Rules;
automatic ventilation cut-off in the protected space;
automatic cut-off of burning units of boilers and incinerators, if they are located in the protected space.

3.9.4 Design mass of aerosol shall be delivered within max. 2 min for the machinery spaces, emergency diesel generator rooms and other spaces where liquid fuel or other highly inflammable or inflammable liquids are applied.

3.9.5 Generators shall be so located as to provide even distribution of fire extinguishing aerosol in the protected space. If there are dead spaces in the protected space formed by the equipment and boundaries, additional generators shall be provided to deliver fire extinguishing aerosol directly to dead spaces.

Extinguishing aerosol generators

3.9.6 Each generator type shall have data on the distance (along the axis of aerosol jet) from the place of its emanation from the generator until the boundary of the heat zone with temperature of $+75^\circ C$.

3.9.7 After starting, the generator shall be switched over to the operating mode in max. 10 s.

3.9.8 The generator shall operate for min. 20 s (see 3.9.4).

3.9.9 The design number $N$ of generators shall be determined by the following formula:

$$N = \frac{G}{m}$$  (3.9.9)

where $G$ – design mass of aerosol-forming composition (kg)
$m$ – mass of aerosol-forming composition in one generator (kg)

The received broken number $N$ shall be expressed in round bigger integer.

If $N$ is equal to 1, the number of generators is 2, if $N$ is equal to 2, then it is 3.

3.9.10 Generators shall be fitted directly in the protected space on non-combustible foundation.

3.9.11 Generators shall be self-actuated when the ambient temperature is min. $250^\circ C$.

3.9.12 Generators shall be arranged so that the distance from the generators to the escape routes and other places with people, was not less than the distance of the safe area with temperature of $75^\circ C$, and to the combustible materials – not less than the distance of the safe area with temperature of $200^\circ C$.

3.9.13 In storerooms for highly inflammable and combustible materials, explosion-proof generators shall be arranged. For cargo pump rooms of tankers carrying oil products with a flash point of $60^\circ C$ and over, explosion-proof generators of ordinary type may be used.

Control and alarm board

3.9.14 Control and alarm board shall meet the requirements of 2.3, 2.6, 2.8 Part IV of the Rules.

3.9.15 Control and alarm board shall provide for simultaneous remote start-up of all generators in the protected space. If there are more than 4 generators in the protected space they may be actuated in group provided that the requirements of 3.9.4 are complied with.

3.9.16 Where several spaces are protected by aerosol fire extinguishing system, generators in each space shall be actuated separately from the control and alarm board.

3.9.17 In the event of voltage break the aerosol fire extinguishing system power supply shall be switched over automatically to the emergency source of power.

3.9.18 Control and alarm board shall not emit electrical impulses that may result in false start-up of the generators including power supply emergency switch-off and switch-on, short circuit or wire breaking.

Cable runs

3.9.19 Starting circuits shall be provided with the use of shielded cables. The cable
network shall comply with Section 12 Part IV of the Rules.

3.9.20 Aerosol fire extinguishing systems shall have functions to check working order of starting electrical circuits with the fault circuit address, providing functional testing of the detection systems and stopping of ventilation.

3.10 INERT GAS FIRE EXTINGUISHING SYSTEM

3.10.1 As inert gas either smoke gases of autonomous boilers may be used after performing treatment in order to reduce the content of oxygen, carbon oxide, corrosion-active substances and solid combustible particles, or combustion products of specially fitted generators. Each source shall be equipped with automatic air supply regulator for supplying inert gas with oxygen content of max. 5%.

3.10.2 The gas quantity shall be sufficient to obtain the minimum volume of free gas equal to at least 25% of the gross volume of the largest protected space every hour for a period of 72 hours.

3.10.3 The distribution pipeline and discharge nozzles shall be arranged to provide uniform delivery of the inert gas.

3.11 ADDITIONAL REQUIREMENTS TO PASSENGER VESSELS

3.11.1 On passenger multi-deck vessels and vessels equipped with accommodation cabins excepting ships with engine capacity of 220 kW or less, the fire main shall be arranged according to a ring circuit. To disconnect single sections of the fire main the latter shall be fitted with valves in accessible places.

3.11.2 Closed spaces (holds) intended for transportation of motor vehicles and other machinery with filled fuel tanks shall be fitted with one of fire smothering systems and automatic fire detection system.

3.11.3 On ships equipped with remotely driven doors the wheelhouse shall be fitted with executive alarm of the door closing.

3.12 ADDITIONAL REQUIREMENTS FOR FIRE EXTINGUISHING SYSTEMS AND FIRE PROTECTION OF OIL TANKERS AND THEIR TENDERS

3.12.1 On tankers fire extinguishing stations shall be located outside the deck of bulk cargo tanks.

3.12.2 Machinery spaces shall be fitted with forced ventilation producing excessive air pressure.

3.12.3 Pump rooms and cargo pumps fitted therein shall be equipped with facilities for the collection and withdrawal of leaked cargo.

3.12.4 Classification of explosion-hazardous zones and spaces onboard the oil tankers is given in 1.4 of the present part of the Rules.

3.12.5 No belt drives may be used as pump drives in explosive areas and fire-hazardous rooms (see 1.4 of the present part of the Rules).

3.12.6 Tankers carrying oil products with a flash point over 60°C, may be fitted with fixed foam extinguishing system.

3.12.7 Boiler rooms at oil cleaning stations working with inflammable liquids with flash point of max. 60°C shall be fitted with two fire extinguishing systems.

3.12.8 Stems of sluice valves of cargo tanks shall be led on the deck via sealing glands. The glands shall be so designed that they can be replaced or tightened from the deck. The stems shall not be hollow.

3.12.9 The liquid level in cargo tanks shall be measured basically by closed method of measurement without opening the tank neck. The open method of measuring the liquid level may be used only as a reserve method.

3.12.10 To drain the static electricity hoses intended for loading and unloading of inflammable liquids shall be fitted with earthing conductor made of flexible wire or a plate with edges soldered to the flanges.

3.12.11 Gas outlet pipes of boilers and internal combustion engines of oil tankers shall be fitted with spark-extinguishers.
Smoke flues of other technical equipment on board these ships shall be fitted with spark arresters.

3.12.12 All sections of the gas-collecting system shall provide for free flow and drainage of condensate and cleaning the main.

3.12.13 Flame-breaking fittings fitted on gas outlet pipes shall be made of corrosion-resistant material.

Flame-breaking fittings shall be so designed that they can be replaced or disassembled without dismantling gas outlet pipes.

Openings in voids (above cargo) shall not be used for pressure equalization. They shall be provided with self-closing and tightly sealing covers. Flame arresters and screens are not permitted in these openings.

3.12.14 High-pressure monitors shall be fitted on ships with carrying capacity of 2000 t and over; other ships may be fitted only with portable foam generators or manual air-foam hoses. In this case the rate of foam-forming medium solution delivery by each foam generator or air-foam hose shall be at least 25% of the designed value.

3.12.15 The main arranged within fire extinguishing station shall be fitted with a check valve.

Two branches shall be arranged before the check valve led on the deck to monitors, and on each branch – doubled fire nozzles of diameter about 70 mm for connection of fire hoses and air-foam hoses. Monitors which shall be fitted at port and starboard sides near the fore bulkhead of the aft superstructure or accommodation spaces faced to the cargo deck.

If medium expansion foam is used, valve boxes shall be fitted instead of doubled fire nozzles and have the number of fire nozzles equal to 50% of the design number of foam generators.

3.12.16 In oil tankers extending pipes shall be made of steel or light alloys in a number equal to 50% of the design number of the foam generators; both ends of the pipes shall be fitted with connecting fittings for fire hoses and portable foam generators. Extending pipes shall be from 4 to 5 m long; a light tripod shall be arranged in the middle of each pipe. Extending pipes shall be located in the after part of the ship.

3.12.17 Each air-foam hose fitted on the cargo deck shall deliver the foam in a quantity of at least 4 m³/min to the distance of at least 15 m.

3.12.18 Tankers shall be equipped with a system for continuous monitoring the concentration of hydrocarbon gases (oil vapours). Sampling points or detector heads shall be located in places where potentially hazardous leakages may occur. When the hydrocarbon gas concentration reaches a pre-set value which corresponds to 10% of the lower flammable limit, a continuous audible and visual alarm signal shall be automatically effected as per 5 of this Part of the Rules.

3.12.19 Tankers shall be supplied with portable gas analyzer with set of spares and calibration means intended for measuring the concentration of inflammable vapours of carried goods. For monitoring oil vapour contents on ships intended for carriage of oil products with a flash point lower than 60 °C, two manual portable gas analyzers shall be provided.

3.12.20 The cargo system structure shall provide for loading/unloading of goods carried by closed method that is necessary for cargo operations with oil products and inflammable liquids.

The ends of filling pipes of the cargo tanks shall be placed at the tank bottom, the distance between these ends and the tank bottom shall be not less than 0.25 of the pipe internal diameter.

Cargo connections of the cargo system manifold shall be equipped with tight blank flanges made of materials preventing spark formation caused by strikes.

3.12.21 Where pumping oil stations operate with inflammable liquids with flash point of max. 60 °C, they shall be supplied with steam or electricity either from the shore or from another vessel.
3.12.22 Gas outlet pipes of the engines and smoke flues of the boilers of oil tankers carrying oil products with flash point of max. 60 °C and the ships which service oil tankers (service and crew boats, auxiliary ships, floating stores) shall be fitted with spark arresters (spark extinguishers).

3.12.23 Smoking spaces in oil tankers shall be fitted with exhaust ventilation, which provides 20-fold air exchange per hour.

3.12.24 In oil tankers intended for carriage, storage or pumping of liquids with flash point below 60 °C provision shall be made for filling dry compartments adjacent to cargo tanks with inert gases and their ventilation.

For non-self-propelled barges of push-trains ventilation of peak compartments shall be provided if after cofferdams are filled with water up to scuttle covers or these compartments are filled with inert gases.

Ventilation shall provide at least six-fold air exchange per hour in peak compartments and at least three-fold air exchange per hour in the compartments adjacent to cargo tanks.

3.12.25 Structural parts of equipment arranged in or intended for application in explosion-hazardous areas and spaces shall be made of materials providing electrostatic and galvanic sparking safety.

3.12.26 Places where pump / fan drive shafts penetrate bulkheads and watertight decks in explosive areas and fire-hazardous rooms shall be fitted with gastight stuffing boxes. The design temperature of the exterior elements of stuffing boxes shall not exceed the permissible temperature specified according to the vapor flash point of the cargo. The components of stuffing boxes shall be made of materials precluding the spark formation.

3.12.27 If metal bellows are used in glands, such bellows shall be designed to operate at pressure not less than the maximal test one specified for testing the compartments (Table P.10.4.1 Annex 10).

3.12.28 Cargo pumps, ballast pumps and stripping pumps fitted in cargo pump rooms and driven by shafts passing through pump room bulkheads shall be equipped with temperature sensing devices for shafts, bearings and pump casings. Alarm signals shall be automatically effected in the cargo control room or the pump control station.

3.12.29 Shafts of mechanical steering gears of oil tankers intended for transportation of oil products with flash point of max. 60 °C, shall be led above the deck in chutes or boxes. Parts of those gears exposed to friction shall be so designed that to prevent sparking caused by friction or impacts.

3.12.30 All tools (sledge hammers, mallets, wrenches, etc.) used to carry out works in explosive spaces and areas of oil tankers shall be made of materials preventing sparking caused by impacts.

3.13 FIRE EXTINGUISHING SYSTEMS AND STATIONS OF SHIPS LESS THAN 25 M IN LENGTH

3.13.1 The requirements stated in 3.1 – 3.12 apply to ships less than 25 m in length, unless specified otherwise in the present Chapter.

3.13.2 On open undecked vessels the engines shall be covered with removable casings made of non-combustible material.

3.13.3 Removable casings of the engines shall be fitted with air ducts of diameter not less than 80 mm, one of ducts shall end at the height of 70 mm above the bottom and the other – at the casing cover.

3.13.4 On undecked vessels without separate main engines room fuel tanks shall be located at least 800 mm apart from the engine and gas outlet pipelines. In this case fuel tanks shall be enclosed by removable shields.

Ventilation of the fuel tanks area, piping outfit and trays mounting shall be made in the same way as for tanks located in separate rooms.

3.13.5 For fuel tank filling pipes shall be led on the deck preventing from fuel ingress
into the hull. Nipple plugs shall be made of non-sparking material.

3.13.6 The places of penetration of smoke flues through the wooden decks and bulkheads shall be fitted with fireproof bead with a size of at least 150 mm per side. Structures adjacent to the bead from combustible materials shall be insulated with roofing steel above the asbestos layer not less than 10 mm thick.

3.13.7 Cooking oven shall be located at least 150 mm apart from structures of combustible materials protected by non-combustible heat insulation (see 2.3.3) with the thickness of insulation of at least 25 mm and insulated area spreading over the oven borders for at least 250 mm.

3.13.8 Gas appliance and vessel with the capacity up to 20 L may be located in the same room; they may be connected by means of rubberized fabric hose.

3.13.9 On ships of less than 25 m long, excepting tugboats, pushboats, passenger ships, oil tankers and ships carrying hazardous goods, fixed water extinguishing system may be dispensed with. Here the machinery space shall be fitted with gas or aerosol extinguishing system and for other spaces – independent portable or movable gas and foam extinguishers.

3.13.10 In the room where internal combustion engines are located, it is sufficient to have one fire nozzle located directly near the fire pump.

3.13.11 On ships excepting tugboats, pushboats, passenger ships, special purpose ships, oil tankers and ships carrying dangerous goods, water may be fed by one jet.

3.13.12 On ships fitted with foam extinguishing system foam-forming liquid may be fed to the suction chamber of fire pump.

3.13.13 Fire pump may be fed with water from one outboard valve.

3.13.14 Pipelines of water fire extinguishing system, except for such pipelines on M-СІ, М-П and О-П classes ships may be made without corrosion-protective coating.

3.13.15 Fire hoses shall be at least 10 m long.

3.13.16 Hand fire hoses may be used with nozzle of diameter less than 12 mm.

3.13.17 On ships mentioned in 3.3.31 the water manifold for delivery of water for other vessels may be dispensed with.

3.14 FIXED LOCAL FIRE-EXTINGUISHING SYSTEMS FOR MACHINE SPACES

3.14.1 Fixed local application fire-extinguishing systems shall be fitted on М-СІ, М-П and О-П classes passenger ships with minimum gross tonnage of 500 and cargo ships of these classes with minimum gross tonnage of 2000.

3.14.2 Machinery spaces of А category above 500 m³ in volume, in addition to the fixed fire-extinguishing system required in Table 3.1.6, shall be equipped with fixed local fire-extinguishing system. In the case of unattended machinery spaces, this system shall have both automatic and manual start capabilities. Continuously manned machinery spaces shall provide a manual start from the propulsion machinery control station or from another place permanently attended. The automatic system start shall be realized by the fire detection system. In this case, design measures shall be taken to prevent spontaneous start of the system.

3.14.3 Fixed local fire-extinguishing systems are to protect high fire risk areas of the following machinery and equipment (without the necessity of engine shutdown, personnel evacuation, or sealing of the spaces):

1. main internal combustion and diesel generators;
2. incinerators;
3. purifiers for heated fuel oil;
4. boiler fronts (in places where nozzles are arranged);
5. inert gas generators stated in 3.10;
6. fuel heaters.

For units with more than one engine, at least two system sections shall be provided.
3.14.4 Activation of local system shall initiate audible and visual alarms distinct in both respects from other alarms transmitted to the protected space, to the central control station (if any) or to the wheelhouse. Signal shall inform on the particular system in operation.

3.14.5 Electric equipment of the system and its starting alarm shall comply with the requirements of 5 of this Part and 11.4 of Part VI of the Rules.

3.15 ADDITIONAL REQUIREMENTS FOR FLOATING OBJECTS

3.15.1 Landing stages, examination vessels and other floating objects intended for accommodation of more than 12 persons, as well as other floating objects with crew of min. 3 persons, shall be equipped with fixed water extinguishing systems, using fixed fire pumps as per the requirements of 3.3.3, 3.3.5, 3.3.6, 3.3.10, 3.3.13, 3.3.16.

3.15.2 Portable diesel-pump set connected to the ship water extinguishing system may be used as a fire pump as per the following requirements:

1. It shall provide for simultaneous operation of two hand fire hoses with a jet diameter of not less than 12 mm at a suction height of not less than 5 m and a discharge pressure of 0.4 to 0.6 MPa and shall be fitted with self-suction structure;

2. The pump motor shall be capable of start-up both at positive and negative ambient temperature (down to –5 °C). Capacity of the pump fuel tank shall be sufficient for the pump operation within 1.5 hours; fuel capacity on a ship shall be sufficient for filling the fuel tank;

3. Size and type of connecting fittings of flow-line hoses and nozzles shall be the same as those adopted on a ship for fixed water extinguishing station;

4. The diesel-pump set shall be fitted with arrangements and tools according to the manufacturer specification and shall be stored on the deck in special locker or box.

3.15.3 Fire protection of floating objects used as floating hotels, hostels, resthouses, floating bases for processing bioresources of water medium shall depend on the number of people living on the board:

1. up to 50 persons – for passenger ships with a length of 65 m;

2. up to 200 persons – for passenger ships with a length of 65 to 100 m;

3. up to 200 persons – for passenger ships with a length of 100 m.

If the floating objects stated in 3.15.3 provide the presence of special personnel of 50 persons and more, then the fire protection shall comply with the requirements of 3.15.3.2 or 3.15.3.3.

3.15.4 If ships stated in 3.15.3 are not equipped with their own electric power sources, emergency fire pumps, like for passenger ships as per 3.3.1 shall not be fitted there.

3.15.5 Fire protection of floating docks, electric stations, workshops and depot ships is the same as for cargo ships.
4 ADDITIONAL FIRE SAFETY REQUIREMENTS FOR DOMESTIC / GENERAL SERVICE EQUIPMENT AND SYSTEMS

4.1 LOCATION AND EQUIPMENT OF GALLEYS

4.1.1 Galleys shall be separated from cargo zone by accommodation spaces and located in spaces adjacent to store rooms for inflammable and combustible materials, spaces for fuel and lubricating oil excepting distribution stations containing liquefied gas cylinders for domestic purposes.

4.1.2 At least two exits shall be provided for each galley serving more than 50 persons. For galleys working on electricity or steam, only one exit is allowed.

4.1.3 Cookers working on electricity, gas as well as fuel oil or solid fuel may be used. Flash point of fuel oil for galleys shall exceed 60 °C.

Cooking ranges that operate using fuel oil or solid fuel shall be fitted with a metal casing with fire-brick lining and black removal device.

4.1.4 Drip trays for collecting fuel leakage shall be placed below the range fuel nozzles; they shall have a size exceeding the overall dimensions of the nozzle for at least 100 mm with shoulders at least 75 mm high.

4.1.5 Equipment of daily service fuel tanks and supply piping shall comply with the requirements of 10.10.25, 10.10.26 and 10.13.25 – 10.13.30 Part IV of the Rules.

4.1.6 Daily service tanks shall not be located in the galley room.

No fuel tanks may be located above the cooking range. A capacity of daily fuel service tank fitted in the galley room shall be sufficient for daily fuel consumption but not over 0.05 m³.

4.1.7 Check valve of the supply piping shall be remotely controlled from an accessible place outside the galley.

4.1.8 Smoke funnels of the cooking ranges laid inside the ship’s spaces shall be covered with heat insulation made of non-combustible material of a thickness sufficient to prevent heating of the insulation outer surface over 60 °C.

4.1.9 The structure of exhaust ventilation ducts shall comply with the requirements specified in 10.12.32, 10.12.33 of Part IV of the Rules.

4.1.10 The galleys shall have gutterways draining to the water holding tank.

4.1.11 Cooking ranges of М-СП, М-ПР, О-ПР, М and О class ships shall be fitted with storm protective guards. The cooking range side faced towards the personnel shall be fitted with guard rails 0.8 to 1.2 m high.

4.1.12 Structure of electric equipment included in cooking ranges shall comply with applicable requirements specified in 9 Part VI of the Rules.

4.2 STRUCTURE OF HEATING SYSTEMS

4.2.1 For heating ship’s spaces, they use equipment working on oil fuel, solid fuel or gaseous fuel burning units or from power supply network.

4.2.2 On ships carrying hazardous goods in bulk, it is not allowed to use heating appliances working on oil fuel, liquid gas or solid fuel.

The equipment for central heating of ship’s spaces working on solid fuel may be used for ships carrying highly inflammable liquids¹.

¹ Class 3 as per GOST 19433 (closed-cup flash point of max. 61 °C).
4.2.3 Stove heating may be used on non-self-propelled and coast vessels other than passenger ships and oil tankers.

4.2.4 For stoves and heaters, fuel oil may be used with a flash point over 60 °C. Fuel oil stoves shall be equipped with fuel metering units which provide reliable operation of the stove under all operating conditions of a ship, and leaking fuel collectors.

4.2.5 Brick stoves shall be protected with casings of steel roofing as per the following requirements:
   .1 Thickness of outer walls of fire chambers and flues shall be at least 130 mm;
   .2 Thickness of brickwork of the upper ceiling shall be at least 200 mm;
   .3 Fire chamber shall be separated from the deck plating made of combustible materials by a brickwork at least 250 mm thick.

4.2.6 All heaters shall be so designed and arranged as to minimize the fire risk.

4.2.7 Outer surfaces of stoves, heating system heaters with working temperature over 60 °C, shall be closed by protecting housings or screens. The temperature on the casing/screen surface shall not exceed 60 °C.

4.2.8 Electric heating elements shall comply with requirements of 9.2 Part VI of Rules.

4.2.9 In the places where steam heating tubes penetrate wooden bulkheads or bulkheads faced with combustible material, anti-fire beads shall be provided of at least 50 mm on each side, faced with steel sheets over the layer of mineral heat-insulating material 2 mm thick.

        For water heating tubes, the beads shall be of at least 25 mm for each side. In this case, isolation of mineral heat-insulating material is not required.

4.2.10 For the unit and arrangement of heating appliances and stoves the following requirements shall be met:
   .1 Additional solid fuel equipment may not be fitted in spaces with fuel cans or fuel oil equipment;
4.2.11 For stove funnels, the requirements of 4.3.20.6 shall be met: Funnels shall be made of steel and fitted with casings forming a vent cavity or insulated with heat-insulating material. Funnels shall be fastened and fitted with spark-arresters.

4.3 SHIP'S DOMESTIC PLANTS WORKING ON COMPRESSED / LIQUEFIED NATURAL GAS

General requirements

4.3.1 The requirements of this Chapter are applied to all the ship's domestic plants, working on compressed or liquefied natural gas containing mixture of different hydrocarbon gases with methane content in it of over 85%. These units may be used in accommodation spaces and in the wheelhouse for cooking purposes or water heating, they shall include one or several vessels for compressed or liquefied natural gas, one or several pressure regulators, distribution networks and gas appliances, for example, gas ovens or water heaters, which consume max. 1.5 kg/h of compressed liquefied natural gas.

4.3.2 Onboard domestic units working on compressed or liquefied gas may not be located in machinery spaces.

4.3.3 Each ship may be fitted with several compressed / liquefied gas units. Gas appliances in spaces separated by a cargo zone or built-in tank shall not be supplied from the same gas unit.

4.3.4 Deck openings located up to 3 m clear of the doors or other types of enclosures of the spaces or areas which contain elements of domestic compressed / liquefied gas units shall be provided with coamings at least 150 mm high.

4.3.5 All equipment of onboard domestic units, including gas pipelines, shall be secured.

Compressed / liquefied gas vessels

4.3.7 In addition to onboard units, working on compressed or liquefied natural gas, vessels with a maximum capacity of 35 kg, may be used.

4.3.8 Vessels for compressed or liquefied natural gas shall meet the requirements 8 Part IV of the Rules and have marking with at least the following data:

1. manufacturer's brand mark / name;
2. cylinder symbol;
3. cylinder No. as per the manufacturer's system;
4. weight of gas cylinder (kg);
5. weight of light cylinder (kg);
6. cylinder capacity (L);
7. date (month and year) of manufacture;
8. service pressure and test pressure (MPa);
9. stamp of the manufacturer.

The cylindrical part of the cylinder shall bear inscriptions “NATURAL GAS”, “Next survey date” and “DO NOT USE AFTER XX / XXXX”, where XX/XXXX is expiry date month/year.

4.3.9 Vessels shall not be filled with compressed or liquefied gas on board a ship.

Distribution station

4.3.10 Distribution station shall be located on an open deck in a special locker or enclosure of a deck superstructure or a deckhouse, provided that it is gastight and has openings only outside.

The deck station location shall provide the minimum length of the distribution network gas pipelines up to the consumers and free movement of people on the ship's deck.

4.3.11 The distribution station shall not be located in one superstructure or deckhouse with accommodation spaces, and its structure shall comply with requirements 2.5.3.1, as well as the following requirements:

1. Effective natural ventilation through openings or slots in the upper and lower parts of the locker or enclosure shall be provided. In addition to the natural ventilation artificial ventilation may be provided; the ventilators shall be of explosion-proof type and shall preclude the spark formation;
Measures shall be taken to prevent the increase of temperature inside the room by 50 °C, and the temperature increase of the station vessels by 40 °C.

The station shall provide the natural lighting by day and electric lighting with explosion-proof lighting fixtures used only at night. Electric lighting switch shall be fitted outside the room of the distribution station. Elements of the ship's lighting located near the station entrance door and outer ventilation devices of the station shall be as well explosion-proof;

Measures shall be provided for full gas elimination outside the station in case of its leakage, it shall not enter the inner ship spaces;

The doors shall bear an inscription or a symbol warning on the explosion danger and prohibiting the use of open flame and smoking;

The distribution station room shall provide a direct exit to the open deck;

At the distribution station entrance, dry powder fire extinguisher or carbon dioxide fire extinguisher shall be fitted;

Compressed / liquefied gas vessels shall be located in the vertical position, with valves up, in special holders made of spark-proof materials and shall be secured to the station walls by quick-release fastenings;

No unauthorised equipment may be arranged at the distribution station.

Vessel storage locker shall comply with the requirements of 4.3.10 and 4.3.11, and with the following:

The cabinet shall not be located near the plating of the fore / after bulwark;

The cabinet shall be made of fire resistant materials and shall provide for sufficient ventilation through the upper / lower part holes.

The following may be fitted at one distribution station:

A vessel connected to the network; connection to the compressed or liquefied gas line shall be executed by means of a rubber-textile hose not longer than 1 m with metal clamps providing gas-tightness and reliable fastening which is connected to a pressure reducing valve on the vessel top. The hose shall be resistant to working medium and shall be designed for a working pressure of min. 0.6 MPa;

A group of vessels with one of them being connected to the distribution system and other used as spare vessels; two vessels may be connected to the distribution network manifold; a check valve or a cock shall be fitted between each vessel and the manifold and the station shall bear an inscription prohibiting simultaneous use of both vessels.

Each domestic unit, working on compressed or liquefied gas, may be simultaneously connected with up to 4 vessels connected by automatic or non-automatic switch. In this case, the ship shall contain max. six vessels per unit, including reserve ones.

On passenger ships with kitchens or canteens for passengers, each unit may be connected with up to six working vessels connected with automatic or non-automatic switch. Onboard these ships, the number of vessels per unit, including reserve ones, shall not exceed nine.

Storage of spare and empty vessels

Spare and empty vessels outside the distribution station, which are not connected to the distribution network of compressed or liquefied gas, shall be stored outside the accommodation area only in dedicated steel lockers or in closed enclosures meeting the requirements of 4.3.10 – 4.3.14. Stop fittings of the above vessels shall be closed irrespectively of their extent of filling with compressed gas.

Distribution network

Compressed or liquefied gas line and their fittings shall comply with the requirements of 10.2 and 10.3 Part IV of Rules.

Gas-consuming appliances and spaces for their fitting

Domestic gas appliances for cooking and water heaters shall comply with require-
ments of GOST R 50696, GOST R 54821, GOST R 51847, GOST 31856, confirmed by declarations or certificates of products conformity to the requirements of Technical Regulations of the Customs Union “On safety of appliances working on gaseous fuel” (TR CU 016/2011) or to the requirements of stated national standards drawn by authorities accredited as per the legislation of the Russian Federation on accreditation in the national accreditation system, as well as to the requirements of this Chapter.

4.3.18 Domestic units for cooking purposes or water heating shall be:

.1 secured to avoid their shifting for all loading conditions during the ship operation;
.2 connected to the connecting gas pipelines to avoid the risk of their inadvertent disconnection.

Not fixed gas-consuming appliances may be connected to the gas pipeline with the corresponding steel flexible pipes or flexible hoses for high pressure suitable for the used gas of 1 m long.

The structure of domestic units for cooking shall provide the stormy fencing of burners.

4.3.19 Gas-consuming appliances shall be fitted with automatic devices that stop the gas supply in case of the burner extinction. Such device when used in water heaters shall have the pilot flame.

This device may be absent in appliances fitted in spaces above the bulkhead deck and used only in the presence of the attending personnel.

4.3.20 All gas-consuming appliances intended so as to provide the evacuation of the combustion products outside the spaces, shall be provided with separate flues complying with the following requirements:

.1 Horizontal section of the smoke flue shall have an inclination towards the gas-consuming appliance of at least 0.01;
.2 The total length of horizontal sections of the flue shall not exceed 3 m;
.3 Flues shall have not more than 3 bends with a bending radius not less than the pipe diameter;
.4 Flue outlets shall provide sufficient draught in the funnel;
.5 Connections of the pipe sections shall be tight, without any clearance;
.6 Smoke funnel ends in the horizontal plane shall be higher than superstructure, where they are located, but not less than 0.5 m. In oil tankers smoke funnel outlets shall be at least 2 m from the cargo zone. A distance from a funnel or a flue to a combustible structure shall be at least 350 mm;
.7 Flue outlets shall be selected with regard to the requirement on maximum possible exclusion of combustion products entering the ship's space;
.8 Heat insulation of flues laid inside the ship's spaces, including in passages through the hull structures (bulkheads, decks, etc.) shall comply with the applied requirements of 1.9.2 Part IV of the Rules.

4.3.21 The gas consuming equipment may be placed in the wheelhouse only in case of no channels for penetrating the gas into the ship's inner spaces.

On board the tankers and ships carrying hazardous goods, the above placement is not allowed.

4.3.22 Spaces with gas consumers shall be equipped as per the requirements of 4.1 and comply with the following requirements:

.1 They shall not be arranged below the bulkhead deck and shall be fitted with effective ventilation for evacuating the combustion products and air change;
.2 They shall have an exit giving to the open deck and opening scuttle (window). The galley need not be fitted with the scuttle or window, when an exit from the galley is provided to non-accommodation space (a corridor) with opening scuttles or a door leading to the open deck;
.3 Where the space is below the bulkhead deck, it shall be equipped with artificial ventilation, and above the gas oven, the ventilating cowl shall be fitted;
.4 In the lower part of the water heaters' space an air grating shall be provided with a cross-sectional area not less than 0.02 m² per each water heater;
5 Bulkheads and decks shall be watertight, door coamings shall be at least 150 mm high. No ladders or elevators may be arranged from the spaces of gas-consuming appliances to the spaces located below;

6 The space height shall be at least 2.2 m. When using exhaust device of dimensions exceeding the overall dimensions of a gas stove, the space height may be reduced to 1.9 m;

7 The space volume shall be determined on the condition of 4 m$^3$ per each burner of the gas stove and 7.5 m$^3$ per a water heater.

When easily detachable exhaust ventilation box is fitted above the gas stove, the volume of the space with two-burner gas stove may be reduced to 6 m$^3$, that with three-burner gas stove – to 10 m$^3$ and that with four-burner gas stove – to 12 m$^3$;

8 at the entrance to gas consumer space, dry powder fire extinguisher or carbon dioxide fire extinguisher shall be fitted.

4.3.23 The distance between the gas-consuming appliances and the bulkheads shall be at least 75 mm.

4.4 LIGHTING

4.4.1 Ships shall be provided with electric lighting as per the requirements of 10 Part VI of the Rules.

4.4.2 Kerosene lighting may be used only on ships without electric power sources of the lighting network.

Kerosene lamps for lighting shall be fitted in suspended metal peak lanterns, permanently attached on-site and protected from impacts. Upper parts of lighting fixtures shall be situated no closer than 350 mm from the ceiling. The ceiling above the lamp shall be protected with suspended metal plate of diameter 150 mm or shall be fitted onto the non-combustible heat-insulating material.
5 FIRE ALARM

5.1 GENERAL REQUIREMENTS

5.1.1 Ships shall be equipped with manual fire alarm and automatic fire detection alarm systems, as well as fire smothering system release warning system complying with the requirements of 11.4 Part VI of the Rules.

5.1.2 In cargo spaces instead of automatic fire alarm system, automatic sample extraction smoke detection system may be used. The following requirements are imposed to this system:

1. The system shall be designed to operate continuously;
2. Detection of smoke or other combustion products shall initiate visual and audible signals in the wheelhouse or in the permanently attended place (if any);
3. After checking the system response, it shall be returned to the normal working mode without replacement of any elements;
4. The system power interruption shall initiate audible and visual signals different from the system response signals;
5. The system structure shall exclude the leakage of toxic, highly inflammable and extinguishants to accommodation, service and machinery spaces and control stations;
6. Each cargo space shall be fitted with smoke intake, located so that the distance from it to any area of the deck located above it, measured horizontally could not exceed 12 m;
7. Smoke inlets shall not be placed in locations where they can be damaged in case of impact;
8. Each sampling point shall be connected to max. 4 smoke intakes;
9. The same point for air sampling can be connected to smoke intakes of only one cargo space;
10. The structure of air sampling device shall be self-draining and shall be protected from possible damage when loading/unloading;
11. The sensing unit of the system shall be actuated when the smoke density inside the measuring chamber reaches the value to weaken the light by 6.65 % per meter;
12. Smoke monitoring shall be provided in separate pipes for air sampling;
13. At least two ventilators for air sampling shall be provided, with capacity sufficient for system operation in normal working mode of the ventilation system in the cargo space;
14. Devices shall be provided to enable sampling the same air volumes from each connected smoke intake;
15. Minimum internal diameter of air sampling tubes shall be 12 mm. When combining the air sampling with fixed gas extinguishing system, the pipe diameter shall be determined by the requirements to the pipe;
16. Devices for periodic blowing air sampling pipes with compressed air shall be provided.

5.1.3 Ship’s general alarm system shall be used as fire warning alarm for crew, passengers and special personnel in accordance with the requirements of 11.3 Part VI of the Rules.
6 FIRE PROTECTION OUTFIT SPARE PARTS AND TOOLS

6.1 FIRE PROTECTION OUTFIT

General provisions

6.1.1 Requirements of this Section apply to ships under design and construction as well as passenger ships in service with regard to availability of fireman kits and fire extinguishers.

6.1.2 On non-self-propelled ships operated without a crew, fire protection outfit and fire extinguishing systems are not required.

6.1.3 Fire protection outfit shall be provided and its reliability and readiness for immediate use under all operating conditions shall be ensured.

6.1.4 On passenger ships, places of fire protection outfit arrangement shall be marked with indicators made of photoluminiscent material or by means of lighting. Requirements for indicators of photoluminiscent materials shall be similar to those for light evacuation indication panels (see 16.1.11 Part VI of the Rules).

6.1.5 Inland navigation ships shall be fitted with fire protection outfit according to the norms specified in Table 6.1.5, with regard to the following:

.1 Each space where oil fuel is used shall be fitted with one additional blanket;

.2 Tankers shall be supplied with portable gas analyzer for measuring the concentration of inflammable vapours of goods carried. To control the percentage of oil vapour on ships intended for the transportation of oil products with flash point below 60 °C, two hand portable gas-analyzers shall be provided;

.3 Fireman’s outfit shall be required on ships, including those being in operation, with a crew or attending personnel more than 4 persons in number.

6.1.6 All fire protection outfit items shall be kept in permanent ready-for-use condition and be located in accessible places.

<table>
<thead>
<tr>
<th>Table 6.1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fire protection outfit rates</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ship type</th>
<th>Fire smothering blankets (pcs)</th>
<th>Set of fire-fighting tools (set)</th>
<th>Fire buckets (pcs)</th>
<th>Fireman’s outfit (set)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Passenger ships length (m):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 and less</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>—</td>
</tr>
<tr>
<td>30 to 65</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>—</td>
</tr>
<tr>
<td>65 to 100</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>over 100</td>
<td>3</td>
<td>6</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>2. Oil tankers and carriers of motor transport with filled tanks and inflammable fluids in containers with a length (m):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 and less</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>—</td>
</tr>
<tr>
<td>30 to 65</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>65 to 100</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>over 100</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>3. Other ships length (m):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 and less</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>—</td>
</tr>
<tr>
<td>30 to 65</td>
<td>1</td>
<td>1</td>
<td>4</td>
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<tr>
<td>65 to 100</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>over 100</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>
6.1.7 Sets of fireman’s outfit shall be stored ready for use in accessible places as far apart from each other as practicable.

6.1.8 Depending on the purpose ship’s spaces shall be fitted with portable fire extinguishers according to the rates specified in Table 6.1.8 with regard to the following:

<table>
<thead>
<tr>
<th>Ship spaces</th>
<th>Type of fire extinguisher</th>
<th>Number of fire extinguishers per one space</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Control stations</td>
<td>Carbon dioxide or dry powder</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Air-foam or dry powder</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>ditto</td>
<td>1 – on ships with engines of a capacity up to 110 kW One per each boiler</td>
</tr>
<tr>
<td>2. Machinery spaces with main and auxiliary engines working on oil fuel</td>
<td>Air-foam or dry powder</td>
<td>1</td>
</tr>
<tr>
<td>3. Boiler rooms with self-contained boilers working on oil fuel</td>
<td>Carbon dioxide or dry powder</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Air-foam or dry powder</td>
<td>1</td>
</tr>
<tr>
<td>4. Galleys with equipment working on oil fuel or gas</td>
<td>Dry powder or carbon dioxide</td>
<td>One (additionally to the outfit of the relevant space)</td>
</tr>
<tr>
<td>5. Galleys with electrical equipment</td>
<td>Carbon dioxide or dry powder</td>
<td>2 (when a distribution switchboard is located in the machinery space, one fire extinguisher shall be added to that stated in para. 2)</td>
</tr>
<tr>
<td>6. Stores for highly inflammable and combustible materials</td>
<td>Air-foam or dry powder</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>ditto</td>
<td>One per each 20 m of the corridor</td>
</tr>
<tr>
<td>7. Spaces containing electric generators with total power output exceeding 200 kW</td>
<td>Air-foam or dry powder</td>
<td>1</td>
</tr>
<tr>
<td>8. Rooms with main distribution switchboards or emergency distribution switchboards</td>
<td>Air-foam or dry powder</td>
<td>1</td>
</tr>
<tr>
<td>9. Cargo pump spaces and fuel distribution stations</td>
<td>ditto</td>
<td>One per each 20 m of the corridor</td>
</tr>
<tr>
<td>10. Closed decks</td>
<td>Air-foam or dry powder</td>
<td>1</td>
</tr>
<tr>
<td>11. Insulated spaces, heated or cooled, with any types of equipment using solid fuel, oil fuel or liquefied gas as a fuel</td>
<td>Air-foam or dry powder</td>
<td>1</td>
</tr>
<tr>
<td>12. Open decks on passenger ships</td>
<td>Air-foam or dry powder</td>
<td>One for each deck with a length up to 20 m and two for each deck with a length over 20 m</td>
</tr>
<tr>
<td></td>
<td>ditto</td>
<td>1 – for ships up to 25 m in length, 2 – for ships over 25 m in length</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>Two for each 30 m sections of the decks, but not less than prescribed in 13</td>
</tr>
<tr>
<td>13. Open decks on other ships excepting tankers</td>
<td>Air-foam or dry powder</td>
<td>One for fore and aft ends of open decks in addition to those prescribed in 13</td>
</tr>
<tr>
<td>14. Open decks of oil tankers</td>
<td>Air-foam or dry powder</td>
<td>2</td>
</tr>
<tr>
<td>15. Open decks of ships equipped for carriage of hazardous goods</td>
<td>With fire extinguishant, suitable for fire extinguishing of particular hazardous goods carried</td>
<td>2</td>
</tr>
<tr>
<td>16. Cargo spaces of ships intended for the carriage of solid hazardous goods in bulk or in containers</td>
<td>Dry powder</td>
<td>2</td>
</tr>
<tr>
<td>17. Cargo space of ships intended for carriage of hazardous goods in bulk</td>
<td>Air-foam or dry powder</td>
<td>One for each 20 m of the deck length, for each side. One near each of the entrances to these spaces from accommodation and service spaces</td>
</tr>
<tr>
<td>18. Cargo space of ships intended for carriage of passengers and vehicles</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

1 See 6.1.8.4.  
2 A greater number of fire extinguishers of minimum capacity with a charge of 12 kg may be used.
.1 In spaces with a floor area not exceeding 4 m² (galleys, distribution stations, stores, stations, broadcasting centers), carbon dioxide and dry powder fire extinguishers with a charge of 1.5 kg may be fitted;

.2 In spaces containing electrical equipment with rated voltage of 24 V gas fire extinguishers may be replaced by foam fire extinguishers;

.3 No portable carbon dioxide fire extinguishers or other gas fire extinguishers may be fitted in accommodation spaces;

.4 The quantity of fire extinguishant in fire extinguishers located in ship's cargo spaces intended for carrying hazardous goods in bulk shall be determined depending on scope of their employment for extinguishing fires of particular hazardous goods;

.5 Gasoline engined ships shall be fitted with at least two air-foam or dry powder fire extinguishers in the machinery space and the spaces where fuel tanks or fuel system units are located.

6.1.9 Manual portable fire extinguishers shall comply with the following requirements:

.1 They shall be located in places protected from direct sunlight and precipitation, with handles located not over 1.5 m above the deck or space flooring; they shall be located at least 1.5 m away from heating appliances or other heat sources;

.2 Fire extinguishers shall be located in special holders ensuring fastening and release of fire extinguishers;

.3 In accommodation spaces they shall be located at the distance not exceeding 15 m of the protected area. Access to fire extinguishers shall be provided through one door only;

.4 Where several fire extinguishers are located in a space according to 6.1.8, part of them shall be located in the vicinity of entrance and the rest – in the places with the greatest risk of fire inside the space;

.5 Where one fire extinguisher is located in a space or on a ship, it shall be located in the vicinity of the entrance to this space or near the place with the greatest risk of fire;

.6 In machinery spaces, the location of fire extinguishers shall provide minimum distance of 10 m between any point of the room and the nearest extinguisher.

6.1.10 Metal boxes with sand shall be fitted in boiler rooms, in rooms containing boilers-incinerators (at the furnace front side) in the area of the paint room as well as at the places of reception and distribution of fuel or at distance not more than 10 meters from the filling station (counting from the filling sleeve).

6.1.11 Metal boxes with sand shall not be fitted in machinery spaces and pump rooms. In those spaces, boxes containing sawdust impregnated with fat soda solution shall be fitted instead. One box with sand or sawdust may be replaced with one portable foam or dry powder fire extinguisher.

Requirements for fire protection outfit

6.1.12 Fire smothering blankets shall be fitted in spaces where fuel oil is used. These blankets shall:

.1 be stout and durable;

.2 be made of non-combustible material; clean unraised felt of minimum 10 mm thickness may be used;

.3 have an area of \((1.5 \times 2)\) m and be stored in special cases made of thin steel plate or in special containers. These cases or containers shall be painted red and bear an inscription “Fire blankets”.

6.1.13 Fire tools shall satisfy the following requirements:

.1 One set of fire tools shall include: fire axe, fire crowbar, fire boat-hook;

.2 Each set shall be stowed and secured on stationary boards in accessible places. The boards and the tools shall be painted red. The tool holder shall prevent the spontaneous tool coming out under conditions of roll and make it easy to release the tool;

.3 On ships for the carriage of motor vehicles with fuel (except for diesel fuel) in tanks, one set shall be placed near the entrances of accommodation and machinery spaces to cargo spaces.
6.1.14 Fire buckets shall be provided with a hemp rope. They shall be stowed on the open decks in supports. The buckets shall be painted red and bear an inscription “Fire”.

6.1.15 The fireman’s outfit shall include:

1. fire helmet ensuring effective protection against impacts;
2. protective clothing made of a material capable of protecting the skin against the heat radiated by fire, against burns and scalding by steam. The outer surface of the clothing shall be waterproof; tarpaulin and polyvinyl chloride fabrics may not be used as outer material of the clothing;
3. boots and mittens of a dielectric material;
4. portable accumulator lantern of a safe type with a minimum lighting period of at least 3 h. Ships carrying hazardous goods, oil tankers and other ships with cargo spaces and areas which may contain explosive mixture with air of combustible gases, vapours or dust, shall provide for IExd or IExp explosion-proof lanterns (see 2.10.7 and Appendix 1 Part VI of the Rules). The group and temperature class shall correspond to the category of the goods carried;
5. a fire axe with a helve made of hard wood. Helves made of other material shall be covered with dielectric insulation;
6. self-contained breathing apparatus operated by compressed air, with air cylinders containing at least 1.2 m³ of air or other self-contained breathing apparatus capable of operation 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 tested by static load of 3.5 kN. It should be fastened directly to the apparatus or to a separate belt by means of a snaphook to avoid spontaneous separation of the line from the apparatus.

Two spare cylinders or two spare apparatuses shall be provided for each self-contained breathing apparatus. All air cylinders for apparatuses shall be interchangeable.

The passenger ships carrying not more than 36 passengers and the cargo ships fitted with means for complete recharging air cylinders with purified air may have only one spare cylinder or one spare breathing apparatus for each self-contained breathing apparatus.

The passenger ships carrying more than 36 passengers shall have two spare cylinders or two spare apparatuses for each self-contained breathing apparatus.

6.1.16 Manual portable fire extinguishers shall comply with the following requirements:

1. Fire extinguishers shall be charged with an extinguishing medium not releasing toxic gases;
2. Fire extinguishers intended for location on the open decks shall be supplied with charges capable of being used at negative temperatures of ambient air;
3. Capacity of foam extinguishers shall be at least 0.009 m³;
4. Dry powder extinguishers shall contain at least 4 kg of the powder and carbon dioxide extinguishers shall contain at least 3 kg of carbon dioxide;
5. When using fire extinguishers with non-foam extinguishing medium, their fire rating (see 6.1.17.2) shall be not lower than that of foam extinguishers with a capacity of 0.009 m³;
6. Fire extinguishers shall be fitted with safety devices actuated in the event of pressure rise above the permissible value;
7. Weight of the fire extinguisher shall not exceed 23 kg;
8. Dry powder fire extinguishers shall be selected with regard to the purpose of fire-extinguishing powder medium;
9. Portable fire extinguishers shall be provided with devices which indicate whether they have been used.

6.1.17 Portable fire extinguishers shall comply with the following requirements:

1. Fire extinguishers shall be charged with an extinguishing medium which does not release toxic gases;
2. Fire extinguishers intended for location on the open decks shall be supplied with charges capable of being used at negative temperatures of ambient air;
.3 Fire extinguisher shall maintain the steady position, excluding its falling-out or shifting any condition possible during the ship operation;

.4 Fire extinguishers shall be fitted with safety devices preventing from breaking of the casing in the event of pressure rise above the permissible value;

.5 The fire extinguisher shall be fitted with assembled flexible hose with device shutting off the fire extinguishant jet. Flexible hose shall provide for free passage of fire extinguishant through the nozzle, fixed to the fire extinguisher casing without breaks or hoggings. It shall not touch the floor, ground or wheels when transporting the fire extinguisher and shall be flexible in the whole working temperature range.

6.1.18 Metal boxes with sand and soda impregnated sawdust shall comply with the following requirements:

.1 Boxes capacity shall be at least 0.1 m³;

.2 Each box shall have an opening cover and a device for holding the cover open. A scoop shall be provided in each box.

6.1.19 Explosive zones, spaces and areas, as well as open decks of oil tankers and oil recovery ships shall be provided with outfit items, whose material and structure shall exclude sparking when using these items.

Fire protection outfit of ships less than 25 m in length

Table 6.1.21

<table>
<thead>
<tr>
<th>Description</th>
<th>Fire protection outfit norms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual portable fire extinguishers: dry powder or foam</td>
<td>1 in the machinery space, 1 in the galley working on gas, oil fuel or solid fuel</td>
</tr>
<tr>
<td>dry powder or carbon dioxide</td>
<td>1 in the room containing control equipment of the ship</td>
</tr>
<tr>
<td>Metal boxes containing sand and soda impregnated sawdust¹</td>
<td>1 at the places of fuel charge and distribution</td>
</tr>
<tr>
<td>Blankets</td>
<td>1 in the machinery space</td>
</tr>
<tr>
<td>Fire buckets</td>
<td>2</td>
</tr>
<tr>
<td>Set of fire-fighting tools (set)</td>
<td>²</td>
</tr>
</tbody>
</table>

¹ It may be replaced with a fire extinguisher.

² On crew boats ships with engines of a capacity up to 165 kW it may be dispensed with.

.2 a box containing sand or dry soda impregnated sawdust with a capacity of at least 0.05 m³;

.3 blankets with a size of 1.0 × 1.5 m.

International shore connection

6.1.23 On М-СІ, М-ПР and О-ПР class ships, international shore connection for receiving water from shore shall be stored in special box painted red with inscription “Connection of international type” in the accessible place together with emergency party equipment.

6.2 SPARE PARTS AND TOOLS

6.2.1 М-СІ, М-ПР and О-ПР class ships shall have spare parts and tools according to the norms specified in Table 6.2.1. The provided standards shall fully apply to fixed firefighting systems of oil tankers, chemical tankers and ships carrying hazardous goods.

Other ships shall have spare parts and tools stated in 1.1, 1.2, 1.5, 1.6, 1.7, 8.2 and 8.3 Table 6.2.1.

6.2.2 Spare parts and tools for fire extinguishing systems shall be stored at fire extinguishing stations.

6.2.3 Spare parts shall be marked.
<table>
<thead>
<tr>
<th>Spare parts and tools</th>
<th>Table 6.2.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spare parts and tools</strong></td>
<td>Quantity per ship</td>
</tr>
<tr>
<td><strong>1 Fire extinguishing system</strong></td>
<td>One</td>
</tr>
<tr>
<td>1.1 fire hose of each applied length / diameter with connecting fittings</td>
<td>Two</td>
</tr>
<tr>
<td>1.2 adapter heads of each applied size (if the ship is provided with cranes of different diameters)</td>
<td>Four</td>
</tr>
<tr>
<td>1.3 fast-connecting fittings (hose heads)</td>
<td>5% of total amount, but not less than 10</td>
</tr>
<tr>
<td>1.4 fast-connecting fittings (hose heads for ships with gross tonnage of 4000 and over)</td>
<td>4 (for ships with gross tonnage of up to 300 – as per the hose number, but not more than 4)</td>
</tr>
<tr>
<td>1.5 rubber O-rings for connecting heads, monitors and instruments</td>
<td></td>
</tr>
<tr>
<td>1.6 hose clamps</td>
<td></td>
</tr>
<tr>
<td>1.7 wrenches for sprinkler heads (if they are fitted with special wrenches)</td>
<td>One</td>
</tr>
<tr>
<td>1.8 assembled hydrant of each applied size</td>
<td>One</td>
</tr>
<tr>
<td>1.9 wheel for assembled hydrant of each applied size</td>
<td>One</td>
</tr>
<tr>
<td>1.10 valve trays with O-rings to fire hoses of each applied size</td>
<td></td>
</tr>
<tr>
<td><strong>2 Sprinkler system</strong></td>
<td>One</td>
</tr>
<tr>
<td>2.1 assembled sprinkler heads</td>
<td>5 pcs per section</td>
</tr>
<tr>
<td>2.2 wrenches for sprinkler heads (if they are fitted with special wrenches)</td>
<td>1 pcs per section</td>
</tr>
<tr>
<td>2.3 alarm and monitoring device parts</td>
<td>One set according to delivery specification</td>
</tr>
<tr>
<td><strong>3 Water-spraying, water screen, water-sprinkling systems</strong></td>
<td></td>
</tr>
<tr>
<td>3.1 different sprayers used in the system</td>
<td>5% of total number of those fitted</td>
</tr>
<tr>
<td>3.2 wrench for fitting sprayers (if they are fitted with special wrenches)</td>
<td>1</td>
</tr>
<tr>
<td><strong>4 Foam extinguishing system</strong></td>
<td></td>
</tr>
<tr>
<td>4.1 assembled hydrant of each applied size</td>
<td>One</td>
</tr>
<tr>
<td>4.2 air-foam hose or foam applicator unit</td>
<td>One</td>
</tr>
<tr>
<td>4.3 reservoir eye glasses</td>
<td>One</td>
</tr>
<tr>
<td>4.4 rubber rings for connections</td>
<td>One</td>
</tr>
<tr>
<td><strong>5 Carbon dioxide system</strong></td>
<td></td>
</tr>
<tr>
<td>5.1 assembled cylinder valves, with the cylinder number:</td>
<td></td>
</tr>
<tr>
<td>less than 50</td>
<td>One</td>
</tr>
<tr>
<td>50 to 100</td>
<td>Two</td>
</tr>
<tr>
<td>100 and more</td>
<td>Three</td>
</tr>
<tr>
<td>5.2 wrenches for assembling and dismantling the cylinder valves and other special valves</td>
<td>One set per station</td>
</tr>
<tr>
<td>5.3 closers to be fitted on pipes from the cylinder valves when removing the cylinders</td>
<td>25% of receivers number</td>
</tr>
<tr>
<td>5.4 slot diaphragms</td>
<td>According to the number of containers</td>
</tr>
<tr>
<td>5.5 bushes of a push type and their washers for safety devices</td>
<td>10% of receivers number</td>
</tr>
<tr>
<td>5.6 non-return valves</td>
<td>5% of total amount, but not more than 1</td>
</tr>
<tr>
<td>5.7 nozzle outlets of each type and size</td>
<td>Two</td>
</tr>
<tr>
<td>5.8 scales for weighing the cylinders or device for measuring the level of carbon dioxide;</td>
<td>One</td>
</tr>
<tr>
<td>5.9 parts of devices for monitoring the level of carbon dioxide in the tank</td>
<td>According to delivery specification</td>
</tr>
</tbody>
</table>
### Spare parts and tools

<table>
<thead>
<tr>
<th>Spare parts and tools</th>
<th>Quantity per ship</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>6 Aerosol system</strong></td>
<td></td>
</tr>
<tr>
<td>6.1 extinguishing aerosol generator</td>
<td>One generator of each applied type</td>
</tr>
<tr>
<td><strong>7 Inert gas system</strong></td>
<td></td>
</tr>
<tr>
<td>7.1 starting valve (slide valve) for supplying gas to the</td>
<td>1</td>
</tr>
<tr>
<td>protected spaces</td>
<td>According to delivery specification</td>
</tr>
<tr>
<td>7.2 automatic control parts</td>
<td></td>
</tr>
<tr>
<td><strong>8 For all systems</strong></td>
<td></td>
</tr>
<tr>
<td>8.1 control and monitoring devices: pressure gauges,</td>
<td>One</td>
</tr>
<tr>
<td>vacuum-gauges, thermometers of all the types used in the</td>
<td>Set</td>
</tr>
<tr>
<td>systems</td>
<td></td>
</tr>
<tr>
<td>8.2 adequate amount of sealing material for the system</td>
<td>As per the number of doors and dampers, whose</td>
</tr>
<tr>
<td>repair under ship's conditions</td>
<td>automatic closing is effected by fuses</td>
</tr>
<tr>
<td>8.3 fuses for automatic closing of fire doors and dampers</td>
<td>According to the delivery specification approved by the</td>
</tr>
<tr>
<td></td>
<td>River Register</td>
</tr>
<tr>
<td>8.4 spares and tools for the fire extinguishing systems</td>
<td>According to the delivery specification approved by the</td>
</tr>
<tr>
<td>remote control equipment</td>
<td>River Register</td>
</tr>
<tr>
<td>8.5 spare parts and tools for fire alarm systems</td>
<td>1-2 sets</td>
</tr>
<tr>
<td>8.6 independent fire-retarding divisions of each type and</td>
<td></td>
</tr>
<tr>
<td>size</td>
<td></td>
</tr>
</tbody>
</table>

---

End of Table 6.2.1
7 EMERGENCY ESCAPE BREATHING DEVICES

7.1 GENERAL REQUIREMENTS

7.1.1 Requirements of this Section of the Rules are applied to emergency escape breathing devices used on M-CTI and M-TPP class ships with gross tonnage of 500 and over for individual protection of respiratory and visual organs of the personnel engaged in evacuation of people in case of fire.

7.1.2 Emergency escape breathing devices shall operate by means of compressed air or oxygen generated as a result of the chemical reaction in the closed cycle device. They shall not be used by the crew for fire-fighting purposes, for entering voids or tanks with insufficient oxygen content, fire-fighting emergency party. In the above cases, they shall use self-contained breathing apparatuses working on compressed air, whose cylinders shall contain min. 1200 L of air or self-contained breathing apparatuses capable of operation for at least 30 min.

7.1.3 The number of emergency escape breathing devices and their location (including the reserve ones) shall be indicated in the fire control plans. There shall be at least two reserve escape breathing devices in a passenger ship and one escape breathing device in a cargo ship.

7.1.4 Operating period of emergency escape breathing devices shall be min. 10 min.

7.1.5 Emergency breathing device shall include a helmet or similar item covering the entire face and having a transparent visor. The helmet and its front part shall be made of flame-resistant material.

7.1.6 Emergency escape breathing device shall be designed in a manner to prevent carrying inactive device in hands.

7.1.7 The structure of emergency escape breathing devices shall provide their easy and fast putting on.

7.1.8 (shall be considered to have lost force.)

7.2 LOCATION OF THE EMERGENCY ESCAPE BREATHING DEVICES

Arrangement in superstructure spaces

7.2.1 All the ships in the accommodation spaces area shall provide for at least two emergency escape breathing devices.

7.2.2 In passenger ships, at least two emergency escape breathing devices shall be located in each vertical fire zone.

7.2.3 In passenger ships carrying more than 36 passengers, in addition to the required in 7.2.2, two more emergency escape breathing devices shall be located in each vertical fire zone.

7.2.4 Requirements of 7.2.2 and 7.2.3 are not applied to the ladder enclosures making separate vertical fire zones, and to vertical fire zones in aft parts of the ship, where they are located:

- cabins, offices, dispensaries and public spaces (having a deck area of less than 50 m²) with furniture and furnishings different from
those of restricted fire risk\(^1\), with the following fire risk characteristics\(^2\):

- flammability group – low-flammable and medium-flammable;
- inflammability group – flame-resistant and medium-inflammable;
- group of flame spreading over the surface – low-spreading and medium-spreading;
- smoke generation group – with small and medium smoke-generating capacity;
- group of toxic effluents – low-hazard and moderate-hazard;

\(^1\) Fire risk – a combination of medium’s (material’s) properties specifying its combustion and flame propagation, generation of fire risk factors.

\(^2\) GOST 12.1.044, GOST R 50810, GOST 30402, GOST 30244.

cleaning gear lockers, drying rooms having a deck area of 4 m\(^2\) or less;

\(^{.3}\) public spaces having a deck area of 50 m\(^2\) and over, with furniture and furnishings different from those of restricted fire risk, barber shops and beauty parlours, saunas;

\(^{.4}\) machinery spaces and main galleys, their auxiliary spaces, trunks and passageways to the spaces listed above.

### Arrangement in machinery spaces

7.2.5 On all ships, within the machinery spaces, emergency escape breathing devices shall be situated in illuminated and accessible places on the escape routes and be ready for use in case of fire. The location of emergency escape breathing devices shall take into account the layout of the machinery space and the number of persons keeping the watch and working in the space. Such places can be control stations and workshops.

This requirement may be omitted, if the personnel in the machinery space is equipped with personal portable breathing devices.
Part IV

POWER INSTALLATION AND SYSTEMS
1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION

1.1.1 The present Part of the Rules applies to ship power installation components (engines, shafting, gears, disengaging and elastic couplings, propellers, compressors, pumps, fans, separators, boilers, heat exchangers, pressure vessels, refrigerating plants, automation equipment) and systems (pipelines, valves and fittings, tanks, filters and other equipment), unless otherwise specified in the present Part of the Rules, and contains the requirements to the aforesaid ship power installation components and systems, including their arrangement and installation.

1.1.2 The requirements of the present Part of the Rules to power installations and their components, except for 1.11 and 2.14, are established considering that the flash point of fuel oil (in the closed cup) used for engines and boilers shall exceed 60 °C and the flash point of fuel oil used for emergency diesel generators shall be not less than 43 °C.

1.2 TERMS AND DEFINITIONS

1.2.1 The following terms are used in this Part of the Rules.

1. Automatic oil burner unit means a device for combustion of fuel oil, the operation of which is controlled without any direct attendance of the operating personnel.

2. Auxiliary engines mean drive engines of generators providing electrical power for the ship and engines of cargo and fire pumps.

3. High-temperature organic heat transfer fluid means synthetic and mineral oils comprising dialkylbenzenes resistant to high temperatures (up to 450°C).

4. Main engines mean engines intended for driving propellers and/or equipment that ensures the main purpose of the ship.

5. Engines mean internal combustion engines.

6. Dual fuel system means the system which enables the engines to operate both on heavy and diesel fuel due to change-over from one kind of fuel to another; this system includes heavy and diesel fuel preparation systems.

7. Remote control means remote start and stop of ship machinery and remote change of frequency and direction of rotation of main engines.

8. Ship’s length means the design length of a ship (length corresponding to the design waterline).

9. Inflammable liquids — see the definition in 2.2.14 Part 0 of the Rules.

10. Closed method of loading and unloading oil products mean the method of performing cargo handling operations by both shore-based and onboard facilities by means of sealed piping system ensuring communication of the oil compartments with the atmosphere only through the gas outlet system.

Closed method includes also cargo handling operations of oil products by portable ejectors; here, sealing is ensured by sealing devices preventing from leakage of oil products’ vapour.

11. Engine room — see the definition in 2.2.24 Part 0 of the Rules.

12. Machinery spaces — see the definition in 2.2.25 Part 0 of the Rules.

13. Local control station means a control station equipped with controls, in-
instrumentation and communication equipment designed to control power installation components, and located in proximity to a controlled unit or directly on it.

.14 **Normal operating conditions** mean designed operating conditions of the ship, ship machinery, systems and their components in all envisaged operation modes.

.15 **Equipment** means filters, heat exchangers, vessels, tanks and other arrangements ensuring the operation of the power installation.

.16 **Pump rooms** mean cargo pump compartments in tankers.

.17 **Control stations** mean spaces where the main navigational instruments, ship control equipment, radio sets, broadcasting centres, central and fire-fighting stations are located, accumulator rooms and power equipment rooms for radio sets or for emergency lighting as well as spaces for emergency power sources.

.18 **Working pressure** (for boilers, heat-exchangers and pressure vessels) means a maximum pressure determined by the designer for continuous operation mode without limitation in time.

.19 **Rated power** means a maximum unlimited in time power used for calculations required by the Rules.

.20 **Design steaming capacity of the boiler** means maximum output of steam of the design parameters within a time unit in the continuous operation mode without limitation in time and with all possible steam consumers connected.

.21 **Rated rotational frequency** means rotational frequency corresponding to the rated output.

.22 **Design pressure** means over-pressure for which the strength of the components of systems and ship machinery is calculated according to the requirements of the Rules or national standards.

---

1 GOST R 52857, GOST 14249, GOST R 52630, GOST 25215, GOST 25859.
1.3 OPERATION IN CONDITIONS OF HEEL AND TRIM

1.3.1 Power installation components shall be designed for operation under conditions of long-term (static) heel of the ship of up to 15°, short-term (dynamic) heel of up to 22.5° (roll period of 7 to 9 s) with simultaneous static trim by the bow or stern of up to 5° and dynamic trim (pitch) of up to 7.5°.

Power installation components to be used for operation in emergency situations shall be designed for operation under long-term heel of up to 22.5°, dynamic heel of up to 22.5° with simultaneous static or dynamic trim of up to 10°.

Long-term heel and trim shall be taken into account simultaneously, the same as roll and pitch.

In oil tankers of MCTI4,5 class the prime movers of emergency power sources shall be designed for operation under long-term and dynamic heel of the ship of up to 30°.

If the length of the ship of M-CTI4,5 class exceeds 100 m, long-term trim by the bow or stern can be taken as (500/L)°, where L is the ship’s length, in m.

1.4 CONTROL DEVICES

1.4.1 The starting and reversing arrangements shall be so designed and placed that each engine, reverse reduction gear, coupling, and other machinery can be started or reversed by one operator.

1.4.2 The duration of reversing (a period of time from the reversing of a steering control to the beginning of propeller operation with a thrust opposite in direction) depending on the ship’s speed shall not exceed:
- 25 s at full speed;
- 15 s at slow speed.

1.4.3 Proper working direction of control handles and handwheels shall be clearly indicated by arrows and relevant inscriptions.

1.4.4 The setting of the control handle in the direction from or to the right of the operator or turning the handwheels clockwise when controlling main engines, gears and couplings locally or remotely shall correspond to the ahead running of the aforementioned equipment.

If the main engine is controlled by the handle, the latter shall move round the circumference in the vertical plane in parallel to the longitudinal axis of the ship. When this handle is moved in the direction of the bow, the ship shall run forward; when the handle is moved towards the stern, the astern running shall be enabled. The engine shall be started and reversed, when this handle is in the STOP position (neutral position). The amplitude of handle movement from the STOP position to the FULL AHEAD position or from the STOP position to the FULL ASTERN position shall not exceed 90°.

1.4.5 Control arrangements shall be so designed as to eliminate the possibility of spontaneously changing the positions prescribed.

1.4.6 The control devices of main engines shall have an interlocking system so as to prevent non-authorised starting of main engines as well as starting with a shaft-turning gear engaged.

1.4.7 If the design of ship machinery in addition to the power-driven start envisages manually driven start, the manual drive shall be disabled automatically when the drive is started from the power source. The drives of the starting device shall have an interlock excluding the possibility of their unauthorized start while ship machinery is running.

1.4.8 Main engines and propellers shall be controlled from the control station in the wheelhouse or from the control station in the engine room. Transfer of control between the aforesaid stations shall be possible only from

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1 The heel appearing due to loading of the ship in service when the total center of gravity of variable loads (transported cargo, fuel and oil stores, oily waters and sewage waters) is beyond the centre line of the ship. Long-term heel remains until measures are taken to right the ship.

2 Trim appearing in case of particular loading of the ship and remaining throughout the entire voyage.

The duration of reversing of the thruster at maximum thrust shall not exceed 25 s.
the engine room or from the central control station (see 1.2.1.29).

1.5 CONTROL STATIONS
1.5.1 Remotely controlled equipment and machinery shall be fitted with local control stations.
Local control stations need not be fitted in ships less than 25 m in length.

1.6 MEANS OF COMMUNICATION
1.6.1 Each main engine control station shall be equipped with two independent means of two-way communication with the wheelhouse. One of these means of communication shall be an engine-room telegraph.

In ships with main engines remotely controlled from the wheelhouse one means of communication between the wheelhouse and the engine room may be used. In this case the engine-order telegraph or a similar appliance shall be used.

1.6.2 Engine-order telegraphs shall be equipped with alarm devices.

1.6.3 When two-way communication equipment is used, measures shall be taken to ensure good audibility during the operation of engines and other equipment.

1.7 INSTRUMENTS AND ALARMS
1.7.1 Instruments shall be verified or calibrated and arranged in accessible and illuminated places.

1.7.2 The limiting values shall be marked on scales of pressure and revolution frequency metering devices as brightly painted signs. Forbidden areas of revolution frequency shall be marked on tachometer scales with well visible paint. The marks may be made on protective glasses of the devices.

1.7.3 Sound signals shall be audible in any part of the machinery space while the machinery is running. The sound of engine-room telegraph signals shall differ from other signals in the machinery space.

1.8 MACHINERY SPACES

Passageways

1.8.1 Main and auxiliary engines, assemblies and equipment shall be located in machinery spaces so as to provide free movement of the personnel from their control stations and places of maintenance to the exits. The width of the passageway throughout its length shall be not less than 600 mm and the height — not less than 1900 mm. The width of the passageway may be reduced locally to 500 mm.

In hydrofoil craft, hovercraft and displacement ships of a length less than 25 m, the width of passageways shall be min. 400 mm.

1.8.2 The width of passageways shall be at least 1000 mm from the main engine control station side and between the main engines.
The width of the passageway shall be min. 800 mm if the main engines are remotely controlled.

Means of escape

1.8.3 Each machinery space (other than indicated in 1.8.4), shafting tunnels and each space where main switchboards are installed shall be provided with at least two means of escape, one of which may give through a watertight door to a space which has an independent escape route. The second means of escape shall lead directly to the open deck; for this purpose a vertical steel ladder may be used. The means of escape shall be as widely separated as possible. Ladder trunks shall have clear dimensions not less than 600 × 600 mm.

1.8.4 The second means of escape may be omitted:
.1 from machinery spaces with an area not exceeding 25 m², where the existing escape route does not lead to the adjacent machinery or accommodation space. The area of machinery spaces is determined as per 2.2.5 Part III of the Rules.
.2 in ships not over 25 m in length;
.3 from auxiliary spaces without risk of fire and being enclosed inside the machinery space which has two means of escape;
.4 from enclosed central control stations where main switchboards are not located;
.5 from spaces containing no fuel oil fired engines;
.6 from incinerator rooms.

**1.8.5** If two adjacent machinery spaces communicate through a door and each of them has only one means of escape to the open deck, these means of escape shall be located at the opposite sides.

**1.8.6** Cargo pump rooms in oil tankers shall have at least one means of escape leading directly to the open deck.

**1.8.7** Steps of companion ladders shall have a depth of at least 150 mm and a width of at least 560 mm. Ladders shall be made of sliding-safe plates or grills. Ladder inclination shall not exceed 60° to horizon.

In hydrofoil craft, hovercraft and displacement ships of a length less than 25 m, the width of companion ladders shall be at least 500 mm; vertical companion ladders may be used as well.

**1.8.8** Vertical ladders shall have a width of at least 500 mm. A distance between separate steps shall be not more than 300 mm.

**1.8.9** Plates of bottom plating in the machinery space shall be made of corrugated sheet material. They shall be removable and have fasteners to prevent shifting. Plate thickness shall be such as to avoid sagging in operation. The plate weight and dimensions shall be such as to provide its hoisting by one person (the maximum weight of a single plate is 25 kg).

Engine units, assemblies and valves shall not have prominent parts above the bottom plating in the passageways. Access to such units shall be provided through covers in plating. Covers and hoisting arrangements shall not have prominent parts.

**1.8.10** Platforms intended for maintenance and repair of engines, units, equipment, devices and other components of power installations shall have a width of at least 450 mm and handrails with a height of at least 900 mm.

Hard iron grills shall be provided instead of platforms, where the latter impose the regular air circulation in the machinery space.

Outer edges of the platforms and grills shall have coamings with a height of at least 40 mm.

**1.8.11** All moving parts of engines, assemblies, equipment and drives that are dangerous for attending personnel shall be guarded by handrails or housings.

**1.9 ARRANGEMENT OF POWER INSTALLATION COMPONENTS**

**1.9.1** Power installation components, equipment, pipelines, valves and fittings shall be so located as to be freely accessible for maintenance and repair. Access for repair need not be provided, where a component may be replaced without dismantling other components of the power installation.
1.9.2 All parts of the power installation and pipelines which external surfaces are heated to a temperature above 60 °C and which are dangerous for attending personnel shall be equipped with arrangements to prevent or restrict heat radiation (thermal insulation, screening etc.).

Surfaces of power installation components including pipelines which are heated to a temperature above 220 °C shall have insulation made of non-combustible materials. If insulation is oil-absorbing, in the machinery spaces where fuel or oil is stored or used, insulation shall be coated with metal sheets or equivalent oil-tight material. Measures shall be taken to prevent insulation damage due to vibration and mechanical damages.

1.9.3 The distance from the outer surface of insulation of power installation components to the walls of fuel oil tanks shall be at least 600 mm.

For ships with a length less than 25 m, this distance shall be minimum 400 mm provided that temperature of the outer surface of insulation does not exceed 60 °C.

1.9.4 Boilers which are installed in the same space with internal combustion engines shall be separated by metal enclosures in the furnace area or other design measures shall be foreseen to prevent the equipment of this space from flame action in the event of its ejection from the furnace.

1.9.5 Fuel oil fired boilers situated on platforms or intermediate decks and not enclosed by water-tight bulkheads shall be fenced by tight coamings with a height of not less than 200 mm.

The deck (or platform) under the boilers enclosed by coamings shall be also water-tight.

1.9.6 In oil tankers boilers shall be installed abaft cofferdams beyond the cargo tank area.

In oil tankers intended for transportation of oil products with a flash point up to 45 °C inclusive, tender vessels of oil tankers and cargo ships intended for transportation of easily inflammable cargo solid fuel boilers shall not be installed.

1.9.7 Fuel and oil tanks and oily water collecting tanks shall not be located above the stairways, engines, boilers, exhaust gas pipes, funnel uptakes, electrical equipment and control stations of main components of power installations.

1.9.8 Motors for driving cargo pumps, stripping pumps and pump room fans in oil tankers, combination bulk carriers, oil skimming ships other than steam ones, and driving hydraulic and electric motors of the relevant protection class (see 16.2 Part IV of the Rules) shall not be installed in cargo pump rooms. The motors specified in this paragraph shall be arranged:

- in artificially ventilated rooms adjacent to cargo pump spaces, but having no exits to these rooms and no communication with them;
- in ventilated air-tight enclosures inside the pump room.

Stuffing boxes shall be installed in places where pump/fan drive shafts pass through bulkheads and decks. The structure of stuffing boxes shall comply with the requirements specified in 3.12.16, 3.12.27 and 3.12.28 of Part III of the Rules.

To drive the cargo pumps, stripping pumps and pump room fans in cargo pump rooms of the above mentioned ships, it is allowed to install steam engines with working temperature of max. 150 °C and hydraulic motors.

1.9.9 Equipment used for preparation and delivery of fuel oil to the engine, boiler, inert gas generator, incinerator (fuel pumps, separators, filters and heaters with fuel pressure over 0.18 MPa), as well as hydraulic units containing combustible liquids with working pressure over 1.5 MPa and making no part of main and auxiliary engines, boilers and equipment, shall be arranged in separate rooms with self-closing steel doors.

If it is not possible to arrange such equipment and units in separate rooms, for example, on high-speed ships (hovercraft, hydrofoil craft, WIG craft, captured air bubble craft) and in ships with a length less than 25 m, the arrangements ensuring collection and removal of fuel and working fluid leakages shall be installed in places of possible fuel or working fluid leakages from hydraulic units.
1.9.10 For the requirements to arrangement of emergency diesel generators, see 4.3 Part VI of the Rules.

1.9.11 For the requirements to arrangement of fuel tanks, see 10.13.25 to 10.13.29.

1.10 INSTALLATION OF ENGINES, BOILERS AND EQUIPMENT

1.10.1 Engines, boilers and equipment shall be installed and fixed on foundations. Strength and rigidity of foundations shall be proved by calculations considering static and dynamic loads which can appear during operation of engines, boilers and equipment.

1.10.2 Equipment may be installed on the outer shell plating, watertight bulkheads, shafting tunnel walls and on fuel oil or oil tank walls provided that it is fixed to the stiffeners or on the brackets welded to the plating in the stiffeners area.

1.10.3 Spacers fitted between foundations and bedplates shall consist of not more than two parts.

1.10.4 Main and auxiliary engines, gears, thrust bearings of shaft lines and self-contained boilers shall be fixed to the ship foundations by all fitted coupling bolts or by special stops to prevent its displacement due to any type of load possible while the ship is in operation.

1.10.5 Bolts fastening main and auxiliary engines, boilers, bearings of shafting to ship foundations, bolts connecting the shafting parts, end nuts of propeller, intermediate and thrust shafts, as well as bolts with hindered access during operation, shall be reliably locked to prevent spontaneous unscrewing.

1.10.6 Shock absorbers and shock-absorbing mounts shall:
   .1 maintain their vibration-isolating properties after exposure to limit environmental temperatures specified in 1.3.1 Part V of the Rules;
   .2 be resistant to aggressive mediums and different types of radiations which are possible on board the ship.

1.10.7 Boilers shall be mounted on foundations so that welded joints in boiler structures do not rest on supports.

1.11 USE OF GASOLINE ENGINES

1.11.1 Gasoline engines may be used:
   . to drive portable fire and bilge pumps in all ships other than oil tankers and ships carrying easily inflammable cargoes.

1.11.2 Engines in open ships shall be covered by protective housings. Protective housings made of inflammable materials shall have lining from the inside made of steel roofing on the layer of mineral insulating material.
   In enclosed ships all wooden parts in the machinery space shall have sheeting made of steel roofing on the layer of mineral insulating material.

1.11.3 Watertight floors shall be installed in front of engine and beyond it. Hand pump or motor-driven pump drainage shall be provided in the places of engine installation in enclosed machinery spaces separated by floors as well as in spaces where oil tanks are situated.

1.11.4 Carburettor and engine fuel pumps shall be installed so as to avoid flame ingress from carburettor on fuel pump.

1.11.5 Suction pipes of carburettor shall be led outside the removable housings and be raised over it for at least 500 mm. Suction pipes on the ends shall be fitted with heads with flame arresters.

1.11.6 Carburettor suction pipe inlet shall be located not less than 300 mm above the cylinder heads and provided with flame screens, where engines are installed in enclosed spaces. If there are no suction pipes, flame arresters shall be mounted at carburettor air inlet.

1.11.7 In wooden ships drip trays shall be fitted under the engines, pumps, fuel tanks, valves and all other units of the fuel system where fuel oil leakage is possible. Edges of the trays shall have collars.
1.11.8 A gasoline tank shall be installed in a compartment (enclosure) isolated from the internal combustion engine compartment in ships with continuous deck. These compartments (enclosures) shall be equipped with natural ventilation for gasoline vapour removal.

1.11.9 Protective housings of the engines, machinery spaces, compartments with fuel tanks shall have plenum-exhaust ventilation.

Ventilation tubes of these compartments shall not be connected with each other.

Ventilation tubes from the engine housings and tubes removing gas from the fuel tanks shall be equipped with flame arresters.

1.11.10 Air tubes from the gasoline tank and from the compartment shall be separate, their outlet holes shall be apart from each other as far as possible and shall be fitted with ejecting heads with flame arresters.

1.11.11 Closed motor spaces shall have ventilation which provides removal of accumulated gasoline vapours before the engine start.

1.11.12 Fuel tanks and oil pipelines shall be made of metal resistant to corrosion caused by influence of fuel environment.

1.11.13 For the purpose of fuel tank filling fill-in branch pipes shall be led out to the deck, which shall prevent the fuel ingress inside the hull.

In wooden ships wood around the fill-in branch pipes shall have appropriate lining.

1.11.14 No tubular glass fuel level indicators shall be installed on fuel tanks.

1.11.15 Electric indicator of gasoline level in the tank shall be of explosion-proof type.

1.11.16 It is not allowed to provide devices for sediment discharge in the fuel tanks. When such device is used, self-locking valves shall be additionally provided with thread plug on the outlet end and a drip tray shall be placed under the tank.

1.11.17 A locking device shall be installed on the fuel pipeline directly before the engine which shall allow locking the pipeline from the ship control station.

Fuel pipelines shall be protected against mechanical damage and be located so as they can be inspected throughout the length. The pipes shall be connected by hard-brazed nipples with coupling nuts.

1.11.18 Gasoline pipeline joints shall be free of gaskets. The gasoline pipeline shall be mounted in easily accessible places and protected against damage.

For installation of engines on shock absorbers it is allowed to use gasoline pipeline flexible joints made of gasoline-proof and fireproof materials.

1.11.19 All units of the fuel system shall be placed on the opposite side relatively to the exhaust manifold.

1.11.20 In the motor spaces, accumulators shall be installed only in a closed box on the side opposite to the carburettor or fuel injecting equipment. Exhaust ventilation shall be provided.

Accumulators shall not be located under the fuel tanks.

1.12 SHIP’S SPEED

1.12.1 The output of main engines in self-propelled ships (for tugboats and pushers – in lightship condition) of M-CTI, MIP and O-IIP classes shall be such as to provide the ship’s speed of at least 10 knots in calm deep water in conditions of maximum operating draught.

1.12.2 The power installation shall ensure the ship’s astern operation under normal operating conditions. Rotational speed of shaft lines at steady-state free astern running of the ship shall be at least 70 %, and for ships with direct propeller transmission — at least 85 % of design rotational speed of shafts for ahead running.

1.12.3 The power installation of the ship with a single main engine, when the main engine turbosupercharger (turbosuperchargers) fails, shall provide such a motion speed that the ship can remain steerable.
2 INTERNAL COMBUSTION ENGINES

2.1 SCOPE OF APPLICATION
AND MATERIALS

2.1.1 Requirements of the present Section apply to engines with an output of 55 kW and above.

2.1.2 Engines with output less than 55 kW shall comply with the requirements of 2.3 and applicable requirements of 2.1.3 to 2.1.6 and 2.2.

2.1.3 Engine parts are to be of materials stated in Table 2.1.3.

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
<th>Chapter of Part X of the Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Foundation frame, crank-case, built-in thrust bearing body</td>
<td>Cast iron, Cast steel, Rolled steel, Forged steel, Aluminium alloy</td>
<td>2.11 – 2.13, 2.7, 2.2, 2.6, 4.2</td>
</tr>
<tr>
<td>2. Cylinder block, cylinder heads, inlet and outlet valves</td>
<td>Cast iron, Cast steel, Aluminium alloy (for cylinder blocks and heads)</td>
<td>2.11 – 2.13, 2.7</td>
</tr>
<tr>
<td>3. Cylinder bushes and their elements</td>
<td>Cast iron, Cast steel, Forged steel</td>
<td>2.11 – 2.13, 2.7, 2.6</td>
</tr>
<tr>
<td>4. Piston</td>
<td>Cast iron, Cast steel, Forged steel, Aluminium alloy</td>
<td>2.11 – 2.13, 2.7, 2.6, 4.2</td>
</tr>
<tr>
<td>5. Rod, connecting rod, head connection pins</td>
<td>Steel forgings</td>
<td>2.6</td>
</tr>
<tr>
<td>6. Crankshaft, thrust shaft of built-in thrust bearing</td>
<td>Forged steel, Cast steel, Cast iron</td>
<td>2.11 – 2.13</td>
</tr>
</tbody>
</table>

End of Table 2.1.3

2.1.4 It is allowed to use alloy steels, including heat resistant, high temperature oxidation resistant and high strength steels or alloy cast iron for the engine parts if the chemical composition of these alloy materials does not deteriorate their mechanical properties and strength characteristics as compared to the ones specified in 2 Part X of the Rules and in Table 2.1.3. The compliance of the properties and characteristics of the alloy materials with the requirements of the Rules shall be confirmed by the manufacturer’s documents containing data on chemical composition, mechanical properties and strength characteristics of such materials, as well as documents of test laboratories (centres) on checks and tests of these materials for their compliance with the chemical composition, properties and strength characteristics specified by the manufacturer in the technical documentation agreed with the River Register.

2.1.5 Nodular cast iron is allowed for use at temperatures up to 300 °C, and grey cast iron — up to 250 °C.
2.1.6 In the manufacture process of parts using welding technology the requirements of 7 to 9 Part X of the Rules shall be complied with.

2.2 TESTING OF PARTS

2.2.1 Steel parts of engines are subject to ultrasonic testing during the manufacture process according to Table 2.2.1.

Ultrasonic testing shall be carried out in accordance with the requirements of 2.21 Appendix 10 Part X of the Rules shall be complied with.

<table>
<thead>
<tr>
<th>Cylinder bore, mm</th>
<th>Part No. according to Table 2.1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤400</td>
<td>1, 2, 4, 6, 7</td>
</tr>
<tr>
<td>&gt;400</td>
<td>1, 2, 4, 5, 6, 7</td>
</tr>
</tbody>
</table>

2.2.2 Forged and cast steel parts, the numbers of which are listed in the right column of Table 2.2.2, including their welded joints, shall be tested during manufacture for the surface soundness by the magnetic particle or liquid penetrant method.

<table>
<thead>
<tr>
<th>Cylinder bore, mm</th>
<th>Part No. according to Table 2.1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤400</td>
<td>1, 5, 6</td>
</tr>
<tr>
<td>&gt;400</td>
<td>1 to 12</td>
</tr>
</tbody>
</table>

2.2.3 Non-destructive testing of engine parts, the numbers of which are not listed in Table 2.2.2 and their welded joints is carried out at the manufacturer’s discretion.

2.3 GENERAL TECHNICAL REQUIREMENTS

2.3.1 Engines shall be capable of operation under overload conditions exceeding the rated output by 10 % for not less than 1 h at operating cycles of not less than 6 h.

2.3.2 Reversible engines intended to be used as main engines in direct propeller transmission units shall ensure at least 85 per cent of the design ahead output in the reverse mode.

2.3.3 Minimum steady rotation frequency of main engines with direct propeller transmission shall not be more than 30 per cent of the nominal rotation frequency.

2.3.4 The possibility of safe cranking of main engines shall be ensured.

2.3.5 Fasteners of engine moving parts as well as fasteners located in hardly accessible places shall have fittings or be so designed as to prevent from spontaneous unscrewing.

Engine moving parts shall be covered by protective housings.

2.3.6 Lubrication devices for engine parts and units shall be easily accessible and safe for maintenance during the operation of the engines.

2.3.7 Safety and protective devices shall be so designed and installed so that in case of their actuation they are not hazardous both as regards fire and for the attending personnel.

2.3.8 Remote and automatic control systems shall meet the applicable requirements of 11 of this Part.

2.3.9 Engine systems and pipelines shall meet the applicable requirements of 10 of this Part.

2.3.10 Turbocharger rotors shall be designed so that equivalent stresses in any section do not exceed 0.95 of the yield point of part’s material at the rotation frequency equal to 1.2 times the rated one.

2.3.11 Engine parts, pipelines and units operating under excessive pressure shall undergo hydraulic tests according to 6.2.2 of RTSC.

2.4 FRAME

2.4.1 Mating surfaces of the frame parts forming the engine crankcase shall be oil- and gas-tight and fixed together by means of calibrated pieces.

2.4.2 The crankcase and detachable covers of the crankcase inspection ports shall withstand maximum possible operating load with the covers being securely fastened in such a
way as to prevent their displacement in the event of explosion.

2.4.3 The engine frame and conjugated parts shall be fitted with draining arrangements (drain grooves, pipes) and other facilities preventing the ingress of fuel and oil into circulating oil.

The cooling spaces of the cylinder blocks shall be fitted with drain arrangements providing complete drainage.

2.4.4 No ventilation of crankcases or use of any arrangements causing flow of external air into the crankcase is allowed. If a forced extraction of the gases from the crankcase is provided (e.g., for smoke detection purpose), vacuum in the crankcase shall not exceed 250 Pa.

For engines with an output up to 750 kW suction of gas/air from the crankcase by turbo-blowers or blowers may be admitted provided that oil separators are fitted to prevent the ingress of oil with the suction gas/air inside the engine.

Vent pipes or drain oil pipes of crankcases of two or more engines shall not be combined.

A diameter of the vent pipes from the crankcase shall be as small as practicable; the ends of the vent pipes shall be fitted with flame arresters and arranged so as to prevent water ingress inside the engine.

Vent pipes shall be led to the weather deck or to the places where exhaust ventilation is provided.

2.4.5 Engine crankcases shall be fitted with safety valves as follows:

1. engines having a bore of 200 mm and over, but not exceeding 250 mm, shall have at least one valve at each end of the crankcase, if the number of cylinders is less than eight; additional valve shall be fitted near the middle of the crankcase, if the number of cylinders is eight and above;

2. engines having a bore exceeding 250 mm, but not exceeding 300 mm, shall have at least one valve in way of each alternate crankthrow, but at least two valves for the crankcase;

3. engines having a bore exceeding 300 mm shall have at least one valve in way of each main crankthrow;

4. Additional safety valves shall be fitted on separate crankcase spaces, such as camshaft drive, when the gross volume of such spaces exceeds 0.6 m³;

5. no crankcase safety valve is required for engines having a bore not exceeding 200 mm or having a crankcase gross volume not exceeding 0.6 m³.

2.4.6 The safety valves shall comply with the following requirements:

1. The design of valves shall ensure immediate opening of valves at an overpressure of not more than 0.02 MPa in the crankcase and their closing to exclude inrush of air into the crankcase;

2. crankcase safety valve discharges shall be shielded in order to reduce the possible danger from emission flame.

2.4.7 The total open flow area of the safety valves fitted on the engine crankcase shall be not less than 0.0115 m² per a cubic meter of the crankcase gross volume. In calculations of the gross volume of the crankcase the moving engine parts located inside the crankcase need not be included.

Each safety valve to be fitted in the crankcase as required in 2.5.5 may be replaced by two combined safety valves of respectively reduced area, provided that passage area of each valve is not less than 0.0045 m².

2.4.8 Crankcase drain holes shall be fitted with gratings or screens to prevent foreign objects from getting into the drain piping.

The aforementioned requirement also applies to dry crankcase engines.

2.4.9 When a cylinder bore exceeds 230 mm, each working cylinder may be fitted with a relief valve set to pressure exceeding the maximum combustion pressure by not more than 40 per cent when running at the rated power.

2.5 CRANKSHAFT

2.5.1 Requirements of the present Chapter apply to forged or cast steel crankshafts of
engines having the cylinders either in line or in V-arrangement with one crankthrow between main bearings; meanwhile intervals between explosions in engine cylinders are equal one to another.

2.5.2 The results of crankshaft strength calculations made according to the Guidelines of the River Register P.008-2004 "Strength calculations for internal combustion engine crankshafts" or according to the method taking into consideration the requirements of the Rules and the above mentioned manual agreed with the River Register shall be submitted for agreement to the River Register together with technical documentation.

2.5.3 A diameter of lightening holes in crankshaft journals shall not exceed 0.4d_j, where d_j is a diameter of the crankshaft journal.

2.5.4 A journal-to-web transition radius for solid-forged and semi-built crankshafts shall be not less than 0.05d_j.

Where flanges are provided, a journal-to-web transition radius shall be not less than 0.08d_j.

2.5.5 The outlets of oil channels to the journal surface shall be arranged in the journal bearing surface areas subject to minimum load.

Edges of oil channel exits to the journal surface shall be rounded by radius not less than 0.25 times the channel (hole) diameter and grinded.

2.5.6 Thermal surface hardening of crankshaft journals shall not extend on fillets except the cases when crankshafts in whole are subject to hardening.

2.5.7 Built-up crankshaft shall be so designed as to provide minimum stress concentration in the journal-to-web transition.

2.5.8 Hot interference of web on journal shall be within (0.0014÷0.0018) d_j.

Control marks shall be drawn on the outside surface of journals in places of connection with journals and crankpins.

2.5.9 If an engine frame has built-in thrust bearing, the thrust shaft diameter in the bearing area shall be not less than the journal diameter and also not less than that determined by the formulae of Section 3 if this Part.

2.6 SUPERCHARGING AND AIR SUPPLY

2.6.1 In the event of failure of the turbocharger the main engine shall be capable of operation at reduced power which shall not be less than 20 per cent of the rated power.

2.6.2 Where supercharging air is cooled, the air discharge branch pipes shall be fitted with thermometers and condensate drain cocks after each air cooler.

It shall be possible to remove the accumulating precipitations from the air receivers if no supercharged air coolers are available.

2.6.3 Air suction branch pipes of engines, turbo-compressors and scavenging units shall be fitted with safety screens to prevent foreign objects from getting inside the branch.

2.6.4 Turbocharger rotors shall be balanced in assembly according to 4.3.2.

2.6.5 Standard specimens (see 1.2.2.19 of RTSC) of turbocharger rotors shall withstand the tests at a rotation speed equal to 1.2 of the design one for at least 3 min without damages and residual deformations.

2.7 FUEL APPLIANCES

2.7.1 High-pressure injection pumps of main engines shall be fitted with a device for quick shutting-off the fuel supply to any cylinder of the engine. Exemption from this requirement is allowed for engines with a cylinder bore not over 180 mm having grouped fuel pumps.

2.7.2 High-pressure fuel oil injection pipes shall be made from thick-walled seamless steel pipes as per GOST 8734 free of welded or soldered intermediate joints.,

2.7.3 Engine fuel system shall allow hand pumping of high-pressure pipelines.
2.7.4 High-pressure pipelines shall be located in places easily accessible for inspection and replacement and shall be fastened.

2.7.5 External high-pressure fuel pipelines from the high-pressure fuel pumps (from the high-pressure fuel manifolds) to the burners shall be protected against the ingress of fuel on engine and surrounding equipment in the event of pipeline failure. The engines shall have the appliances for collection and discharge of fuel leakages and the high-pressure fuel pipeline damage alarm complying with the applicable requirements of 11.4.

If the design of the engine ensures safe operation of the engine when its fuel system components operating under high pressure are faulty (it shall be specified by the manufacturer), instead of the above mentioned measures it is allowed to provide only alarm on fuel system faults affecting safety of engine operation.

2.7.6 There shall be provided pipelines for draining the leaked fuel into special tanks. Measures shall be taken to prevent the ingress of leaked fuel into the lubrication system.

2.8 LUBRICATION

2.8.1 Turbocharger bearings lubrication system shall prevent the ingress of oil into supercharging air.

2.8.2 It shall be possible to lubricate turbocharger bearings in the run-out term after execution of the engine stop command.

2.8.3 If there are separate oil collectors in the lubrication system, oil drain pipelines from two or more engines shall not be combined.

2.8.4 (shall be considered to have lost force.)

2.8.5 The design of pipelines delivering oil to friction assemblies shall exclude water hammers in lubricating system.

2.9 COOLING

2.9.1 Engines shall be provided with cooling systems ensuring their safe operation. Technical justifications for cooling systems (liquid cooling of various types, air cooling, combined liquid-air cooling) shall be submitted to the River Register.

2.9.2 Where telescopic devices are used for cooling of the piston inside spaces, protection against hydraulic hammer shall be provided.

2.10 STARTING ARRANGEMENTS

2.10.1 The manifold supplying air from the master starting air valve to the cylinder starting valves shall be fitted with safety valve and with a device relieving pressure in this manifold after the start or with any other facility protecting the starting manifold from destruction in case of explosion in the pipeline.

The relief valve shall be loaded to a pressure not exceeding 1.2 times of that in the starting air manifold. The relieving device and the relief valve may be fitted directly on the master starting air valve.

2.10.2 Flame arrestors or rupture discs shall be fitted on each branch pipe supplying air to starting valves of cylinder covers on reversible engines.

In case of non-reversible engines a flame arrestor or rupture disk shall be fitted on the manifold supplying starting air from the main starting air valve to the receiver (collector) which supplies air to starting valves in the engine cylinder covers.

It is not required to install flame arrestors or rupture discs on engines with cylinder diameter of 230 mm or less.

2.10.3 Electrically-started engines shall be fitted with hinged generators for automatic charging of starting accumulator batteries.

2.11 GAS EXHAUST

2.11.1 Exhaust collectors shall be so designed as to allow thermal expansion and provide gas-tightness in case of vibration.

2.11.2 Exhaust collectors shall be fitted with drain cocks at the ends of the collector and hatches for cleaning the collector. If the exhaust collectors have liquid cooling the
hatches for cleaning their cooling spaces shall be provided.

2.11.3 When designing exhaust manifolds it is required to provide measuring the gas temperature before turbo-superchargers and after them.

2.12 CONTROL AND ADJUSTMENT

2.12.1 Starting and reversing arrangements shall prevent the engine from:

.1 changing the direction of the crankshaft as compared with the required one;
.2 reversing when the fuel supply is actuated;
.3 starting before reversing is completed.
.4 starting the engine when the turning gear is engaged.

2.12.2 Each main engine shall have a governor so adjusted that the engine speed can not exceed the rated (nominal) value by more than 15 per cent.

Additionally each main engine with an output of 220 kW and over which may be disengaged from the shafting by means of disengaging coupling, shall be fitted with a separate overspeed protective device so adjusted that the engine speed can not exceed the maximum speed by more than 20 per cent.

2.12.3 Each diesel generator shall be fitted with a speed governor which shall meet the following requirements:

.1 when 100 per cent of the diesel generator rated power is suddenly thrown off, the instantaneous rotation speed variation shall not exceed 10 per cent of the rated value, and steady rotation speed after 5 s shall not differ from the rotation speed of previous mode by more than 5 per cent of the rated value;

.2 in case of sudden loading of up to 70 % and further (after reaching the steady rotation speed) instantaneous loading of the remaining 30 %, the instantaneous variation of the rotation speed actuating motor of generator / diesel generator shall not exceed 10% of the rated value, and the steady rotation speed after 5 s after accepting of each part of the specified loads shall not differ from the rated rotation speed by more than 5 %. The value of surged load of the first stage can be reduced to 50 %, or the surge load may be allowed in the form of more than two stages in case when the diesel generator's actuating motor may be loaded by more than two stages, which is specified by the manufacturer of the motor and confirmed by the technical documentation approved by the River Register. The load stages of such actuating motors of the generators and the values of permitted load for each stage shall be specified in "Technical characteristics" section of the documents issued by the River Register for engines / diesel generators in order to take them into account by the design bureaus together with the requirements of Sect. 3 of Part VI of the Rules when designing the ships;

.3 steady rotation frequency recovery time can be increased on agreement with the River Register if in the electrical installation there are no consumers which require increased stability of frequency;

.4 speed governor for emergency diesel generator shall have characteristics meeting the aforementioned requirements with respect to change of the rotation speed when 100 % load is taken off and put on.

In addition to the speed governor each diesel generator with an output of 220 kW and above shall be fitted with a separate overspeed protective device so adjusted that the engine speed can not exceed maximum rotation speed by more than 20 per cent.

The separate protective device stated in 2.12.2 and in the present paragraph shall be a device having no connection with the governor, and shall be actuated in the event of failure of the governor or its driving gear.

.5 the steady rotation frequency when the diesel generator load specified in 2.12.3.1 and 2.12.3.2 is taken off and put on shall be attained within max. 5 s;

.6 steady rotation frequency variations (swing) of AC diesel generator in any of the steady modes under load of 25 to 100 % of the rated power shall be within ±1 % of the nominal rotation frequency.
.7 under idle load of up to 25% of the rated power the steady rotation frequency of the diesel alternator crankshaft shall not differ from the nominal value by more than ±5%.

Each mechanical governor of diesel generator shall have a device for local and remote regulation of rotation frequency within 10% of the rated rotation frequency. Electronic governors of diesel generators do not require a device for local and remote regulation of engine crankshaft rotation frequency.

2.12.4 The requirements to provide the engines with overspeed protective devices according to 2.12.2 and 2.12.3.4 do not apply to the engines equipped with electronic control systems, the design and operation principle of which make it impossible for these engines to exceed the maximum rotation speed by more than 20%.

2.13 INSTRUMENTS

2.13.1 Local control stations of main and auxiliary engines shall be equipped with instruments for measuring the following:

.1 rotational speed of the crankshaft, rotational speed the propeller shaft if disengaging couplings are installed;
.2 lubricating oil pressure at the engine inlet;
.3 water pressure in the inner cooling system;
.4 outboard water pressure in the cooling system;
.5 starting air pressure at the main starting valve inlet;
.6 fuel pressure at the fuel injection pump inlets (where an oil-fuel priming pump is installed);
.7 pressure in the cooling systems of injectors and pistons;
.8 pressure in the reversing arrangement system;
.9 supercharging air pressure at the engine inlet;
.10 exhaust gas temperature at each cylinder (if the engine design makes it possible to measure such temperature) and (or) exhaust gas temperature at the turbine inlet;
.11 temperature of cooling water and oil at the engine inlet and each cylinder and piston outlet (for engines with an output of 220 kW and above), cooling water and oil temperature at the engine outlet (for engines with an output less than 220 kW);
.12 lubricating oil temperature at the engine inlet;
.13 supercharging air temperature after air coolers;
.14 current and voltage in the charging circuit and voltage in the discharging circuit of starting accumulator batteries (for engines with electric starting);
.15 fuel temperature at high-pressure pump inlets (for fuel which requires heating).

Notes. 1. Where pressure (2.13.1.6, 2.13.1.7, 2.13.1.9) and temperature (2.13.1.10 to 2.13.1.13) are measured by means of devices installed directly on the engine, it is not required to install these devices in the local control station.

2. The requirement to the device specified in 2.13.1.4 does not apply to the local control stations for the engines with air cooling systems, combined liquid-air cooling and liquid-cooling systems using coolers, in which water of the internal loop circulates in the channels adjoining to the ship's shell plating from the inside (box coolers). For engines with output less than 220 kW it is allowed not to install the devices for checking the parameters specified in 2.13.1.3 and 2.13.1.4 in the engine local control stations. 2.13.1.3 In this case the efficiency of liquid and liquid-air cooling systems of engines is checked as per the temperatures specified in 2.13.1.11 and air-cooling systems, as per the temperatures specified in 2.13.1.10 and 2.13.1.12.

3. The requirement to the devices specified in 2.13.1.11 does not apply to the local control stations for engines with air-cooling systems. It is allowed not to install the devices to check the temperature specified in 2.13.1.13 in the local control stations.

4. Devices for changing the parameters specified in 2.13.1.14 can be replaced with starting accumulator batteries charge/discharge electronic indicators.

2.13.2 (shall be considered to have lost force.)
2.14 GASOLINE ENGINES

2.14.1 Requirements stated in the present Section are applicable also for gasoline engines. The requirements of 1.11 shall be also executed.

2.14.2 Exhaust manifold and connecting branch pipes shall have water cooling.

2.15 ADDITIONAL REQUIREMENTS TO ENGINES OPERATING ON VARIOUS GRADES OF FUEL

2.15.1 The engines can operate on fuel oil meeting the requirements of 1.1.2 which substitutes for the corresponding types of the specification fuel listed in the technical documentation of the manufacturer or is produced (extracted) by means of non-conventional sources and types of primary energy (alternative fuel), or is a mixture of alternative and specification fuel with properties differing from the specification fuel, provided the engine characteristics during operation on this fuel in all operating conditions, including variable conditions, do not differ from the certificate ones and the engines comply with the requirements of 2.1 to 2.13, 2.15.3 and 2.15.4.

2.15.2 A possibility to switch promptly to the specification fuel oil for fuel fired engines as specified in 2.15.1. In the process of such transfer the engine output shall drop by more than 20%.

2.15.3 When the fuel specified in 2.15.1 is used in the engine, the safety valves shall be fitted in the crankcases and the under-piston cavities of the engine near each crankthrow. The design and actuation pressure of safety valves depend on the properties of fuel-air mixture produced in the crankcase and on the engine output at the moment of transfer from one grade of fuel to another one.

2.15.4 When the fuel specified in 2.15.1 with saturated vapour pressure exceeding 25 kPa at 40 °C is used, the devices (sensors or other similar devices) measuring the concentration of vapours of the specified fuel flowing through the sealings shall be fitted in the crankcases and under-piston cavities.
3 SHAFTING

3.1 GENERAL REQUIREMENTS, MATERIALS, TESTING

3.1.1 Materials intended for shafting parts shall meet the requirements specified in the right column of Table 3.1.1.

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
<th>Chapter of Part X of the Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Intermediate, thrust and propeller shafts</td>
<td>Forged steel, Rolled steel up to 250 mm in diameter</td>
<td>2.6</td>
</tr>
<tr>
<td>2. Propeller shaft liners</td>
<td>Copper alloy, Stainless steel</td>
<td>3.1</td>
</tr>
<tr>
<td>3. Connecting half-couplings</td>
<td>Forged steel, Cast steel</td>
<td>2.6, 2.7</td>
</tr>
<tr>
<td>4. Connecting bolts</td>
<td>Forged steel</td>
<td>2.6</td>
</tr>
<tr>
<td>5. Stern tubes</td>
<td>Rolled steel, Cast steel, Cast iron</td>
<td>2.2, 2.7, 2.11, 2.12</td>
</tr>
<tr>
<td>6. Sterntube and strut bushes</td>
<td>Cast steel, Copper alloy, Cast iron</td>
<td>2.7, 3.1, 2.11, 2.12</td>
</tr>
<tr>
<td>7. Lining of stern bush bearing</td>
<td>Non-metallic materials, Metal alloys</td>
<td>—</td>
</tr>
<tr>
<td>8. Thrust bearing cases</td>
<td>Rolled steel, Cast steel, Cast iron</td>
<td>2.2, 2.7, 2.11, 2.12</td>
</tr>
</tbody>
</table>

3.1.2 It is allowed to use alloy steels, including corrosion resistant and high strength steels, for the shafting parts if the chemical composition of the alloy steel does not deteriorate its mechanical properties and strength characteristics as compared to the ones specified in 2.6 and 2.7 Part X of the Rules and in Table 3.1.1. The compliance of the properties and characteristics of the alloy steel with the requirements of the Rules shall be confirmed by the manufacturer’s documents containing data on chemical composition, mechanical properties and strength characteristics of such steel, as well as documents of test laboratories (centres) on checks and tests of alloyed steels for their compliance with the chemical composition, properties and strength characteristics specified by the manufacturer in the technical documentation agreed with the River Register.

3.1.3 Intermediate, thrust and propeller shafts shall be made of steel with tensile strength from 430 to 690 MPa.

The aforementioned shafts shall undergo non-destructive testing during manufacture according to 2.20 to 2.23 Appendix 10 Part X of the Rules shall be complied with.

3.1.4 (shall be considered to have lost force.)

3.1.5 Propeller shaft liners, sterntube and strut bushes may be made of plastics or other non-metallic materials.

3.1.6 After machining the propeller shaft liners and the stern tubes shall be hydraulically tested according to 6.2.15 of RTSC.

3.1.7 In case of post-assembly oil lubrication of bearings the stern tube sealings shall be hydraulically tested for leakages (tightness) by pressure of not less than 0.1 MPa according to 6.3.11 of RTSC.

3.1.8 Formulae for calculation of the shaft diameter given in the present Section determine the minimum shaft diameter ignoring allowance for subsequent grooving of journals during the service life.

3.1.9 In all ships measures shall be taken to prevent the propeller shaft from slipping out of the stern gland and flooding of the engine.
3.2 SHAFT DIAMETER CALCULATION

3.2.1 Calculations of shaft diameters using the formulae stated in the present Chapter are preliminary, as the dimensions of all shafting elements shall be specified after the torsional circuit has been formed with due regard to the calculation results of torsional vibration stresses including modes corresponding to rotation speed values forbidden for continuous work (see 6.4).

In case when shaft diameter calculation by the formula (3.2.2) is impossible due to special geometry of shafting elements, special strength calculation confirming compliance with the Rules shall be submitted to the River Register.

3.2.2 Intermediate, thrust or propeller shaft diameter, except for hydrofoil craft shafting, shall be not less than that determined by the formula, in mm:

\[
d \geq \frac{560}{R_m+160} k C_{EW} \sqrt{\frac{P}{\left[ n \left[ 1 - \left( \frac{d_i}{d_r} \right)^6 \right] \right]}}.
\]

(3.2.2)

where \( R_m \) — tensile strength of the shaft material, in MPa. The formula (3.2.2) is reliable at \( R_m = 400\div600 \) MPa; when \( R_m > 600 \) MPa, \( R_m = 600 \) MPa shall be taken;

\( k \) — coefficient equal to:

- for intermediate shafts with forged flanges or flanged keyless clutches 130
- for intermediate shafts with key clutches 140
- for thrust shafts in rolling bearings 142
- for propeller shafts at a distance of not more than 4 diameters of the propeller shaft from the bow face of the propeller boss and in the plain bearing journals 160
- for propeller shafts at a distance exceeding 4 diameters of the propeller shaft from the bow face of the propeller boss and the shaft sections between the bearing journals 150

\( C_{EW} \) — strengthening coefficient equal to:

- for ships without ice strengthening 1.0
- for ships designed for navigation in broken ice 1.05
- for icebreakers and icebreaker-type ships 1.07

\( P \) — rated power transmitted by the shaft, in kW;

\( n \) — rated rotational speed, in min\(^{-1}\);

\( d_i \) — diameter of the shaft axial hole, in mm; if this diameter is less than or equal to 0.4\( d_r \), then \( d_i = 0 \);

\( d_r \) — actual shaft diameter, in mm.

The diameter of the bow face of the propeller shaft on the section from the stern tube gland to the flange or the clutch may be gradually reduced to the value equal to 1.05 times of the intermediate shaft diameter. Parts of the propeller shaft contacting with water shall have external diameter as greater as 5 per cent as compared with the diameter determined by the formula (3.2.2), when the shaft has no continuous lining or other effective anti-corrosion protection.

A diameter of hydrofoil craft propeller shafts located outside the hull at an upwash angle of 12° and more considering the running pitch shall be not less than the diameter determined by the formula, in mm:

\[
d_{sh} = 696.19 K_1 K_2 \sqrt{\frac{P}{(R_{EH} n)}}.
\]

where \( K_1 \) — coefficient for power installations taken equal to:

- single-shaft 1.0
- two-shaft 1.15

\( K_2 \) — coefficient taken, depending on propeller shaft surface hardening, equal to:

- no hardening is provided 1.0
- hardening by rolling the shaft surface is provided 0.92

\( R_{EH} \) — yield point of the rudder stock material, in MPa.

3.3 CORROSION PROTECTION

3.3.1 Propeller shafts, including their journals and shaft sections between the journals, shall be protected from corrosion.

3.3.2 Liner material shall comply with the requirements of Table 3.1.1.

3.3.3 A bronze shaft liner thickness \( s \) shall be not less than that determined by the formula, in mm:
\[ s = 0.03d'_t + 7.5, \] (3.3.3)

where \( d'_t \) — actual diameter of the propeller shaft, in mm.

The liner thickness between the bearings may be reduced down to \( 0.75s \).

### 3.3.4 Continuous liners shall be used. Liners consisting of separate sections shall be connected by welding or by another alternative method. The butt welded joints of the liner shall be arranged outside the region of bearings.

### 3.3.5 A sealing shall be installed on the propeller shaft cone to avoid ingress of water on it.

This requirement does not apply to the ships of less than 25 m in length, except for the ships of М-СП, М-ПП and О-ПП classes.

### 3.4 HOLES AND CUT-OUTS IN SHAFTS

#### 3.4.1 If a radial hole is arranged in a shaft, the shaft diameter shall be as greater as 10 per cent along a length of minimum seven diameters of the hole. The hole shall be located in the middle of the thickened part of the shaft and its diameter shall not exceed 0.2 times the increased shaft diameter.

Hole edges shall be rounded with a radius of not less than 0.35 of the hole diameter. The hole surface shall be finished to surface average roughness of 0.63 \( \mu \)m and less according to GOST 2789.

#### 3.4.2 Diameter \( d \) of a shaft having a longitudinal cut-out shall be not less than that determined by the formula, in mm:

\[ d = 1.2d_0 + 0.114(1.5l + b), \] (3.4.2)

where \( d_0 \) — shaft diameter determined by the formula (3.2.2), in mm;

\( l \) — overall length of the cut-out, in mm;

\( b \) — width of the cut-out, in mm.

A thickened part of the shaft shall be of such length that it will protrude from each side out of the cut-out limits for a length not less than 0.25 times the design shaft diameter \( d_0 \). The transition from the increased diameter to the design diameter shall be smooth.

The cut-out width shall be not less than 0.1 times but not greater than 0.25 times the design shaft diameter \( d_0 \). The cut-out ends shall be rounded with a radius equal to the cut-out half width.

The edges shall be rounded with a radius not less than 0.35 times the cut-out width. Cut-out surface shall be finished to surface average roughness of 1.25 \( \mu \)m and less.

#### 3.4.3 Where a key slot is provided on a cylindrical section of a shaft, the shaft diameter shall be increased by 5 per cent as compared with that determined by the formula (3.2.2) on the part exceeding the length of the key slot.

It is not necessary to increase the shaft diameter if the key slot is located on the shaft cone.

### 3.5 SHAFTING DESIGN

#### 3.5.1 Propeller shaft cone for the propeller shall be made with a conicity not greater than 1:12.

#### 3.5.2 For propeller shafts with a diameter of 100 mm and over the end of key slot on the propeller shaft cone shall have a spoon-type shape and shall be at a distance not less than 0.2 times the propeller shaft diameter from the greater cone base.

End of key slot may be of ski-type shape for a propeller shaft diameter less than 100 mm.

Dimensions of key slots, the shape and ratio of dimensions of spoon-type preparation of the bow propeller shaft cone end shall correspond to requirements of national standards1.

#### 3.5.3 The shaft cone for the propeller and coupling in keyless connections shall be made with the following conicity for the following connections:

- with end nut \( \leq 1:15 \)
- without end nut \( \leq 1:50 \)

1 GOST 8838, GOST 24071, GOST 23360
Thread journals

3.5.4 External diameter of a thread journal for propeller fixing nut shall be not less than 60 per cent of the greater cone diameter.

Connecting couplings

3.5.5 Connecting bolts, couplings and half-couplings shall be made of steel with tensile strength not less than that of shafting steel.

3.5.6 Diameter \( d_b \) of coupling flange bolts shall be not less than that determined by the formula, in mm:

\[
d_b = 0.535 \sqrt[3]{d_{int}/(ir)} ,
\]

(3.5.6)

where \( d_{int} \) — diameter of the intermediate shaft determined by the formula (3.2.2) with due regard to reinforcements; if the shaft diameter is increased due to dangerous stresses from torsional vibration, then \( d_{int} \) shall be equal to the actual diameter of the intermediate shaft;

\( i \) — number of bolts in the connection;

\( r \) — bolt pitch circle radius, in mm.

3.5.7 Fifty per cent (50\%) of the total number of cylindrical bolts of shafting flange connections, but not less than three, shall ensure transition fit H/js (finish 5-7) according to GOST 25347.

3.5.8 Intermediate shaft connecting flange thickness measured on the centre circle of connecting bolts shall be not less than the diameter of connecting bolt determined by the formula (3.5.6).

Propeller shaft flange thickness shall be not less than 0.25 times the intermediate shaft diameter determined by the formula (3.2.2).

3.5.9 Rounding radius of transition from a flange to the shaft shall be not less than 0.08 times the shaft diameter.

3.5.10 Safety of use of cardan shafts in ship shaftings shall be confirmed by the technical justifications submitted to the River Register.

Bearings

3.5.11 Length of bearings in the arm shall be not less than 2.5 times the shaft diameter.

3.5.12 A shut-off valve controlling water supply for the stern tube bearing lubrication shall be installed directly on the stern tube or on the after peak bulkhead.

A flow direction indicator shall be fitted on the pipeline feeding water for the stern tube bearing lubrication.

3.5.13 A device for measuring oil temperature in the stern tube is to be provided.

3.5.14 Where hydrostatic lubrication is used for stern tube bearings, the lubricating oil tank shall be located above the maximum ship’s draught waterline and fitted with oil level indicators.

If the tank is located in hardly accessible place or outside the space where main engines or propeller electric motors are installed, low oil level alarm shall be provided which can be seen or heard from the main engine or the propulsion plant control station.

3.5.15 If propeller shaft rotation speed \( n \) 350 min\(^{-1}\), indicative values of maximum permissible distances \( l_{max} \) between the adjacent bearings of the displacement ships shafting shall be calculated by the following formula, in mm:

\[
l_{max} = k_1 \sqrt{d_r} ,
\]

(3.5.15-1)

where \( d_r \) — actual shaft diameter, in mm (see 3.2.2);

\( k_1 \) — coefficient for bearings taken equal to:

- oil-lubricated plain bearings 450
- grease-lubricated stern tube rolling bearings made of grey cast iron 405
- water-lubricated stern tube bearings 440

At 700 n > 350 min\(^{-1}\):

\[
l_{max} = k_2 \sqrt{d_r/n} ,
\]

(3.5.15-2)

where \( k_2 \) — coefficient:

- for oil-lubricated plain bearings, 
  \( k_2 = 11455 - 106373.5/n \);
- for grease-lubricated stern tube rolling bearings made of grey cast iron and rubber or plastic water-lubricated stern tube bearings
  \( k_2 = 133.378 n - 1690.881 - 0.224 n^2 + 0.000126 n^3 \).
At 2000 > n ≥ 700

\[ l_{\text{max}} = 1857.5 \sqrt{d_t/n^{0.5}}. \]

Indicative values of maximum permissible distances \( l_{\text{max}} \) between the adjacent bearings of hydrofoil craft shafting can be determined considering the design by the following formula, in mm:

\[ l_{\text{max}} \leq 57d_t. \]

Values \( l_{\text{max}} \) and \( d_{\text{prop}} \) for hydrofoil craft shall be corrected by results of shaft check for longitudinal stability and determining the critical speed. The static strength of hydrofoil craft shafting shall also be estimated and its fatigue strength shall be calculated.

3.5.16 Minimum distance \( l_{\text{min}} \) between adjacent main bearings of the shaft line shall be not less than \( l_{\text{min}} = 174 \sqrt{d_t}. \)

3.5.17 The propeller shaft shall lean on two bearings in the stern tube. It is allowed to install one stern bearing in a stern tube with a length less than 4.5 times the shaft diameter when using water-lubricated rubber or plastic plain bearings and 3 times the shaft diameter when using oil-lubricated plain bearings.

3.5.18 Length of stern unit bearings and circumferential velocity of propeller shafts shall correspond to the requirements of Table 3.5.18.

**Table 3.5.18**

<table>
<thead>
<tr>
<th>Material of bearing insert, lubricating medium</th>
<th>Stern bearing length to shaft diameter ratio for bearings</th>
<th>Circumferential velocity of propeller shafts, m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubber and plastic designed for operation in outboard water</td>
<td>1.0 to 1.5, 3.0 to 4.0</td>
<td>≤6.0</td>
</tr>
<tr>
<td>Mild alloy designed for operation in oil lubrication</td>
<td>≥0.8, ≥2.0</td>
<td>—</td>
</tr>
<tr>
<td>Grey cast iron, grease</td>
<td>≥1.0, ≥2.5, ≤3.0</td>
<td>—</td>
</tr>
</tbody>
</table>

3.5.19 Propeller shafts supported on rolling bearings and propeller shafts in stern tubes with plain bearings lubricated with oil or closed-loop pressurized water shall be fitted with sealings.

3.5.20 Lubrication shall be supplied to the stern tube in a such manner as to provide its supply to both stern and bow stern tube bearings. If grease is used, it shall be supplied through bow and stern bearings.

3.5.21 Stern tube with oil-lubricated bearings shall be fitted with connections for filling the tube with oil, testing and drainage; a ventilation pipe shall be attached also. These connections and the stern tube shall be so designed that oil, water and air entered the tube could be completely removed.

### 3.6 KEYLESS CONNECTIONS OF PROPELLERS AND SHAFTING COUPLINGS

3.6.1 A keyless assembly of the propeller and the propeller shaft shall be designed without intermediate sleeve between the propeller boss and the shaft.

3.6.2 When assembling keyless connection, the axial shift \( \Delta h \) of the boss in relation to the shaft or intermediate sleeve, as soon as the contact area between mating surfaces is obtained after elimination of the clearance, shall be not less than determined by the formula, in m:

\[
\Delta h = k \left[ 8 \cdot 10^{-3} B \left[ 19.1 P \left( nD_t \right)^2 + T^2 \right] / ( h z ) \right] \]

where \( B \) — coefficient of the connection material and configuration, in MPa:\n
\[
B = \left[ \left( 1 + w^2 \right) / \left( 1 - w^2 \right) - v_y \right] / E_y + \left[ \left( 1 + w^2 \right) / \left( 1 - w^2 \right) - v_w \right] / E_w ;
\]

\( y \) — mean coefficient of the boss outer diameter:

\[
y = \left( D_{z1} + D_{z2} + D_{z3} \right) / \left( D_{y1} + D_{y2} + D_{y3} \right) ;
\]

\( w \) — mean coefficient of the shaft bore:

\[
w = \left( D_{w1} + D_{w2} + D_{w3} \right) / \left( D_{w1} + D_{w2} + D_{w3} \right) ;
\]

\( v_y \) — Poisson’s ratio for boss material;

\( v_w \) — Poisson’s ratio for shaft material, for steel \( v_w = 0.3; \)
$E_r$ — modulus of elasticity of boss material, in MPa;

$E_w$ — modulus of elasticity of shaft material, in MPa;

$P$ — power transmitted by the connection, in kW;

$T$ — propeller thrust at ahead speed, in kN;

$D_w$ — mean outer shaft diameter in the place of contact with the boss or intermediate sleeve (Fig. 3.6.2), in m:

$$ D_w = \left( D_{w1} + D_{w2} + D_{w3} \right) / 3; $$

without intermediate sleeve:

$$ D_{w1} = D_{y1}; \quad D_{w2} = D_{y2} ; \quad D_{w3} = D_{y3} ; \quad D_w = D_y ; $$

with intermediate sleeve:

$$ D_{w1} \neq D_{y1} ; \quad D_{w2} \neq D_{y2} ; \quad D_{w3} \neq D_{y3} ; \quad D_w \neq D_y ; $$

$\alpha_r$ — linear expansion coefficient of boss material, in $1/\degree\text{C}$;

$\alpha_w$ — linear expansion coefficient of shaft material, in $1/\degree\text{C}$;

$t_c$ — temperature of the connection in service conditions, in $\degree\text{C}$;

$t_m$ — temperature of the connection during assembling, in $\degree\text{C}$;

$k$ — coefficient for the connection taken equal to:

without intermediate sleeve 1

with intermediate sleeve 1.1

$h$ — effective length of the shaft cone or intermediate sleeve with the boss, in m;

$z$ — taper of the boss:

$$ z = \left( d_{\text{con.max}} - d_{\text{con.min}} \right) / L_{\text{con}} , $$

$d_{\text{con.max}}$ — maximum cone diameter, in mm;

$d_{\text{con.min}}$ — minimum cone diameter, in mm;

$L_{\text{con}}$ — propeller shaft cone length;

$n$ — rotational speed of the connection, in min$^{-1}$.

For connection with steel shaft without axial drilling the coefficient $B$ can be taken according to Table 3.6.2 by means of linear interpolation.

**Table 3.6.2**

| Coefficient $B \times 10^5$, in MPa$^{-1}$, for the steel shaft with $w = 0$, $E_r = 2.059 \times 10^5$ MPa, $v_r = 0.3$ and for copper alloy boss with $v_r = 0.34$ at $E_r$ in MPa | Coefficient $B \times 10^5$, in MPa$^{-1}$, for steel boss with $v_r = 0.3$ at $E_r = 2.059 \times 10^5$ MPa |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.98-10^5 | 1.078-10^5 | 1.176-10^5 | 1.274-10^5 | 1.373-10^5 | 1.471-10^5 | 1.569-10^5 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1.2 | 6.34 | 5.80 | 5.34 | 4.96 | 4.63 | 4.34 | 4.09 | 3.20 |
| 1.3 | 4.66 | 4.27 | 3.94 | 3.66 | 3.43 | 3.22 | 3.04 | 2.40 |
| 1.4 | 3.83 | 3.52 | 3.25 | 3.03 | 2.83 | 2.67 | 2.52 | 2.00 |
| 1.5 | 3.34 | 3.07 | 2.84 | 2.65 | 2.48 | 2.34 | 2.21 | 1.77 |
| 1.6 | 3.02 | 2.77 | 2.57 | 2.40 | 2.25 | 2.12 | 2.01 | 1.61 |
| 1.7 | 2.79 | 2.56 | 2.38 | 2.22 | 2.09 | 1.97 | 1.87 | 1.50 |
| 1.8 | 2.62 | 2.41 | 2.24 | 2.09 | 1.97 | 1.86 | 1.76 | 1.41 |
| 1.9 | 2.49 | 2.29 | 2.13 | 1.99 | 1.87 | 1.77 | 1.68 | 1.36 |
| 2.0 | 2.39 | 2.20 | 2.05 | 1.91 | 1.80 | 1.70 | 1.62 | 1.31 |
| 2.1 | 2.31 | 2.13 | 1.98 | 1.85 | 1.74 | 1.65 | 1.57 | 1.27 |
| 2.2 | 2.24 | 2.07 | 1.92 | 1.80 | 1.69 | 1.60 | 1.53 | 1.24 |
| 2.3 | 2.18 | 2.01 | 1.88 | 1.76 | 1.65 | 1.57 | 1.49 | 1.22 |
| 2.4 | 2.14 | 1.97 | 1.84 | 1.72 | 1.62 | 1.54 | 1.46 | 1.19 |
3.6.3 When assembling steel couplings and shafts with cylindrical mating surfaces, the interference fit $\Delta D$ shall be determined by the following formula, in m,

$$
\Delta D = 8 \cdot 10^{-3} B \sqrt{19.1 P / (n D_w)} + T^2 / h.
$$

(3.6.3)

Designations are stated in 3.6.2.

3.6.4 For propeller bosses and half-couplings in keyless assemblies with the shafts, the following condition shall be met

$$
A \left[ \frac{C}{D_y} + (\alpha_y - \alpha_w) t_m \right] / B \leq 0.75 R_{eH},
$$

where $A$ — shape factor of the boss:

$$
A = \sqrt{1 + 3 y^4 / (y^2 - 1)}.
$$

The coefficient $A$ can be calculated by the formula $A^4 = 0.5756 - 0.5937 y^2$, which is valid in the range $y = 1.2 - 2.4$;

$C = \Delta h_x z$ — for connections with conical mating surfaces, in m;

$C = \Delta D_e$ — for connections with cylindrical mating surfaces, in m;

$\Delta h_x$ — actual shift when the boss is assembled at a temperature $t_m$, in m $\Delta h_x \geq \Delta h$;

$\Delta D_e$ — actual interference fit of connection with cylindrical mating surfaces, in m $\Delta D_e \geq \Delta D$;

$D_y$ — see 3.6.2;

$R_{eH}$ — yield point of the boss material, in MPa.

Other designations are stated in 3.6.2.

3.7 BRAKING DEVICES

3.7.1 Each shaft line shall comprise appropriate breaking or stopping devices to prevent rotation of shaft in the event of the main engine failure or repair or when towing the ship with non-running main engines.
4 GEARS, DISENGAGING AND ELASTIC COUPLINGS

4.1 GENERAL

4.1.1 The requirements of the present Section apply to reverse reduction gearing with cylindrical gears with external and internal teeth, planetary and bevel gears, disengaging and elastic couplings which are installed in power installation components. The requirements of this section apply to disengaging electromagnetic and hydraulic couplings as far as applicable.

4.2 MATERIALS AND WELDING

4.2.1 Materials intended for manufacture of gearing and coupling parts shall meet the requirements referenced in the right column of Table 4.2.1. Materials of parts specified in points 4, 5 and 6 of Table 4.2.1 may also be selected in accordance with national standards1.

4.2.2 Gearing and coupling shafts shall be made of steel forgings or steel castings. Non-flanged gearing and coupling shafts may be made of round rolled steel.

Separately forged gearwheel shafts and pinion shafts shall be made of steel with tensile strength of not less than 430 MPa. Tensile strength of gearing shafts shall be not less than tensile strength of material of intermediate shafts of the shaft line.

4.2.3 Main gearing pinions shall be made of alloy steel with tensile strength of 620 to 980 MPa.

4.2.4 Gearing and coupling cases are to be made of nodular cast iron or as steel welded structures made of flat steel with sleeves made of forged steel or cast steel. When circumferential velocity of pinions does not exceed 60 m/s and that of the coupling housing — 40 m/s, the gear housings and coupling castings can be made of grey cast iron, nodular cast iron or as steel welded structures made of flat steel with sleeves made of forged steel or cast steel.

4.2.5 Essential parts of couplings intended for transmitting torque to the propeller shall be made of forged steel, cast steel or nodular cast iron having mainly ferrite structure. For medium loaded external parts of couplings aluminium alloys with appropriate mechanical properties may be used. Pinions of hydraulic slip couplings can be made of grey cast iron and the housings — of aluminium alloy if the mechanical properties specified in 2.6, 2.7 and 2.11 Part X of the Rules are provided.

4.2.6 Cases of elastic couplings transmitting torque to the generators shall be made of

---

1 GOST 977, GOST 7505, GOST 8479.
nodular cast iron with ferrite structure, forged steel or cast iron.

4.2.7 It is allowed to use alloy steel or alloy cast iron for gearing and coupling parts if the chemical composition of these alloy materials does not deteriorate their mechanical properties and strength characteristics as compared to the ones specified in 2 Part X of the Rules and in Table 4.2.1. The compliance of the properties and characteristics of the alloy materials with the requirements of the Rules shall be confirmed by the manufacturer’s documents containing data on chemical composition, mechanical properties and strength characteristics of such materials, as well as documents of test laboratories (centres) on checks and tests of these materials for their compliance with the chemical composition, properties and strength characteristics specified by the manufacturer in the technical documentation agreed with the River Register.

4.2.8 Shafts, pinions and gearwheels of main gearings shall undergo non-destructive testing according to the requirements of 2.20 to 2.23 Appendix 10 Part X of the Rules shall be complied with.

4.2.9 Manufacture of gearing and coupling parts with application of welding shall meet the requirements of Part X of the Rules.

4.3 GENERAL REQUIREMENTS

4.3.1 The reverse reduction gears at ahead running in steady mode shall provide not less than 70 per cent of the ahead rated power.

4.3.2 Parts rotating at circumferential speed from 5 to 20 m/s shall be statically balanced, while those rotating at speed over 20 m/s shall be dynamically balanced. The accuracy of dynamic balancing shall be determined by the formula:

$$v \leq (65.786 - 0.139 V) \cdot 10^3 / n,$$

(4.3.2)

where $v$ — distance between the centre of gravity and the geometrical axis of rotation of the part concerned, in mm;

$n$ — rotational speed, in min$^{-1}$;

$V$ — peripheral velocity, in m/s.

The formula (4.3.2) is applicable in the range $V = 20 \div 300$ m/s.

If $V$ is below the stated range, the circumferential velocity shall be taken equal to 20 m/s, above the stated range — 300 m/s.

Rigid elements of the couplings shall be balanced together with the parts they are rigidly adjoined.

4.3.3 The main gearing shall be so designed as to provide access to all bearings.

The gear cases shall have a sufficient number of access manholes with detachable covers.

The manholes shall be so arranged as to allow inspection of the teeth throughout the length and all bearings inside the gearing.

4.3.4 The gear cases shall be provided with venting arrangements.

The vent pipes of gearing cases with volume of 0.5 m$^3$ and above shall be led to the open deck or other places where exhaust ventilation is provided. The ends of the vent pipes shall be fitted with flame arresters and arranged so as to prevent the ingress of water into the gearing.

4.3.5 When the main thrust bearing is housed in the gearing case, the lower part of the case shall be strengthened.

4.3.6 Plain bearings of main gearing shall have devices for measuring axial and radial shaft positions without case disassembling. Each plain bearing and each thrust bearing shall be provided with devices for measuring temperature.

4.3.7 In structures of hovercraft gearing safety devices shall be provided operating when torque reaches values 1.35 times the rated torque.

4.3.8 Planetary gearing shall have equalising devices. The rim of epicyclical wheel with more than three planetary pinions shall be flexible in the radial direction.

4.4 GEARING

4.4.1 While gearwheels manufacture the following shall be checked: pitch and general
Tooth side surface roughness shall not exceed 10 μm before spinning in case of tooth forming by milling or shaping. Roughness shall not exceed 4 μm if the required tooth shape is reached by grinding or lapping. Tooth fillet radius on standard instrument profile shall be not less than 0.25 times the normal pitch.

Tooth side surface roughness shall not exceed 10 μm before spinning in case of tooth forming by milling or shaping. Roughness shall not exceed 4 μm if the required tooth shape is reached by grinding or lapping. Tooth fillet radius on standard instrument profile shall be not less than 0.25 times the normal pitch.

Teeth of pinions and gear wheels with the ratio \( B/d_1 \geq 0.3 \) (Fig. 4.4.3) shall be bevelled on the end faces to an angle of \( 45^\circ \leq \varphi \leq 60^\circ \) to a depth not less than 1.5 of the teeth module, where \( B \) is the gear wheel (pinion) width, \( d_1 \) is the pitch diameter.

**Fig. 4.4.3 Gear wheel section**

**4.4.4** Hardness of the pinion teeth shall be at least 15 per cent greater than that of the wheel teeth. This requirement does not apply to surface hardened gears (carburized, nitrided, face-hardened etc.).

**4.4.5** The strength of teeth and other pinion and wheel elements shall be confirmed by calculations according to 4.4.6. There shall be taken into account additional loads due to torsional vibrations, storm weather, ship manoeuvres, tugging, different loading conditions, relationship between the propeller resistance irregularity and the number of blades.

**4.4.6** The results of strength calculations for the gearings of reduction gears and reverse reduction gears of main engines accomplished according to the Guidelines P.007-2004 "Strength calculations" or according to the method agreed with the River Register shall be submitted for agreement to the River Register together with technical documentation.

**4.4.7** Where oil is fed to tooth gearing and plain bearing under pressure, it shall be possible to filter oil and adjust its pressure adjustment, manometer, thermometer and excessive oil pressure safety device shall be installed.

It shall be possible to control the oil level in the oil bath in case of lubrication by submersion.

**4.4.8** Lubrication of tooth engagements and bearings shall be arranged in such a way as to prevent oil foaming and emulsification.

**4.4.9** Where rolling bearings are used in gears, it is recommended to fit additional thermometer on the oil outlet line from the gear.

**4.5 TOOTH COUPLINGS**

**4.5.1** The spur coupling side surface carrying capacity \( p \) is checked using the following relationship, in MPa:

\[
p \leq p_{zul},
\]

where \( p = 9.9 \times 10^8 \frac{k}{B h d z n} \).  

\[
P = \frac{1}{15} \left( \frac{n^3 d_1^2 M}{M_{zul}} \right) \leq 4.5.
\]

Values are possible if the manufacture accuracy class is less than 6 and residual specific unbalance is less than 100 g mm/kg according to GOST ISO 1940-1.

\[
П = \frac{1}{15} \left( \frac{n^3 d_1^2 M}{M_{zul}} \right) \leq 4.5.
\]

In equations (4.5.1-1) and (4.5.1-2):

\( P \) — power of the drive, in kW;

\( k \) — factor coefficient into account the type of the drive and coupling for engines:

\( \lambda \) turbine, electrical and diesel engines 1.0

with hydraulic coupling or electromagnetic slip coupling between the engine and the gearing;
4.5.2 Teeth of couplings at \( \frac{dn}{2} \leq 6 \times 10^9 \text{ mm/min}^2 \) shall be lubricated by immersion with controlled permanent oil level in the coupling. When \( \frac{dn}{2} > 6 \times 10^9 \text{ mm/min}^2 \), circulation lubricating system shall be provided.

4.5.3 The requirements of 3.5.5 to 3.5.9 shall be taken into account when determining dimensions of sleeves, flanges and bolts of tooth couplings.

### 4.6 ELASTIC COUPLINGS

4.6.1 Dimensions and characteristics of elastic couplings between the main engines and the gearing shall be determined with due regard to the requirement that they shall be capable of withstanding the load due to additional torsional vibration stresses (torques) appearing in the event of failure of any of the cylinders.

4.6.2 Stresses in loaded coupling elements working at shear loads and made of non-strengthened rubber or polyurethane shall not exceed 0.25 to 0.45 MPa depending on rubber quality or design of spring (elastic) elements at average torque of the drive engine. The quality of rubber is considered sufficient if besides the tensile strength, elongation at failure, residual elongation and apparent stresses at preset elongation complying with the appropriate requirements of the coupling manufacturer's design documentation and determined in accordance with GOST 270, elastic-hysteresis characteristics in accordance with GOST 23326, hardness in accordance with GOST 263 and ability to change the form and dimensions under the action of external loads and restore initial configuration when the load is taken off, the elastic compression is within 35 to 65 % and elastic elongation is within 250 to 550 %.

To reduce the negative influence of a nick, the built-in end pieces of couplings made of non-strengthened rubber or organic (organosilicone) material shall be strengthened.

Note. Strengthened rubber is a laminated rubber, the layers of which can be fitted with or separated by cord.

4.6.3 When determining dimensions of cases, flanges and bolts of elastic couplings the requirements of 3.5.5 to 3.5.9 shall be taken into account. 3.5.5 – 3.5.9.

4.6.4 If elastic coupling is so designed that while working under load it produces axial forces on parts of the connected drive engine, measures shall be taken to neutralise these forces.

4.6.5 The elastic couplings of diesel generator sets shall absorb impact loads due to short-circuit. Where no such data is available, the maximum torque shall be at least 4.5 times the nominal torque being taken by the coupling.

### 4.7 DISENGAGING COUPLINGS

4.7.1 Disengaging couplings of main engines shall be fitted with devices to prevent slipping for long (over 10 s) periods of time.

4.7.2 It shall be possible to control disengaging couplings from the station where the
main engines are controlled. Local reserve control arrangements shall be provided directly at the disengaging couplings.

4.7.3 Where two or more engines devoted to a common propeller shaft are driving it through disengaging couplings, their control arrangement shall prevent a simultaneous engagement of the engines when running in opposite directions.

4.7.4 A power-driven turning gear shall be provided with an interlocking to prevent the disengaging coupling from engagement when the turning gear is engaged.
5 PROPELLERS

5.1 GENERAL REQUIREMENTS

5.1.1 The requirements of this section apply to metallic solid and detachable-blade propellers, water-jet and vertical axis propellers and steerable thrusters.

5.1.2 The design and the dimensions of ice-breaker propellers, as well as propulsion units of special design (paddle wheels, hovercraft air propellers, etc.) shall comply with the requirements of national standards.

5.2 MATERIALS, TESTING AND WELDING

5.2.1 Materials intended for manufacture of propellers shall meet the requirements referenced in the right column of Table 5.2.1.

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
<th>Chapter of Part X of the Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Solid propellers, including steerable thrusters</td>
<td>Cast steel, Copper alloy</td>
<td>2.7, 3.2</td>
</tr>
<tr>
<td>2. Detachable-blade propellers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Blades</td>
<td>Cast steel, Copper alloy</td>
<td>2.7, 3.2</td>
</tr>
<tr>
<td>2.2 Bosses</td>
<td>Cast steel, Copper alloy</td>
<td>2.7, 3.2</td>
</tr>
<tr>
<td>2.3 Bolts (studs) for securing blades, hub cones and sealings</td>
<td>Copper alloy, Forged steel</td>
<td>3.1</td>
</tr>
<tr>
<td>3. Hub cones</td>
<td>Cast steel, Copper alloy</td>
<td>2.7</td>
</tr>
<tr>
<td>4. Pump jet systems</td>
<td>Cast steel, Copper alloy</td>
<td>2.7, 3.2</td>
</tr>
<tr>
<td>4.1 Pump impeller</td>
<td>Cast steel, Copper alloy</td>
<td>2.7, 3.2</td>
</tr>
<tr>
<td>4.2 Pump shaft</td>
<td>Cast steel, Forged steel</td>
<td>2.7</td>
</tr>
</tbody>
</table>

5.2.2 For the parts specified in 1, 2.1, 2.2, 3, 4.1 and 5.2 of Table 5.2.1, it is allowed to use plastic and other nonmetallic materials the requirements to which are outlined in 6 Part X of the Rules shall be complied with.

5.2.3 Propellers for ships without ice strengthening may be made of cast iron with lamellar graphite corresponding with the requirements of 2.12 Part X of the Rules.

5.2.4 Blades of propellers and vertical axis propellers and pumps impellers of water-jet propeller shall undergo non-destructive testing during manufacture. The methods, scope and standards of non-destructive testing are specified in 8 and in 2.20 to 2.23 Appendix 10 Part X of the Rules shall be complied with.

5.2.5 Welding and testing of welded joints shall be carried out according to the requirements of 7 and 8 Part X of the Rules shall be complied with.
5.3 PROPELLER DESIGNING

5.3.1 In solid propellers and detachable-blade propellers the maximum thickness $S$, in mm, of expanded cylindrical section (Fig. 5.3.1-1) shall be not less than:

$$S = A \left[ 13.2 k P \left( \frac{z_b b \sigma_m n}{60} \right) + 9.81 cm \left( \frac{D n}{300} \right)^2 \right] / \sigma_m ,$$

(5.3.1-1)

where $A$ — coefficient determined by the formula

$$A = k_1 + k_2 \cdot \exp \left( - \frac{H}{D} / k_3 \right)$$

(5.3.1-2)

$k_1$, $k_2$, $k_3$ — coefficients adopted from Table 5.3.1-1 depending on the radius $r$ of design cross-section arrangement;

$H/D$ — pitch ratio on radius $r$;

$$m$$

$m$ — blade rake, in mm;

$D$, $R$ — propeller diameter and radius, respectively, in m;

$n$ — propeller rotational frequency, in min$^{-1}$;

$z_b$ — number of blades;

$b$ — width of the expanded cylindrical section of the blade, in m;

$\sigma$ — maximum permissible stress taken equal to $\sigma_m = 0.6 R_m + 155 \text{ MPa}$, in MPa:

- for steels $550$
- for non-ferrous alloys $610$
- for cast iron $290$

$R_m$ — tensile strength of blade material in tension, in MPa;

$H$ — propeller pitch, in m.

Propeller blade thickness is checked in two cross-sections: the design root section and the blade section at the radius (see Figure 5.3.1). $r = 0.6 R$

The location of the design root section is adopted as follows:

- for solid propellers — at the radius of $0.2 R$, if the propeller boss radius is less than $0.2 R$, and at the radius of $0.25 R$, if the propeller boss radius is greater or equal to $0.2 R$;

$k$ — coefficient adopted from Table 5.3.1-2 considering the following:

- if a ship is equipped with the engines having less than 4 cylinders, the coefficient $k$ shall be increased by 5 %;

- for shaft lines fitted with hydraulic or electromagnetic clutches $k$ values may be reduced by 5 %.

For double-propeller ships without ice strengthening $k$ values may be reduced by 5 %.

Table 5.3.1-2

<table>
<thead>
<tr>
<th>Material</th>
<th>Coefficient $k$ for ships without ice strengthening</th>
<th>Coefficient $k$ for ships with ice strengthening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alloy brass or bronze</td>
<td>5.8</td>
<td>8.5</td>
</tr>
<tr>
<td>Cast steel</td>
<td>8.6</td>
<td>9.4</td>
</tr>
<tr>
<td>Cast iron</td>
<td>8.8</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 5.3.1-1

<table>
<thead>
<tr>
<th>Radius of design cross-section $r$</th>
<th>$k_1$</th>
<th>$k_2$</th>
<th>$k_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.20 $R$</td>
<td>82.672</td>
<td>157.369</td>
<td>0.632</td>
</tr>
<tr>
<td>0.25 $R$</td>
<td>74.927</td>
<td>138.053</td>
<td>0.765</td>
</tr>
<tr>
<td>0.35 $R$</td>
<td>54.556</td>
<td>128.399</td>
<td>1.047</td>
</tr>
<tr>
<td>0.60 $R$</td>
<td>38.902</td>
<td>78.985</td>
<td>1.023</td>
</tr>
</tbody>
</table>

Table 5.3.1-3

<table>
<thead>
<tr>
<th>$r/R$</th>
<th>$c$</th>
<th>$r/R$</th>
<th>$c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.20</td>
<td>0.50</td>
<td>0.35</td>
<td>0.30</td>
</tr>
<tr>
<td>0.25</td>
<td>0.45</td>
<td>0.60</td>
<td>0</td>
</tr>
</tbody>
</table>

Fig. 5.3.1 Expanded cylindrical section
for detachable-blade propellers — at the radius of $0.3R$ with coefficients $A$ and $c$ taken for $r = 0.25R$.

Note: In the design section, the blade thickness is determined regardless of the blade-boss fillet. The holes of the fastening elements of the blades of detachable-blade propellers shall not bring to reduction of the design root section.

5.3.2 Minimum thicknesses $S_k$ of the blade end edges for ships:

- without ice strengthening 0.0035$D$
- with ice strengthening 0.0050$D$

5.3.3 If the propeller blades of special shape are used, the thicknesses of blades shall be selected by results of detailed strength calculations fulfilled according to the requirements of this Part of the Rules.

5.3.4 Fillet radii of the transition from the blade root to the boss shall be:

- suction side 0.04$D$
- pressure side 0.03$D$
- both sides if the blade has no slope 0.03$D$

5.3.5 The propeller boss shall be provided with holes through which the empty spaces between the boss and the shaft cone and the hollow inside the propeller cap are filled with grease.

5.3.6 Internal diameter of the thread of studs $d_k$ securing detachable blades to the boss shall be not less than that determined by the following formula, in mm:

$$d_k \geq 1.78\sqrt{\frac{\alpha A F_m}{R_{ch}}}, \quad (5.3.6-1)$$

where $F_m$ — force acting on a stud, in N:

$$F_m = 280 \times 10^6 R_{p0.2} P C^2 R_{m} C_G \left(\frac{1}{n z_b Z C_m d_e}\right); \quad (5.3.8-2)$$

$\alpha_A$ — tightening factor for fastening bolts: $\alpha_A = 1.2 \div 1.6$;

$R_{sh}$ — yield point of material, in MPa;

$R_{p0.2}$ — yield point when plastic deformation reaches 0.2 per cent of the initial design length, in MPa

$P$ — see 5.3.1;

$n$ — propeller rotational frequency, in min$^{-1}$;

$C_m$ — strengthening coefficient equal to:

- for ships without strengthening 1.0
- for ships designed for navigation in broken ice 1.05
- for icebreakers and icebreaker-type ships 1.07

$C_G$ — coefficient taking into account the propeller dimension ($C_G = 0.85 \div 1.1$):

$$C_G = \sqrt{C_F G + D}/12.2, \quad (5.3.8-3)$$

$C_F G$ — coefficient equal to:

- for fixed-pitch propellers 5.2
- for detachable-blade propellers 6.2

If $C_G$ is beyond the range of 0.85 to 1.1, this coefficient is taken equal to the corresponding limit value;

$D$ — propeller diameter, in m;

$z_b$ — number of blades;

$Z$ — number of fastening bolts of blades;

$R_m$ — tensile strength of blade material in tension, in MPa;

$d_c$ — bolt pitch circle diameter, in mm.
5.3.9 Blade fastening bolts shall be screwed using drawing-up controlling device so that preliminary tightening of bolts is 60 to 70 per cent of the yield point.

Measures shall be taken to prevent spontaneous untwisting.

5.4 PROPELLER BALANCING

5.4.1 The completely finished propellers shall be statically balanced. The extent of balancing shall be checked by a test load, which being suspended from the tip of every blade in horizontal position, shall cause the propeller to rotate.

The weight \( m \) of the test load shall be determined by the formula, in kg:

\[
m \leq k \frac{m_p}{R},
\]

where \( k \) — coefficient adopted from Table 5.4.1 depending on the rated rotational speed of the propeller \( n \);

<table>
<thead>
<tr>
<th>( n, \text{ min}^{-1} )</th>
<th>( k )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 200</td>
<td>0.55</td>
</tr>
<tr>
<td>Over 200 to 500</td>
<td>0.5</td>
</tr>
<tr>
<td>Over 500</td>
<td>0.25</td>
</tr>
</tbody>
</table>

\( m_p \) — propeller weight, in t;

\( R \) — radius of the propeller, in m.

5.5 HYDRAULIC DRIVE OF VERTICAL AXIS PROPELLER PITCH CHANGING MECHANISM

5.5.1 In the hydraulic drive system of vertical axis propeller pitch changing mechanism at least two pumps of equal capacity (main and standby) shall be provided. One of these pumps can be driven by the main engine. Each pump shall ensure moving of blades in all operation modes of propellers.

If more than two pumps are installed, their capacity is selected in a way that in case of failure of any of these pumps the total capacity of the remaining operating pumps shall be sufficient to move the blades within a time period specified in 5.6.7.

Ships with two vertical axis propellers shall be fitted with independent standby pump for both propellers.

In ships with main engines of total power of less than 220 kW it is allowed to use a hand pump as a standby pump. The capacity of this hand pump shall be sufficient to move the blades within a time period specified in 5.6.7. Instead of this pump it is also possible to use a hand drive to turn the propellers blades. When served by one person the force on the handle of this drive shall not exceed 160 N.

5.5.2 Pitch changing mechanism shall enable setting of blades to the ahead running position in case of failure of pitch changing mechanism hydraulic drive system.

5.6 REQUIREMENTS TO WATER-JET PROPELLERS, VERTICAL AXIS PROPELLERS AND STEerable THRUSTERS

5.6.1 Pumps of water-jet propellers shall comply with the applicable requirements of 7.7.

5.6.2 Parts of vertical axis propellers, steerable thrusters, water intake and nozzle of water-jet propellers, including their welded joints, shall be tested for absence of surface and hidden effects, including by means of non-destructive testing, the methods, scope and standards of which are specified in 8 and in 2.20 to 2.23 Appendix 10 Part X of the Rules shall be complied with.

5.6.3 Shafts and impellers of water-jet propeller pumps and parts of vertical axis propeller rotors during manufacture shall undergo ultrasonic inspection according to 2.21 Appendix 10 Part X of the Rules shall be complied with.

5.6.4 Strength calculations of vertical axis propeller blades shall be carried out and shall comply with the requirements to propellers described in 5.3.2 and 5.3.3.

5.6.5 Hydraulic control system for moving control centre and blades of vertical axis pro-
peller shall comply with the requirements of 5.5.

5.6.6 In ships with vertical axis propellers, where the overload of main engines under operating conditions is possible, the devices automatically protecting the main engines from overload shall be used.

5.6.7 The travelling time of control centre and blades of vertical axis propeller from full ahead position to full astern position with disabled main engines shall not exceed 20 s.

5.6.8 If propulsion plants with steerable thrusters are used, at least two steerable thrusters shall be installed on the ship.

The control stations equipped with necessary devices and communication facilities according to requirements of 1.5 and 1.6 shall be provided.

5.6.9 Propeller shafts of steerable thrusters shall comply with the applicable requirements of 3 of this Part and their vertical shafts shall comply with the applicable requirements of 2.3 Part V of the Rules.

5.6.10 Steerable thrusters shall be equipped with devices securing their position when the thruster is turned to any permissible angle.

5.6.11 If the ship’s course is changed by turning the steerable thrusters, the time of turning of each thruster by 180° shall not exceed the following values (s) for installations with propeller diameter:

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<tr>
<th>Propeller Diameter</th>
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<tr>
<td>up to two (m)</td>
<td>20</td>
</tr>
<tr>
<td>over two (m)</td>
<td>30</td>
</tr>
</tbody>
</table>

5.6.12 The design of steerable thruster shall exclude ingress of overboard water in its internal spaces. When installed the sealings used for this purpose shall be leak tested by pressure corresponding to the maximum height of liquid column in the pressure tanks.

5.6.13 After assembly the inner part of steerable thruster shall be tested by test hydraulic pressure corresponding to the maximum operating immersion depth considering the pressure head of sealing arrangements.
6 TORSIONAL VIBRATION

6.1 GENERAL REQUIREMENTS

6.1.1 Torsional vibration calculations (performed by organization certified by the River Register on computer application for torsional vibration calculations) for onboard propulsion plants, diesel engines tested on the manufacturer’s benches, diesel-generator units, geared diesel units, air-injection units and dieselpump units (hereinafter referred to as the units) with engine output of 110 kW and more shall be submitted to the River Register in the course of approval of:

.1 of engineering design of a new ship;
.2 engineering design of a new engine or unit;
.3 technical documentation modernized, re-equipped or re-classed ship.

6.1.2 In the process of technical documentation development the vibration oscillation calculations are made in the following cases:

.1 when installing a main engine, the model and the parameters of which differ from that of the specification for the ship engine;
.2 when installing onboard an engine of the same model but with increased supercharging or of modified design, or with crankshaft or pistons made of material other than stated in the specification;
.3 when a new flywheel is installed or the existing one is grooved and the moment of inertia of the new flywheel differs from the former one by 10 % and over;
.4 when an additional flywheel is installed;
.5 when a torsional oscillation damper (dynamic vibration absorber) is installed, withdrawn or replaced with a damper (vibration absorber) with other technical parameters; the damper (vibration absorber) has been repaired with changing the damping or elastic characteristics (changing the grade of silicone fluid, clearances in the silicone damper, material or dimensions of the flywheel, spring packs, diameter of the damper pins etc.);
.6 when elastic coupling is installed, withdrawn or replaced by a coupling with different technical parameters;
.7 when a new propeller (propulsion device) is installed which dimensions or material differ from those stated in the specification, or the blades’ edges of the existing propeller were cut off, and the moment of inertia of the new propeller (propulsion device) or propeller (vertical axis propeller) with cut-off blades together with entrained water differs from the former one by 10 % and over;
.8 when additional power consumer (shaft generator, pump etc.) is installed, withdrawn or replaced by a power consumer of other type and the moment of inertia of the receiver is commensurable with the moment of inertia of the crank gear of the working cylinder;
.9 if the shafts’ diameters are changed by 2 % and over or their compliance is changed by more than 5 %. Torsional vibration calculation may not be submitted if the change of dimensions of separate shaft sections does cause the change of shaft flexibility by more than 5 % or, if the shaft flexibility is changed, to dangerous torsional vibrations;
.10 when the unit is modernized with replacement of the engine (generator, reduction gear, compressor, pump) with an engine (generator, reduction gear, compressor, pump) differing from the earlier installed one.

Note. Torsional vibration calculations need not to be submitted if it is proved by the documents that the torsional diagram of torsional vibrating system is fully analogous (by appearance and parameters of torsional diagram links) to the torsional diagram used for the torsional vibration calculations of the propulsion plant of the studied ship or unit and considered by the River Register.
earlier or the differences of mass moment of inertia or flexibility of connections do not exceed 10% and 5%, respectively.

6.1.3 Torsional vibration calculations shall be submitted (see 6.1.1) for the basic variant and other variants of operation of onboard propulsion plants, engines bench tested by the manufacturer and units:

1. maximum power take-off and idling speed (with the propeller blades at zero position) for installations comprising vertical axis propellers;
2. connection of additional power consumers if their moments of inertia are commensurable with the inertia moments of the crank gear of the working cylinder;
3. reverse mode in installations with reverse reduction gear and different reduction at ahead and astern speed;
4. with spare (changeable) propeller if it differs from the primary one;
5. with one disabled cylinder for installations with elastic couplings and reduction gears. A disabled cylinder is the cylinder the non-operation of which has maximum effect on increase of stresses and variable torques.

6.1.4 Torsional vibration calculations shall include:

1. reduced torsional diagram of the system and summary table of data characterising this diagram including rated power, rated and nominal engine crankshaft rotation speed, its cylinder arrangement (in-line, V-type), the number and working order of the cylinders, the cylinder bore, the piston stroke, names of weights and joints, diameters, length of all shafts of the system, compliance of the joints, weight inertia moments, as well as data on the gear-box, couplings, damper (vibration absorber), propeller or power consumer used in calculations;
2. tables of calculations of free vibration frequency of any form having essential resonances in the range from 0.2 to 1.2 times the nominal speed;
3. tables of calculations of disturbing moment values in relation to the shaft rotation frequency and disturbing moment harmonic orders;
4. values of vector sums of vector diagrams for all disturbing moment harmonic orders being under consideration;
5. calculation results of resonance torsional vibration parameters including data on design stresses in the weakest sections appearing due to all essential resonances. If principal order resonance is located near the range of 0.85 to 1.05 of nominal rotation speed, stresses appearing due to non-resonance forced vibrations due to the principal order shall be calculated for this range. When elastic coupling is provided, amplitudes of elastic moments or stresses in its elements shall be determined and compared with the permissible values; if reduction gear is provided, amplitudes of elastic moments shall be determined and compared with mean torque;
6. conclusions based on the calculation results.

For other requirements to the scope and presentation of torsional vibration calculations, see 2 of the Guidelines Ð.009-2004 “Torsional vibration calculations and measurements for shaftings and units”.

6.2 PERMISSIBLE STRESSES AND MOMENTS

6.2.1 Permissible stresses due to resonance, by-resonance and non-resonance forced vibrations in the course of continuous operation (engine operation in a mode with crankshaft constant rotation speed for over 30 min) shall not exceed the values determined by the formulas:

for main engine crankshafts and propeller shafts
\[ \tau_{\text{perm}} = \pm (45 - 0.4\sqrt{d} - 13n/n_{\text{rated}}); \quad (6.2.1-1) \]
for intermediate and thrust shafts
\[ \tau_{\text{perm}} = \pm (69 - 0.6\sqrt{d} - 20n/n_{\text{rated}}); \quad (6.2.1-2) \]
for crankshafts of engines driving generators and other onboard machinery of essential purpose, as well as for generator shafts in rotation speed range of (0.85–1.05)n_{\text{rated}}
\[ \tau_{\text{perm}} = \pm (22.5 - 0.2\sqrt{d}); \quad (6.2.1-3) \]
where \( \tau_{\text{perm}} \) — permissible stresses, in MPa;
— shaft diameter in the weakest section, in mm;

— rotational speed under consideration, in min\(^{-1}\);

— rated rotational speed, in min\(^{-1}\).

For ships, the main engines of which operate in the conditions with crankshaft rotation speed below the rated value for more than 5 h (for example, tugs, trawlers, etc.), in all cases \( n = n_{\text{rated}} \).

It is necessary to avoid resonance in the rotation speed ranges where main engines operate for more than 1 h.

In case when resonances occur in the rotation speed range \((0.85 \div 1.05)n_{\text{nom}}\), stresses due to them shall not exceed 70 % of permissible stresses being determined by the formulae (6.2.1-1) and (6.2.1-2).

### 6.2.2 Permissible stresses due to torsional vibration (see 6.2.1) are given relating to shafts made of steel with tensile strength from 430 to 510 MPa.

For shafts made of steel with tensile strength above 510 MPa, permissible stresses may be determined by the formula

\[
\tau = \tau_{\text{perm}} \left(2R_m - 510\right)/R_m,
\]

where \( \tau_{\text{perm}} \) — permissible stresses, in MPa, determined by the formulae (6.2.1-1), (6.2.1-2) or (6.2.1-3);

\( R_m \) — tensile strength of the shaft material in tension, in MPa.

When using materials with tensile strength above 780 MPa, \( R_m = 780 \) MPa shall be adopted for calculation purpose.

### 6.2.3 To prevent damage of engine crankshaft or propeller shaft caused by impermissible stresses due to torsional vibrations appearing in the rotation speed zones conditionally called prohibited for long-term operation, the stresses from torsional vibrations in these zones free for fast (max. 1 min) passing (see 6.3) shall not exceed the values determined by the formulae:

for intermediate shafts and thrust shafts

\[
\tau'_{\text{perm}} = 1.7\tau_{\text{perm}};
\]

for crankshafts of engines driving auxiliary engines and generator shafts

\[
\tau'_{\text{perm}} = 5\tau_{\text{perm}};
\]

where \( \tau'_{\text{perm}} \) — permissible stresses for rotational speed ranges prohibited for continuous running, in MPa;

\( \tau_{\text{perm}} \) — permissible stresses, in MPa, determined by the formulae (6.2.1-1) to (6.2.1-3) accordingly. Formulae (6.2.3-1) to (6.2.3-3) are not applied in the ranges of \( 0.3 \div 0.4 \) and \( 0.85 \div 1.05 \) of the nominal rotation speed in which forbidden zones are not allowed.

### 6.2.4 Variable torques in shafting in the rotation speed range of 0.85 to 1.05 of rated one shall not exceed 80 % of maximum mid-range torque transferred by shafting.

### 6.2.5 Variable elastic torque in any stage of the reduction gear in the course of long-term operation (see 6.2.1) and fast passing (see 6.2.3) through the resonance shall not exceed the permissible values determined by the manufacturer for these conditions. If there are no such permissible values, the elastic torque shall not exceed 30 % of maximum mid-range torque of the given stage. Alternatively the limit value of elastic torque of gear stage is set to ensure reliable teeth behaviour in bending. In this case the corresponding calculation shall be submitted.

Displacement of clearances in engagement when the direction of rotation is changed shall be considered possible only for short-term transient conditions (max. 5 min) at rotation speed of 0.35 of rated one and lower.

### 6.2.6 Variable torque in coupling with elastic (rubber) components, stresses corresponding to it or temperature in material of elastic component caused by torsional vibrations in the course of long-term operation (see 6.2.1) and fast passing (see 6.2.3) shall not exceed the permissible values determined by the manufacturer for these conditions.
Permissible compression stresses $\sigma_{perm}$ and shear stress permissible in elastic couplings with rubber components shall be determined with the help of the following formulas.

In case of static load — transfer of constant torques at minor dynamic loads due to misalignment, weak torsional vibrations, etc., in MPa:

$$\sigma_{perm} = (70 + 0.5H^2) \cdot (10\beta + H/10.5);$$  \hspace{1cm} (6.2.6-1)

$$\tau_{perm} = H - 20,$$  \hspace{1cm} (6.2.6-2)

where $H$ — Shore hardness of rubber ($H = 30 \div 75$);

$\beta$ — shape variation coefficient at compression equal to the ratio of the loaded surface area of the rubber component to its free surface area.

In case of static load with occasional short-term (max. 5 min) dynamic loads — transient conditions, engine starts and stops, passing through torsional vibration resonances, in MPa:

$$\sigma_{perm} = (50 + H^2/80) \cdot (10\beta + H/10.5);$$  \hspace{1cm} (6.2.6-3)

$$\tau_{perm} = 0.5H - 5.$$  \hspace{1cm} (6.2.6-4)

In case of dynamic load — transfer of considerable variable torque due to torsional vibrations (over 75% of mid-range torque of engine), operation under conditions of increased misalignment, etc., in MPa:

$$\sigma_{perm} = (47 + H^2/130) \cdot (10\beta + H/10.5);$$  \hspace{1cm} (6.2.6-5)

$$\tau_{perm} = 0.4H - 6.$$  \hspace{1cm} (6.2.6-6)

6.2.7 If the prime movers are rigidly connected with generator units with no permissible values determined by the manufacturer, the variable torque in the course of long-term operation (see 6.2.1) shall not exceed the nominal torque of generator over 2.5 times, in case of fast passing through the resonance over six times.

6.2.8 Fitness of dampers for torsional vibration reduction shall be estimated according to the manufacturer’s recommendations, for example, by permissible elastic torque or permissible heat density. The due dates of maintenance of torsional vibration dampers specified by the manufacturer shall be observed.

6.3 MEASUREMENT OF TORSIONAL VIBRATION PARAMETERS

6.3.1 Data obtained from torsional vibration calculations for onboard propulsion plants, engines bench tested at the manufacturer and units shall be confirmed by the results of measurements of torsional vibration amplitudes and/or stresses in torsional vibrating system elements and elastic couplings thermometry carried out by organization certified by the River Register to conduct this type of activity.

Measurement of torsional vibration parameters is made:

1. on propulsion plant of the first ship in a series, prototype engine of a series bench tested at the manufacturer and prototype unit of a series;

2. on series-built propulsion plants, engines, units or propulsion plants, engines, units being repaired, if the modernization or repair has brought to changes in torsional vibrating system in cases specified in 6.1.2.

If after introducing changes to the design or technical parameters of separate components of torsional vibrating system (engine, couplings, gearings, shafts, propeller) the torsional vibration calculations reveal no essential deviations of stress caused by torsional vibration to the dangerous side as compared to the measurements and calculations made prior to introducing such changes, it is allowed not to measure torsional vibration parameters;

3. on propulsion plants, engines and units in service in the course of periodical control tests envisaged by the technical documentation or the manufacturer’s recommendations and conducted by the ship owner to check the operational efficiency of torsional vibration.

---

1 Deviations at which the stress due to torsional vibrations reaches 80% of the values specified in installed 6.2.1.
dampers or special devices to reduce torsional vibration amplitudes after a specific operation period;

4. At control tests after repair of torsional vibration dampers or special arrangements for damping torsional vibration amplitudes, if changes have been introduced in the course of repair which brought to changing their damping or elastic characteristics.

Tests for measuring torsional vibration parameters shall be performed in operation modes of the installation, for which the calculations are made according to 6.1.1 to 6.1.3.

6.3.2 Measured natural vibration frequency shall not differ from the design one by more than 5%. Otherwise, the torsional diagram and (or) the parameters of its members shall be corrected and free vibration parameters shall be recalculated.

6.3.3 The stresses shall be determined on the basis of torsiography (measuring of vibration amplitudes) for maximal vibration amplitudes of the respective section of the torsiogram; when assessing non-resonance forced vibrations harmonic analysis of the torsiogram shall be made.

6.3.4 Torsional vibration parameters shall be measured as per the program developed by the organization conducting the tests according to the requirements of this Section and agreed with the River Register while the ship follows a direct course in the water areas, the depth of which is at least four times the ship draught, with the wind force up to three.

6.3.5 Tests shall include measurement of torsional vibration parameters in operation modes for which the calculations according to 6.1.2 and 6.1.3 shall be made:

1. in the entire rotation speed range from minimum steady to maximum one and in the maximum output mode with different variants of start of engines and power consumers. Special attention shall be given to measurement of parameters at the rotation speeds corresponding to full, moderate and low speed of the ship and to check of resonance and by-resonance stresses detected by calculations and expected by results of rotation speed prohibited zone calculations;

2. for the modes listed in 6.3.5.1 while the engine operates with one disabled cylinder.

Tests shall be carried out with the engine control by means of remote automated control system and manual control.

6.3.6 If the stress measurement (strain measurement) is not carried out during the tests, the calculations by results of torsional vibration amplitude measurement (torsiogram) shall be made. In this case when processing the test results by maximum vibration amplitudes within a cycle the graphs of vibration amplitude progress in the place of their measurement are plotted. Besides the aforementioned graphs the test report shall contain the progress graphs of harmonic component amplitudes obtained by Fourier analysis of the processed test results and the stress scales for various shafting sections determined when calculating free vibration parameters of the shaft system under examination.

Effective stresses on the shafting sections under examination shall be determined by summing the stresses calculated by amplitudes of basic harmonic components and the corresponding stress scales.

If the tests reveal development of forced non-resonance vibrations, the organization performing the tests shall make the Fourier analysis of the torsiogram and determine the stresses in dangerous cross-sections of shafting caused by these vibrations.

6.3.7 In diesel plants with reduction gears and reverse reduction gears the torsional vibration amplitude shall be measured on the crankshaft fore end. If it is impossible to measure torsional vibration amplitude on the crankshaft fore end, the amplitude shall be measured on the shafting after the engine.

Measurements on shafting are also taken in the following cases:

1. when design stresses in any section of shaft system are equal or exceed 80% of the value $\tau_{perm}$ determined by the formulae (6.2.1-1) and (6.2.1-2);
.2 if the torsional vibrating system has elastic coupling;
.3 if dangerous vibration shapes according to results of calculation are predicted which cannot be exactly detected by the torsiographic method on the bow end of the engine crankshaft.

6.3.8 For other requirements to measurement of torsional vibration parameters and processing their results, see Section 3 Guidelines P.009-2004.

6.4 RESTRICTED ROTATION SPEED RANGES

6.4.1 When the effective stresses and temperatures exceed the values permitted for long-term operation (see 6.2.1), the organization conducting the tests shall set prohibited rotation speed zones (see 6.2.3). Forbidden rotation speed zone covers the range between the rotation speed being characterised by the equality of acting and permissible stresses with extension to either side by value of 0.03 of the nominal rotation speed.

6.4.2 Accuracy of tachometer measurement shall be within ±2.5 %, if there are forbidden rotation speed ranges.

6.4.3 Prohibited rotation speed zone shall be clearly marked on the tachometers by well-visible preferably red paint or designated by other method at all control stations of the power installation.

6.4.4 Limit values within the prohibited rotation speed zones:
.1 for direct drives — permissible stresses (see 6.2.1 to 6.2.3) more than 2.5 times;
.2 for reverse reduction gears — nominal torques more than 2 times;
.3 for systems with elastic couplings — maximum pulse torque specified in the technical documentation of the coupling manufacturer.

6.4.5 In the rotation speed zone of \((0.85\div1.05)n_{\text{rated}}\) the prohibited zones are not allowed.

Prohibited rotation speed zone shall be passed at a maximum possible speed determined based on the conditions with no engine overload.
7 COMPRESSIONS, PUMPS, FANS AND SEPARATORS

7.1 SCOPE OF APPLICATION

7.1.1 The requirements of this Section of the Rules apply to:

.1 power-driven air compressors;
.2 pumps being a part of systems regulated by 10 of this Part and 3 of Part III of the Rules, except for hand-driven pumps;
.3 fans being a part of systems regulated by 10 of this Part;
.4 centrifugal separators making part of fuel and oil systems.

7.2 EXAMINATIONS AND TESTS OF PARTS

7.2.1 Shafts and impellers (rims) of compressors, pumps, fans and separators during manufacture are subject to ultrasonic control according to the requirements of 2.21 Appendix 10 Part X of the Rules shall be complied with.

7.2.2 Forged and cast steel parts including their welded joints during the manufacture shall undergo surface soundness control according to 6.1.5 of RTSC. Non-destructive control of parts and their welded joints shall be carried out in case of any doubts about the presence of defects.

7.2.3 Parts of compressors, pumps and fans operating under excessive pressure shall undergo hydraulic test according to 6.2.29 of RTSC.

7.3 MATERIALS AND WELDING

7.3.1 Materials intended for manufacture of compressor, pump, fan and separator parts shall meet the requirements referenced in the right column of Table 7.3.1.

7.3.2 The requirements of 2.1.4 to 2.1.6 shall be taken into account when using alloy steels and cast iron, nodular and lamellar graphite cast iron as well as application of welding.

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7.4 GENERAL REQUIREMENTS

7.4.1 Construction and design of compressors, pumps, fans and separators shall meet the requirements of 1.3 and 1.5.

7.4.2 Fasteners of compressors, pumps, fans and separators as well as fasteners located in hardly accessible places shall have fittings or be of such design as to prevent spontaneous slackening and unscrewing.

Drive moving parts shall be covered by protective housings.

7.4.3 Devices for units and parts lubrication shall be easily accessible and safe for serving personnel during the operation of the units.

7.4.4 Safety and protection devices shall be so designed and installed as to avoid the fire risk and danger for servicing personnel due to its operation.

7.4.5 Parts contacting with the environment causing corrosion shall be manufactured of anti-corrosion material or have corrosion-resistant coatings.

Units and parts of mechanisms which are made of materials with different electric potentials and which may contact with aggressive media, shall be protected against electrolytic corrosion.

7.4.6 Heating surfaces of compressors, pumps, fans and separators presenting fire hazard shall have heat- and fire-resistant insulation, or design measures shall be taken to prevent the ingress of fuel and oil to the indicated surfaces of the aforementioned equipment.

Heat insulation shall be covered by metallic housing or fuel- and oil-proof composition.

7.4.7 Systems and pipelines of compressors, pumps, fans and separators shall comply with the requirements of 10 of this Part.

7.5 POWER-DRIVEN AIR COMPRESSORS.

7.5.1 Compressors and their drives shall be so designed as to provide continuous operation (more than 1 h) at full load.

7.5.2 Inlet branch pipes of compressors shall be fitted with meshes.

7.5.3 Air purification and cooling shall be provided according to the requirements of 10.16.15, 10.16.16.

7.5.4 Compressor cooling chambers shall be fitted with discharge devices.

7.5.5 A safety valve shall be installed on each compressor stage or directly after it to prevent the pressure rise in the stage above 1.1 of the rated one at closed valve on the pressure piping.

7.5.6 A fuse or alarm device shall be fitted on the pressure branch pipe directly after the compressor which is actuated when air temperature reaches 125 °C.

7.5.7 Air cooler cases shall be fitted with safety devices ensuring free air discharge in case of piping breakage.

7.5.8 A manometer shall be fitted after each compressor stage.

7.5.9 It shall be possible to measure air temperature on the pressure branch pipe directly after the compressor.

7.5.10 Built-on compressors shall be equipped with instrumentation permitting to estimate the operating parameters of these compressors.

7.5.11 Compressors shall be installed in the places where sucked air has minimum pollution with combustible liquid vapours.

7.6 CRANKSHAFTS OF POWER-DRIVEN AIR COMPRESSORS

7.6.1 Checking calculation method mentioned in 7.6.3 and 7.6.4 is applicable to steel and cast iron crankshafts of onboard compressors with in-line, V-shaped and W-shaped cylinder arrangement, with one- and multi-stage compression.

7.6.2 Crankshafts shall be made of steel with tensile strength from 410 to 780 MPa.

Cast iron crankshafts shall be made of nodular cast iron according to 2.11 Part X of the Rules.
7.6.3 The diameter \( d_k \) of compressor crankshaft journals shall be not less than the one determined by the formula, in mm:

\[
d_k = 0.25k \sqrt{D_p^2 p_k \sqrt{0.3L_p^2 f + (s \varphi_1)^2}} ,
\]

(7.6.3)

where \( k \), \( f \), \( \varphi_1 \) — coefficients adopted from Tables 7.6.3-1, 7.6.3-2 and 7.6.3-3;

<table>
<thead>
<tr>
<th>Coefficient ( k )</th>
<th>( R_m ), MPa</th>
<th>( k )</th>
<th>( R_m ), MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>360</td>
<td>1.43</td>
<td>660</td>
<td>1.23</td>
</tr>
<tr>
<td>460</td>
<td>1.35</td>
<td>780</td>
<td>1.20</td>
</tr>
<tr>
<td>560</td>
<td>1.23</td>
<td>880</td>
<td>1.18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficient ( f )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle between cylinder axes</td>
</tr>
<tr>
<td>0°</td>
</tr>
<tr>
<td>45°</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficient ( \varphi_1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cylinders</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

\( D_p \) — design diameter of the cylinder, in mm, at compression:
- single-stage \( D_p = D_c \)
- two- and multi-stage in separate cylinders \( D_p = D_h \)
- two-stage in one step piston \( D_p = 1.4D_h \)
- two-stage in one differential piston \( D_p = \sqrt{D_l^2 + D_h^2} \)

\( D_c \) — cylinder diameter, in mm;
\( D_h \) — high pressure cylinder diameter, in mm;
\( D_l \) — low pressure cylinder diameter, in mm;
\( p_h \) — high-pressure cylinder pumping pressure;

\( L_p \) — design distance between main bearings, in mm:
- \( L_p = L' \) if there are two displaced crankthrows between two main bearings;
- \( L' \) — actual distance between main bearing centres, in mm;
- \( s \) — piston stroke, in mm.

7.6.4 Thickness of crank web \( h_k \) (Fig. 7.6.4) shall be not less than that determined by the formula, in mm:

\[
h_k = 0.105k_1 D_p \sqrt{\psi_1 \psi_2 + 0.4} p_c \varphi_1 \varphi_2 / b ,
\]

(7.6.4-1)

where \( k_1 \) — coefficient:

\[
k_1 = a \sqrt{R_m/(2R_m - 430)},
\]

(7.6.4-2)

Fig. 7.6.4. Shaft web thickness.

\( r \) — fillet radius

\( \varepsilon \) — absolute value of the shaft journal overlap, in mm

\( a \) — coefficient for shafts equal to:
- with entire surface nitrided or strengthened 0.9
- forged in dies or in the direction of fibers 0.95
- not exposed to strengthening 1

\( R_m \) — tensile strength of the material at tension, in MPa; if the material with tensile strength over 780 MPa is used, \( R_m = 780 \) MPa shall be taken for calculations;

\( D_d \) — design diameter of the cylinder (see 7.6.3), in mm;

\( \psi_1, \psi_2 \) — coefficients adopted from Tables 7.6.4-1, 7.6.4-2; for determination of
coefficient \( \psi_2 \), minimum fillet radius shall be taken;

\[
\begin{array}{|c|c|c|}
\hline
\frac{B}{d_k} & \psi_1 & \frac{B}{d_k} \ \psi_1 \\
1.2 & 0.62 & 1.8 & 1.08 \\
1.4 & 0.65 & 2.0 & 1.15 \\
1.5 & 1.0 & 2.2 & 1.27 \\
\hline
\end{array}
\]

\textbf{Table 7.6.4-1}

\[
\begin{array}{|c|c|c|c|c|c|c|c|}
\hline
r/h_1 & \text{Coefficient } \psi_2 \text{ at } \varepsilon/h_1, \text{ equal to } \varepsilon/k_1 \\
0 & 0.07 & 4.5 & 4.5 & 2.8 & 3.7 & 3.3 & 2.75 \\
0.10 & 3.5 & 3.5 & 3.34 & 3.18 & 2.88 & 2.57 & 2.18 \\
0.15 & 2.9 & 2.9 & 2.82 & 2.65 & 2.4 & 2.07 & 1.83 \\
0.20 & 2.5 & 2.5 & 2.41 & 2.32 & 2.06 & 1.79 & 1.61 \\
0.25 & 2.3 & 2.3 & 2.2 & 2.1 & 1.9 & 1.7 & 1.4 \\
\hline
\end{array}
\]

\textbf{Table 7.6.4-2}

\textbf{Note. } r \text{ and } \varepsilon \text{ — see Figure 7.6.4.}

\( \rho_0 \) — pumping pressure according to instructions of 7.6.3, in MPa;

\( c_1 \) — distance from the centre of the main bearing to the centre plane of the crank web;

for shifted cranks located between two main bearings a distance shall be taken to the centre plane of the crank web which is the most distant from the support, in mm;

\( f_1 \) — coefficient adopted from Table 7.6.4-3;

\( b \) — crank web width, in mm.

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Angle between cylinder axes} & f_1 & \text{Angle between cylinder axes} & f_1 \\
0^\circ & 1.0 & 60^\circ & 1.4 \\
45^\circ & 1.7 & 90^\circ & 1.1 \\
\hline
\end{array}
\]

\textbf{Table 7.6.4-3}

\textbf{7.7.3} Pumps shall be so designed as to provide control of their parameters, draining of inner spaces and connection of pressure gauge and for self-priming pumps — vacuum pressure gauge.

\textbf{7.7.4} If the pump design allows the pressure rise above the rated value, there shall be provided a safety valve on the pump case or on the pipeline before the first shut-off valve.

\textbf{7.7.5} In pumps intended for inflammable liquid pumping liquid cross-over from safety valves shall be directed into the suction chamber of the pump.

\textbf{7.7.6} Measures shall be taken to avoid water hammers; application of relief valves for these purposes is not recommended.

\textbf{7.7.7} Strength of the pump parts shall be checked by the manufacturer for loads corresponding to the design parameters of the pump. Stresses in the parts shall not exceed 40 per cent of tensile strength of the part material.

\textbf{7.7.8} Critical rotation speed of the pump rotor shall be not less than 1.3 times the design rotation speed.

\textbf{7.7.9} Pumps equipped with self-sucking devices shall provide operation in conditions of “dry suction”\(^1\) and shall have devices (strainer, fine filter) to prevent the operation of the self-sucking device with contaminated water.

\textbf{7.7.10} Shaft sealings of pumps for inflammable liquids shall be such that the possible leakages do not cause formation of inflammable mixture of liquid and air vapours.

\textbf{7.7.11} Glands of rotating parts of pumps for inflammable liquid pumping shall be so designed as to prevent their heating above 50 °C.

\textbf{7.7.12} When using material with low electric conductivity (plastic, rubber etc.) in conditions of

\(^1\) Pump operation mode in which the suction pipeline and the wet end of pump are not filled with pumped liquid.
structure of pumps for inflammable liquids measures shall be taken for removal of electrical charges from them by means of additions to its composition or using discharging and earthing devices.

7.7.13 Cases of cargo pumps (except for submersible pumps) shall be fitted with temperature sensors.

7.8 FANS

7.8.1 Fans intended for the systems indicated in 10 of this Part shall comply with the following requirements:

.1 fan and air blower rotors shall be dynamically balanced jointly with connecting couplings according to 4.3.2;

.2 inlet branch pipes of fans and air blowers shall be fitted with safety screens to prevent foreign objects from getting inside.

7.8.2 Impeller shall be so designed that equivalent stresses in any section shall not exceed 0.65 of the yield stress of the impeller material at rotation speed equal to 1.3 times the rated value.

7.8.3 The impeller shall undergo strength test at the manufacturer on acceleration unit at a rotation speed equal to 1.3 of the rated value for 5 min. Strength shall be considered sufficient if no signs of deformation are revealed after the test.

7.9 REQUIREMENTS TO FANS OF CARGO PUMP SPACES ONBOARD OIL TANKERS

7.9.1 Air clearance between the impeller and the body of a fan shall be not less than 0.1 of the diameter of the impeller shaft journal in the bearing area, but not less than 2 mm in all cases. Clearance exceeding 13 mm is not allowed.

7.9.2 Protective meshes with square cells having a side dimension not greater than 13 mm shall be fitted at the inlet and outlet of ventilation ducts to prevent foreign objects from getting inside the fan.

7.9.3 To prevent accumulation of electric charges on rotating parts and the body the latter shall be made of antistatic materials. Installation of fans onboard the ship shall ensure their safe grounding to the ship’s hull according to requirements of 2.6 Part VI of the Rules.

7.9.4 The impeller and the body in the area of possible contact with the impeller shall be made of non-sparking materials.

The following combinations of the impeller and the body materials are considered non-sparking:

.1 non-metallic materials having antistatic properties;

.2 non-ferrous base alloys;

.3 stainless austenitic steel;

.4 the impeller is made of aluminium or magnesium alloy and the body is made of cast iron or steel (including stainless austenitic steel), when a ring made of non-ferrous base alloys is installed inside the body in the impeller area;

.5 any combination of cast iron and steel impellers and bodies (including the variant when the impeller and the body are made of austenitic stainless steel) provided that the clearance between them is not less than 13 mm.

7.9.5 The following combinations of materials are not admitted:

.1 the impellers are made of aluminium and magnesium alloys, and the bodies are made of ferrous base alloys;

.2 the impellers are made of ferrous-base alloys and the bodies are made of aluminium or magnesium alloys;

.3 the impellers and the bodies are made of ferrous-base alloys and the clearance between them is less than 13 mm.

7.10 CENTRIFUGAL SEPARATORS

7.10.1 The design of separators shall exclude leakages of oil products and their vapours in any separation mode.

7.10.2 Separator drums shall be dynamically balanced. Position of detachable parts shall be marked. The design of disk holder and drum shall exclude the possibility of their incorrect assembly.
7.10.3 The “rotor – stator” systems shall be designed in a way that the critical rotation speed zones exceed the operating rotation speed in empty and filled states.

7.10.4 The design of shift sleeves shall exclude the possibility of sparking and overheat of couplings in all operation modes of separator.

7.10.5 The design of separator electric heaters shall comply with the requirements of 16.2.32 to 16.2.34 Part VI of the Rules. The design of steam heaters shall comply with the applicable requirements of 8.18.

7.10.6 Rotating parts of separator shall meet the strength requirements at the rotation speed exceeding the rated one (see 1.2.1.21) by less than 30 %. The equivalent stresses in these parts shall not exceed 0.65 of the yield point of the material of parts.

7.10.7 Strength of rotating parts of separator shall be tested while testing a specimen on the manufacturer's bench at a rotation speed exceeding the rated one by not less than 30 %.

7.10.8 The separation process monitoring system, including check of drum rotation speed, shall be provided.

7.10.9 The separators shall be equipped with protection system automatically disabling the separator in case of impermissible vibration of the unit according to 13.2.17.
8 BOILERS, HEAT EXCHANGERS AND PRESSURE VESSELS

8.1 GENERAL REQUIREMENTS

8.1.1 The requirements of this Section of the Rules apply to:
steam boilers (including waste-heat boilers) with steam working pressure of at least 0.07 MPa;
hot-water boilers with water temperature above 115 °C;
heat exchangers and pressure vessels (except for fluid pressure vessels), which being in service are fully or partially filled with gas or steam with a working pressure of at least 0.07 MPa and have a capacity of at least 0.025 m³ or with a production of working pressure for a capacity of at least 0.03 MPa m³ (boiler vaporizers, condensers, steam heaters, pneumatic tanks of ship systems, carbon dioxide cylinders and fire extinguishing medium reservoirs making a part of fire-fighting systems etc.);
boilers with high-temperature organic heat transfer fluid, including waste-heat boilers;
burning units of fuel oil fired boilers as pertaining to materials and dimensions conditioned by strength of structural members.

8.1.2 Hot-water boilers water temperature of max. 115 °C, filters and coolers of main and auxiliary machinery as pertaining to materials and dimensions of components shall comply with the requirements to heat exchangers and pressure vessels according to this Section of the Rules.

8.1.3 Vessels intended for storage of compressed gases and used in various systems and units while the ship is in service can be manufactured according to the national standards1. The requirements of 8.18.17 to 8.18.20 shall be met.

8.1.4 Prior to manufacture of boilers, heat exchangers and pressure vessels the documentation which is specified in RTSC shall be submitted to the River Register for approval.

8.1.5 Requirements for feed water systems are stated in 10.17.

8.1.6 Scope of technical supervision for boilers, heat exchangers and pressure vessels during the manufacturing process is specified in RTSC.

8.1.7 Provisions of the present Section of the Rules do not apply to:
.1 manned submersibles and deep water diving systems as pertaining to their design and strength of pressure hull;
.2 liquefied gas cylinders manufactured according to national standards2;
.3 units and parts of ship machinery which are not independent pressure vessels;
.4 arrangements comprising a system of pipes under pressure and arranged outside the boilers, heat-exchangers and vessels;
.5 air coolers with working pressure in air cavity less than 0.1 MPa;
.6 heat exchangers and fluid pressure vessels, except for the ones specified in 8.1.2.

8.1.8 Requirements to hydraulic tests are specified in 6.1.7 to 6.1.9 and 6.2.41 to 6.2.42 of RTSC.

8.2 CLASSIFICATION

8.2.1 Boilers, heat exchangers and pressure vessels are classified in accordance with Table 8.2.1 depending on their parameters and design features.

1 GOST 9731, GOST 12247, GOST R 50539.
2 GOST 15860, GOST R 55559.
Classification of boilers, heat exchangers and pressure vessels

<table>
<thead>
<tr>
<th>Item</th>
<th>Class</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boilers, including waste-heat boilers and hot water boilers with water temperature above 115°C, steam superheaters and steam accumulators</td>
<td>$p &gt; 0.35$</td>
<td>$p \leq 0.35$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure vessels and heat exchangers with toxic, flammable or explosive working medium</td>
<td>Any parameters</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Pressure vessels and heat exchangers</td>
<td>$p &gt; 4.0$ or $t &gt; 350$ or $s &gt; 35$</td>
<td>$1.6 &lt; p \leq 4.0$ or $120 &lt; t \leq 350$ or $16 &lt; s \leq 35$</td>
<td>$p \leq 1.6$ and $t \leq 120$ and $s \leq 16$</td>
<td></td>
</tr>
</tbody>
</table>

Note. $p$ — working pressure, in MPa; $t$ — operating temperature, in °C; $s$ — wall thickness, in mm.

8.3 MATERIALS, WELDING AND HEAT TREATMENT

8.3.1 Materials intended for manufacture of parts of boilers, heat exchangers and pressure vessels shall meet the requirements referenced in the right column of Table 8.3.1.

Materials for parts of boilers, heat exchangers and pressure vessels of class III, as well as parts specified in 1.5 and 2.5 of Table 8.3.1, can be selected in accordance with the national standards.

8.3.2 For manufacture of components of boilers, heat exchangers and pressure vessels it is allowed to use carbon and carbon-manganese steels at design temperatures of up to 400°C and low-alloy steel of up to 500°C. Application of these steels for media with temperatures above the specified values is allowed provided their mechanical properties and long-term strength within 100 000 hours are guaranteed by the manufacturer of steel. The same shall be specified in the accompanying documents. Components and valves of boilers and heat exchangers for media with temperatures above 500 °C shall be made of alloy steel.

8.3.3 For heat exchangers and pressure vessels with design temperatures below 250 °C the shipbuilding steel can be used according to 2.2 Part X of the Rules shall be complied with.

Table 8.3.1

<table>
<thead>
<tr>
<th>Components of boilers, heat exchangers and pressure vessels</th>
<th>Material</th>
<th>Chapter of Part X of the Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Boilers</td>
<td>Rolled steel</td>
<td>2.3</td>
</tr>
<tr>
<td>1.1 Shells, end plates, tube plates, drums, headers and chambers</td>
<td>Seamless steel</td>
<td>2.4</td>
</tr>
<tr>
<td>1.2 Heated and non-heated pipes</td>
<td>Rolled steel</td>
<td>2.3</td>
</tr>
<tr>
<td>1.3 Furnaces and elements of combustion chambers</td>
<td>Forged steel</td>
<td>2.6</td>
</tr>
<tr>
<td>1.4 Girders, long and short stays</td>
<td>Rolled steel</td>
<td>2.3</td>
</tr>
<tr>
<td>1.5 Bodies of valves for working pressure of 0.7 MPa and over</td>
<td>Forged steel</td>
<td>2.6</td>
</tr>
<tr>
<td>2 Heat exchangers and pressure vessels</td>
<td>Cast steel</td>
<td>2.7</td>
</tr>
<tr>
<td>2.1 Shells, distributors, end plates, headers and covers</td>
<td>Cast iron</td>
<td>2.11, 2.12</td>
</tr>
<tr>
<td>2.2 Tube plates</td>
<td>Copper alloys</td>
<td>3.1</td>
</tr>
<tr>
<td>2.3 Tubes</td>
<td>Rolled steel</td>
<td>2.3</td>
</tr>
<tr>
<td>2.4 Reinforcing elements, long and short stays</td>
<td>Copper alloys</td>
<td>3.1</td>
</tr>
<tr>
<td>2.5 Bodies of valves for working pressure of 0.7 MPa and over, 50 mm in diameter and over</td>
<td>Sealed steel</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>Copper alloys</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>Rolled steel</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>Forged steel</td>
<td>2.6</td>
</tr>
<tr>
<td></td>
<td>Rolled steel</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>Cast steel</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>Copper alloys</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>Cast iron</td>
<td>2.12</td>
</tr>
</tbody>
</table>

1 GOST 5520, GOST 5654, GOST 1060, GOST 977, GOST 7505, GOST 8479.
For noncritical parts of heat exchangers (partitions, displacers, branch pipes, bends, supports) and vessels with working pressure below 0.7 MPa and design temperatures below 120°C it is allowed to use semi-killed steel.\(^1\)

8.3.4 If the yield point at elevated temperature is taken as the design characteristic of the material, the tensile tests of the material shall be carried out at the design temperature according to Appendix 10 Part X of the Rules; if the long-term strength limit is taken as the design characteristic, the data on limit long-term strength at the design temperature shall be submitted to the River Register and shall comply with Table 2.3.7-2 Part X of the Rules shall be complied with.

8.3.5 The manufacturer is to submit to the River Register data on mechanical properties and long-term strength of steel and welded joints at the design temperature, technological characteristics, welding technique and heat treatment.

8.3.6 Boiler valves up to 200 mm in diameter designed for working pressure up to 1 MPa and temperature up to 200 °C with the exception of safety and feed valves may be manufactured of nodular cast iron which meets the requirements given in 2.11 Part X of the Rules shall be complied with.

8.3.7 Components and valves of heat exchangers and pressure vessels with a working pressure up to 1 MPa and a diameter up to 1000 mm may be manufactured of nodular cast iron with entirely ferritic structure according to 2.11 Part X of the Rules shall be complied with.

8.3.8 Application of copper alloys for components of boilers, heat exchangers and pressure vessels as well as for their valves is allowed at design temperatures up to 250 °C and working pressures up to 16 MPa.

It is not allowed to use copper and copper alloys for parts of boilers with high-temperature organic heat transfer fluid and parts of their systems.

8.3.9 For parts specified in 1.2 and 2.3 of Table 8.3.1 electric-welded tubes with longitudinal seam can be used provided their density and strength correspond to that of seamless tubes (see also 8.5.35).

8.3.10 Welding and testing of welded joints shall be carried out according to the requirements of 7 and 8 Part X of the Rules shall be complied with.

8.3.11 Butt joints shall be used.

8.3.12 Arrangement of longitudinal welds in line with longitudinal seams of structures composed of several sections is not allowed.

8.3.13 Components in which the material structure may be changed after welding of plastic processing shall undergo the relevant heat treatment.

When performing heat treatment of a welded structure, the requirements of Part V of RINS shall be met. X of the Rules shall be complied with.

8.3.14 Heat treatment is required for:

1. plate-steel elements of boilers, vessels and heat exchangers subjected to cold stamping, bending and flanging with plastic deformation of surface fibres exceeding 5 per cent;
2. tube plates welded of several components; in this case heat treatment may be performed before drilling tube holes;
3. welded end plates manufactured by cold stamping;
4. elements subjected to hot forming with the temperature at the end of this process being lower than that of forging;
5. welded structures manufactured of steels with carbon content over 0.25 per cent.

8.4 TESTS

8.4.1 Boilers, heat exchangers and pressure vessels as well as their valves and fittings, assembly units and parts shall undergo hydraulic strength and leak tests in accordance with the requirements of RTSC.

---

1 GOST 380, GOST 1050.

2 GOST 8731, GOST 8733, GOST 1060.
8.5 BOILER DESIGN

8.5.1 Requirements of the present Chapter apply to structure of onboard steam and hot-water boilers.

8.5.2 Boilers shall be designed and manufactured so as to keep their workability in conditions of list and trim in accordance with 1.3.

8.5.3 Boiler walls heated by smoke gases shall be isolated from thermal flow influence. It is allowed to use non-isolated smoke-heated boiler walls over 20 mm thick only for gas temperatures up to 800 °C.

8.5.4 Long and short stays in the boiler structure as well as connecting tubes shall be located so as to avoid bending or shearing loads. Members, strength walls, reinforcements etc. shall have no changes in length of cross-sections exceeding 20 %.

Control drilled holes shall be provided at short-stay ends with a depth of 25 mm plus wall thickness, plus weld height.

8.5.5 For walls reinforced by short stays and exposed to flame and high-temperature gases the distance between the stays’ centres shall be not greater than 200 mm.

8.5.6 Corner stays of gas-tube boilers shall be arranged at least 200 mm clear of the flame tubes. Where flat walls are reinforced with welded-on girders, this should be done so that the load involved is transferred as far as possible to the boiler shell or the most rigid parts.

8.5.7 The distance between flame tubes and the boiler shell shall be not less than 100 mm. The distance between any two flame tubes shall be not less than 120 mm.

8.5.8 Branches and nozzles shall be of rigid construction and have a minimum length sufficient for fixing and dismantling the boiler valves without removing the insulation. Branch pipes shall not be exposed to bending forces exceeding the limits determined by the designer.

8.5.9 Pads intended for installation of valves and pipes, as well as branches, sleeves and nozzles passing through the entire thickness of the boiler wall shall be welded from both sides. Branches and nozzles may also be welded by a fillet joint with single-edge preparation using removable backing strip, or by some other method that ensures the penetration throughout the thickness of the part being attached.

8.5.10 Walls are considered protected against the influence of heat flow if they are protected by refractory insulation or by compact tube row (with maximum clearance between tubes in row up to 3 mm) or by two tube rows situated in staggered order, with longitudinal interval equal to not more than two external tube diameter, or by 3 or more tube rows situated in staggered order with longitudinal interval not exceeding two and a half of external tube diameters.

8.5.11 Boiler drums and headers having a wall thickness greater than 20 mm shall be protected against direct heat flow in accordance with the requirements of 8.5.10. It is recommended that in vertical gas-tube boilers the gas uptake pipe passing through the steam space of the boiler shall be protected against direct affection of hot gases.

8.5.12 Boilers shall be equipped by manholes for inspection and cleaning of all inner surfaces. If it is impossible to equip manholes, sight holes shall be foreseen.

8.5.13 Where non-metallic sealing gaskets are used, manhole and sight hole closures shall be so designed as to prevent the gasket from being forced out.

8.5.14 Manholes shall have clear dimensions of not less than: 300×400 mm — for oval-shaped manholes, 400 mm — for round-shaped manholes.

Oval-shaped manholes on cylindrical shells shall be located so that the minor axis of the manhole is arranged longitudinally.

8.5.15 Gas-tube vertical boilers shall have at least two sight holes on the casing in the working water level area located one opposite the other.
8.5.16 All boiler components that impose free access to inner surfaces or their inspection shall be of a removable type.

8.5.17 Openings for manholes and sight holes in flat walls, end plates and covers having a diameter over 4-time wall thickness, where \( s \) is the wall thickness, shall be reinforced by means of welded nozzles, branch pieces and pads, or by increasing the design wall thickness. Openings shall be arranged at a distance not less than 1/8 of the size of the opening from the design diameter contour.

8.5.18 Openings in cylindrical, spherical and conical walls and in dished ends shall be reinforced by increasing the wall thickness by means of welded disc-shaped reinforcing plates (pads), welded tubular elements, nozzles, sleeves, branches or by compensation of wall weakening in the opening area by excessive wall thickness as compared to the design one.

Opening reinforcements shall be made on removable spacers or using other methods providing the proper welding quality at weld root.

Disc-shaped pads and tubular elements may be used jointly for reinforcement of the same openings in non-flat walls and end plates.

8.5.19 Materials used for the wall to be reinforced and for reinforcing elements shall have identical strength characteristics. When using reinforcing materials with lower strength characteristics as compared to those of the wall to be reinforced, the area of the reinforcing sections shall be increased as compared to the area of reinforcing section of the material having the same strength characteristics as the wall to be reinforced according to the results of strength and stability calculation of the wall to be reinforced with use of reinforcing material with lower strength characteristics.

The reinforcing elements shall be reliably attached to the reinforced wall.

8.5.20 Openings in non-flat walls shall be located at the distance at least 3-time wall thickness, but not less than 50 mm apart from the welded joints.

8.5.21 The greatest dimension of openings being reinforced in non-flat walls shall not exceed 500 mm.

8.5.22 Minimum thickness of tubular elements (branches, sleeves, unions) attached to the walls of boilers, heat exchangers or pressure vessels by welding shall be not less than 5 mm;

8.5.23 Thickness of smooth flame tube shall be not less than 7 and not greater than 20 mm. Thickness of corrugated flame tube shall be not less than 10 and not greater than 20 mm.

8.5.24 Smooth flame tubes with a length up to 1400 mm may be made without stiffening rings. If there are two and more flame tubes in the boiler, stiffening rings of adjacent tubes shall not lay in one plane.

8.5.25 In the flanged area of solid ends non-reinforced openings are allowed with a diameter less than the wall thickness but not more than 25 mm. Solid ends are heads which have no openings or those with openings located at a distance of not less than 0.2 times of the external diameter from the outside contour of the cylindrical section and with a diameter of not more than 4-time wall thickness but not over 100 mm.

8.5.26 The minimum wall thickness of dished steel ends shall not be less than 5 mm. The requirement does not apply to the end plates made of non-ferrous alloys and stainless steels.

8.5.27 The use of welded dished end plates is allowed provided the positive results of strength calculations of such bottoms are submitted to the River Register. Strength calculations shall comply with the requirements of Section 9 of Guidelines P.010-2004 “Strength calculation of boilers, heat exchangers and pressure vessels” and apply strength coefficient \( \varphi \) (strength coefficient of welded joints or coefficient of bottom weakening by holes depending on the value of which coefficient is less).
8.5.28 Flanged end plates (Fig. 8.5.28) are allowed within the range of diameter up to 500 mm and for working pressures not over than 1.5 MPa. The radius of curvature of the end plates $R_b$ shall not exceed $1.2D$ and distance $l$ shall not exceed $2s$.

![Flanged end plates](image)

8.5.29 Radius of curvature of rectangular header sides shall be not less than 1.3 of the wall thickness and in any case not less than 7 mm. The minimum thickness of header walls designed to accommodate expanded tubes shall be not less than 14 mm; the width of ligaments between the holes shall be not less than 0.25 times the pitch between the centres of the holes.

8.5.30 Fillet welded joints (Figure 8.5.30) are allowed at $\alpha_2 \leq 30^\circ$ and $s \leq 20$ mm. The joint shall be welded by two-side welding. For conical shells with $\alpha_1 \geq 70^\circ$, fillet joints may be welded without edge preparation provided that the strength requirements for walls of conical elements subject to external pressure are met.

![Fillet welded joints](image)

8.5.31 Working pressure depending on minimum thickness of smoke tube walls shall correspond to the value stated in Table 8.5.31. A minimum wall thickness of stay tubes more than 70 mm in diameter, in mm, for tubes:

- peripheral, 6
- arranged inside a tube bundle, 5

<table>
<thead>
<tr>
<th>Table 8.5.31</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Working pressure at minimum thickness</strong></td>
</tr>
<tr>
<td><strong>of smoke tube wall</strong></td>
</tr>
<tr>
<td>Outer diameter of smoke tube, in mm</td>
</tr>
<tr>
<td>3.0</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>57</td>
</tr>
<tr>
<td>63.5</td>
</tr>
<tr>
<td>70</td>
</tr>
<tr>
<td>76</td>
</tr>
<tr>
<td>83</td>
</tr>
<tr>
<td>89</td>
</tr>
</tbody>
</table>

8.5.32 Thickness of spherical and cylindrical walls and tubes shall be not less than:
- .1 5 mm for drawn and welded elements;
- .2 12 mm for tube plates with expanded tubes and radially situated holes;
- .3 6 mm for tube plates with welded tubes;
- .4 stated in Table 8.5.32 (for tubes). Reduction of wall thickness caused by bending or expansion shall be compensated by allowances.

<table>
<thead>
<tr>
<th>Table 8.5.32</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thickness of spherical and cylindrical walls and tubes</strong></td>
</tr>
<tr>
<td>$D_s$, in mm</td>
</tr>
<tr>
<td>Up to 20</td>
</tr>
<tr>
<td>Over 20 to 30</td>
</tr>
<tr>
<td>$&lt; 30 \times 37$</td>
</tr>
<tr>
<td>$&lt; 37 \times 51$</td>
</tr>
<tr>
<td>$&lt; 51 \times 70$</td>
</tr>
<tr>
<td>$&lt; 70 \times 95$</td>
</tr>
</tbody>
</table>

**Note.** $D_s$ — internal tube diameter; $s$ — tube wall thickness.

8.5.33 It is allowed to use tubes with alternating knurled smoothly outlined stamped turbulators of circular, spiral or hemispheric form on their inner surface. The tube wall thickness after knurling or bending shall be not less than the design value.

8.5.34 Length of expanding end in the tube plate in expanded connection shall be not less than 12 mm and not greater than 40 mm.
Expanded connections for working pressure above 1.6 MPa shall be made with packing grooves.

8.5.35 The tubes securely seated in the headers and tube plates by expansion of their ends shall be seamless.

8.5.36 Design measures shall be taken to prevent steam generation in economizers of boilers.

8.5.37 Finned-tube boilers shall be provided with an effective soot-blowing system and be accessible for inspection of heating surfaces.

8.5.38 Fastening elements of the boiler excepting those which are not loaded, shall be not welded directly to the boiler walls (shell, ends, headers, drums etc.) but shall be attached by means of welded-on plates.

8.5.39 A nameplate indicating all main technical characteristics of boiler (nominal heat load, efficiency, fuel type, maximum power consumption, maximum water or steam temperature, permissible and maximum working pressure, water flow rate or steam output) shall be provided in a visible place.

8.5.40 Boiler rooms shall satisfy the requirements of 1.8 to 1.10.

8.6 GENERAL REQUIREMENTS TO VALVES

8.6.1 All boiler valves shall be fitted on special welded-on branches, nozzles and pads, and shall be secured thereto on flanges by studs and bolts. The studs shall have a full thread holding in the pad for a length of at least one external diameter of the stud; stud holes in pads shall be blind.

The bore of threaded nozzle fitted valves shall be not greater than 15 mm, special pads being used for attaching them to the boiler. Construction of pads, branches and nozzles shall satisfy the requirements of 8.5.18, 8.5.19, and 8.5.22.

8.6.2 The valve covers shall be secured to the valve cases by studs or bolts. Valves with bore diameter of 32 mm and less may have screwed covers provided that they are fitted with stops.

8.6.3 The valves and cocks shall be fitted with open and shut position indicators. Position indicators are not required where the design allows to see whether the valves are opened or shut.

All valves shall be arranged to be shut with a clockwise motion of the wheels.

8.6.4 Each self-contained boiler of class I (see 8.2) shall be equipped with at least two feed valves. Boilers of class II and waste-heat boilers shall have one feed valve.

8.6.5 The feed valves shall be of a non-return type (check valves). A shut-off valve shall be installed between the check valve and the boiler. The check and shut-off valves may be housed in one casing. The shut-off valve shall be fitted directly on the boiler.

8.7 WATER LEVEL INDICATORS

8.7.1 Each boiler with free water evaporating surface shall be provided with at least two independent water level indicators, one of which shall be a sight glass with a scale (see 8.7.3). A lowered or remote water level indicator with independent measuring points can be used as a second water level indicator. The second level indicator need not be installed when the boiler is fitted with the low water level protection devices, as well as low and high water level alarms. The sensors of protection devices and alarm shall be independent and shall have different measuring points.

Boilers with a steaming capacity of 750 kg/h and less as well as waste-heat boilers with free water evaporating surface and steam accumulators of waste-heat boilers may be fitted with one water level indicator having a transparent face provided that the boiler water sampling valve is fitted according to 8.13 on lower water level mark.

8.7.2 Forced circulation boilers shall be provided with two independent alarm devices to signal a shortage of water supply to the boiler instead of water level indicators.
The second alarm device is not required if it is fitted in the burning unit according to the requirements of Section 11 of this Part.

These requirements are not applicable to waste-heat boilers.

8.7.3 Flat rippled sight glasses shall be used in water level indicators for boilers with a working pressure up to 3.2 MPa. For boilers with a working pressure of 3.2 MPa and above sets of mica sheets shall be used instead of glass or plain glass with a mica layer to protect the glass from water and steam effects, or other materials resistant to action of the boiler water.

8.7.4 The water level indicators shall be fitted on the front of the boiler, at the same height and at equal distance from the vertical centre line of the drum/boiler shell.

8.7.5 All water level indicators shall be provided with shut-off devices both on the water and steam sides.

Shut-off devices shall have safe drives for disconnection of the devices in the event of glass breakage.

8.7.6 It shall be possible to blow off the water and steam spaces of water level indicators separately. Blow-down ducts shall have an inner diameter of not less than 7 mm. The design of water level indicators shall prevent the gasket material from being forced into the ducts, and allow cleaning the blow-down ducts as well as replacing the glasses while the boiler is in operation.

8.7.7 Water level indicators shall be so installed that the middle of the glass is above the lowest working level of water in the boiler, and the lower edge of the gauge slot is above the highest point of the heating surface by not less than 50 mm.

8.7.8 Water level indicators shall be connected to the boiler by means of independent branch pieces. No tubes leading to these branches are allowed inside the boiler. The branches shall be protected from affection of hot gases, radiant heat flow and intensive cooling. If the gauge glasses are fitted on hollow bodies, the inside space of such water level indicators shall be divided by partitions.

No nozzles or branch pieces for other purposes may be fitted on the water level indicators and connecting pipes.

8.7.9 The branch pieces for attachment of water level indicators to the boiler shall have an inside diameter, in mm, of not less than:

<table>
<thead>
<tr>
<th>Branch Type</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bent branch pipes for steam boilers of class I</td>
<td>32</td>
</tr>
<tr>
<td>Straight branch pipes for boilers of class I</td>
<td>20</td>
</tr>
<tr>
<td>Bent branch pipes for other boilers</td>
<td>15</td>
</tr>
</tbody>
</table>

8.7.10 Design, dimensions, number, location and lighting of water level indicators shall ensure control of water level in the boiler.

Where water level visibility is inadequate, irrespectively of the height of water level indicator location, or where the boilers are remotely controlled, provision shall be made for remote (lowered) water level indicators or other types of water gauges installed at the boiler control stations.

This requirement is not applicable to waste-heat boilers and their steam accumulators (steam separators).

8.7.11 Remote water level indicators for boilers may have an error not exceeding ±20 mm as compared to water level indicators of gauge glasses fitted on the boiler while the relevant delays of the level indications at the highest possible rate of change shall not exceed 10 per cent of the difference between the upper and lower levels.

8.8 LOWEST WATER LEVEL AND HIGHEST HEATING SURFACE POINT

8.8.1 On each boiler with free water surface (surface of evaporation) the lowest water level shall be marked on the boiler water level indicator by means of a reference line drawn on the indicator frame or body. Moreover, the lowest water level shall be marked on a plate with a reference line and inscription “Lowest level”. The plate shall be attached to the boiler shell close to the water level indicators.

The reference line and the plate shall not be covered with boiler insulation.
8.8.2 The lowest water level in the boiler shall be not less than 150 mm above the highest heating surface point, including the heel conditions up to 5° to either side and all possible operation trim conditions.

For boilers with design steaming capacity less than 750 kg/h the distance between the lowest water level and the highest heating-surface point may be reduced down to 125 mm.

8.8.3 The upper ends of the uppermost downcomers are assumed to be the highest point of the heating surface of water-tube boilers.

For vertical fire-tube boilers with smoke tubes and gas uptake pipes passing through the steam space, the position of the highest heating surface point shall be specified.

8.9 PRESSURE GAUGES AND THERMETERS

8.9.1 Each boiler shall have at least two pressure gauges connected with the steam space by separate pipes fitted with check valves or stop cocks.

Three-way valves or cocks shall be provided between the pressure gauge and the pipe to shut off the pressure gauge from the boiler, connect it to the atmosphere, blow off the connecting pipe and install the control pressure gauge.

8.9.2 One of the pressure gauges shall be installed on the front of the boiler on clearly visible and lightened place, the other — on the panel at the central control station or at the local boiler control station.

8.9.3 Boilers with design steaming capacity below 750 kg/h and waste-heat boilers are allowed to have one pressure gauge.

8.9.4 A pressure gauge shall be provided at the water outlet from the economizer.

8.9.5 Pressure gauges shall have a scale sufficient for hydraulic testing of the boiler.

The working pressure shall be marked with a red line on the pressure gauge scale.

8.9.6 Pressure gauges fitted on boilers shall be protected against affection of heat from the boiler hot surfaces.

8.9.7 Steam superheaters and economizers shall be equipped with thermometers. Remote temperature control does not preclude the need for providing local thermometers.

8.9.8 Thermometers shall also be installed on the following pipelines:

.1 lines feeding water to the boiler;
.2 suction lines of waste-heat boiler circulation pump;
.3 lines feeding hot water or steam-water mixture from waste-heat boilers to the steam separator (steam accumulator) or to autonomous boiler drum;
.4 outlet hot water or steam lines.

8.10 SAFETY VALVES

8.10.1 Each boiler shall be fitted with at least two spring-loaded safety valves of the same design and size, which shall be installed on a common branch piece of the drum and one valve fitted on the superheater outlet header. The superheater safety valve shall be so adjusted as not to open before the safety valve being installed on the drum.

Safety valves of the impulsive action type are recommended for steam boilers with a working pressure of 4 MPa and above.

One safety valve is sufficient for steam boilers with design steaming capacity below 750 kg/h as well as steam accumulators and steam separators.

Safety valve shall be adjusted and sealed by the ship crew. If there are two safety valves, one of them shall be sealed.

8.10.2 Total passage area of safety valves $f$ shall be not less than the one calculated by the formulae, in mm$^2$:

for saturated steam

$$f = k \frac{G}{(10.2 p + 1)}; \quad (8.10.2-1)$$

for superheated steam

$$f = k \sqrt{\frac{v_h}{v_s}} \frac{1}{(10.2 p + 1)}, \quad (8.10.2-2)$$
where \( k \) — coefficient adopted from Table 8.10.2;

<table>
<thead>
<tr>
<th>Height of valve lifting ( h ), in mm</th>
<th>Coefficient ( k )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( d/20 \leq h &lt; d/16 )</td>
<td>22</td>
</tr>
<tr>
<td>( d/16 \leq h &lt; d/12 )</td>
<td>14</td>
</tr>
<tr>
<td>( d/12 \leq h &lt; d/4 )</td>
<td>10.5</td>
</tr>
<tr>
<td>( d/4 \leq h &lt; d/3 )</td>
<td>5.25</td>
</tr>
<tr>
<td>( d/4 \leq h )</td>
<td>3.3</td>
</tr>
</tbody>
</table>

*Note.* \( d \) — minimum diameter of the valve, in mm.

\( G \) — design steaming capacity, in kg/h;

\( p \) — working pressure, in MPa;

\( \nu_s \) — specific volume of superheated steam at the corresponding working pressure and temperature, in \( \text{m}^3/\text{kg} \);

\( \nu_t \) — specific volume of saturated steam at the corresponding pressure, in \( \text{m}^3/\text{kg} \).

Safety valves shall be not less than 32 mm and not greater than 100 mm in diameter.

8.10.3 The passage area of the safety valve installed on non-disconnected superheater is included in the total cross-sectional area of the valves to be determined by the formulae (8.10.2-1) and (8.10.2-2). This area shall not exceed 25 per cent of the total area of the valves.

8.10.4 The safety valves shall be so adjusted that the maximum pressure during their operation shall not exceed the working pressure by more than 10 per cent.

Safety valves of boilers of class I after each actuation shall be totally closed at a pressure drop in the boiler not below 85 % of the working pressure.

8.10.5 Economizers shall be fitted with a spring safety valve with a diameter not less than 15 mm.

8.10.6 Where safety valves are fitted on the common branch, the cross-sectional area of the branch shall be not less than 1.1 times the total cross-sectional area of the valves.

8.10.7 Passage area of waste-steam branch of the safety valve and of the pipe connected thereto shall be not less than twice the total free passage area of the valve. If safety valve is double, total cross-sectional area of both valves shall be taken for calculation.

8.10.8 A drain pipe free of stopping devices shall be provided on the valve body or on the waste-steam pipe, if the latter is located below the valve, for condensate removal.

8.10.9 The safety valves shall be connected directly to the boiler steam space without any stopping devices. No feeding pipes leading to the safety valves may be installed inside the boiler. No steam extraction devices for other purposes may be fitted on the safety valve bodies or their connections.

8.10.10 Safety valves shall be so arranged that they can be lifted manually by a special drive. The gear of one of the valves shall be controlled from the boiler room, and that of the other valve — from the upper deck or other accessible place outside the boiler room.

Remote drive for safety valves of steam superheaters, waste-heat boilers and their steam accumulators (separators) may be controlled only from the boiler room.

8.10.11 Safety valves shall be so designed as to prevent their adjustment when the seal is not removed.

Safety valve springs shall be protected against direct affection of steam and shall be manufactured of heat- and corrosion-resistant material, as well as sealing surfaces of seats and valves.

8.11 SHUT-OFF VALVES

8.11.1 Each boiler shall be separated from all connected pipelines by means of shut-off valves fitted directly on the boiler.

8.11.2 In addition to local control, the shut-off valves of steam pipelines shall be provided with remote control gears for the operation from the upper deck or from other accessible position outside the boiler room.

8.11.3 Where on a ship there is one boiler of class I with a superheater or economizer, the superheater and economizer shall be so arranged as to be disconnectable from the boiler.
8.11.4 Requirements for steam pipes and boiler blow-down pipes are set forth in 10.18.

8.12 BLOW-DOWN VALVES

8.12.1 Boilers, steam superheaters, economizers and steam accumulators shall be fitted with blow-down arrangements and, if required, with drain valves.

Blow-down and drain valves shall be fitted directly on the boiler shell. At a working pressure below 1.6 MPa these valves may be installed on welded-on profiled branch pieces.

8.12.2 The inner diameter of blow-down valves and pipes shall be not less than 20 mm and not more than 40 mm. For boilers with design steaming capacity below 750 kg/h the inner diameter of the valves and pipes may be reduced to 15 mm.

8.12.3 In boilers with free water surface of evaporation, the scum arrangements shall be so provided as to ensure scum and sludge removal from the entire evaporation surface.

8.13 SAMPLING VALVES

8.13.1 Each boiler shall be provided with at least one water sampling valve or cock. Such valves or cocks shall not be fitted on pipes and branches intended for other purposes.

8.14 DEAERATION VALVES

8.14.1 Boilers, steam superheaters and economizers shall be equipped with sufficient number of valves and cocks for deaeration.

8.15 CONTROL, ADJUSTMENT, ALARM AND PROTECTION OF BOILERS

General requirements

8.15.1 Requirements of this Chapter apply to the boilers designed for attended operation according to the technical documentation.

Requirements to control, adjustment, alarm and protection of boilers designed for unattended operation are stated in Section 11 of this Part.

8.15.2 Automation systems and their elements shall meet the requirements of Section 11 of this Part.

Adjustment and protection

8.15.3 Water-tube boilers of class I shall be equipped with feed water governors and combustion controls.

8.15.4 Governors and controls shall be capable of maintaining the water level and other controlled parameters within the predetermined limits over the entire load range and shall ensure change-over from one operation mode to another one within not more than 5 min.

8.15.5 Boilers shall be equipped with non-disconnectable protective devices for the lowest water level limit in the boiler.

8.15.6 Boilers with automatic combustion controls shall be fitted with protection devices according to the requirements of 8.16.9 to 8.16.11.

Alarm

8.15.7 Boilers with automatic feed water governors and combustion controls shall be equipped with visual and audible alarm at the boiler control station.

8.15.8 Visual and audible alarm shall be actuated when:

1. water level reaches the lowest limit;
2. water level reaches the highest limit;
3. failures occur in the boiler oil burning system (see 8.16.10);
4. failures occur in the automatic control systems and protection devices.

8.15.9 The lowest level limit alarm shall be actuated prior to actuation of the protection devices.

8.15.10 When heavy fuel is used, audible and visual alarm shall be provided, which shall be actuated when:

1. heavy fuel before the injector reaches the minimum or maximum temperature;
. heavy fuel in the boiler fuel service tank reaches the minimum or maximum temperature (only for ships of Group I as regards the automation scope).

8.15.11 Provision shall be made for manual disconnection of the audible alarm after it has been actuated.

8.16 OIL BURNING UNITS OF FUEL OIL FIRED BOILERS

General requirements

8.16.1 Control, protection, interlock and alarm devices shall meet the requirements of Section 11 of this Part.

8.16.2 Electrical equipment for burning units shall meet the requirements of Part VI of the Rules.

8.16.3 Fuel oil used for boilers shall have a flash point in accordance with the requirements given in 1.1.2.

Burners

8.16.4 The burners shall be so designed as to ensure the possibility of controlling the size and shape of the flame jet.

8.16.5 In case of variable-delivery burners provision shall be made for controlling the combustion air supply.

8.16.6 Inlets of the boiler fans shall be protected against the ingress of moisture or foreign items.

8.16.7 Rotating parts of burners and boiler fans shall be fenced by protective housings for the attending personnel safety.

Burning units

8.16.8 The present requirements apply to burning units equipped with automated mechanical combustion controls of boilers.

8.16.9 Burning units shall be interlocked for fuel supply to the boiler furnace to be possible only under the following conditions:

.1 the burner is in the operating position;

.2 electrical supply is fed to all the electrical equipment;

.3 air is fed into the boiler furnace;

.4 the pilot burner is alight or electrical ignition is switched on;

.5 water level in the boiler is normal;

.6 program of furnace and gas ducts ventilation is completed before lighting up.

8.16.10 Burning units shall be equipped with non-disconnectable protection devices being actuated within not over than 1 s (for pilot burner – not more than 10 s) and shutting off automatically the fuel supply to the burner in the cases of:

.1 loss or low head of air flow to the furnace;

.2 flame-jet cut-off at the burner;

.3 water level in the boiler reaching its lowest limit.

Fuel supply shall be cut-off by two self-closing series-connected valves. This requirement is not mandatory when the fuel service tank of the boiler is arranged below the burning unit.

8.16.11 Burning units shall be equipped with a burner flame jet monitor. Such monitor shall respond only to the flame jet of the burner under control.

8.16.12 Burning units of boilers of class I shall be capable of being manually controlled. Manual control shall be provided directly at the boiler; in this case all automatic devices required in 8.16.9 and 8.16.10 shall function as well.

8.16.13 Provision shall be made for the burning unit to be shut off from two stations, one of which shall be situated outside the boiler room.

8.16.14 Before each boiler ignition the furnace and gas ducts shall be well-ventilated to provide three air changes in the entire furnace and gas ducts prior to smoke tube inlet. The furnace and gas ducts shall be ventilated for at least 15 s.

8.16.15 Abrupt turns and stagnant zones in exhaust gas pipelines are not allowed.
8 Boilers, Heat Exchangers and Pressure Vessels

Piping and valves

8.16.16 Pipelines and valves of burning units shall meet the requirements of Section 10 of this Part.

8.16.17 On the fuel pipeline near the burners it is allowed to use flexible pipelines made of fuel resistant materials.

8.16.18 Design measures shall be provided to prevent the burners from being turned and removed from their working positions until fuel supply to them is not shut off.

8.16.19 When steam or air atomizing burners are used, design measures shall be provided to prevent the ingress of air or steam into the fuel oil and vice versa.

8.16.20 If boiler fuel is heated, design measures shall be taken to prevent inadmissible oil overheating in the heaters in case when the steam-generating capacity of the boiler is reduced or the burners are shut-off.

8.16.21 Drip trays shall be provided in places of possible oil leakage.

8.16.22 Inspection devices shall be provided in the boiler furnace for observing the combustion process. There shall be installed arrangements to prevent flame and hot air ejection from the furnace space when removing the burners.

8.16.23 Appropriate devices shall be provided for the suppression of hand lighting primers of the boiler.

8.17 HEAT EXCHANGERS AND PRESSURE VESSELS

8.17.1 The elements of heat exchangers and pressure vessels contacting with salt outboard water or other aggressive media shall be manufactured of corrosion-resistant materials protected from corrosion by means of corrosion-resistant coatings.

8.17.2 Heat exchangers and pressure vessels shall meet the requirements of 1.3.

8.17.3 The requirements of 8.5.4, 8.5.8, 8.5.9, 8.5.12, 8.5.13, 8.5.17 to 8.5.22, 8.5.25, 8.5.32 to 8.5.35 apply to heat exchangers and pressure vessels.

8.17.4 Heat exchangers and pressure vessels shall be so designed as to provide thermal elongation of their shells and separate parts.

8.17.5 Heat exchangers and pressure vessels shall be so designed as to provide their attachment to the foundations. If fastening to foundations of heat exchangers and pressure vessels is impractical, overhead attachments shall be provided.

8.17.6 Manholes shall be provided to enable inspection of the internal surfaces of heat exchangers and pressure vessels. If it is impossible to equip manholes, sight holes shall be foreseen. If the length of a heat exchanger or pressure vessel is over 2.5 m, sight holes shall be provided at both ends.

Manholes or sight holes are not required for dismountable structures or when the design and materials of heat exchangers and pressure vessels completely exclude corrosion and contamination of internal surfaces.

Manholes or sight holes may be omitted for heat exchangers and pressure vessels for which inspection through such holes is impossible due to their construction.

Dimensions of manhole openings are indicated in 8.5.14.

8.17.7 Requirements to installation of the heat exchangers and pressure vessels are stated in 1.10.

8.17.8 Each heat exchanger, pressure vessel or their groups shall be fitted with non-disconnectable safety valves. Where there are several non-communicating spaces, safety valves shall be provided for each space. Hydrophores shall be fitted with a safety valve to be installed on the water side.

8.17.9 Safety valves shall be of spring-loaded type. In fuel and oil heaters it is allowed to use safety diaphragms installed on the fuel or oil side.

8.17.10 The discharge capacity of the safety valves shall be such that under no condition
the working pressure is exceeded by more than 15 per cent.

8.17.11 The safety valves shall be so designed as to allow their stamping or be fitted with equivalent protection means to prevent the valve adjustment without authorization by the attending personnel.

The materials used for springs and sealing surfaces of the valves shall be capable to withstand corrosion effect of the medium.

8.17.12 Level indicators and sight glasses may only be installed on heat exchangers and pressure vessels where the conditions of control and inspection stated in technical documentation of the manufacturer require so. Level indicators and sight glasses shall be protected from impacts. Flat glass plates shall be used for level indicators containing steam, fuel, oil or refrigerants.

In deaerators cylindrical glasses may be used.

8.17.13 Heat exchangers and pressure vessels shall be fitted with welded-on pads or short rigid connecting pieces to mount valves. At hydrophores threaded connections may be used.

8.17.14 Pressure vessels and heat exchangers shall be equipped with blow-down and drainage devices.

8.17.15 Each heat exchanger and pressure vessel or their groups being disconnectable from each other shall be equipped with pressure gauges and compound gauges.

If heat exchangers have several spaces, pressure gauges shall be provided for each space.

The pressure gauges shall meet the requirements set forth in 8.9.1 and 8.9.5.

8.17.16 On fuel heaters where temperature of fuel on heating elements may exceed 220 °C, a warning alarm sensor giving indication of temperature rise or failure of fuel flow through the heater shall be installed in addition to the temperature control device.

8.18 SPECIAL REQUIREMENTS FOR HEAT EXCHANGERS AND PRESSURE VESSELS

Air receivers

8.18.1 Safety valves on air receivers after actuation shall fully stop the air bleeding in case of pressure drop in the air receiver to 0.85 of the working pressure.

8.18.2 Where compressors, reduction valves or pipelines intended for air supply to air receivers are fitted with safety valves which are so installed that air supply to air receivers under pressure exceeding the working pressure is excluded, the safety valves on the air receiver may be omitted. In this case each air receiver shall be equipped with a fuse instead of the safety valve.

8.18.3 The air receiver fuse shall have a fusion temperature from 100 to 130 °C. The fusion temperature shall be punched out on the fuse.

Air receivers having a capacity over 700 l shall be fitted with fuses of not less than 10 mm in diameter.

8.18.4 Each air receiver shall be equipped with a drain device for moisture removal. In case when air receivers are arranged horizontally, moisture drain devices shall be fitted at both ends of the receiver.

Condensers

8.18.5 The condenser design and its location onboard a ship shall be such as to enable the tube replacement. The condenser shall have welded steel shell. Baffles shall be provided inside the condenser at the steam inlets to protect the tubes against direct steam impact.

Pipe attachments shall exclude sagging and vibration with an amplitude exceeding 1 mm in the midspan of pipe.

8.18.6 Covers of condenser water chambers shall be fitted with manholes in a such number and so located as to ensure access to the tubes in any part of the tube nest for the pur-
pose of expansion, replacement, packing or plugging.

Cathodic protection shall be provided for the water chambers, tube plates and tubes for prevention of electrolytic corrosion.

8.18.7 The condenser of the turbo generator shall ensure the operation under emergency conditions with any casing of the turbine set being disconnected.

8.18.8 The condenser shall be so designed as to enable connecting of monitoring and control instrumentation.

Heat exchangers and vessels of fire-fighting installations

8.18.9 The design of heat exchangers and pressure vessels of refrigerating plants and fire-fighting installations shall meet the requirements of Sections 9 of this Part and 13 Part III of the Rules.

Pressure vessels being a part of process equipment

8.18.10 Covers of the pressure vessels being a part of the process equipment which are periodically opened shall be fitted with devices preventing their incomplete closing or spontaneous opening. It is also necessary to prevent the cover opening in case of excessive pressure or vacuum in the pressure vessel as well as against pressurization of the vessel in case of incomplete closing of the cover.

8.18.11 The inside arrangements of the pressure vessels being a part of the process equipment (mixers, coils, trays, diaphragms etc.), which interfere the internal inspection, shall be of removable type.

8.18.12 Sight glasses not more than 150 mm in diameter intended for observation of the mixer working space may be fitted on pressure vessels with a pressure not exceeding 0.25 MPa.

8.18.13 For the pressure vessels being a part of the process equipment with a pressure over 0.25 MPa closing appliances of the loading holes shall be so designed that in case of cover sealing loss the hot medium shall be removed in the direction safe for the operating personnel.

8.18.14 The pressure vessels being a part of the process equipment that operate under vacuum and are heated by steam or hot water with a temperature over 115 °C shall be fitted with safety valves to prevent an excessive pressure in the space operating under vacuum above 0.85 times the test pressure in case of leakage in the heating system.

The vessels mentioned herein shall be designed for strength at the design pressure equal to safety valve opening pressure. In this case the design stresses in the pressure vessel walls shall not exceed 0.8 times the yield stress of the material at the design temperature.

8.18.15 Strength of flanges, bolts and studs of periodically opened covers of pressure vessels being a part of the process equipment shall be confirmed by calculations carried out by designer according to the requirements of the Rules. The design stresses shall not exceed 0.4 times the yield stress of the material at the design temperature.

Diameter of bolts and studs shall be not less than 16 mm in all cases.

8.18.16 For steam-heated and water-heated agitators and also for walls of pressure vessel mixing chambers which are in contact with the processed products an allowance c to the design wall thickness shall be taken for at least 2 mm.

Compressed and liquefied gas vessels

8.18.17 Strength calculations for compressed/liquefied gas vessels carried out in accordance with the Guidelines P.010-2004 shall be submitted. Compressed/liquefied gas vessels are portable pressure vessels specially made for storage of compressed gases, refrigerant or CO₂ which are used during the ship operation and can not be filled using onboard facilities.

For manufacture of these vessels it is allowed to use steels with upper yield point over 750 MPa, but less than 850 MPa.
8.18.18 Non-disconnectable safety devices shall be provided in case of temperature rise inside the vessels to avoid impermissible internal pressure. It is possible to use safety valves and diaphragms with an opening pressure exceeding the working pressure by 10%, but less than 90% of the test pressure.

8.18.19 Durable marking indicating the date of the next test of the vessel shall be applied on compressed/liquefied gas vessels.

8.18.20 It is not required to install safety devices for the compressed gas vessels with capacity less than 100 litres, provided the following requirements are met:

.1 vessels shall not be arranged in the ship’s hull below the main deck;
.2 temperature in the rooms where the vessels are placed shall not exceed the temperature specified in 1.3.1 Part V of the Rules.
.3 rooms where compressed gas vessels are placed shall not be in the immediate proximity from accommodation spaces, control stations and rooms in which inflammable substances and fuel are stored.

8.18.21 Gas from the safety devices shall be withdrawn to the atmosphere through closed takeoff.
Gas from safety devices of cylinders carbon dioxide fire extinguishing system shall be withdrawn according to requirements of 3.8.21 Part III of the Rules.

8.19 STRENGTH CALCULATION

8.19.1 Strength calculations for boilers, heat exchangers and pressure vessels shall be carried out according to the Guidelines P.010-2004 and (or) Guidelines P.037-2010 “Procedure of strength calculations for ship heat exchangers”. It is allowed to use other procedures and programs agreed with the River Register.

8.20 BOILERS WITH HIGH-TEMPERATURE ORGANIC HEAT TRANSFER FLUID

8.20.1 Boilers with high-temperature organic heat transfer fluid shall be arranged in separate rooms with exhaust ventilation ensuring at least six air changes per hour.

If the location is different, the boilers specified in this Section shall be enclosed with welded coaming of at least 150 mm in height equipped with a drain pipe into closed discharge tank.

8.20.2 The design of boiler shall exclude the possibility of rise of heat transfer fluid temperature above the permissible value when the heat transfer fluid circulation stops.

Maximum operating temperature of heat transfer fluid shall be lower than its heat-resistance by at least 50°C.

8.20.3 The design of furnace and burning unit shall ensure uniform distribution of heat flows or such distribution of heat flows at which in any point of heated surfaces the temperature of fluid boundary layer does not exceed the value determined for the used heat transfer fluid by the designer.

Arrangement of burning unit and design of furnace shall make it impossible for the flame to contact the heated surfaces.
The burning unit shall guarantee that the heat flow of the boiler does not exceed its nominal value.

8.20.4 Each boiler shall be equipped with:

.1 stop valves on pipelines feeding the heat transfer fluid to the boiler and discharging the heat transfer fluid from it. Valves shall be arranged in a place accessible and safe for maintenance and have a remote control, or a device for discharge of high-temperature organic heat transfer fluid from system shall be provided. It is allowed to install three-way valves with remote control and non-return-stop valves without remote control at the outlet of heat transfer fluid from the boiler;
.2 spring safety valve of fully covered design. Total capacity of the installed safety valves shall be not less than the volume gain of heat transfer fluid in the boiler at maximum heating intensity. Nominal inside diameter of valves shall be not less than 25 mm and not more than 130 mm. It is allowed not to install the safety valve if the boiler is directly connected to the expansion tank and cannot be disconnected from it. Safety valve actuation pressure shall not exceed the maxi-
mum working pressure by more than 10% (for the requirements to safety valves, see 8.10.4, 8.10.10 and 8.10.11);

.3 pressure gauge installed on the pipeline delivering high-temperature organic heat transfer fluid to the boiler;

.4 device for emergency enclosed discharge of heat transfer fluid to separate discharge tank and remote stop of circulating pumps;

.5 hatches specified in 8.5.12, 8.5.14 and 8.5.15.

8.20.5 Each boiler shall be equipped with soot-blowing system.

8.20.6 Boiler pipes shall be connected to manifolds by means of welded joints.

8.20.7 Boilers shall be equipped with valves having bellow seals, the valves being attached by welding.

8.20.8 Boilers shall be equipped with alarm and protection against limit values of gas and heat transfer fluid temperatures at the outlet of the boiler.

8.20.9 If waste-heat boilers have bypass channels, the boiler shall be equipped with a stop arrangement to stop gas delivery to the boiler when the protection operates.

8.20.10 Boilers with high-temperature organic heat transfer fluid shall be equipped with automatic controls of combustion, audible and light alarm according to the applicable requirements of 8.15, interlock according to 8.16.9 and protection according to 8.16.10.
9 REFRIGERATING PLANTS

9.1 SCOPE OF APPLICATION

9.1.1 The requirements of this Section of the Rules apply to onboard refrigerating plants of transport, refrigeration and catching vessels and their equipment.

9.1.2 Refrigerating plants for cooling cargo holds and cargo chambers of portable refrigerating containers carried by a ship, shall comply with all requirements of the present Section of the Rules.

9.2 GENERAL TECHNICAL REQUIREMENTS

9.2.1 Elements of the refrigerating plant shall maintain workability under conditions of rolling and trim according to 1.3.

9.2.2 The equipment being a part of the refrigerating plant shall be installed and fastened onboard in accordance with 1.10.2, 1.10.3, 1.10.5, 7.4.2.

9.2.3 For the requirements to hydraulic tests, see 6.2.54 to 6.2.57 of RTSC.

9.3 REFRIGERANTS AND DESIGN PRESSURE

9.3.1 In this Rules the refrigerants are divided into the following three groups:

I — non-flammable refrigerants (halon);

II — toxic and inflammable refrigerants with lower inflammability point at the bulk concentration of the refrigerant vapour in the air of 3.5 per cent and over (ammonia);

III — explosive or inflammable refrigerants with lower inflammability point at the bulk concentration of the refrigerant vapour in the air of less than 3.5 per cent (propane, propylene).

Refrigerants of Group III are allowed only for refrigerating systems of ships intended for carriage of liquefied gases in bulk when the cargo is used as a refrigerant.

9.3.2 In strength calculations of the elements operating under the pressure of the refrigerant a design pressure shall be taken not lower than the excessive pressure of the refrigerant saturated vapour at 50 °C according to Table 9.3.2.

<table>
<thead>
<tr>
<th>Table 9.3.2 Design pressure of refrigerant saturated vapours</th>
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<tbody>
<tr>
<td>Refrigerant Group Symbol</td>
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* To be used instead of R12 which is not permitted for newly built refrigerating plants.

** To be used at medium (from minus 30 to plus 30 °C) condensation points instead of R22 which is not permitted for new refrigerating plants since 01 January 2020.

Design pressure for the components of refrigerating plants operating under pressure of refrigerants with low (below 50 °C) critical temperatures shall be selected according to thermodynamic properties of the refrigerant.

Refrigerating plant components operating under pressure shall be checked by strength calculation at a pressure equal to the hydraulic test pressure. Here, the stresses occurred shall not exceed 0.9 times the yield stress of the material.

9.4 REFRIGERATING CAPACITY AND COMPOSITION OF REFRIGERATING EQUIPMENT

9.4.1 Refrigerating plant shall provide permanent maintaining the temperature within
cooled spaces that is required according to the type of the cargo carried and the navigation area at a ship’s normal operating conditions.

9.4.2 Refrigerating plant shall maintain the required temperature when the main equipment operates for all refrigeration consumers at ambient air temperature not lower than +40 °C and outboard water temperature not lower than +30 °C.

9.4.3 The drive capacity, the refrigerating capacity, the heat-exchange surface area of evaporators and air cooler condensers as well as the heat-exchange surface area of cooling batteries with coolant circulating therein shall be sufficient for maintaining the required temperatures within cooled spaces at continuous 24-hour operation of the main equipment and supplying refrigeration to other consumers.

The main equipment shall include at least two similar condensers and, when intermediate coolant systems or cascade and stage cycles are used, two similar evaporators, interstage heat exchangers and intermediate vessels.

9.4.4 The drive capacity, the refrigerating capacity, the surface areas stated in 9.4.3, of the refrigerating plant intended also for refrigerating non-precooled cargo onboard, shall be sufficient for its cooling down to the required temperature within period of time for which its undamaged state is guaranteed, at continuous operation of all the equipment including standby units.

9.4.5 Standby equipment of a compressor refrigerating plant shall consist of a compressor together with a drive motor, condenser, control system and valves which are necessary to provide independent operation of all units of the equipment.

Refrigerating capacity of standby equipment shall be such as to supply refrigeration to all consumers when any one of the main compressors or condensers is out of order.

9.4.6 In ships with a capacity of cooled holds not exceeding 300 m³ the refrigerating plant without standby equipment may be used. The plant capacity and the cooling surface area shall be sufficient for maintaining the required temperatures at continuous operation for 18 hours a day.

9.4.7 Piping joints between the elements of the refrigerating plant shall be such that the equipment is able to operate at any combination of the equipment. Heat exchangers and other apparatus shall be fitted with connection joints for suction and discharge lines for the refrigerant pumping and exhaustion.

9.4.8 Cooling batteries shall be so located as to provide the uniform cooling of the space.

The batteries shall consist of at least two independent sections, with each section capable of being shut-off separately. No cooling batteries with direct evaporation of refrigerant of Group II may be used.

9.4.9 Where the refrigerant pump circulation systems are used, at least two refrigerant circulation pumps shall be fitted with one of them being a standby pump.

If the pump circulation system capable of operating when the pumps are switched off, standby pump may be dispensed with. In this case the refrigerating plant capacity shall comply with the requirements of 9.4.1 and the refrigerating capacity of freezing chambers or refrigerants shall not be reduced by more than 20 per cent.

9.4.10 Liquid coolant system of a group of refrigeration consumers shall have at least two liquid coolant pumps with one of them being standby.

If onboard the ship there are two or more groups of refrigeration consumers with independent liquid coolant systems, including those with different temperatures, each group of consumers shall be fitted with at least one liquid coolant pump; For this consumers one common pump ensuring required delivery and head of working medium can be used as a standby pump.

9.4.11 Refrigerating plant shall be fitted with at least two cooling water circulation pumps, one of them shall be standby. Any
outboard water pump of adequate supply capacity and liquid head may be used as a standby one.

9.4.12 Cooling water shall be supplied by at least two outboard valves. Where general-purpose outboard valves are used, each of them shall provide the sufficient water supply to ensure operation of the refrigerating plant in normal operating conditions of the ship.

9.5 MATERIALS

9.5.1 Quality and main characteristics of materials used for manufacture of component parts, units and fastening of the refrigerating equipment subject to dynamic loads, excessive pressure, variable and low temperatures at operation, shall comply with the relevant requirements of Part X of the Rules shall be complied with.

Materials shall be chosen depending on the working temperature and physical and chemical properties of the refrigerant with due regard to the following:

.1 materials of the elements being in contact with refrigerants and their solutions, lubricating oils, cooling media and media to be cooled, shall be inert and resistant to their action;

.2 materials of the equipment parts operating at temperatures below minus 70 °C shall not have irreversible structural changes and shall maintain sufficient strength at these temperatures;

.3 steel structures operating at temperatures down to minus 50 °C shall comply with the requirements of 2.3.7 Part X of the Rules;

.4 materials used for manufacture of refrigerating plant components operating at temperatures below minus 50 °C shall be selected according to the requirements of Section 5 Part X of the Rules shall be complied with.

9.5.2 The elements contacting with corrosive media shall be made of materials with adequate corrosion-resistant properties to those media or shall be protected with corrosion-resistant coatings.

Joints and structures of machinery and equipment made of materials with different electrolytic potentials, that can contact with sea water, shall be protected against galvanic corrosion.

9.5.3 Steel pipes of the refrigerant, liquid coolant and their connecting parts made of steel other than stainless steel, shall be zinc-plated from the outside or have equivalent protection against corrosion from the outside. Surfaces being in contact with the refrigerant or liquid coolant shall not to be zinc-plated.

9.6 ELECTRICAL EQUIPMENT

9.6.1 Electrical equipment of refrigerating plants, automatic devices as well as illumination of refrigerating machinery rooms, refrigerant storerooms and cooled spaces shall comply with relevant requirements of Part VI of the Rules.

9.7 REFRIGERATING MACHINERY ROOM

9.7.1 The refrigerating machinery room shall comply with the requirements of 1.8.1, 1.8.7 and the present Chapter.

Refrigerator machines using refrigerants of Group II and III shall be located in separate gas-tight spaces.

Drainage of the refrigerating machinery room shall be made in accordance with the requirements of 10.7.34.

9.7.2 Pumps, compressors, apparatus and pipelines shall be located in the refrigerating machinery room in a such manner as to be readily accessible for maintenance and replacement of their parts without dismantling the pumps, compressors, apparatus from their foundations. They shall be located apart from the bulkheads of other spaces and surfaces of the adjacent equipment for at least 100 mm.

9.7.3 The refrigerating machinery room shall have two exits located as far apart as possible from each other with doors opening outwards. Where the refrigerating machinery room is located above or below the open deck, the exits shall be fitted with steel stair-
ways leading to the doors of spaces giving to the open deck.

In unattended automated refrigerating machinery rooms, where refrigerants of Group I are used, the second exit may be dispensed with.

9.7.4 Exits from the refrigerating machinery room where refrigerants of Groups II and III are used shall not lead to accommodation and service spaces or spaces communicating with them and shall be arranged considering the refrigerant density. One of the exits shall lead to the open deck.

Exits with corridors or trunks shall be fitted with supply and exhaust ventilation; The supply ventilation shall be of forced type. The switching-on device of this ventilation shall be located both inside and outside the refrigerating machinery room in the immediate proximity to the exit door.

9.7.5 Exits from the refrigerating machinery room where refrigerants of Groups II and III are used, shall be fitted with a water-screen arrangement. The water screen actuation device shall be located outside the room in the immediate proximity to the exit door.

A fire hydrant with a hose connected to the fire main system shall be installed in the refrigerating machinery room.

9.7.6 The refrigerating machinery room shall be equipped with an independent ventilation system providing 10 air changes per hour.

9.7.7 In addition to the main ventilation satisfying the requirements of 9.7.6 each refrigerating machinery room shall be equipped with emergency ventilation ensuring air change per hour for refrigerating machinery room using refrigerants:

<table>
<thead>
<tr>
<th>Groups</th>
<th>Air Changes per Hour</th>
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<tr>
<td>II and III</td>
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The ventilation system shall ensure air exhaust from either the uppermost or lowermost parts of the room depending on the refrigerant density.

When calculating the emergency ventilation system the supply of the main ventilation fans may be taken into account provided that the main ventilation is able to operate together with the emergency ventilation in the event of de-energization of the refrigerator machinery distribution switchboard.

9.8 REFRIGERANT STOREROOMS

9.8.1 Refrigerant storerooms shall be separated from other spaces; their location onboard and the construction of the boundaries shall comply with the requirements of Part III of the Rules.

Refrigerant storerooms shall be gas-tight.

9.8.2 The refrigerant reservoirs shall be fastened in such a way as to prevent their shifting at rolling motions of a ship.

Non-metal spacings shall be placed between the bottles and the storeroom plating as well as between particular bottles.

9.8.3 Refrigerant storerooms shall be fitted with an independent ventilation system and shall be insulated in such a manner that the inside temperature can not exceed 45 °C.

9.8.4 In the room where the refrigerant store is kept reservoirs with other compressed gases shall not be kept. No combustible materials may be used for the room fitting.

9.8.5 The refrigerant may be stored in fixed receivers if the receivers and the rooms where they are located, comply with the requirements of 9.7.5, 9.7.7, 9.13.1, 9.13.2, 9.13.4, 9.16.5, and 9.16.6.

It shall be possible to discharge the refrigerant of Group II from the discharge pipe of each receiver after the system has been filled or replenished.

Discharge pipes from the refrigerant storage receivers shall not be laid through accommodation and service spaces.

9.9 COOLED CARGO SPACES

9.9.1 Refrigerating equipment, batteries, devices as well as pipelines and air pipes located in cooled spaces shall be secured and protected against damage by the cargo.

9.9.2 Air coolers of air cooling systems may be located both in separate spaces and in
cooled cargo spaces. When installed in cooled cargo spaces, the air coolers shall be fitted with a condensate collector. For cooled spaces with temperatures below 0 °C it is recommended to provide condensate collectors with a heating system.

No air coolers with direct evaporation of refrigerants of Group II may be used.

9.9.3 If air coolers of air cooling systems are installed in a separate room, they shall be accessible when the cargo space is completely loaded. Where this is impracticable, air coolers shall be accessible from the adjacent non-cooled neighbouring spaces. Dimensions of the opening for passage to the air cooler room shall be sufficient to permit the fan impeller and the electric motor to be carried through.

9.9.4 Where air cooling channels pierce tight bulkheads, the latter shall be equipped by sluice valves rated for the same pressure as the bulkheads. The sluice valve controls shall be located in accessible places above the freeboard deck.

9.9.5 For transportation of cargoes that require air change in cooled cargo spaces to ensure its safety, a ventilation system shall be provided that ensures supply of clean atmospheric air, cooled or heated, into the cargo spaces.

9.9.6 Each inlet and outlet in the bulkheads or enclosures of the cooled cargo spaces shall be supplied with air-tight closers.

9.9.7 Air channels laid through the cooled spaces to other spaces shall be sealed and insulated.

9.9.8 Where refrigerating plants are fitted with air cooling system of cargo holds with direct evaporation of refrigerant of Group II in the air coolers, an independent ventilation system shall be provided for each hold or a group of such holds.

9.9.9 Cooled spaces shall be equipped with telethermometric arrangements. Otherwise these spaces shall be equipped with at least two thermometric tubes with a diameter not less than 50 mm.

Thermometric tube sections laid through non-cooled spaces shall be insulated.

9.9.10 Drainage of the cooled spaces shall be accomplished according to the requirements of 10.7.40 to 10.7.43.

9.10 FREEZING AND COOLING CHAMBERS

9.10.1 Air coolers and fans shall be located within freezing chambers according to the requirements of 9.9.1 and 9.9.3.

9.10.2 The refrigerating machinery room shall be equipped with devices for controlling the operation of freezing and cooling apparatus using the direct evaporation system.

9.10.3 Where the direct evaporation system of refrigerant of Group II is used in the freezing chamber, an emergency exhaust ventilation is required and the chamber shall be gastight.

9.10.4 Valves of pipelines running into the freezing chamber shall be located outside the chamber.

9.10.5 It shall be possible to open freezing and refrigerating chambers from inside even if the doors are closed from outside.

9.11 SPACES CONTAINING PROCESS EQUIPMENT

9.11.1 Compressors, pumps, apparatuses and vessels operating under refrigerant pressure shall be located in the refrigerating machinery room.

9.11.2 Spaces containing the process equipment using the direct evaporation system of refrigerant of Group II, shall be fitted with a fire hydrant with a hose connected to the water fire-extinguishing system.

9.11.3 Spaces containing the process equipment shall be fitted with an independent ventilation. In addition to the main ventilation, spaces which contain the process equipment using the direct evaporation system shall be fitted with emergency ventilation.
The number of air changes per hour of the main and emergency ventilation systems shall comply with the requirements of 9.7.6 and 9.7.7.

9.11.4 Spaces containing the process equipment using the direct evaporation system of refrigerant of Groups II and III, shall be fitted with two exits in accordance with 9.7.3 and 9.7.4. Where refrigerant of Group II is used, these exits shall be equipped by the water-screen arrangements. The water screen starting device shall be located outside the room in the immediate proximity to the exit door.

9.12 COMPRESSORS, PUMPS, FANS

9.12.1 Compressors shall comply with the requirements of 7.6.8, 7.7 and the present Section.

9.12.2 Strength of the compressor parts subject to dynamic loads and excessive pressure during operation shall be rated on the assumption of the design pressure values in accordance with 9.3.2.

9.12.3 Compressors arranged on the refrigerant suction and discharge sides shall be fitted with shut-off valves regardless of automatically controlled valves’ availability.

9.12.4 Refrigerant, oil and cooling water cavities shall be equipped with drain arrangements.

9.12.5 A safety valve or any other self-operating safety device bypassing the refrigerant to the compressor suction side at excessive pressure rise above the permissible value according to the requirements of the operating documentation shall be fitted on the discharge line of the intermediate and final compression stages of the compressor between the discharge chamber and the shut-off valve. The discharge capacity of the safety device shall be not less than the maximal volume or bulk flow of the protected compressor stage.

The pressure rise after opening the safety valve shall not exceed the opening pressure by 10 per cent.

No shut-off devices are permitted on the bypass line.

9.12.6 Pumps shall comply with the requirements of 7.8.

9.12.7 Fans shall comply with applicable requirements of 7.9.

9.13 HEAT EXCHANGERS AND PRESSURE VESSELS

9.13.1 Heat exchangers and pressure vessels included in the refrigerating plants as pertaining to materials and valves shall comply with the requirements of 8.17 (except for 8.17.8 and 8.17.10), 8.18 (except for 8.18.1 to 8.18.4, 8.18.7, 8.18.8) and this Chapter. Strength calculations for them shall be fulfilled considering 8.19.1.

9.13.2 Shell-and-tube heat exchangers and vessels with the refrigerant chamber capacity of 50 dm³ and over shall be fitted with safety valves of such design discharge capacity as to prevent the pressure rise by more than 10 per cent of the opening pressure at full opening of the safety valve.

The discharge capacity $G$ shall be not less than that determined by the formula, in kg/s,

$$G = \frac{qS}{r},$$

where $q$ — heat flow intensity in the event of fire, in kW/m² (taken equal to 10 kW/m² in all cases);

$S$ — area of the vessel (apparatus) outer surface, in m²;

$r$ — specific heat of refrigerant evaporation at the opening pressure of the safety valve, in kJ/kg.

Safety devices shall consist of two safety valves and a changeover device providing connection of at least one safety valve to the vessel or apparatus in all cases. Each valve shall be rated for the full discharge capacity.

No shut-off valves may be installed between the apparatus or vessels and the safety device.

9.13.3 Pressure apparatus and vessels shall be fitted by discharge devices for the discharge of air, water, lubricating oil and liquid coolant.
9.13.4 Apparatus and vessels containing liquid refrigerant of Groups II and III shall be fitted with emergency discharge devices for the refrigerant.

The design drainage period of the refrigerant shall not exceed 2 minutes at constant excessive pressure of the refrigerant in the vessel (apparatus) being equal to the design pressure taken in accordance with 9.3.2.

9.14 AIR COOLERS

9.14.1 The evaporators of air coolers with direct evaporation of the refrigerant shall have welded or soldered structure. Flanged joints between sections and pipelines are normally not used, but if it is impossible to make welded or soldered joints the flanged joints shall be located in places accessible for leak tests.

9.14.2 Where a single air cooler is used for cooling of the cargo spaces, its evaporator shall consist of at least two independent sections with each section capable of being shut-off separately.

9.15 VALVES AND FITTINGS. SAFETY VALVES

9.15.1 Refrigerating plant systems shall be fitted with shut-off, control and safety valves rated for pressure of at least 1.25p, where p is the design pressure taken in accordance with 9.3.2.

Valves shall be made of steel. Application of built-in shut-off valves made of lamellar graphite cast iron for inlet and outlet cavities of the refrigerator compressors as well as valves made of nodular cast iron is allowed for refrigerants of Groups I and II at the medium temperatures not lower than –40 °C.Π

9.15.2 The safety valve spring attachments shall provide opening of the safety valves at a pressure not exceeding the design pressure according to 9.3.2 by more than 10 per cent.

9.16 PIPING

9.16.1 Piping of the refrigerant, liquid coolant and cooling water systems shall comply with applicable requirements of Section 10 and the present Chapter.

Piping for refrigerants of Groups II and III as well as the piping sections containing liquid refrigerant of Group I belong to Class I piping according to Table 10.1.2.

9.16.2 The refrigerant and liquid coolant pipelines shall be made of seamless pipes. The liquid coolant pipelines shall be made of steel pipes.

9.16.3 The refrigerant discharge lines of compressors and pumps shall be fitted with retaining (non-return) valves. The latter are not required for compressors using refrigerants of Group I and not fitted with discharge facilities.

9.16.4 Liquid piping of refrigerants with low water solubility shall be fitted with desiccating facilities for moisture absorption. The latter shall be installed either together with filters or structurally combined with them.

9.16.5 The refrigerant drainage pipes from the safety valves other than those specified in 9.12.5 shall be led overboard below the waterline corresponding to the minimal draught of a ship. These pipes shall be fitted with the refrigerant leakage detectors and retaining valves installed in the immediate proximity of the ship’s side. Refrigerants of Group I may be discharged into the atmosphere in the places non-hazardous for people.

9.16.6 Refrigerant emergency drainage pipes from the apparatus and vessels shall be led to the emergency drainage manifold located outside the refrigerating machinery room but near the entrance thereto. Each drainage pipe shall be fitted with shut-off valves and refrigerant leakage detectors behind the each valve. The valves shall be protected from access of unauthorized personnel and be adapted for sealing in the closed position.

The common line from the overboard drainage manifold shall be fitted with retaining valve and be led overboard below the waterline corresponding to the minimal draught of a ship. Compressed air or steam feeding line shall be provided for purging the common line.
The inner diameter of the refrigerant emergency drainage pipe from single apparatuses or vessels shall be not less than the safety valve diameter determined by valve capacity according to 9.13.2. Cross-sectional area of the overboard drainage manifold shall be not less than the sum of the cross-sectional areas of three largest emergency drainage pipes from single apparatus and vessels connected with the manifold.

9.16.7 The minimal wall thickness of the sections led overboard below the waterline according to 9.16.5 and 9.16.6 shall be taken not less than specified in column 3 of Table 10.2.13.

9.17 INSTRUMENTS

9.17.1 Compressors, units and piping of the refrigerating plant shall be fitted with control and monitoring devices for checking the parameters of working media and the performance characteristics. In addition, a provision shall be made for installation of control and monitoring devices for testing.

9.17.2 Instrumentation shall be installed in accessible and illuminated places. Maximal and minimal permissible values of the controlled parameters checked shall be indicated on the instrumentation scales.

9.18 AUTOMATION MEANS

9.18.1 Automation systems including their elements and joints shall comply with applicable requirements of Section 11.

9.18.2 When the refrigerating plant is controlled automatically, manual control shall be available also.

Where the two automatic devices operating in parallel are provided, manual control may be dispensed with.

9.18.3 The refrigerant compressors shall be necessarily fitted with automatic devices disconnecting its drive in the event of:

1. impermissible (hereinafter as compared to the value specified in the technical documentation of refrigerating plant) suction pressure drop;
2. inadmissible rise of the discharge pressure;
3. inadmissible drop of the lubricating oil pressure;
4. inadmissible rise of the discharge temperature (for refrigerating plants using the refrigerants of Groups II and III as well as automated plants with unattended operation);
5. inadmissible axial displacement of the centrifugal compressor rotor;
6. inadmissible rise of temperature of the centrifugal compressor friction bearings.

9.18.4 Liquid separators, intermediate vessels and circulation receivers (where pump circulation system of the refrigerant is used), as well as free-level type evaporators shall be fitted with automatic devices that ensures the following:

1. maintaining either constant level of the refrigerant required for normal operation of the evaporator or constant vapour overheating temperature;
2. stopping the feeding of the liquid refrigerant to the evaporators and intermediate vessels of all types at the compressor switching off;
3. switching off the compressor in the event of inadmissible rise of the refrigerant level.

9.18.5 Installations with shell-and-tube type evaporators shall be fitted with automatic devices switching off the compressor in the following cases:

1. flow of the liquid coolant through the evaporator is interrupted, or this evaporator is disconnected from the refrigerant system;
2. in case of inadmissible drop of the liquid coolant temperature.

9.18.6 Refrigerating plants shall be fitted with alarm devices sending warning to the refrigerating plant control station in case of actuation of the automatic protection devices specified in 9.18.3 to 9.18.5.

It shall be possible to decode the above signals at the local control station of the refrigerating plant.

9.18.7 Where entirely automated refrigerating plant is used, the wheelhouse shall be fit-
ted with an alarm device which is actuated when the temperature inside the cooled spaces deviates from the admissible value required for the given type of cargo.

9.18.8 Each room where pressurized refrigerant equipment is located shall be fitted with gas analysers and refrigerant leakage alarm devices. The alarm signals shall be sent to the refrigerating plant control station.

9.18.9 Automated refrigerating plants shall comply with the requirements of Section 11 of this Part.

9.19 INSULATION OF THE COOLED SPACES

9.19.1 All metal parts of the hull located inside the cooled cargo spaces shall be insulated.

9.19.2 Insulation of the cooled cargo spaces shall be made of biostable odourless materials.

9.19.3 Surfaces of bulkheads and inner bottom plating in the fuel tanks area shall be coated by oil-resistant odourless material. The coating shall be applied prior to insulating those surfaces.

9.19.4 Insulation of the cooled cargo spaces shall be either protected against penetration of moisture or fitted with effective drainage means during operation; it shall also be protected against damage by rodents.

9.19.5 Insulation of the cooled cargo spaces shall be covered by lining or any other suitable coating. Insulation coating shall be protected in the places which can be damaged by the cargo.


9.20 INSULATION OF PIPELINES

9.20.1 Pipelines in the places where they penetrate the bulkheads and decks shall not have direct contact with the latter to avoid heat exchange.

9.20.2 Insulation of the pipelines shall be protected against moisture penetration.

9.20.3 Insulation of pipelines shall be made of non-combustible heat-insulating materials according to the requirements of Part III of the Rules. This requirement is not applied to insulation of the pipes located within cooled cargo spaces and storerooms.

9.20.4 Anti-condensate materials and adhesives used with insulation and insulation of pipeline valves shall comply with the requirements of Part III of the Rules.
10 SYSTEMS

10.1 GENERAL PROVISIONS

10.1.1 Requirements of the present Section of the Rules apply to the following systems used in ships:
- .1 bilge and drain systems;
- .2 ballast systems;
- .3 cargo systems of oil tankers;
- .4 air, gas-freeing, overflow and sounding pipes;
- .5 exhaust gas systems;
- .6 fuel systems;
- .7 lubricating oil systems;
- .8 cooling water systems;
- .9 compressed air systems;
- .10 ventilation systems;
- .11 steam and boiler blow-down systems;
- .12 liquefied gas systems;
- .13 toxic media systems;
- .14 feeding and condensate systems;
- .15 open-ended steam pipes from safety valves;
- .16 tank cleaning and washing systems;
- .17 hydraulic drive systems.
- .18 with high-temperature organic heat transfer fluid;
- .19 cargo heating.

Requirements to systems and pipelines are set out in the relevant Sections of this Part and other Parts of the Rules. For the requirements to cargo heating system, see 4.19 Part IX of the Rules.

The requirements described in 10.1.2, 10.2, 10.3, 10.4, 10.5 and 10.6 also apply to ship systems ensuring ship’s habitability for the crew and passengers (systems of steam and water heating, fresh water, etc.), if applicable to the specified systems.

10.1.2 Depending on purpose and parameters of pumped media the pipelines in the present Rules are divided into 3 classes as indicated in Table 10.1.2. For each class of pipelines the joint types, heat treatment, welding procedures and methods and scope of testing are assigned.

### Medium parameters for pipeline classes

<table>
<thead>
<tr>
<th>Pumped medium</th>
<th>Design pressure p and temperature t* pipeline class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Toxic and inflammable media with a working temperature above the flash point or inflammable media having a flash point below 60 °C (closed cup test), liquefied gases, corrosive media*</td>
<td>Any parameter</td>
</tr>
<tr>
<td>Steam</td>
<td>p, MPa</td>
</tr>
<tr>
<td>&gt; 1.6</td>
<td>&gt; 300</td>
</tr>
<tr>
<td>Fuel</td>
<td>p, MPa</td>
</tr>
<tr>
<td>&gt; 1.6</td>
<td>&gt; 150</td>
</tr>
<tr>
<td>Air, gases, water, lubricating oil, hydraulic oil</td>
<td>p, MPa</td>
</tr>
<tr>
<td>&gt; 4.0</td>
<td>&gt; 300</td>
</tr>
</tbody>
</table>

*see 10.2.12.

Note. 1. Piping with one of the above-stated parameters are Class I pipelines; piping with both parameters are Class II and Class III pipelines.
2. Cargo oil pipes of oil tankers and ships carrying dangerous cargos in bulk, as well as open-ended pipelines (draining, overflow, gas exhaust, air and steam discharge from valves), are class III pipelines.
10.2 PIPELINES
Material, manufacturing and application

10.2.1 Materials used in the manufacturing of pipes and valves shall comply with the requirements of Part X of the Rules shall be complied with.

10.2.2 Steel pipes intended for manufacturing of Class I and Class II pipelines as well as for the following Class III pipelines:
1. bilge and drain pipelines;
2. feed water pipelines;
3. ballast pipelines (if they are used as fuel pipes or laid through the fuel tanks);
4. fuel oil, lubricating oil pipelines;
5. fuel and lubricating oil heating coils;
6. boiler steam and circulation pipelines;
7. compressed air systems;
8. hydraulic pipelines,
shall be seamless or welded if they are equivalent to weldless pipes by density and strength.

Pipes and valves made of carbon steel and carbon-manganese steel shall be used for media with a temperature not exceeding 400 °C; those made of low-alloy steel — with a temperature not exceeding 500 °C.

It is allowed to use carbon and carbon-manganese steels for media with temperature exceeding the permissible one, provided their mechanical properties and long-term strength within 100 000 h are guaranteed by the steel manufacturer at such high temperature; the same shall be specified in the accompanying documentation.

Pipes and valves for media with a temperature above 500 °C shall be made of alloy steel. This requirement does not apply to exhaust gas pipes.

10.2.3 Copper pipes for pipelines of Classes I and II shall be seamless.

Pipes and valves made of copper and copper alloys shall be used for media having a temperature not exceeding 200 °C and those made of copper-nickel alloys — for temperatures not exceeding 300 °C. Bronze valves can be used for media having a temperature of up to 260 °C.

10.2.4 Nodular cast iron may be admitted for pipes and valves of bilge, ballast and liquid cargo piping laid inside the double bottom space or cargo tanks.

Nodular cast iron valves may be admitted for media with a temperature not over 350°C.

Side valves and side branch pipes, as well as valves fitted on the collision bulkhead and in fuel and lubricating oil tanks, can be made of nodular cast iron of entirely ferritic structure according to requirements of 2.11 Part X of the Rules shall be complied with.

10.2.5 Piping made of lamellar graphite cast iron may be used for cargo and ballast tanks of tankers except clean ballast pipelines laid through the cargo tanks.

Pipes and valves made of lamellar graphite cast iron may also be used for cargo lines on the open deck, excepting the end sections and valves of cargo piping for connection to the cargo hoses.

However, lamellar graphite cast iron shall not be used for:
1. valves for media with a temperature above 220 °C;
2. pipes subject to water hammer;
3. pipes directly connected to the outer shell plating;
4. valves fitted on the hull plating and the collision bulkhead;
5. valves arranged on fuel and lubricating oil tanks under static head, unless they are protected against mechanical damage.

10.2.6 Pipes made of aluminium alloys may be used for handling media with temperature nor exceeding 150 °C if the measures for protection of pipelines against contact corrosion are taken.

10.2.7 Application of plastic pipelines shall comply with Table 10.2.34.

10.2.8 The plugs and threaded portion of deck bushes of sounding pipes on the open decks shall be of bronze or brass.

10.2.9 Self-closing valves of sounding pipes in fuel oil tanks shall prevent formation of sparks. Sight glasses on fuel and lubricating oil pipelines shall be heat-proof.
Piping bend radii

10.2.10 The inner bending radius of steel, copper and aluminium pipes handling media under a pressure above 0.5 MPa or having a temperature over 60 °C, as well as bending radius of pipes intended for homing action shall be at least 2.5\(d_1\) (\(d_1\) is the outer diameter of the pipe).

Bending of a lesser radius may be permitted provided that no thinning of the pipe wall occurs during the bending.

The inner bend radius of the boiler blow-off pipes shall be at least 3.5\(d\) (\(d\) is inside diameter of the pipe).

Bend radius of pipes used in other conditions than those mentioned herein can be lessen to 1.5\(d\) in case of machine bending.

Heat treatment of pipes

10.2.11 For the requirements to heat treatment of pipes after bending, see 2.4.9 Part X of the Rules shall be complied with.

Pipe wall thickness

10.2.12 The wall thickness \(s\), in mm, of metal pipes operating under the internal pressure shall be not less than determined by the formula:

\[
s = s_0 + b + c, \quad (10.2.12-1)
\]

where \(s_0\) — basic thickness of a wall, in mm:

\[
s_0 = d_p/(2\sigma_{\text{lim}} \varphi + p);
\]

\(d\) — outside diameter of a pipe, in mm;

\(p\) — design pressure (maximum working pressure that shall be assumed equal to the maximum opening pressure of safety valves or hydraulic test pressure in cases where safety valves are not provided), in MPa.

For pipelines of carbon dioxide fire extinguishing systems (from the bottles to the starting valves) \(p\) shall be assumed equal to the design pressure of bottles.

For pipelines with fuel heated to temperature over 55°C the design pressure shall be taken not less than 1.4 MPa;

\(\sigma_{\text{lim}}\) — permissible stress, in MPa;

\(\varphi\) — strength factor taken as 1 for seamless pipes and welded pipes which are considered to be equivalent to seamless pipes;

\(b\) — allowance for actual reduction of pipe wall thickness due to bending, in mm; it shall be chosen in such a way that the stresses in the bent part of the pipe due to internal pressure do not exceed the permissible stresses.

Where precise values of thickness reduction after bending are not known, the allowance is determined by the formula:

\[
b = 0.4d s_0/R, \quad (10.2.12-2)
\]

\(R\) — mean radius of the pipe bend, in mm;

\(c\) — corrosion allowance, in mm, adopted from Table 10.2.12-1 for steel pipes and Table 10.2.12-2 for non-ferrous metal pipes. For pipes manufactured of corrosion-resistant alloys in accordance with GOST 5632 the corrosion allowance can be reduced to zero.

### Table 10.2.12-1

<table>
<thead>
<tr>
<th>Working medium, purpose of piping</th>
<th>(c), mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturated steam</td>
<td>0.8</td>
</tr>
<tr>
<td>Superheated steam</td>
<td>0.3</td>
</tr>
<tr>
<td>Heating steam coils for water and oil products in tanks and cargo tanks</td>
<td>2.0</td>
</tr>
<tr>
<td>Feed water in open circuit systems</td>
<td>1.5</td>
</tr>
<tr>
<td>Feed water in closed circuit systems</td>
<td>0.5</td>
</tr>
<tr>
<td>Blow-down pipelines of boilers</td>
<td>1.5</td>
</tr>
<tr>
<td>Compressed air</td>
<td>1.0</td>
</tr>
<tr>
<td>Hydraulic (oil) systems</td>
<td>0.3</td>
</tr>
<tr>
<td>Lubricating oil</td>
<td>0.3</td>
</tr>
<tr>
<td>Fuel</td>
<td>1.0</td>
</tr>
<tr>
<td>Cargo pipelines</td>
<td>2.0</td>
</tr>
<tr>
<td>Liquefied gas</td>
<td>0.3</td>
</tr>
<tr>
<td>Refrigerant piping</td>
<td>0.3</td>
</tr>
<tr>
<td>Fresh water</td>
<td>0.8</td>
</tr>
<tr>
<td>Sea water</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**Notes:**
1. If the pipes have corrosion protection, the corrosion allowance can be reduced by not more than 50 %.
2. Where pipes of special steel alloys with sufficient corrosion resistance are used, the corrosion allowance may be reduced to zero.

### Table 10.2.12-2

<table>
<thead>
<tr>
<th>Pipe material</th>
<th>(c), mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper, brass and similar alloys, as well as copper-tin alloys, except those with lead content</td>
<td>0.8</td>
</tr>
<tr>
<td>Copper-nickel alloys (with Ni content at least 9 %)</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Table 10.2.12-3

Permissible stress for copper and copper alloy pipes which have undergone heat treatment (annealing)

<table>
<thead>
<tr>
<th>Pipe material</th>
<th>Tensile strength $R_m$, in MPa</th>
<th>Permissible stress $\sigma_{lim}$, in MPa, at medium temperature, in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper</td>
<td>220</td>
<td>50</td>
</tr>
<tr>
<td>Aluminium brass</td>
<td>320</td>
<td>78</td>
</tr>
<tr>
<td>Copper-nickel alloy 95/5 and 90/9</td>
<td>270</td>
<td>69</td>
</tr>
<tr>
<td>Copper-nickel alloy 70/30</td>
<td>360</td>
<td>81</td>
</tr>
</tbody>
</table>

Note. The permissible stresses for intermediate values of $\sigma_{lim}$ should be determined by linear interpolation.

For the pipes laid inside the tanks the corrosion allowance stated in Table 10.2.12-1 shall be increased by the corrosion allowance for the external medium influence which is assumed for the appropriate medium in accordance with the present Table.

For carbon or alloy steel pipes the permissible design stresses are chosen equal to the lowest of the following values: $R_m/2,7$; $R_{y,\alpha}/1,8$; $R_{\sigma,\alpha}^{100000}/1,8$; $R_{\sigma,\alpha}^{100000}/1,0$, where $R_m$ — tensile strength of the pipe material, in MPa; $R_{y,\alpha}$ — minimum yield strength or proof stress at the design temperature, in MPa; $R_{\sigma,\alpha}^{100000}$ — ultimate long-term stress to produce rupture in 90 000 h at design temperature, in MPa; $R_{\sigma,\alpha}^{100000}$ — ultimate stress to produce 1% creep in 90 000 h at design temperature, in MPa.

The design temperature $t$ for determining permissible stresses is taken equal to the maximum temperature of the media inside the pipes.

The determining of permissible stresses on the long-term strength and on the creep limit is not required.

For copper and copper alloy pipes which have undergone heat treatment the permissible stress is taken according to Table 10.2.12-3.

In case of using pipes having negative manufacturing allowance for the wall thickness, the pipe wall thickness shall be determined by the formula, mm:

$$s_i = s/(1 - 0.01a),$$ (10.2.12-3)

where $s$ — pipe wall thickness calculated by the formula (10.2.12-1); $a$ — negative manufacturing tolerance for pipe wall thickness, in %.

10.2.13 Wall thickness of steel, copper and copper-alloy pipes shall be not less than the values stated in Table 10.2.13. If corrosion-resistant steel and titanium pipes are used, their wall thickness is determined by results of pipe strength calculations agreed with the River Register.

10.2.14 Wall thickness of plastic pipes are determined according to national standards.

10.2.15 Heat exchangers and pressure vessels used in the systems shall meet the requirements of Section 8 of this Part.

Protection of pipelines against excessive pressure

10.2.16 The pipelines where pressure may exceed the design value shall be fitted with safety devices preventing the pressure rise in the pipelines over the design pressure.

Fuel and lubricating oil shall not be bled off from the safety valves in an open way.

10.2.17 If a pipeline is fitted with a reducing valve, a pressure gauge and safety valve shall be provided after it.

Bypass of the reducing valve is permissible.

1 GOST 29325, GOST ISO 4065, GOST 18599, GOST R ISO 3126.
### Table 10.2.13

Wall thickness of copper and copper alloy pipes

<table>
<thead>
<tr>
<th>Outside diameter, in mm</th>
<th>pipes of systems other than stated in columns 3 to 8</th>
<th>air, overflow, sounding pipes of tanks</th>
<th>outboard water pipelines (bilge, ballast, cooling, fire extinguishing etc.)</th>
<th>pipes passing through the tanks (see 10.5.9 to 10.5.11)</th>
<th>heating coils, cleaning and cargo oil pipelines</th>
<th>pipelines of carbon dioxide fire extinguishing system from bottles to starting valves</th>
<th>from starting valves to discharge nozzles</th>
<th>copper</th>
<th>copper alloys</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2.18 Due to the pipeline class the following types of non-flanged connections are allowed:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.1 welded butt joints of full penetration type with provisions for the root side quality are allowed for piping of any class and outside diameter;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.2 welded butt joints of full penetration type without special provisions for the root side quality are allowed for Class II and Class III pipelines of any outside diameter;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.3 slip-on sleeve welded joints are allowed for Class III with any outside diameter of pipes;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.4 slip-on threaded joints — for class I pipelines with outer diameter of pipes of 33.7 mm and less; for class II pipelines with outer diameter of pipes of 60.3 mm and less; for class III pipelines with outer diameter of pipes of 57 mm and less, except for the pipelines with toxic and inflammable medium or service conditions under increased cyclic loads and intense corrosion or erosion. It is allowed to use threaded joints in carbon dioxide fire-extinguishing systems only inside the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
protected rooms and in carbon dioxide cylinder room;

.5 screwed nipple joints — for pipelines of all classes with inner diameter of 32 mm and less. The number of screwed nipple joints shall be kept to a minimum.

10.2.19 Flange connections of pipelines shall correspond to the following types shown on Fig. 10.2.19.

Fig. 10.2.19 Types of flanged joints and pipelines

Dimensions of flanges shall comply with the national standards1.

Note. In tapered threaded connection of pipes of type D, if necessary, the pipe shall be flared after the flange is fitted.

10.2.20 Type of flange connection shall be chosen depending on the pipe class in compliance with the requirements of Table 10.2.20.

The following galvanic intrinsic safety means shall be provided on pipelines of any purpose intended for connection of pipelines from the shore or other ship and located in explosive zones and spaces:

.1 electrically insulating joints (flanged or of other type), electrically insulating supports or non-conductive pipe sections with total insulation resistance from the hull of at least 10 kOhm;

.2 electrically insulating mats, plates and guards to prevent contact between metal parts of the piping from the shore or other ship and the hull. This requirement applies also to ships in service.

10.2.21 Material for gaskets shall be resistant to the media conveyed.

Gaskets in the joints of the fuel pipelines shall provide tightness at temperatures of the media conveyed of not lower than 120 °C.

10.2.22 Flexible joints shall be fitted with flanges or nipples at the ends. Flexible joints shall be located in easily accessible places. It shall be possible to shut down these joints by valves from the fuel oil, lubricating oil, compressed air and cooling water systems to replace the flexible joint in the event of breakage.

Flexible joints shall be of fire-resistant type when being used in pipelines of the following types:

pipelines for conveying fuel oil and lubricating oil;
used for delivery of other flammable fluids if a damage of the joints can cause danger to the ship or people;
driving watertight doors;
connected to holes in the outer shell plating (including the bilge system).

Note. A fire-resistant joint is a joint that, being attached to the pipeline filled with water and having an open end, withstands the temperature of 800 °C during 30 minutes and is watertight in the following testing by the design pressure.

Material of flexible joints shall be chosen with due regard to the media used, pressure, temperature and environment conditions. The bursting pressure of flexible joints shall at least 4 times exceed the design pressure.

Flexible joints being used in hazardous spaces shall be electrically conductive.

Testing of welds

10.2.23 The control of welded joints using non-destructive methods shall be accom-
Flanged joint type selection

<table>
<thead>
<tr>
<th>Pipeline class</th>
<th>Toxic media, liquefied gases</th>
<th>Steam</th>
<th>Fuel and oil</th>
<th>Other media</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$p$, MPa</td>
<td>$t$, °C</td>
<td>Type of flange connection</td>
<td>Type of flange connection</td>
</tr>
<tr>
<td>I</td>
<td>$&gt;$ 1</td>
<td>$&lt;$ –50</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>$\leq$ 1</td>
<td>$\leq$ –50</td>
<td>Any type</td>
<td>$\leq$ 400</td>
</tr>
<tr>
<td></td>
<td>$\leq$ –50</td>
<td>$&lt;$ –50</td>
<td>A – B*</td>
<td>A – B*</td>
</tr>
<tr>
<td></td>
<td>$&gt;$ 400</td>
<td>$&lt;$ –50</td>
<td>$\leq$ 400</td>
<td>$\leq$ 400</td>
</tr>
</tbody>
</table>

Notes. 1. For the type of flange connection see Fig. 10.2.19.
2. The type B* joint shall be applied only for pipes with outside diameter not exceeding 150 mm.
3. The type F connections are used only for water pipelines.

Testing of electrical resistance

10.2.24 Electrical resistance of each flexible joint intended for use in explosive rooms and spaces shall be tested prior to installation of the joint. Electrical resistance between any two points of such flexible joint shall not exceed $1 \times 10^6$ Ohm.

Corrosion protection

10.2.25 Steel pipes of outboard water, as well as air, measuring and overflow pipes of water, ballast and fuel tanks, gas outlet pipes of cargo tanks, air pipes of cofferdams of oil tankers after bending and welding, shall be protected against corrosion.

10.2.26 In the process of design and installation of ship pipelines of overboard water the design measures shall be taken to reduce the corrosive and erosive wear of pipelines.

10.2.27 Pipelines for corrosion-active medium shall be made with minimum number of bends. Bending radii shall be not less than 2.5 of their outer diameters.

If it is not possible to keep to these bending radii, for example, in confined places, special fittings shall be used.

Do not apply welded bends made of pipe sectors with nominal diameter less than 200 mm. Bend of 90° shall have at least three sectors.

Do not apply bent or welded fittings for manufacture of side or sea chest branch pipes.

10.2.28 Use of tee-joints, legs and nipples for connection of branches, welded pieces and other elements shall not cause reduction of flow area of the main in places of their installation.

10.2.29 The flow rate determined by the formula (10.2.29) for pipeline sections with welded fittings (tee-joints, welded branches, etc.), orifice plates, as well as side and sea chest branch pipes, shall not exceed the values stated in Table 10.2.29.

Compliance of the design flow rate in pipeline sections specified in this paragraph and sea chest connecting passages with the present requirements shall be proved by calculation by the formula, in m/s:

<table>
<thead>
<tr>
<th>Pipeline material</th>
<th>Permissible flow rate, m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel, including zinc-coated steel</td>
<td>2.5</td>
</tr>
<tr>
<td>Copper</td>
<td>0.9</td>
</tr>
<tr>
<td>Copper-nickel alloys: ( \text{M} \text{J} \text{K}5-1 )</td>
<td>2.0</td>
</tr>
<tr>
<td>( \text{M} \text{J} \text{K} \text{M} \text{t}10-1-1 )</td>
<td>2.5</td>
</tr>
<tr>
<td>( \text{M} \text{J} \text{K} \text{M} \text{t}30-1-1 )</td>
<td>3.5</td>
</tr>
<tr>
<td>Aluminium brass</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Notes. 1. In pipelines with fittings having radii of rounding in places of connection to the main of 0.15 diameters of the latter and more, bent branches with bending radius exceeding 2.5 of outer diameter without welded bends and orifice plates the flow rate can exceed the values stated in Table by 30%.

2. In drenching, water-screen, sprinkling and ballast systems the permissible flow rates irrespective of design version of used components of pipelines can exceed the values specified in the Table by 30%.

\[ V_m = 0.354 \times 10^{-3} \frac{Q}{d^2} \]  \hspace{1cm} (10.2.29)

where \( Q \) — maximum flow rate on the gage section, in m³/h;
\( d \) — pipeline inner diameter, in mm.

10.2.30 If non-ferrous alloy bottom and side valves are used, the hull plating and all components of the system contacting these valves shall be protected from contact corrosion. Sacrificial anode system against contact corrosion of receiving and discharge welded branch pipes with valves shall be made with use of standard bracelet type end sacrificial anodes or bracelet type interflanged sacrificial anodes installed on branch pipe flanges. Mated elements shall have electrical insulation. Bottom and side valves shall have insulation from both sides.

10.2.31 When connecting sea water steel pipelines with valves and cases of pumps, units and heat exchangers made of non-ferrous alloys, the measures shall be taken to protect from contact corrosion as specified in 10.2.30.

Plastic pipelines

10.2.32 The requirements of 10.2.33 to 10.2.54 apply to pipelines and pipeline components made of the following types of plastic:

1. thermoplastic and thermosetting plastic materials with or without reinforcement;

2. polyvinyl chloride (PVC);

3. fibre reinforced plastic (FRP).

10.2.33 Plastic pipes and pipelines components of ship systems responsible for damage control and floodability shall be fire-proof (see 1.2.1.9, 1.2.1.13 Part III of the Rules).

10.2.34 Depending on pipeline ability to maintain integrity during fire resistance tests, the following three levels of fire resistance are specified:

L1 — for pipelines which withstand the fire resistance tests in dry condition during 1 h;

L2 — for pipelines which withstand the fire resistance tests in dry condition during 30 min;

L3 — for pipelines which withstand the fire resistance tests in filled condition during 30 min.

For the scope of application of plastic pipelines depending on fire resistance level, location and supplied media, see Table 10.2.34.

Ship systems footnoted in Table 10.2.34 shall meet the supplementary requirements corresponding to the footnote number:

1. valves with remote control outside the room shall be provided on the ship’s side;

2. remotely closing valves shall be provided for cargo tanks;

3. if the cargo tanks contain inflammable liquids with flash point over 60°C, the "O" symbol may be used instead of "--" or "++";

4. for bilge pipeline servicing only the given space, the "O" symbol may be used instead of "L1";

5. when control functions are not provided, the "O" symbol may be used instead of "L1";

6. for the pipeline between machinery space and deck hydraulic gate the "O" symbol may be used instead of "L1";

7. for passenger ships the "++" symbol shall be used instead of "L1".
### Scope of application of plastic pipelines

<table>
<thead>
<tr>
<th>Medium to be conveyed</th>
<th>Piping system</th>
<th>Requirements to systems and their components located in the spaces corresponding to letter*</th>
</tr>
</thead>
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<td>A</td>
</tr>
<tr>
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<td>L1</td>
</tr>
<tr>
<td></td>
<td>Crude oil tank washing</td>
<td>L1</td>
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<tr>
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<td>2. Inert gas</td>
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<td></td>
<td>Pipeline from purifier</td>
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<tr>
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<td>Main line</td>
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<tr>
<td></td>
<td>Distribution pipelines</td>
<td>L1</td>
</tr>
<tr>
<td>3. Flammable liquids with a flash point of 60 °C and over</td>
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<td>4. Sea water</td>
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<td>Drainage pipelines of internal spaces</td>
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<td>Crude oil tank washing</td>
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<td>Air pipes for domestic needs</td>
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<td></td>
<td>Brine</td>
<td>L1</td>
</tr>
<tr>
<td></td>
<td>Low pressure steam</td>
<td>L1</td>
</tr>
</tbody>
</table>

* A — machinery spaces with engines and boilers and the trunks of these spaces;  
B — other machinery spaces;  
C — cargo pump rooms, including entries to trunks;  
D — cargo spaces of ro-ro ships;  
E — cargo spaces of dry cargoes and trunks;  
F — cargo tanks and trunks;  
G — fuel tanks and trunks;  
H — ballast tanks and trunks;  
I — cofferdams, dry compartments, etc;  
J — accommodation, service spaces and control stations;  
K — open decks.  

**Note.** The following symbols indicate:  
“+” — fire resistance tests not required;  
“*+” — only metallic materials with melting point over 925 °C are to be used.
10.2.35 Material of all pipes, except for pipes located on open decks, in tanks, cofferdams, pipeline tunnels, etc., shall have low flame spread properties (see 1.2.1.16 Part III of the Rules).

10.2.36 Where fire protective coatings are used to provide the fire endurance level required, they shall meet the requirements of 2.1.2.1 Part III of the Rules.

10.2.37 In cases described in 10.2.36 in the places of connections of the system the fire protective coatings shall be applied according to the requirements of 2.1.2.1 Part III of the Rules. These coatings are to be applied only after hydraulic tests of the system. The coatings shall be applied according to the recommendations of the pipe manufacturers.

10.2.38 Fireproof coatings are to be used according to the manufacturer’s instructions.

10.2.39 To select the supports and the distance between them, the permissible stresses and maximum permissible flexure of pipes specified by the pipe manufacturer shall be taken into consideration.

The distance between the supports shall not exceed the values determined by the manufacturer.

To select the supports and the distance between them, it is also needed to consider mechanical and physical properties of pipe material, weight of pipes and liquid in them, external pressure, operating temperature, effect of thermal expansion, external force loads, thrust forces, water hammers and vibration which can appear in the system.

10.2.40 Pipe weight load shall be uniformly spread over the entire bearing surface of the support. Measures shall be taken to minimize the wear of pipes in places of their contact with the supports, such as, for example, use of insulating rubber or fluoroplastic gaskets (sleeves).

10.2.41 Valves, expansion joints and other system components, the weight of which exceeds 2 kg, shall have separate supports.

10.2.42 During installation of pipelines the possible displacement of plastic pipes relative to steel hull structures due to difference of linear expansion coefficients of plastic and steel shall be taken into consideration.

10.2.43 For thermal expansion calculations the operating temperature of the system and installation temperature shall be taken into consideration.

10.2.44 During pipeline installation the temporary point loads shall be taken into consideration (where needed). Such allowance is to include at least the force exerted by a load (person) of 90 kg at mid-span on any pipe of more than 90 mm nominal outside diameter.

10.2.45 To ensure robustness for plastic piping, including open-ended piping, the minimum wall thickness complying is to be increased by 1 to 2 mm as compared to the thickness values calculated taking into account the conditions encountered during service on board vessels.

10.2.46 The pipes shall be protected from mechanical damages, if needed.

10.2.47 Piping systems conveying fluids with a conductivity less than 900 picosiemens per metre (pS/m), such as refined products and distillates, are to be made of conductive pipes.

10.2.48 Regardless of the fluid to be conveyed, plastic pipes passing through hazardous areas are to be electrically conductive.

The resistance of the pipes and fittings to the ground in any point of the piping system shall not exceed 10⁷ Ω. Electrically conductive layers of pipes and mated pipeline components shall have equal conductivity. Otherwise, the pipelines shall be protected from damage by electrical discharges caused by different conductance of electrically conductive layers of pipes and mated pipeline components.

10.2.49 Upon completion of installation the quality of pipeline grounding shall be tested. Attachment points of grounding wires shall be accessible for inspection.
Connections of plastic pipes

10.2.50 The strength of connections shall correspond to the strength of pipeline in which they are installed.

10.2.51 The pipelines can be assembled with use of adhesive, welded, socket welded, flanged and slip-on joints.

10.2.52 Adhesives used for assembly of pipelines shall ensure tightness of joints in the entire range of possible operating temperature and pressure values.

10.2.53 The joints shall be tightened according to the manufacturer’s instructions.

Laying of plastic pipes

10.2.54 When laying plastic pipelines through watertight and fireproof decks and bulkheads of types A or B the requirements of 10.5 shall be met.

Ship hoses

10.2.55 The requirements of this section apply to ship hoses for reception and transfer of chemical cargo, crude oil, oil products, fuel, oil, oily waters and contaminated ballast waters and transfer of cargo vapours.

10.2.56 Only ready-made hoses consisting of hose pieces and end pieces (flanged branch pipes, nipples or other connections) shall be used onboard the ship.

10.2.57 The hose shall be made of rubber reinforced with textile band and (or) steel wire braiding. The hose can be additionally reinforced with one or several layers of wire spiral, rings or in a different way.

Hose material shall be resistant to conducted medium in the entire range of operating temperatures or its inner surface shall be covered with a special coating resistant to such medium.

10.2.58 The outer surface of hose shall be resistant to wear, attrition, sun rays and atmospheric phenomena and shall be impermeable for overboard water and transferred liquids. The outer surface can be covered with polyurethane or other material ensuring buoyancy. Such coating shall have similar properties with regard to external actions.

Design and material of hoses to be used for transfer of liquefied gases shall comply with the requirements of national standards.

10.2.59 End pieces shall be connected to the hose by mechanical or chemical method.

10.2.60 When welding is applied for the end pieces, it shall be carried out by welders having admission certificate of the River Register, and 90% of welded joints shall be exposed to non-destructive testing (see 8.2 Part X of the Rules).

10.2.61 The material of end pieces and flanges shall exclude the possibility of spark formation when contacting with the ship’s hull. The surfaces of end pieces shall be protected from corrosive action of overboard water and transferred medium.

10.2.62 The hose is considered buoyant if its buoyancy reserve when the hose is fully immersed in overboard water and fully filled with it is not less than 20%. The hose buoyancy reserve is calculated by the formula, in %:

\[
K = 100 \left( 1 - \frac{W_h - W_w}{W_h + W_w} \right),
\]

where \( B \) — weight of outboard water displayed by the filly immersed hose, including the weight of the overboard water displaced by the materials ensuring buoyancy and the weight of overboard water in the hose, in kg;

\( W_w \) — weight of outboard water in the hose, in kg;

\( W_h \) — weight of an empty hose in the air, including the weight of materials ensuring its buoyancy, in kg.

Any materials used to provide buoyancy shall be secured on the hose.

10.2.63 Floating hoses shall be of orange colour, or a strip of orange colour in the form of a spiral shall be applied on them. Strip width — 90 mm, spiral pitch — 450 mm. The strip is to be connected to external coating during vulcanization.

1 GOST 6286, GOST 18698.
10.2.64 To transfer the cargo from one ship to another one under way and in the course of cargo handling with use of single point mooring, the floating hoses shall be used. The hose lines shall have a device for emergency detachment.

When using hose lines with a device for emergency detachment, the water hammers which can appear upon device operation shall be taken into consideration; to prevent the water hammers, the flow rate of liquid shall be limited.

10.2.65 The following marking shall be clearly applied on both ends of each hose: manufacturer’s name or trademark; hose serial number by manufacturer’s data; month and year of hose manufacture; pressure ratings; electrical conductivity instructions.

10.2.66 Hoses shall be stored on board in places protected against exposure to direct sunlight and be coiled with due regard to a minimum bending radius and hose manufacturer’s recommendations. Design measures shall be taken to drain and remove cargo remains from the hoses. Store rooms for hoses shall comply with the applicable requirements of 2.5.1 to 2.5.4 Part III of the Rules.

10.2.67 Hoses with permissible nominal pressure not less than 0.034 MPa and vacuum not less than 0.014 MPa shall be used to transfer the evaporations of cargo. Hose bursting pressure shall be not less 5-fold nominal pressure of the hose. Last meter from each end of the hose shall be painted according to Figure 10.2.67 and have a “vapour” inscription made with black characters of at least 50 mm in height. Each flange shall have additional hole on the line of coupling bolts permitting to connect the flange to the connecting branch pipe for vapour delivery. Only electrically conductive hoses shall be used in the systems for vapour delivery to shore.

10.2.68 Electric equipment in systems with use of pipeline heating cables shall comply with the requirements of Part VI of the Rules.

10.2.69 The heating cable shall be installed after hydraulic tests of pipelines and application of corrosion-resistant coating.

10.2.70 Electrically heated pipelines in places of possible mechanical damages of heating cables shall be covered with protecting housings.

10.2.71 Warning notices “Caution! Electric heating!” shall be affixed to electrically heated pipelines and valves.

10.3 PIPELINE VALVES

Construction

10.3.1 The covers of valves with internal diameter over 32 mm shall be secured to valve bodies by bolts or studs. Threaded covers may be used for valves having internal diameter up to 32 mm inclusive, if stops are fitted on these covers.

The nut of plug in a cock shall be well locked to prevent self-unscrewing while handling the cock.

10.3.2 All valves which are provided with remote control are also to be designed for local manual operation.

10.3.3 Compressed air shall not be used in remote control systems of valves located inside the cargo tanks.

10.3.4 Where the valves inside the cargo tanks are remote-controlled by means of a hydraulic system, they shall be also operable with the aid of a hand pump connected to the hydraulic control system of each valve via a separate pipe or directly to the valve actuator.

10.3.5 The service tank of the hydraulic remote control system of the valves inside the cargo tanks shall be located above the top
level of the cargo tanks and all pipelines of the hydraulic system shall be led to the cargo tanks through its upper part.

The service tank shall also be fitted with an air pipe fitted with a flame arresters and led to a safe position on the open deck. This tank shall be fitted with audible and visual alarm being actuated in case the liquid level in the tanks is lowered down to the minimum permissible level.

Marking of valves

10.3.6 The shut-off valves shall be provided with clearly visible fixed nameplates with inscriptions indicating their purpose.

10.3.7 Remotely controlled valves at control stations shall have fixed identification plates indicating their purpose as well as “open” and “closed” position indicators.

Where the remote control is used only to close the valve, the indicators need not be fitted.

Arrangement and installation of valves

10.3.8 The valves fitted on watertight bulkheads shall be secured to welded pads by studs, or the valves may be installed on bulkhead pieces. The stud holes shall be blind.

10.3.9 Valves with a diameter exceeding 10 mm arranged on plastic pipelines shall be secured to the hull structures.

Filters

10.3.10 The design of filters shall enable periodic cleaning of filtering elements.

10.3.11 Filters shall be equipped with devices permitting to see that there is no working medium pressure in filters prior to their opening.

Tubes from such devices shall be brought to trays so as to prevent splashing of working medium.

10.3.12 Filters included in the systems with combustible working medium shall be equipped with interlock excluding the possibility of their opening in case of excessive pressure in the internal spaces of the filter and the possibility of ingress of working medium to the internal spaces of opened filters. If such interlock is not provided, the indelible and non-deformable warning inscription prohibiting opening of filter under pressure shall be applied on filter casing.

10.3.13 Filter casing shall be designed for strength under pressure not less than the test pressure during hydraulic tests of the system.

10.4 SEA CHESTS AND ICE BOXES. BOTTOM AND SIDE VALVES. OPENINGS IN THE OUTER SHELL PLATING

Construction and installation of valves

10.4.1 Bottom and side valves fitted below the freeboard deck level shall not be made of materials easily damaged by fire.

10.4.2 The spindles and closing parts of the bottom and side valves shall be manufactured of corrosion-resistant materials.

10.4.3 Sea chests and ice boxes shall be equipped with detachable gratings or manholes with covers to provide access inside the boxes. See also 5.6.29 Part II of the Rules.

10.4.4 In ships with ice strengthening one of the sea chests shall be ice sea chest. Ice boxes shall be so designed as to provide separation of ice and removal of air from the ice box to ensure operation of the outboard water system.

10.4.5 In ships strengthened for ice navigation, provision shall be made for the heating of the outboard valve boxes and ice boxes, as well as side valves and fittings located above the load waterline.

10.4.6 All discharge openings in the shell plating shall be provided with devices to prevent occasional sea water penetration inside the hull.

Overflow outlets of pipes other than those indicated in 10.4.7, led from spaces located below the freeboard deck as well as along the freeboard deck shall be fitted with check (non-return) valves with forced valve closing
from easily accessible places above the freeboard deck.

10.4.7 Outboard inlet and discharge holes of systems and pipelines of the power installation main and auxiliary machinery located in the machinery spaces shall have locally controlled valves or slide valves accessible for control and maintenance. Drives of the valve controls shall be fitted with an indicator showing whether the valve is open or closed.

The side discharge valves shall be of the non-return shut-off type. Such valve can be replaced with non-return valve or pipeline loop lifted above the highest cargo waterline.

10.4.8 The controls of inlet bottom valves shall be located in readily accessible places and shall be provided with an indicator showing whether the valve is open or closed.

In passenger ships these drives shall be located above the floor level of the machinery space.

10.4.9 Bottom and side valves are to be attached to welded pads.

The valves may be also installed on welded branch pipes provided that they are rigid. Branch pipe wall thickness shall not be less than the minimum thickness of the shell plating in the ship extremities, but not more than 8 mm.

The stud holes shall not penetrate the shell plating and shall be terminated in the welded pads. Gaskets made of lead or other materials which readily deteriorate in the event of fire are not shall not be used.

10.4.10 Side valves of boiler blown-down pipelines shall be attached to welded pads. Welded protective ring shall be fitted on the outer side of the plating.

Valves shall have a collar on the flange that comes through the welded pad, plating and protective ring. The collar on the flange is not needed if there is a collar on the welded pad.

Openings in the outer shell plating

10.4.11 Discharge pipelines of several ship systems can be output through one common opening of the corresponding cross-section in the shell plating of the hull. In these cases discharge pipelines of systems shall have arrangements preventing ingress of working medium from other discharge pipelines brought out through one common opening in the shell plating of the ship.

10.4.12 The location of outboard water inlet and discharge openings in the outer shell plating shall be such as to provide the following:

1. to prevent sucking of the discharged water, sewage, ash and other wastes by outboard water pumps;

2. to prevent the ingress of sewage and discharged water into the ship spaces through the side scuttles as well as discharge of water into the lifeboats and life rafts during launching.

If the requirement of 10.4.12.2 is not met, the discharge openings shall be fitted with appropriate arrangements to prevent ingress of discharged water into the ship spaces, lifeboats and life rafts.

10.4.13 The openings in the outer shell plating of outboard valve boxes and ice boxes shall be fitted with protective gratings. Holes or slots may be provided in the hull instead of gratings. The total area of the holes or slots shall not be less than 2.5 times the area of the outboard valve.

The hole diameter and the slot width in the gratings or outer shell plating shall be not over 20 mm.

The gratings of the sea chests shall be provided with a steam, compressed air or water blowing device. Blowing pipes shall be provided with non-return shut-off valves. The pressure of steam or compressed air in the blowing system shall not exceed 0.3 MPa.

10.5 PIPING ARRANGEMENT

General requirements

10.5.1 Pipes shall be secured in such a way as not to induce excessive stresses in the pipelines due to thermal expansion, the hull deformation and vibrations.
10.5.2 The pipes of the systems and the vent ducts shall be fitted with arrangements for draining or blow-down of the working medium or moisture.

Appropriate design measures shall be taken to protect the hull structures and the equipment from adverse effect of the blown products.

10.5.3 Pipelines conveying hot media and extended along the ship for at least 3 m shall have compensators or sufficient number of bends to provide adequate self-compensation of pipelines.

10.5.4 Piping of the hydraulic systems pipelines shall not be led inside the double-bottom space. Piping of the hydraulic systems shall not have detachable joints in hardly accessible spaces.

Piping penetration through watertight structures

10.5.5 Pipelines through impermeable bulkheads shall be laid considering the room structures and ship systems located in them. Minimum possible number of pipelines shall be laid through the impermeable bulkheads.

10.5.6 Only one pipeline conveying liquid medium to be processed in the fore peak may be routed through the collision bulkhead below the freeboard deck. Furthermore, if the pipeline is led outside the double bottom space, it shall be provided with a shutoff valve or a slide valve mounted on the bulkhead from the fore peak side with a drive located above the freeboard deck.

10.5.7 Penetrations of the piping through the watertight bulkheads, decks and other watertight structures shall be made using sleeves, welded pads or other joints providing tightness of the structures.

The holes for studs shall not penetrate these structures, but shall be kept within the welded pads.

10.5.8 Penetrations of plastic pipes through the watertight bulkheads and decks enclosing watertight compartments shall be fitted with valves with a drive located above the freeboard deck. In places where the plastic pipes pass through the bulkhead of the main vertical fire zone the bulkhead steel sleeves and shut-off valves shall be installed on both sides of the bulkhead.

The valves shall be made of steel or other material equivalent to steel as regards fire resistance properties.

Laying of piping inside the tanks

10.5.9 Laying of drinking water and boiler feed water pipelines through the fuel and lubricating oil storage tanks, and laying of fuel and lubricating oil pipelines through the drinking water and boiler feed water tanks is permitted only when the pipes are led in oil-tight ducts being a structural part of the tank.

Duct-free laying of outboard water and lubricating oil pipelines as well as air, overflow and sounding pipes through the fuel storage tanks is permitted if seamless pipes free of detachable joints inside the tanks are used (see Table 10.2.13).

10.5.10 In case of duct-free laying of the pipelines through the tanks pipe bends shall be arranged inside the tank, if the compensation of thermal expansion is required.

10.5.11 Pipelines laid in tankers shall meet the requirements of 10.9.7 to 10.9.18.

Laying of piping inside the cargo holds and other spaces

10.5.12 Pipes laid through the cargo holds, chain lockers and other spaces in which they are subject to mechanical damages shall be protected.

10.5.13 Fuel, steam and water pipes as well as pressure pipes of hydraulic drives other than drainage pipes shall not be laid inside the cargo holds.

These pipelines can be laid in tunnels only if the use is made of pipes with thick walls (see column 5 of Table 10.2.3) and protective steel casings.

10.5.14 Steam pipes and pipes conveying heated liquids shall not be led inside the paint
stores, lantern rooms or other spaces intended for carriage and storage of readily flammable materials.

10.5.15 Fuel pipelines shall not be laid through accommodation and service spaces. The exception is made for the fuel pipeline of emergency diesel generator and the fuel reception pipelines, which can be laid through sanitary spaces, provided the pipes have a wall thickness of not less than 4 mm and no detachable joints are employed.

Laying of piping in refrigerated spaces

10.5.16 The pipes shall not be laid through the cooled spaces, if they are not intended to serve these spaces. Where laying of such pipes cannot be avoided, they shall be insulated. This requirement is equally applied to air pipes and sounding pipes. In these spaces the pipes shall be free of sections in which water may accumulate and freeze.

Laying of piping in the vicinity of electrical and radio equipment

10.5.17 Pressure pipes shall not be laid neither above the main and emergency switchboards, control panels of the main engines and other essential machinery and equipment nor behind them.

Such pipes may be laid at least 400 mm away from the front and lateral sides of these switchboards and control panels. The pipes laid at a distance of less than 700 mm from the switchboards and control panels shall be free of detachable joints.

If the pipelines with flanged joints are led within the above-mentioned zone, the latter shall be protected by casings.

10.5.18 Laying of pipelines through special electrical spaces (see 2.1.1.15 Part VI of the Rules) and also through accumulator rooms is not allowed, except for carbon dioxide fire extinguishing pipelines and pipelines serving the electrical equipment installed in these spaces.

Laying of piping in unattended machinery spaces

10.5.19 Joints of Class I pipelines conveying fuel oil and lubricating oil shall be of welded type. It is allowed to use detachable joints, but protective casings shall be installed in the places where detachable joints are fitted.

10.6 HYDRAULIC TESTS

10.6.1 Hydraulic tests of valves and pipelines shall be carried out according to 6.2.55 to 6.2.61 and 6.3.45 to 6.3.50 of RTSC. The stresses arising during the hydraulic test shall not exceed 0.9 of the yield point at the test temperature.

10.7 BILGE SYSTEM

Pumps

10.7.1 Each self-propelled ship with the main engines’ total output of 220 kW and above shall be provided with at least two bilge pumps. One of these pumps, a mechanically-driven one, shall be fixed and connected to the bilge system. Self-priming mechanically-driven ballast, sanitary or general service pumps having a sufficient capacity may be used as bilge pumps. A pump driven by the main engine, a water-jet or a steam-jet ejector, if steam boiler is operating continuously, may be used as one of the bilge pumps.

10.7.2 On self-propelled ships with the main engines’ total output less than 220 kW at least two draining means shall be installed. One of them may be a mechanically-driven fixed pump or an ejector and the other — a hand pump with a capacity not less than indicated in Table 10.7.7.

In ships less than 25 m in length not fitted with water fire extinguishing system, one hand bilge pump may be installed. Drainage of compartments may be carried out with flexible hose.

10.7.3 If fire pumps are used as bilge pumps, follow the requirement of 3.3.13 Part III of the Rules.
10.7.4 Passenger ships of more than 100 m in length shall have three bilge pumps connected to the bilge main. These bilge pumps shall be driven from a power source. One of the pumps can be driven from the main engine.

Passenger ships of 100 m in length and less shall have two bilge pumps driven from the power source.

In ships with main engine capacity less than 220 kW one of two bilge pumps driven from the power source can be replaced with a hand pump with a sufficient delivery determined by results of bilge system calculations according to 1.6.2 Appendix 8 of RTSC.

10.7.5 Onboard the ship with water fire extinguishing systems the total capacity of bilge facilities shall be sufficient to remove onboard the water brought inside the ship during operation of these systems.

10.7.6 Non-self-propelled and floating objects fitted with power sources or being supplied from the shore, shall be equipped with drainage means in a same manner as self-propelled ships with the main engines' total output less than 220 kW.

Non-self-propelled and berth-connected ships not fitted with fuel oil fired steam boilers, except bulk oil barges, can have portable pumps as bilge facilities.

A capacity of the hand pump shall be not less than 3.5 m³/h.

10.7.7 In crewed non-self-propelled ships without power sources and not being supplied from the shore, mechanically-driven bilge pump may be omitted, however, the hand pump shall be of portable piston type with a capacity of not less than indicated in Table 10.7.7.

<table>
<thead>
<tr>
<th>0.8LBH, in m²</th>
<th>Pump capacity, in m³/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 50</td>
<td>4</td>
</tr>
<tr>
<td>50 to 200</td>
<td>6</td>
</tr>
<tr>
<td>Over 200</td>
<td>8</td>
</tr>
</tbody>
</table>

Note: Definitions of L, B, H (ship’s length, breadth and depth) are given in Part I of the Rules.

If the required capacity of the pump exceeds that of the hand pumps, the ship shall be provided with portable ejector and a set of hoses ensuring the ejector’s operation from the fire mains of escorting ships.

10.7.8 On non-crewed non-self-propelled ships drainage may be carried out using a pusher or a roadstead ship means.

10.7.9 Centrifugal bilge pumps shall be of self-priming type; otherwise, the system shall be equipped with an air drawn-off device.

10.7.10 Each bilge pump other than the pumps intended for draining bilges and hand pumps of non-self-propelled ships, shall have the capacity determined on condition that the design water flow in the of suction branch of a diameter obtained by the formula (10.7.15), shall be not less than 2 m/s under normal service conditions.

10.7.11 The cargo pump rooms of oil tankers shall be drained by separate pumps or ejectors arranged in these rooms. Stripping pumps may be used as bilge pumps, provided that non-return shut-off valves are fitted at the open ends of the bilge suction and a shut-off valve is arranged on a pipe connecting the valve box and the stripping pump. These spaces can also be drained by hand pumps. The pumps shall be so designed as to prevent spark formation.

10.7.12 For draining fore compartments of oil tankers provision shall be made for a separate pump or ejector, which may be also used for filling and draining of the tanks intended only for ballast water.

10.7.13 To drain cargo spaces of bulk carriers of M-ClI 4,5 class, the pump (pumps) and (or) ejector with capacity (m³/h) of not less than 320A shall be installed, where A — free cross-sectional area of the greatest air or ventilation pipe brought to this space from the open part of the deck (m²).

For bulk carriers of M-ClI 4,5 class, the bilge and filling facilities located towards the bow from the collision bulkhead of ballast tanks and bilge wells of dry spaces, any part...
of which stretches towards the bow from the first fore hold, shall be actuated from the wheelhouse or the power installation control station or from a closed space, which can be accessed from the wheelhouse or power installation control station without passing through open decks of freeboard or superstructure.

10.7.14 On high-speed ships the number of bilge pumps and their capacity are selected by results of fire-extinguishing system hydraulic calculations according to 1.6.2 Appendix 8 RTSC.

Piping diameters

10.7.15 Inner diameter of the bilge main and branch bilge suction diameters directly connected to the pump shall be determined by the formula, in mm:

\[ D_i = 1.5 \sqrt{L (B + H)} + 25, \quad (10.7.15) \]

where

- \( L \), \( B \), \( H \) — ship's length, breadth and depth, see Part I of the Rules.

For worksite craft, \( L \) — the total length of drained compartments, in m.

10.7.16 Inner diameter of branch bilge suction diameters \( d_i \) connected to the main and the diameter of reception pipeline of the hand pump shall be determined by the formula, in mm:

\[ d_i = 2.0 \sqrt{l (b + H)} + 25, \quad (10.7.16) \]

where

- \( l \) — length of a drained compartment, as measured at its bottom, in m;
- \( b \) — width of a drained compartment, in m;
- \( H \) — ship's depth, see Part I of the Rules.

The value \( d_i \) shall not exceed \( D_i \) calculated by the formula (10.7.15).

10.7.17 In all cases the internal diameter of bilge pipelines shall be not less than 40 mm, in ships less than 10 m in length this diameter may be lessen to 20 mm.

The internal diameter of pipes connected to the bilge pump shall be equal to the internal diameter of bilge pump suction.

10.7.18 The cross-sectional area of the pipe connecting the distribution chest with the main bilge line shall be not less than the total cross-sectional area of two greatest branch bilge suction connected to that chest, but not greater than the cross-sectional area of the bilge main.

10.7.19 In ships where bilge pumps are intended for draining only the machinery space, the cross-sectional area of the main bilge line shall be not less than twice the cross-sectional area of the branch suction having the diameter determined by the formula (10.7.16).

10.7.20 The diameters of the emergency bilge suction in the machinery space shall be determined according to 10.7.28.

Pipelines and branch bilge suction arrangement

10.7.21 The bilge lines and their branch suction shall be arranged so as to enable any watertight compartment to be drained by one of the pumps required in 10.7.1 and 10.7.2. This requirement does not apply to the spaces and cofferdams of oil tankers drained by individual pumps, as well as to the tanks intended only for storage of liquids.

10.7.22 The system shall be arranged so as to prevent ingress of outboard water inside the ship or from one impermeable compartment to another one.

For this purpose the suction valves of the distribution chests of bilge lines as well as the valves on the branch suction shall be of non-return shut-off type.

Other equivalent arrangements are allowed.

10.7.23 Each separate bilge pump shall have a direct bilge suction from the compartment where it is installed. The internal diameter of the suction shall be determined by the formula (10.7.15)

10.7.24 The arrangement of the bilge pipes shall ensure draining of the machinery spaces through the suction directly connected to the pump, with the other compartments being simultaneously drained by other pumps.
10.7.25 The arrangement of the bilge pipes shall be such as to enable one of the pumps to operate in cases when the rest of the pumps are inoperative or used for other purposes.

10.7.26 If one pipeline coming forward of and abaft the pump located in the machinery space is available, the control of the non-return shut-off valves mounted on the suction pipes passing to the compartments being drained, shall be carried out from the freeboard deck.

10.7.27 Bilge pipes are not to pass through double bottom compartments. Where it is necessary to lead these pipes through the storage tanks for fuel, lubricating oil, boiler feed water and drinking water, the pipes shall meet the requirements of 10.5.9 to 10.5.11.

Where the pipe is led within the double-bottom space, the bilge suction in each watertight compartment shall be fitted with non-return valves.

10.7.28 In all self-propelled ships with the main engines’ total output of 220 kW and above, emergency draining of machinery spaces shall be provided in addition to the suction pipes required in 10.7.23. For this purpose the cooling water pump with the greatest capacity shall be fitted with the direct bilge suction fitted with a non-return shut-off valve installed at the level providing the drainage of the machinery space. The diameter of this bilge suction shall be equal to the diameter of the pump suction branch.

Where the aforementioned pump is not suitable for operation as an emergency bilge pump in the machinery space, a direct emergency bilge suction shall be led to the pump of greatest available capacity which is not a bilge pump. The capacity of such pump shall exceed the value specified in 10.7.7. The diameter of the emergency bilge suction shall be not less than that of the pump suction branch.

10.7.29 In ships where portable bilge pumps or draining from the tug-pusher are allowed, the drainage of the compartments may be carried out through the deck manholes using a flexible hose, provided that no cargo is stowed under the hose, or through the inlet riser pipes ending in a deck socket or a branch pipe to which the hose is connected.

10.7.30 Oily water separating and filtering equipment shall be used for purification of water before discharging overboard, or collecting tanks shall be provided for bilge water contaminated with oil.

The installation and operation of purification equipment shall not interfere with normal operation of the bilge and ballast systems.

10.7.31 The location and the number of branch bilge suctions shall be chosen by a designer in each particular case in accordance with the design and position of the compartments.

At least two branch bilge suctions of the bilge system shall be installed in each compartment being drained.

One branch bilge suction can be used in short (3 to 4 frame spaces) and narrow (less than 2 m) compartments if it provides draining of compartments.

10.7.32 Branch bilge suctions shall be installed in each compartment so as to provide the maximal extent of draining of the compartment at heel up to 5° to port or starboard.

10.7.33 Branch bilge suctions shall be installed in each watertight compartment at both sides. In compartments with the floor inclination exceeding 5° and in the ship extremities the branch bilge suctions shall be installed as close to the centre line as possible.

10.7.34 Branch bilge suctions of the bilge system shall be installed throughout the entire length of the ship in the following way:

.1 in ships without a trim the suctions shall be installed at the aft bulkheads of the forward compartments and at the fore bulkheads of the aft compartments;

.2 in ships with the trim by the stern the suctions shall be installed at the aft bulkheads of the compartments.

Drainage of machinery spaces

10.7.35 The location and the number of strum boxes of the bilge system (the bilge water collection system) in machinery spaces
shall be taken in accordance with 10.7.31 to 10.7.34; here, one of the strum boxes of the bilge system shall be directly connected to a separately driven bilge pump.

In passenger ships each of the power-operated bilge pumps located in the machinery spaces shall have two branch bilge suction s positioned at the both sides of these spaces.

10.7.36 Branch bilge suctions for bilge drainage of the machinery spaces shall be fitted with accessible mud boxes. The pipes between the mud boxes and the bilges shall be straight. The lower ends of these pipes need not be fitted with strum boxes.

Mud boxes shall have opening covers. The total cross-section area of the mud box holes shall be not less than twice the clear area of the given branch suction.

In ships up to 25 m in length strum boxes may be used instead of mud boxes, provided that they are accessible for cleaning (see 10.7.43).

10.7.37 No strum boxes or strainers may be fitted on the emergency bilge drainage suction.

10.7.38 Refrigerating machinery space accommodating refrigerating plants working on refrigerant can be connected to the bilge system of the ship.

The space for ammonia refrigerating machinery shall have an independent bilge system.

Drainage of tunnels

10.7.39 Bilge suctions shall be located in the after part of the shaft tunnels.

The bilge suctions of the shafting tunnel shall comply with the requirements set forth in 10.7.36.

Drainage of watertight compartment and cargo spaces

10.7.40 Where there is a double bottom under a watertight compartment or a cargo hold which is extended over the full breadth of the compartment, a bilge well shall be arranged at each side.

10.7.41 Where the length of the watertight compartment or a cargo hold exceeds 35 m, the bilge suctions shall be installed in the fore and after parts of this compartment or hold.

10.7.42 Water drainage into the bilges of the watertight compartments or cargo holds from the spaces located in other watertight compartments below the freeboard deck is not allowed.

10.7.43 Branch bilge suctions shall be fitted with strum boxes or strainers. The total cross-section area of holes shall be not less than twice the clear area of the given branch suction.

The strum boxes and strainers shall be removable, or it shall be possible to clean them without disassembling the suction.

The strum boxes shall be protected against corrosion.

Drainage of refrigerated spaces

10.7.44 Provision shall be made for drainage of water from all the spaces, trays, chutes and other places which may accumulate water.

10.7.45 Drain pipes from non-refrigerated spaces shall not be led into the bilges (wells) of refrigerated spaces.

10.7.46 Each drain pipe of refrigerated cargo spaces shall be fitted with a liquid sealed trap or with other equivalent arrangement.

The head of liquid in the trap shall be such as to ensure effective operation of the trap under any service conditions. The liquid sealed traps shall be placed in accessible place outside the insulation.

10.7.47 No shut-off valves may be fitted on the water drainage lines from the refrigerated spaces.

Drainage of cofferdams

10.7.48 Cofferdams filled with water shall be fitted with drainage means. The location of branch bilge suctions shall comply with the requirements of 10.7.40 to 10.7.43.
10.7.49 The cofferdams of oil tankers shall be drained by pumps, including water ejectors.

**Drainage of peaks and other spaces**

10.7.50 Where the peaks are not used as ballast or other tanks, they may be drained by their own hand pumps or water ejectors. The pumps shall be installed above the freeboard deck.

10.7.51 Drainage of the after peak may be carried out through the drain pipe into the bilges or drainage wells of the adjacent compartment. The drain pipe shall be fitted with a self-closing valve installed on the afterpeak bulkhead from the adjacent compartment side.

10.7.52 Drainage of the peaks on non-self-propelled ships and ships less than 25 m in length may be carried out by water draining into the adjacent compartments, if self-closing valves installed on the peak bulkheads are controlled from the deck.

10.7.53 Drainage of chain lockers may be carried out by water draining through the drain openings into the fore peak compartment.

10.7.54 Each sidehull of the catamaran shall be fitted with a separate bilge system complying with the requirements of this Chapter.

**Draining of spaces protected by fixed fire extinguishing systems**

10.7.55 Bilge facilities shall remove water with use of any fixed water fire-extinguishing systems, including spraying systems.

10.7.56 To maintain ship stability in case of application of water fire-extinguishing systems, the following design measures shall be taken:

.1 in passenger ships:

   in spaces above the bulkhead deck, scuppers shall be fitted so as to ensure that such water is rapidly discharged directly overboard;

   in spaces located below the bulkhead deck, the drain system shall be sized to remove not less than 125 % of the total quantity of water delivered by water fire-extinguishing system pumps and shall have required number of fire hose nozzles. The drainage system valves shall be operable from outside the protected space at a position in the vicinity of the extinguishing system controls. Bilge wells shall be arranged at the ship's side at a distance of not more than 40 m from each other in each watertight compartment.

.2 on cargo ships, chemical tankers and ships carrying hazardous goods:

   measures excluding formation of free surfaces in the ship spaces in the course of fire extinguishing. In this case the drain system shall ensure removal of not less than 125 % of total amount of water delivered by water fire-extinguishing system pumps. The drainage system valves shall be operable from outside the protected space at a position in the vicinity of the extinguishing system controls. Bilge wells shall be arranged at the ship's side at a distance of not more than 40 m from each other in each watertight compartment. If during transportation of some cargoes the bilge wells are to be covered, the negative effect on ship stability caused by water which can be delivered to the spaces from fire-extinguishing system and free surfaces which appear in the spaces shall be taken into consideration when calculating ship stability.

10.8 **BALLAST SYSTEM**

**Pumps**

10.8.1 Ballast system of the ship shall be serviced by at least one pump ensuring working medium delivery and pressure required for operation of the system. The capacity of each of such pumps shall be such as to ensure the water flow rate of not less than 2 m/s in ballast system receiving pipelines with diameter calculated by the formula 10.8.5 for the greatest ballast tank.

On catamaran type ships each sidehull shall be equipped with independent ballast system.
10.8.2 General service pumps of capacity sufficient for ballasting operations, including bilge, fire or standby cooling pump, may be used as ballast pumps.

10.8.3 The application of bilge pumps of oil tanker fore compartments as ballast pumps is described in 10.7.9.

10.8.4 The pumps used for pumping ballast water from the double-bottom tanks shall be of self-priming type.

10.8.5 Inner diameter \( d \) of ballast pipe suction for ballast tanks shall be not less than the value determined by the formula, in mm:  
\[
d = 16 \sqrt[3]{V},
\]
where \( V \) — ballast tank capacity, in m³.

10.8.6 The arrangement of the suction shall be such as to ensure pumping of the water from any of the ballast tanks, whether the ship is upright or has a list of \( 5^\circ \).

10.9 LIQUID CARGO PIPING SYSTEM OF OIL TANKERS

Pumps and their drives

10.9.1 Cargo piping system of oil tanker shall make it possible to regulate the loading rate of separate tanks. Provision shall be made for limitation of the flow rate at the suction pipe outlet in the tank up to 1 m/s at the initial loading stage and up to 8 m/s at further loading.

Regulation of the flow rate shall be made by one of the following methods or their combination:

1. using the pump drives capable of smooth adjusting the rotation frequency;
2. using the pump drives capable of adjusting the pump flow; 
3. using the control valves in the system;

10.9.2 Cargo pumps and cargo stripping pumps shall be used only according to their purpose, except as provided in 10.7.11. Intake or pressure pipelines brought to non-cargo compartments shall not be connected to these pumps.

The cargo and stripping pumps shall be arranged in the cargo pump rooms, or these pumps shall be submersible. Electric motors of submersible pumps shall have overheat protection when the pump is in idle operation.

Cargo pumps can be installed on the deck in the cargo tanks area.

10.9.3 The arrangement of the cargo pump driving engines shall comply with the requirements of 1.9.8.

10.9.4 The design of pumps, valves and their drives shall exclude spark formation.

10.9.5 Arrangements shall be provided for stopping each cargo pump and cargo stripping pump from an easily accessible place on the deck.

Where a central control station is provided for cargo operations, pump stopping arrangements shall be also fitted therein.

Switching devices of pump electric motors shall comply with the requirements of 16.2.31 Part VI of the Rules.

10.9.6 Pressure gauges of the cargo oil discharge and cargo stripping mains shall be placed near the pumps, as well as at the central control station of cargo operations.

Piping arrangement

10.9.7 Fuel system intended for fuel supply to other ships shall comply with the applicable requirements of Part III of the Rules.

10.9.8 The cargo pipes shall not be laid through the tanks not intended for liquid cargo storage and shall not be connected to other tanks or pipelines, including the fuel piping of the power installation.

The cofferdams shall not have any connections to the cargo tanks. Cargo bypass valves shall not be fitted inside the cofferdams.

10.9.9 Pipelines not intended for servicing of the cargo tanks shall neither be laid through these tanks and shall nor have any joints with them, except air and sounding pipes of the fuel tanks, which may be laid
through the cargo tanks if they are free of detachable joints, reliably secured and protected against mechanical damage. The wall thickness of these pipes shall be not less than that indicated in column 5 of Table 10.2.13.

10.9.10 Remotely controlled valves shall meet the requirements of 10.3.2 to 10.3.4.

The spindles used to operate the valves located inside the tanks shall be carried to the open deck in gas-tight sealing glands.

The drives shall be so designed as to prevent accumulation of liquid cargo residues inside them.

Replacement of the sealing shall be made from the open deck. The drives shall have arrangements showing whether the valve is open or closed.

The pipes of systems in which different cargo kinds may become mixed or contaminated by water shall have duplicate shut-off valves.

10.9.11 Equipment for liquid cargo heating shall meet the requirements of 10.13.9 to 10.13.15; the pressure of steam used for heating shall not exceed 0.7 MPa.

10.9.12 The pipe flanges and fastening pieces intended for hose connection from the shore, as well as earthing devices shall be made of materials precluding the spark formation.

10.9.13 The piping on the deck and in the cargo tanks shall be secured and fitted with expansion joints.

Where the cargo pipeline is led to the aft, it shall be free of any detachable joints in the superstructure area.

The cargo pipeline penetrating superstructures shall be led in the open trunk. Such pipeline shall be connected to the cargo main by means of an adapter blank flange or a detachable branch pipe positioned in front of the fore bulkhead of the superstructure.

A blank flange shall be installed on the outlet end of this pipe regardless of the number and the construction of the shut-off valves fitted.

Where the pipeline is led to the afore part of the ship, these requirements shall also be complied with.

10.9.14 All the sections of the cargo pipeline interconnected by flanges shall have electrical connection between each other and the pipeline shall have a connection to the hull (see 16.2.25, 16.2.26 and 16.2.28 Part VI of the Rules).

10.9.15 Remote-controlled valves fitted between the cargo mains and the pumps shall have a local manual control.

10.9.16 Where the rubbing parts of valve drives are passed inside the cargo tanks and cofferdams, as well as on the cargo deck, precautions shall be such as to preclude the spark formation.

10.9.17 The ends of filling pipes of the cargo tanks shall be located as close as possible to the tank bottom, however, the distance between these ends and the tank bottom shall be not less than 0.25 of the filling pipe internal diameter.

10.9.18 Piping outlet for washing water drainage to the settling tank shall be located at least 0.25 of the pipe internal diameter above the tank bottom. Free falling of liquid into the settling tank containing washing water and oil residue shall be avoided.

10.9.19 On combination carriers provision shall be made for arrangements disconnecting the pipelines which connect the pump room to discharge tanks. The means of isolation shall consist of a valve followed by a spectacle flange or a spool piece with blank flanges. This arrangement shall be located near discharge tanks or in the pump room immediately after the place where the pipeline passes through the bulkhead.

During transportation of bulk goods the content of discharge tanks is pumped out immediately on the open deck for delivery to shore receiving facilities by means of separate stationary pump and pipeline comprising a valve box with shut-off valve and blank flange.
Cargo tank heating

10.9.20 Steam, hot water or high-temperature organic heat transfer fluids shall be used as a heating medium in cargo heating systems in tanks.

10.9.21 Upstream of each stream heating coil, a non-return shut-off valve shall be fitted, and upstream of shut-off valves at the outlet the gauge valve for checking the condensate quality shall be installed.

Fuel heating coils shall be arranged in the lower part of cargo tanks. In deep tanks, where the heating coils are arranged in several sets throughout the tank height, provision should be made to shut off separate sections of the heating coils when the level of liquid cargo is lowered.

10.9.22 Observation tank shall be provided in the line of condensate return from heating system.

Air pipes of observation tanks of heating steam condensate from the cargo tanks with cargo flash point of 60 °C and less shall be equipped with flame arresting arrangements and brought out to the open deck where they present no hazard to people.

10.9.23 For use of systems with high-temperature organic heat transfer fluid for heating the tanks the requirements of 10.19 shall be met.

10.9.24 Maximum temperature of heating medium shall be not less than the flash point of transported cargo vapours by at least 15 °C.

10.9.25 The heating system shall be equipped with cargo temperature control facilities in tanks. Current temperature in tanks, as well as light and sound alarm about exceeding maximum permissible temperature of cargo or flow rate reduction during pumping through cargo heaters, shall be checked.

10.9.26 Steam temperature in cargo pump room heating system shall not exceed 150 °C.
wave slamming without loss of strength under the most unfavourable operating conditions of the ship. Pipe wall thickness shall be not less than 6.3 mm.

Bending stresses and loads for air pipes of ships of M-CTI class shall be determined in the most dangerous zones, including deck sockets, welded or flanged joints and lower angles of support plates.

Bending stresses shall not exceed 0.8\(R_{el}\), where \(R_{el}\) is yield point of steel.

Irrespective of corrosion protection, the corrosion allowance shall be not less than 2 mm.

Pipes of 600 mm in height and more shall be provided with radially arranged knees used as a reinforcement.

10.10.5 The upper end of each air pipe shall be made as a bend, with its opening facing downwards or shall have other construction preventing the ingress of water, precipitation and solids inside the air pipe.

10.10.6 The open ends of air pipes of the fuel and lubricating oil tanks, as well as those of cofferdams in oil tankers separating cargo or discharge tanks shall be led to positions on the open deck where the issuing vapours have no risk of fire.

The total cross-sectional area of the air pipes of each fuel tank filled by the onboard pumps or shore pumps, shall be not less than 1.25 times the total cross-sectional area of all filling pipes of this tank.

10.10.7 The air pipes of non-heated independent lubricating oil storage tanks of the basic store and waste oil tanks may terminate in spaces where the tanks are installed if precautions are taken precluding slippage of oil onto electrical equipment or heated surfaces in case the tank is overflowing.

10.10.8 Each open end of the air pipes of fuel and discharge-and-circulating oil tanks, as well as those of cofferdams in oil tankers separating cargo or discharge tanks shall be protected with flame arresters. The cross-sectional area of flame arresters shall be not less than the cross-sectional area of the air pipe.

10.10.9 Outlets of air pipes of ships of all classes, except for ships of P and J class, arranged on the open decks shall be fitted with fixed automatic devices to prevent the water ingress into the tank.

Automatic closures of air pipes of ships of M-CTI 4,5 class shall be operational at a roll of up to 40°.

When float-type automatic closures are used, guides ensuring their correct operation at any permissible heel and trim of the ship shall be provided.

10.10.10 The total cross-sectional area of the air pipes in tanks filled by gravity method shall be not less than the total cross-sectional area of the filling pipes of these tanks.

10.10.11 The total cross-sectional area of the air pipes of a tank filled by the onboard pumps or shore pumps, shall be not less than 1.25 times the cross-sectional area of the tank filling pipe. When the diameter of the filling pipeline is less than 50 mm, a diameter of the air pipe may not exceed the diameter of the filling pipe.

The cross-sectional area of a common air pipe from several tanks shall be at least 1.25 times the area of the common filling pipeline of these tanks.

10.10.12 Where a tank filled by onboard pumps or shore pumps is fitted with an overflow pipe, the total cross-sectional area of the tank air pipes shall be not less than one-third of the filling pipe area.

Where the air pipes from several tanks fitted with overflow pipes are combined, the cross-sectional area of the common air pipe shall be at least one-third of the area of the common filling pipe of these tanks.

10.10.13 The air pipes shall be so arranged as to prevent formation of hydraulic locks in the pipes at a heel and trim of the ship specified in 1.3.

10.10.14 The air pipes of fuel and lubricating oil tanks in way of accommodation and refrigerated spaces shall be free of detachable connections.
The laying of the air pipes of fuel tanks through the cargo tanks shall meet the requirements of 10.9.9.

10.10.15 Nameplates shall be affixed to the upper ends of the air pipes.

10.10.16 The air pipes from crankcases of internal combustion engines shall meet the requirements of 2.5.4.

Gas outlet pipes of oil tankers and oil-ore carriers

10.10.17 Each cargo tank shall be provided with a gas-outlet pipe connected to the top of the tank.

Gas-outlet pipes shall not be connected to the air pipes servicing other ship spaces.

The construction of the gas-outlet pipes shall provide measurements of pressure in the cargo tanks, as well as pressure difference at fire-retarding divisions.

Gas-outlet pipes shall be self-draining to cargo tanks at heel and trim specified in 1.3, or shall have fixed arrangements for draining gas-outlet pipes to cargo tanks.

10.10.18 Gas-outlet pipes may be combined into one or several mains. Such combination is allowed only for pipes from cargo tanks with homogeneous cargo. Gas-outlet pipes can be combined with inert gas pipeline.

Internal diameter of separate gas-outlet pipes shall be not less than 80 mm, and that of main pipelines — not less than 100 mm.

Cross-sectional area of the separately laid gas-outlet pipe shall be not less than 1.25 of the cross-sectional area of filling pipeline of the tank on which this pipe is installed, and the cross-sectional area of the gas-outlet main from several tanks shall be not less than 1.25 of the cross-sectional area of the common filling pipeline of these tanks. It shall be taken into account that the cross-sectional area of each gas-outlet pipe shall be not less than 1.25 of the cross-sectional area calculated considering the maximum speed of cargo handling operations specified in the technical design assignment for the ship.

If gas-outlet pipes from various cargo tanks are combined in one main, to disconnect any cargo tank, the shut-off valves or other acceptable means shall be provided. The shut-off valves installed shall have locking arrangements.

Visual indication of the actual state of shut-off valves or cargo tank disconnecting arrangements shall be provided. Where these tanks are disconnected from the gas-outlet main, the relevant shut-off valves shall be opened before starting cargo loading, unloading or ballasting of these tanks. Disconnecting of cargo tanks from gas exhaust pipeline shall not stop flow of gases due to temperature variations in the cargo tank.

10.10.19 Outlet ends of gas-outlet pipes communicating with the atmosphere shall be provided with flame arresters. The cross-sectional area of flame arresters shall be not less than the cross-sectional area of the gas-outlet pipe.

When gas-outlet pipes are combined in a common main, the pipes led from each tank shall be provided with fire-retarding divisions. Fire-retarding divisions shall be positioned in the places where the possibility of liquid cargo ingress into them is excluded in any sailing conditions of the ship including rolling.

Fire-retarding divisions shall be made of material resistant to corrosion. Fire-retarding divisions shall be so designed as to provide the possibility of their replacement or dismantling without gas-outlet pipes reassembling.

10.10.20 Gas-outlet pipes laid from the cargo tanks shall be led to the open deck with due regard to the following requirements:

1. in ships carrying oil products with a flash point less than 45 °C the pipe outlet openings may be positioned above the main deck at a height of not less than \( \frac{1}{3} \) of the ship’s breadth; moreover, their height may not exceed 5 m, but shall be not less than 3 m;

2. in ships carrying oil products with a flash point from 45 up to 60 °C, the pipe outlet openings may be positioned above the main deck at a height of not less than 2.4 m;

3. in ships carrying oil products with a flash point over 60 °C the pipe outlets can be
positioned above the deck at a height of not less than 600 mm.

4 Outlets of gas-outlet pipes of oil tankers of M-СП, M-ПИ and O-ПИ classes during loading, unloading or ballasting shall:
- permit the free flow of vapour mixtures;
- or
- permit the throttling of the discharge of the vapour mixtures to achieve a velocity of not less than 30 m/s;
- be so arranged that the vapour mixture is discharged vertically upwards;
- where the free vapour release method\(^1\) is used, be such that the outlet is not less than 6 m above the cargo tank deck or from the gangway if situated within 4 m of this gangway and at a distance of not less than 10 m horizontally from the nearest air intakes and openings to enclosed spaces accommodating a source of ignition and from the windglass and hawse pipe of chain locker and equipment which can constitute an ignition hazard; and
- where the high-velocity vapour release method\(^2\) is used, be equipped with appropriate discharge arrangements and be arranged at a height not less than 2 m above the cargo tank deck and at a distance of not less than 10 m horizontally from the nearest air intakes and openings to enclosed spaces accommodating a source of ignition and from the windglass and hawse pipe of chain locker and equipment which can constitute an ignition hazard.

Outlets of gas-outlet pipes of oil tankers of M, O, P and \(\mathcal{J}\) classes shall be arranged at a distance of at least 3 m from deck houses, superstructures and places of air intake for the cases specified in 10.10.20.1 and 10.10.20.2 and not less than 1 m for the case described in 10.10.20.3.

10.10.21 Breathing valves fitted on the gas-outlet pipes shall be designed and positioned in such a way that the pressure in cargo tanks does not exceed 15 kPa, if the tanks are not specially designed for higher pressure; and

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\(^1\) SOLAS, Chapter II-2, Part B, Regulation 4, Para 5.3.4.1, Subpara 1.1.

\(^2\) SOLAS, Chapter II-2, Part B, Regulation 4, Para 5.3.4.1, Subpara 1.2.

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10.10.22 Each cargo tank shall have additional arrangement for free flow of mixtures of vapours, air or inert gas to prevent excessive pressure or vacuum in case of failure of arrangements specified in 10.10.20 or other design measures shall be taken to ensure that in the course of cargo handling the cargo tanks are not exposed to excessive pressure and no vacuum is created in them.

Instead of additional arrangement for free flow of mixtures of vapours, air or inert gas in control stations for cargo operations it is allowed to provide continuous indication of pressure in each tank. Alarm for excessive pressure or vacuum in the tank shall be provided.

A gas-outlet pipe with the breathing valve shall have a bypass pipe provided with shut-off valves, or other design measures shall be taken to avoid exceeding pressure or vacuum formation in the cargo tanks during cargo handling.

Overflow pipes

10.10.23 Overflow pipes shall be installed in service and fuel oil settling tanks and led to the fuel storage tank of the basic store.

10.10.24 The cross-sectional area of the overflow pipe shall be not less than the cross-sectional area of the tank filling pipe when filling it with hand pump.

When the tank is filled with the mechanically-driven pump, cross-sectional area of the overflow pipe shall be not less than 1.25 of the cross-sectional area of the tank filling pipeline.

Sounding arrangements

10.10.25 Each tank intended for storage of liquid, as well as bilges and bilge wells with no free access, shall be provided with sounding pipes extended to the open deck or with other liquid level indicators.

Sounding pipes of independent tanks may not be led to the open deck.
Sounding pipes of the fuel oil and lubricating oil tanks shall not be led to the passenger and crew spaces.

10.10.26 Level indicators of fuel oil and lubricating oil tanks fitted with transparent inserts shall be protected against damage.

The transparent inserts of the fuel oil tanks shall be made of flat glass or shockproof plastics which do not lose transparency under the action of fuel oil.

A self-closing cock shall be fitted at the lower end of the level indicator at the connection of the tank. If the level indicator is connected to the tank below the maximum liquid level, the self-closing cock shall be fitted at the top end of the level indicator.

In lubricating oil tanks with a capacity less than 0.5 m³ the installation of self-closing cocks is not required.

10.10.27 Where the double bottom forms bilges at the sides, or the ship has a flat bottom, the sounding pipes shall be installed at each side. These pipes shall be led to positions above the freeboard deck which are at all times accessible for taking soundings. The sounding pipes shall be straight and shall not interfere with taking soundings with a sounding rod.

In ships where the compartments are drained with portable pumps, raisers with fitted portable drain pumps may be used as sounding pipes.

10.10.28 Sounding pipes of fuel oil and lubricating oil tanks may be led above the machinery space floor plates, or into the shafting tunnel, if such design measures are provided or the sounding pipes terminate at such positions that fuel or lubricating oil at occasional spillage through sounding pipes will not come into contact with hot surfaces of boilers, engines, exhaust gas pipes, etc., and also with electric machines and distribution switchboards. Such pipes shall be fitted with self-closing cocks and their height shall be at least 0.5 m above the floor level. These pipes shall not be used as air pipes.

Laying of the sounding pipes of fuel oil tanks through the cargo tanks shall comply with the requirements of 10.9.8.

10.10.29 Sounding pipes of the double-bottom water storage tanks may be led into the above spaces accessible at all times. Such pipes shall not be used as air pipes and shall be fitted with self-closing cocks.

10.10.30 The ends of the sounding pipes led to the open decks shall be fitted with tight plugs complying with the requirements of 10.2.8.

If the sounding pipes are extended above the open decks, they shall be located at such positions where they cannot be damaged, otherwise they shall have appropriate guards.

10.10.31 Provisions shall be made to preclude damage of the bottom plating under the open ends of the sounding pipes while measuring the fuel level in the cargo tanks.

In case of slotted sounding pipes with closed ends, the measures described herein shall be taken for the sounding pipe plug.

10.10.32 The internal diameter of the sounding pipes shall be not less than 25 mm.

Sounding pipes which are laid through refrigerated spaces in which the temperature may be reduced to 0 °C and below, as well as sounding pipes of the tanks provided with the heating system shall have an internal diameter of at least 50 mm.

10.10.33 Outlet ends of sounding pipes shall have nameplates with indelible inscriptions containing information required for identification of these sounding pipes.

10.10.34 Sounding rods and other devices intended for measuring the cargo level on oil-tankers carrying oil products with a flash point 60 °C or less shall be made of spark-proof material.

10.11 EXHAUST GAS SYSTEM

Exhaust gas piping

10.11.1 The gas exhaust pipelines shall be brought to the open decks, except for the
cases specified in 10.11.2. The gas exhaust pipelines shall be so designed as to exclude the possibility of ingress of foreign objects, overboard water or atmospheric precipitations into engines and boilers.

10.11.2 The gas exhaust pipelines can be brought out through the shell plating in the stern in ships of less than 25 m in length. Gas exhaust pipelines can be brought out through the side shell plating to the atmosphere only for the ships with gas exhaust systems in which the gases are cooled by outside water injection/supply. Places for bringing out gas exhaust pipelines shall be selected so as to exclude the possibility of ingress of released gases to the ship’s spaces.

10.11.3 In ships it is allowed to use gas exhaust systems in which the gases are cooled by outside water injection/supply. Places for bringing out gas exhaust pipelines shall be selected so as to exclude the possibility of ingress of released gases to the ship’s spaces.

10.11.4 Each main engine shall be fitted with an individual exhaust gas pipe. Exhaust gas pipes of auxiliary engines may be connected to a common exhaust line provided that a safety device is fitted to preclude:
- gas flow from the common line to the pipes of the engines not actually at work;
- damage of any of the engines during starting.

10.11.5 When the uptakes of the boilers are arranged to discharge into a common uptake, dampers are permitted, provided they have arrangements to lock them in open position. Manholes and vertical ladders shall be provided for inspection and cleaning of the uptakes and air ducts of boilers.

10.11.6 If the waste heat boilers and the composite boilers are so designed that in drained condition (without water) they can not be heated by the exhaust gases, bypass lines and dampers disconnecting the boilers from the exhaust gas supply shall be fitted. Exhaust gas pipelines of the main and auxiliary engines may be connected to a common waste heat boiler or a composite boiler, provided the reliable devices are fitted to prevent exhaust gas pipelines of the engines not actually at work or disconnected ones from the penetration of gases from the working engines; as well as devices to disconnect a waste heat boiler or a composite boiler from the exhaust gas pipeline of any engine; and devices to lead the gases from this engine to the bypass pipeline. Safety and locking devices shall be provided with position indicators of the shut-off device.

10.11.7 Gas exhaust pipelines of engines and boilers shall be thermally insulated by means of suitable insulating material, double walls or screen. It is allowed not to insulate gas exhaust pipelines of engines, the exhaust gases of which are cooled by outside water injection/supply if the temperature of the gas exhaust pipeline surface does not exceed 60°C.

These pipelines can be manufactured with use of flexible hoses and their connections.

10.11.8 Exhaust gas pipelines of the engines and boilers shall be fitted with thermal expansion compensators. Gas exhaust pipelines shall have handholes for cleaning, as well as drain cocks and devices for condensate collection and removal with allowances made for the design of the pipelines.

10.11.9 Exhaust gas pipes laid through the accommodation spaces or the wheelhouse shall be fitted with a gas-tight protective casing inside these spaces. The space between the exhaust gas pipes and the protective casing shall communicate with the atmosphere.

Silencers and spark arresters

10.11.10 Gas exhaust pipelines of engines and boilers shall have spark arresters. Silencers and spark arresters are to be so arranged as to provide easy access for cleaning. For this purpose the pipelines shall have handholes and drain cocks.

10.11.11 Where waste heat boilers and spark arresters of the wet type are installed, measures shall be taken to prevent the ingress of water into the engines when in case of leakage in the boiler pipes or at other failures.

Spark arresters in which the flow of exhaust gases is water-sprayed or passes through the water.
The drain pipes shall be led into the machinery space bilges and shall have hydraulic seals.

10.12 VENTILATION SYSTEM

Ventilation ducts

10.12.1 The ventilation system shall be so designed as to exclude flame and smoke propagation by the system itself. Fans shall be arranged in a way so that the ducts used for different rooms remain within the vertical fire zone served by the fans.

Ventilation ducts shall not penetrate impermeable bulkheads below the freeboard deck.

Exhaust ventilation ducts shall be provided with hatches for inspection and cleaning. The hatches shall be located near the fire dampers.

Ducts used for ventilation of accommodation and service spaces or control stations passing through the machinery spaces, which accommodate engines and boilers, galleys and vehicles spaces, shall meet the following requirements:

.1 Duct walls shall be made of steel according to 10.12.2.1 and 10.12.2.2;
.2 automatic fire dampers shall be installed near the limiting structures through which the ducts are laid;
.3 in places where the ducts pass through the limiting structures of the above mentioned spaces the fire-resistance of these structures shall be provided; or (instead of 10.12.1.2 and 10.12.1.3)
.4 ducts shall be insulated with fireproof structures of A-60 type within the above mentioned spaces;
.5 if ventilation ducts pass through decks, measures shall be taken to decrease the hazard of smoke and hot gas passing from one tween-deck space to another one through ventilation system. These measures shall not affect fire-resistance of the deck.

10.12.2 Trunks and vertical ventilation ducts passing through impermeable decks within one impermeable compartment below the freeboard deck shall be impermeable and shall withstand loads equal to the loads of limiting structures of the specified compartment which appear during tests of this compartment for tightness.

All ventilation ducts shall be made of non-combustible materials. Duct sections of not more than 2 m in length and clear area not more than 0.02 m² shall be manufactured of material with low flame spread properties (see 2.1.3.1 Part III of the Rules), if:

they are to be used only at the end of the ventilation device;
the ducts are not situated less than 600 mm measured along the duct, from an opening in an A or B class division, including continuous B class ceiling.

The ventilation system of the machinery spaces with engines and boilers, galleys and vehicles spaces shall be separated from each other and from the ventilation systems serving other spaces. Ventilation ducts of the above mentioned ventilation systems shall not pass through accommodation and service spaces or control stations. Ventilation ducts can be laid through accommodation and service spaces or control stations if:

.1 duct walls are made of steel having a thickness of at least 3 mm for ducts with width or diameter of up to 300 mm, inclusive, or thickness of at least 5 mm when the duct width or diameter is 760 mm and more; If the duct width or diameter D exceeds 300 mm, but is less than 760 mm, the duct wall thickness δ, in mm, is calculated by the formula:
\[ \delta = 1.7 + \frac{D}{230} \];
.2 ducts are secured and their walls are reinforced;
.3 the ducts are fitted with automatic fire dampers close to the boundaries penetrated;
.4 ducts are insulated by type A-60 structures from the machinery spaces, galleys, vehicle spaces to a point at least 5 m beyond each fire damper; or (instead of 10.12.2.2 to 10.12.2.4);
.5 ducts are insulated with type A-60 structures in accommodation and service spaces or control stations.

10.12.3 If the ventilation duct with clear cross-sectional area of 0.02 m² or less with walls made of metal sheets of max. 1.5 mm passes through type A bulkheads or decks, it
shall be fitted with a steel sheet sleeve having a thickness of at least 3 mm and a length of at least 200 mm. If the duct passes through type A bulkhead, the sleeve shall protrude from each side of the bulkhead by 100 mm. If the duct passes through the deck, the sleeve shall be fully arranged on the lower side of the deck. In the points of passing through the bulkheads the above specified sleeves and ducts shall be fitted with insulation made of non-combustible materials as specified in 2.7.1 of Part III of the Rules.

If the ventilation ducts with clear cross-sectional area over 0.02 m$^2$ pass through type A bulkheads or decks, they shall also be fitted with steel sheet sleeves. The ducts and the sleeves shall meet the following requirements:

.1 sleeves' walls shall have thickness of at least 3 mm and length of at least 900 mm. If the duct passes through type A bulkhead, the sleeve shall protrude by 450 mm from each side of the bulkhead. The insulation of sleeves and ducts shall have at least the same fire integrity as the bulkhead or deck through which the duct passes;

.2 Ducts with clear cross-sectional area more than 0.075 m$^2$ shall be equipped with fire dampers installed on bulkheads. The fire damper shall close automatically, but it shall also be possible to close the damper manually from both sides of the bulkhead or deck. Locations of the dampers and their control drives shall be readily accessible and be painted with red retro-reflecting colour. If the dampers are placed behind ceilings or linings, these ceilings or linings shall be provided with hatches for inspection of dampers. Identification numbers of fire dampers shall be applied on these hatches. Identification number shall also be applied on any remote control of dampers. The dampers shall be fitted with position indicators showing whether the dampers are open or closed.

When the damper is not installed on the bulkhead, the duct between the bulkhead and the damper shall be made of steel or other equivalent material and shall be provided with insulation corresponding to the degree of fire-resistance of the bulkhead.

Fire dampers are not required, however, where ducts pass through spaces surrounded by A class divisions, without serving those spaces, provided those ducts have the same fire integrity as the divisions which they pierce.

Ventilation ducts with clear cross-sectional area more than 0.02 m$^2$ passing through type B bulkheads shall be provided with sleeves of 900 mm long made of steel of not less than 2 mm thick. The sleeve shall protrude by 450 mm from each side of the bulkhead only if the steel duct does not have the same length.

10.12.4 Ventilation ducts shall be properly insulated in places of possible sweating. Drain plugs shall be provided for the portions of ducts where water is likely to accumulate.

10.12.5 Ventilation ducts for removal of explosion and fire-dangerous vapours and gases shall be gas-tight and shall not communicate with the ducts of other spaces.

Closing arrangements of the ducts shall be so designed as to prevent the spark formation.

Outer openings of the ducts other than those indicated in 10.12.18 shall be provided with flame arresters.

10.12.6 Where the artificial ventilation is used on cabin passenger vessels, fans and ventilation ducts are recommended to be placed within the same vertical fire zone where the ventilated spaces are located.

10.12.7 Ventilation ducts which do not pass through cargo spaces:

.1 ducts with clear cross-sectional area not less than 0.075 m$^2$ and all vertical ducts serving more than one tween-deck space shall be made of steel or other material of equivalent fire-resistance;

.2 ducts with clear cross-sectional area less than 0.075 m$^2$, other than the vertical ducts referred to in 10.12.7.1, shall be made of non-combustible materials. Where such ducts are laid through type A or B divisions, due regard shall be given to ensuring the fire-resistance of the division; and

.3 ducts with clear cross-sectional area not more than 0.02 m$^2$ and length not more
than 2 m shall meet the requirement of 10.12.2 for short ducts.

**Arrangement of ventilator heads and air inlets**

10.12.8 Ventilator heads of plenum ventilation and air inlets of the ventilation system shall be so located that the risk of drawing-in air contaminated by gas, oil vapours, etc., is minimized, and the ingress of outboard water into the ventilation ducts is precluded.

The height of fan coamings shall meet the requirements set out in 5.6.20 Part II of the Rules.

**Ventilation of machinery spaces**

10.12.9 The ventilation of machinery spaces shall provide a sufficient supply of air necessary for maintenance and operation of the power installation components in all service conditions.

The ventilation shall ensure removal of air from the lower zones of the spaces, as well as from below floor plates where gases heavier than air may be accumulated.

The ventilation of refrigerated spaces shall meet the requirements set out in 9.7.6 and 9.7.7.

10.12.10 Shafting tunnels shall have ventilation.

10.12.11 The emergency diesel-generator room shall be fitted with an automatic arrangement ensuring air supply sufficient for the emergency diesel-generator to run under full load in any service conditions when the doors (hatches) are closed. If the emergency diesel-generator room is above the bulkhead deck, steel splash-proof shutters opening automatically upon start of emergency diesel generator are used as an arrangement of automatic air inflow for diesel generator operation. Under normal operating conditions the shutters shall be closed.

**Ventilation of ferries’ closed spaces and holds intended for the carriage of motor vehicles and mobile plants**

10.12.12 Closed spaces and cargo holds intended for the carriage of motor vehicles and other mobile plants with fuel in their tanks shall be provided with independent artificial exhaust ventilation capable of ensuring at least:

10 air changes per hour on ferries and passenger ships transporting more than 36 passengers;

6 air changes per hour on all other ships.

10.12.13 The ventilation system shall be equipped with fan control devices. These devices shall be installed in the wheelhouse.

10.12.14 The pumps shall be so designed as to prevent spark formation.

**Ventilation of refrigerated spaces**

10.12.15 Ventilation of cooled rooms shall comply with the requirements set out in 9.9.5 to 9.9.8.

**Ventilation of accumulator rooms and boxes**

10.12.16 Ventilation of the accumulator rooms and boxes shall be of independent type and ensure removing air from the upper part of the ventilated spaces.

The exhaust ducts shall be gas-tight.

10.12.17 The inlet air shall be supplied into the lower part of the ventilated space.

10.12.18 The outlets of ventilation ducts shall be so designed as to preclude the ingress of water, atmospheric precipitation and solids inside them.

No flame arresters shall be installed at the ventilation duct outlets.

The exhaust ducts shall be led to places where the issuing gases do not present a fire risk.
10.12.19 Accumulator boxes with batteries of a charging capacity not over 0.2 kW may be ventilated through the openings in the lower and upper parts of the box to ensure removal of the gases. Charging capacity of batteries is determined according to 8.5.1 Part VI of the Rules.

10.12.20 The rate of air flow $Q$ for the natural ventilation of an accumulator room or box shall be not less than that determined by the formula, in m$^3$/h:

$$Q = 0.111 I n,$$

(10.12.20)

where $I$ — maximum charging current during gas emission, but not less than 0.25 of the current rating of the charging device, in A;

$n$ — number of battery cells.

10.12.21 The cross-sectional area $F$ of a duct in case of natural ventilation of accumulator rooms and boxes shall be not less than that determined by the formula, m$^2$:

$$F = 2.9 \cdot 10^{-4} Q,$$

(10.12.21)

but not less than 0.008 m$^2$ for acid accumulators and 0.012 m$^2$ for alkaline accumulators.

Here $Q$ — air flow rate determined by the formula (10.12.20), in m$^3$/h.

10.12.22 Natural ventilation of the spaces may be used in the following cases:

.1 required air flow rate determined by the formula (10.12.20), is at least 85 m$^3$/h;

.2 the angle of the duct deflection from the vertical is less than 45$^\circ$;

.3 the number of bends of the duct does not exceed 2;

.4 the length of the duct does not exceed 5 m;

.5 the operation of the ventilation system does not depend on the wind direction;

.6 the cross-sectional area of the duct is taken not less than that determined by the formula (10.12.21).

10.12.23 Where the rate of air flow determined by the formula (10.12.20) is 85 m$^3$/h and over, the accumulator room shall be provided with artificial exhaust ventilation.

10.12.24 The internal surfaces of the exhaust ducts, as well as the fans shall be protected against gases emitted by the electrolyte.

10.12.25 The motors of fans shall not be arranged in way of gas exhaust.

The design of fans shall prevent the spark formation as far as practicable.

Ventilation of foam fire-extinguishing and smothering stations, as well as station for drinking water preparation by ozone treatment

10.12.26 Foam fire-extinguishing and smothering stations shall be equipped with the ventilation ensuring at least six air changes per hour.

The carbon dioxide fire-extinguishing stations shall be provided with an exhaust and supply ventilation independent from other ventilation systems. The inlets of exhaust ducts shall be located in lower parts of the station rooms.

Drinking water stations (ozone treatment) shall be equipped with plenum-exhaust ventilation system with 10 air changes per hour.

Ventilation of cargo pump rooms

10.12.27 The cargo pump rooms shall have artificial exhaust ventilation fitted separately for each space. This ventilation shall ensure at least 20 air changes per hour. Outlets of ventilation systems equipped with sparkproof exhaust fans shall be brought out to safe place on the open deck. Inlet ventilation of these spaces may be natural.

lighting in cargo pump rooms, except emergency lighting, shall be interlocked with ventilation such that the ventilation shall be in operation when switching on the lighting. Failure of the ventilation system shall not cause the lighting to go out.

It is also required to meet the requirements of 16.2.30 Part VI of the Rules.

10.12.28 Steam engines for the fan drives may be located in the pump room.

Electrical motors for driving the fans shall be arranged in accordance with 1.9.8 Part IV of the Rules.
10.12.29 Inlets of exhaust ducts shall be situated in the lower zones of the spaces in the places where liquid cargo vapours accumulate.

Outside the pump room these ducts shall be gas-tight and shall not communicate with the vent ducts of cargo tanks or other spaces.

Where the ventilation system of the pump room is used for ventilating the cargo line and the communicating cargo tanks through the cargo line, duplicate shut-off valves shall be provided at the connections of the ventilation duct to the cargo line.

10.12.30 All the closures of the ventilating ducts shall prevent the spark formation as far as practicable.

The fans shall be so designed as to prevent spark formation.

10.12.31 Outlets of exhaust ducts shall be not less than 2 m clear of any opening leading into the ship spaces which may contain a source capable of igniting oil vapours, and shall be so located relative to the inlets of plenum ducts as to prevent contamination of air entering the inlets of ventilation system.

The air intakes of the plenum ventilation shall be situated at least 2.4 m above the main deck and at least 5 m clear of any openings of the cargo tanks and outlets of the exhaust gas pipes (see also 10.10.20).

The outlets of exhaust ducts shall be fitted with flame arresters.

**Ventilation of galleys**

10.12.32 Ventilation systems of galleys shall be separated from ventilation systems serving other spaces.

Supply or exhaust ventilation ducts from galley are to be made as type A structures where passing through accommodation spaces or spaces containing combustible materials. In the upper part of supply ventilation duct at the inlet to galley the fire damper shall be installed. If necessary, the fire damper shall cut off all ventilation duct sections outside the galley.

10.12.33 Each exhaust ventilation duct from galley ranges passing through accommodation spaces or spaces containing combustible materials shall be equipped with:
- detachable box for fat collection;
- fire sliding valve located in the lower part of the duct and fire damper installed in the upper part of the duct.

Exhaust fan switch shall be installed in the galley.

**Ventilation of ship cargo spaces fit for dangerous cargoes**

10.12.34 Ventilation systems of the ships used for transportation of dangerous cargoes shall comply with 3.2 and 4.5 Part IX of the Rules.

**Closing appliances and stopping devices of ventilation**

10.12.35 Inlets and outlets of ventilation system shall be equipped with closing devices operated both from the inside and outside of the ventilated space. These devices shall be installed in easily accessible places and shall have closing device position indicators (opened or closed). Each of the closing devices shall have a marking about its purpose.

10.12.36 It shall be possible to stop forced ventilation of accommodation, service and cargo spaces, control stations and machinery spaces both from the inside and outside of these spaces.

10.12.37 Machinery spaces shall have control facilities for opening and closing the decklights and closing the fire dampers of ventilation system.

The controls of devices used for forced ventilation of machinery spaces shall be so located as to be operated both from the machinery space and from the outside. The devices for stopping forced ventilation of machinery spaces shall be arranged separately from the devices for stopping ventilation of other spaces.

10.12.38 Artificial ventilation system, except for machinery space and cargo space
ventilation system, shall be fitted with controls so grouped as to enable stop of all fans from either of two separate positions which shall be situated as far apart as possible. It shall be possible to stop the fans of ventilation system of cargo spaces from a safe place outside such spaces.

**Ventilation of stairway enclosures of passenger ships**

10.12.39 Passenger ships with stairway enclosures shall be equipped with autonomous ventilation system of these enclosures independent from ventilation system of other ship spaces

**10.13 FUEL SYSTEM**

**Pumps**

10.13.1 Mechanically-driven fuel transfer pump and a standby hand pump shall be provided for fuel oil transferring from reserve tanks into the service tanks. When the fuel oil separator is available, the separator pump may be used for standby purpose.

In ships with a daily consumption of fuel less than 1 t, one hand pump is admissible.

10.13.2 The fuel transfer pumps and the separator pumps, besides local control, shall be provided with stopping means operable from readily accessible positions outside the spaces where the pumps are installed.

**Design and arrangement of pipelines**

10.13.3 Fuel oil pipelines shall be separated from other piping systems. They shall not be affected by intensive thermal flows and shall be accessible for inspection throughout the entire length.

10.13.4 Pipelines used for delivery of heated fuel oil under pressure shall be arranged in accessible and illuminated places.

10.13.5 The fuel pipes shall not be laid under the internal combustion engines, turbines, boilers, near the heated parts and air intake devices of the engines, compressors and electrical equipment, as well as above gas exhaust pipelines, steam lines (except heating steam coils), steam boilers and their funnel uptakes.

10.13.6 Fuel oil pipes from the tanks of capacity over 50 l located outside the double bottom space as well as the pipes intended to equalize the level of fuel in the tanks shall be fitted with shut-off valves located directly on the tanks. These valves shall be capable of being remotely closed from readily accessible places located outside the space containing the tanks.

Daily service tanks shall be fitted with quick-closing valves.

Inlet fuel pipes from the double bottom tanks shall be fitted with shut-off valves located above the tanks (see also 10.13.24).

10.13.7 Service and settling fuel tanks shall have overflow pipes brought to the main fuel tanks. The cross-sectional area of overflow pipe shall be not less than the cross-sectional area of the tank pipe when filling it by means of hand pump. When the tank is filled with a power-driven pump, cross-sectional area of the overflow pipe shall be not less than 1.25 of the cross-sectional area of the tank filling pipeline.

When the fuel oil tanks are connected with each other, a cross-sectional area of the connecting pipelines (valves) shall be at least 1.25 times the cross-sectional area of the filling pipelines for fuel intake.

10.13.8 Filling pipelines of main fuel tanks shall be brought on the deck and fitted with shut-off valves controlled from the deck.

**Heating arrangements of fuel oil tanks**

10.13.9 Fuel oil shall be heated by means of steam or water heating coils, coils with high-temperature organic heat transfer fluid or electric heaters. Electric heaters shall comply with the requirements of 16.2.32 to 16.2.34 Part VI of the Rules.

10.13.10 Heating coils shall be fitted in the lowest part of the fuel tanks. In tanks, where the heating coils are arranged in several sets (sections) throughout the tank height, provision should be made to shut off separate sec-
tions of the heating coils when the fuel level is lowered.

10.13.11 The suction ends of fuel pipes from the daily service tanks and settling tanks shall be so positioned above the heating coils and electric heating appliances as to prevent baring of the latter. This requirement is not applied to the ends of stripping pipes.

10.13.12 Maximum temperature of heated fuel in tanks shall be lower than fuel vapours flash point by at least 10 °C. Fuel heating in service, settling and other tanks of systems for fuel supply to engines and boilers up to the temperature exceeding the specified one is allowed, provided the requirements of 10.10.6 and 10.10.8 and the following conditions are met:

.1 electrical equipment shall not be arranged in the steam space of fuel tanks, unless it is of group II B (see Table II2.1 Appendix 2 Part VI of the Rules) and unless it is explosion-proof electric equipment with explosion protection of i type with sparkproof electric circuit level ie (see Table II2.3 Appendix 2 Part VI of the Rules);

.2 vapours from the upper part of the tank and air pipeline shall not penetrate the machinery spaces;

.3 closed spaces shall not be located above these fuel tanks, except for ventilated cofferdams.

10.13.13 Where necessary, temperature gauges shall be fitted to control the temperature of the fuel oil being heated.

10.13.14 Heating steam condensate shall pass through a sight glass to control its purity.

10.13.15 The pressure of the steam used for fuel oil heating shall not exceed 0.5 MPa.

Water drainage arrangements of fuel oil tanks

10.13.16 For draining water from daily service and settling tanks, these tanks shall be fitted with self-closing valves and pipes connected to contaminated fuel collecting tanks. Water and sludge drain pipes shall be fitted with sight glasses. Where drip trays are available, open funnels may be used instead of sight glasses.

Arrangements for fuel leakage collection

10.13.17 Independent tanks, pumps, filters and other equipment shall be fitted with drip trays in places where the oil may be leaked.

10.13.18 Drain pipes from the drip trays shall be led into collecting tanks.

10.13.19 The internal diameter of drain pipes shall be not less than 15 mm.

10.13.20 The ends of the drain pipes shall be led to the tank bottom with a minimum clearance.

Where the drain tank is situated in the double bottom space, measures should be taken to prevent the ingress of water into the machinery spaces through the open ends of the drain pipes in the event of the shell plating damage. Provision should be made for an alarm device to give warning if the fuel oil reaches the upper limit level in the collecting tank.

10.13.21 If the drain pipes from drip trays fitted in different watertight compartments are led into a common collecting tank, design measures shall be made to prevent water from one flooded compartment to enter the other compartment via open ends of the drains.

Filling of fuel storage tanks

10.13.22 The bunkering of the ship shall be carried out by a closed method through a special pipeline fitted with the valves ensuring fuel supply to all the basic fuel storage tanks. The end of the filling pipe shall be led to the tank bottom with a minimum clearance.

Main fuel tanks shall be equipped with light and sound alarm for 95 % and 98 % filling.

10.13.23 On passenger ships provision shall be made for bunkering stations which are separated from the other spaces and fitted with drain pipes leading into the fuel collecting tanks.
10.13.24 Filling pipes of the tanks located above the double bottom space, as well as filling pipes of the double bottom tanks, shall be connected to the upper part of the tanks. The filling pipeline shall be brought into the tank above the maximum fuel level. The pipeline inside the tank, but above the maximum fuel level, shall have a hole (hydraulic rupture). If for design reasons it is not possible to provide hydraulic rupture, the filling pipes shall be provided with non-return or non-return shut-off valves installed directly on the tank.

Where the filling pipe is used as a discharge pipe, the non-return valve shall be replaced by a remote-controlled shut-off valve operable from an accessible place outside the space where the tank is located.

Fuel tanks

10.13.25 Fuel tanks shall be made of steel or material equivalent to steel (see 1.2.1.13 Part III of the Rules), and shall be arranged outside the machinery spaces accommodating engines and boilers. This requirement does not apply to service tanks and fuel tanks, the capacity of which does not exceed 12 litres and tanks built in the auxiliary units during manufacture of these units.

Types and design of fuel tanks shall comply with the requirements of 2.4.139 to 2.4.141 Part I of the Rules.

10.13.26 The arrangement of the fuel tanks in the machinery spaces (engine rooms) shall comply with the requirements of 1.9.7.

10.13.27 The fuel tanks located on the weather decks and superstructures, as well as in other exposed places shall be protected against the action of sunrays.

Fuel oil tanks, fuel pipelines and pipeline valves shall be located and arranged in such a way as to prevent ingress of fuel or its vapours in spaces where people may stay.

10.13.28 Daily fuel service tanks intended for direct fuel supply to the main engines in the unattended machinery spaces shall be fitted with devices actuating visual and audible warning signals to the wheelhouse when the minimum and maximum fuel oil level is reached in the tanks, or an automatic filling of daily service tanks shall be provided.

If service fuel tank is used for supply of several internal combustion engines, provisions shall be made for the facilities cutting off fuel supply pipelines to each engine and the leakage collection pipelines. The means of isolation shall not affect the operation of the other engines and shall be operable from a position not rendered inaccessible by a fire on any of the engines.

Valves used for taking fuel samples from service fuel tanks shall be of self-closing type.

10.13.29 The compartments located towards the bow from the collision bulkhead shall not be used as fuel tanks or tanks for transportation of other flammable liquids.

10.13.30 Fuel oil tanks shall be provided with manholes with gas-tight covers for inspection and cleaning of the inner chambers.

Fuel supply to internal combustion engines

10.13.31 The equipment of the fuel system shall be capable of supplying fuel duly prepared and cleaned according to the technical documentation of the manufacturer.

10.13.32 The system for fuel supply to internal combustion engines shall have places for release of air from the system. Control cocks on fuel filter cover can be used for this purpose.

10.13.33 Power installations including heavy oil fired engines shall be fitted with dual fuel supply system.

10.13.34 If the main engines are dual fuel internal combustion engines and auxiliary ones are intended for working on diesel fuel only, precautions should be taken to avoid the penetration of heavy fuel into the fuel supply system of auxiliary engines.

10.13.35 The fuel filters shall be capable of cleaning without interrupting the operation of the engine.

Automatically cleaned filters shall be installed in the heavy fuel preparation systems.
10.13.36 When flowmeters (other than fuel consumption meters) and/or fuel combustion catalysts are installed in delivery fuel pipelines, precautions shall be taken to prevent the stopping of fuel supply to the engines in the event of their adjustment or failure.

10.13.37 The diesel generators designed for use as emergency electrical power sources shall be supplied with fuel from independent service tanks located in the emergency diesel generator room. Consumption of the fuel from this tank for other purposes is not allowed. In the course of ship operation the fuel in independent service tanks shall be sufficient to ensure operation of diesel generators with electric power supply to the consumers set out in 4.5.1 Part VI of the Rules within a time period stated in Table 4.2.1 Part VI of the Rules.

10.13.38 Diesel generators shall be supplied with fuel oil from an independent pipeline fitted with filters and shut-off valves.

Fuel supply to boilers

10.13.39 The pipes conveying fuel oil to the burners of each boiler shall be fitted with a locally controlled quick-closing valve. The quick-closing valve is not required when a separate automatic boiler is used.

10.13.40 Thermometers and pressure gauges shall be installed on heavy fuel pipes supplying fuel to the burners for checking temperature and pressure of heavy fuel.

10.13.41 Where fuel is fed to the boilers under hydrostatic pressure, the pipeline supplying fuel to the burners shall be fitted with filters.

10.14 LUBRICATION SYSTEM

Lubricating oil pumps of engines

10.14.1 For maintenance of one main engine with an output of 220 kW and above provision shall be made for at least two lubricating oil pumps (main and standby), one of which may be driven from the engine.

The capacity of the standby pump shall be not less than the capacity of the main one.

10.14.2 Where two or more main engines are installed, a standby oil pump need not be fitted.

10.14.3 Each auxiliary engine shall have a separate lubricating system.

10.14.4 Where the lubricating oil pump is not fitted with a safety or a transfer valve, such valves shall be fitted on the delivery piping.

Lubricating oil supply to engines

10.14.5 The lubricating oil drain pipes from the engine crankcase to the circulating-discharge tank shall be located in the latter in such manner as to be permanently submerged into the oil during the operation of the engine.

Drain pipes from two or more engines shall not communicate with each other.

10.14.6 The pipes of the lubricating oil system shall not communicate with other piping systems, except where they are connected to separators which may be used for fuel separation provided that reliable arrangements are fitted which preclude mixing of fuel and lubricating oil.

While separating, precautions shall be taken to prevent mixing of different lubricating oil grades intended e.g. for main and auxiliary engines, if they use immiscible lubricating oil grades.

10.14.7 The pipelines of the lubricating oil circulating systems shall be provided with:

0.1 magnetic filter on the suction side of the gear pump;

0.2 one coarse filter (strainer) on the suction side of the pump;

0.3 two parallel filters or one duplex filter, or a self-cleaning filter on the discharge side of the main engine pump.

10.14.8 In case of common lubricating oil system of the engine and turbo-superchargers, fine filters shall be installed in front of the turbo-supercharger bearings. The design of the filters shall provide their cleaning without stopping of the lubricating oil circulation. A pressure gauge shall be installed after the filters.
10.14.9 Capacity of each oil filter shall exceed the maximum capacity of the pump by 10 per cent.

10.14.10 The lubricating oil pipelines shall be fitted with pressure gauges and thermometers.

A device for checking the oil supply to the gear shall be installed on the gear oil supply pipeline.

Lubricating oil tanks

10.14.11 Oil tanks, including oil storage tanks, used in the power transmission systems, control systems and heating systems shall be made of steel or material equivalent to steel (see 1.2.1.13 Part III of the Rules) and shall be build in the ship's hull or secured on it. These requirements do not apply to tanks with capacity of 25 litres and less.

Oil tanks shall comply with the requirements of 2.4.139 to 2.4.141 Part I of the Rules for fuel tanks. Hull structures of oil tanks shall not be combined with hull structures of tanks used for other purposes (drinking water, boiler water, fuel, sewage and oily waters tanks) and hull structures of accommodation spaces. Oil tanks shall not be arranged in front of the collision bulkhead.

Oil tanks, their pipelines and valves shall be located and arranged in such a way as to prevent ingress of oil or its vapours in ship spaces. Filling holes of oil tanks shall have nameplates with indelible inscriptions containing information required for identification of these filling holes.

Oil tanks shall be equipped with air pipes according to 10.10.1 to 10.10.16.

10.14.12 The suction pipes from the tanks located outside the double bottom shall be fitted with shut-off valves installed directly on the tanks.

10.14.13 Where lubricating oil in the tanks requires preheating, the requirements of 10.13.9 to 10.13.15 shall be met.

10.14.14 Lubricating oil tanks shall be provided with manholes with watertight covers for inspection and cleaning of inner chambers.

10.14.15 Lubricating drip trays shall be fitted in the places where fuel oil leakage from hydraulic drive and lubricating oil systems is possible.

10.14.16 Lubricating oil service tanks shall be equipped with level indicators. If transparent inserts are used for this purpose, they shall comply with the requirements of 10.10.26.

Arrangements for fuel leakage collection

10.14.17 Tanks, trays and drainage pipes used for collection of oil leakages shall comply with the requirements of 10.13.17 to 10.13.21.

10.15 COOLING SYSTEM

Pumps

10.15.1 Cooling system of engines shall comply with the requirements of 2.9.1.

In ships with a single-shaft power installation the additional pump driven from the power source shall be provided to ensure standby operation of the outer and inner engine cooling pumps. Standby pump need not be installed, if the power installation output is less than 220 kW.

10.15.2 Inner circuit water cooling system may be common for the main and/or auxiliary engines and include one independently-driven pump. In this case, the capacity of the pump shall be sufficient for simultaneous cooling of all engines when running at maximum load.

In this case, the cooling pipe shall have a water control valve at inlets to each of the engines.

10.15.3 Where each of the auxiliary engines is provided with an independent cooling water pump, the standby pumps for these engines are not required.

Where, however, a group of auxiliaries is supplied with cooling water from a common system, one standby pump for inner and outer circuits is sufficient.

If a common cooling line is fitted for the main and auxiliary engines, standby pumps
for cooling the auxiliary engines are not required.

10.15.4 Ballast or other general service pumps used only for clean water may be used as standby cooling pumps.

Piping arrangement

10.15.5 Water cooling system shall be supplied from at least two receivers which shall be interconnected.

In ships with one main engine with an output less than 220 kW one receiver is permitted which is located in the machinery space; two parallel-connected filters are required in such case.

10.15.6 Heating of sea chests of ships with ice strengthening shall comply with the requirements of 10.4.5.

10.15.7 The arrangement of the outboard water discharge pipeline shall be such that the highest cooled spaces of the engines, water coolers and oil coolers are always filled with water and no dead zones are created.

Cooling water filters

10.15.8 Filters shall be fitted on the suction lines of outboard water cooling system servicing the main and auxiliary engines.

Means shall be provided to enable the filters to be cleaned without stopping the cooling pumps.

Other devices of cooling system

10.15.9 Equipment for heating up the engines before starting shall be fitted in ships with ice strengthening. The heating up shall be carried out by heated cooling water. Steam heating up is not allowed.

10.15.10 The dual-cycle engine cooling system shall have expansion tank where the cooling water level is higher than the maximum cooling water level in the engine. The expansion tank shall be connected to the suction piping of the pumps and may be common for the cooling system of several engines. This tank shall be equipped with liquid level monitoring device and alarm on minimum level of cooling liquid in the tank.

To prevent cavitation damages of parts limiting the cooling spaces, the expansion tank shall be installed at the maximum possible height and fitted with hydraulic gate.

10.15.11 Expansion tanks shall be provided with manholes with gas-tight covers for inspection and cleaning of inner chambers.

Cooling systems with shell plating coolers

10.15.12 In engine cooling systems it is allowed to use shell plating coolers of inner cycle liquid. Such coolers are flat rectangular boxes directly adjoining the shell plating of the ship (inner cycle liquid circulates in flat ducts formed by partitions of these boxes and gives up heat to overboard water through shell plating of the ship), provided the following conditions are met:

.1 ships with one main engine shall have at least two shell plating coolers, one of which is a standby one;

.2 in ships with two and more main engines with one shell plating cooler for each engine it is allowed not to install standby cooler;

.3 each shell plating cooler shall be equipped with a device for air discharge;

.4 pipelines for delivery of inner cycle to coolers and discharge of cooling liquid from them shall be fitted with shut-off valves complying with applicable requirements of 10.4;

.5 devices for removal of inner cycle cooling liquid from the shell plating coolers shall be provided;

.6 calculations confirming serviceability of coolers under operating conditions of the ship set out in the specification shall be submitted.

10.16 COMPRESSED AIR SYSTEM

Number and capacity of starting air receivers

10.16.1 The compressed air system of main engines shall ensure simultaneous starting and reversing of main engines.

10.16.2 The total amount of starting air for the main engines starting and pneumatic con-
trol system shall be stored in at least two air receivers or two groups of air receivers; the capacity of each air receiver, or each group of air receivers shall be at least 50 per cent of that required in 10.16.3 and 10.16.4.

10.16.3 The total capacity of the air receivers for starting and reversing of the main engines shall be sufficient to provide at least 12 successive ahead and astern starts of the main engine in ready-to-start condition.

10.16.4 The total amount of starting air for the main non-reversible engines, as well as for main diesel generators shall be sufficient to provide at least 6 starts of the engine of the greatest available capacity in ready-to-start condition and, where there are more than 2 engines, not less than 4 starts of each engine in ready-to-start condition.

10.16.5 For auxiliary engines starting at least one air receiver shall be provided with the capacity sufficient for 6 starts of each auxiliary engine in ready-to-start condition and, where there are more than two auxiliary engines, not less than 4 starts of each engine in ready-to-start condition.

When one such air receiver is installed, it shall be possible to start the auxiliary engines from one air receiver or one group of air receivers of the main engines.

10.16.6 The total amount of the starting air stored in air receivers of the main engines indicated in 10.16.2 can be used to feed the typhoon whistle, as well as for domestic needs provided that:

.1 one air receiver (one group of air receivers) is separated from the other receivers by non-return valve and is intended only for main engines starting;

.2 the air receiver is fitted with automatic replenishing means and with alarm devices warning if pressure in the air receiver drops below the working pressure by not more than 0.5 MPa.

10.16.7 Air receivers of the auxiliary engines indicated in 10.16.5 may be replenished from the main air receivers indicated in 10.16.6; here, back air flow shall be precluded.

10.16.8 The air receivers shall be installed in such a way as to provide total removal of moisture under all working conditions.

Compressors

10.16.9 There shall be at least two main compressors, one of them may be hinged. In the event of failure of the compressor with the greatest capacity, the capacity of the rest compressors shall be sufficient to fill air receivers of the main engines from the pressure required to carry out the last start and manoeuvre to the pressure required to carry out the number of starts and manoeuvres referred to in 10.16.3 and 10.16.4, within one hour.

One self-contained compressor or compressor driven from auxiliary diesel with electric starter and manual start can be installed on high-speed ships. On high-speed ships with non-reversible main engines it is allowed to install one compressor suspended on main engines, provided the air receivers are filled by means of on-shore facilities.

10.16.10 In ships with non-reversible main engines the air receivers may be filled using an independently driven compressor. Compressed gas from the gas intake device, electric starter or other starting equipment may be used as the second starting device.

The capacity of the compressor or gas intake devices shall comply with the requirements of 10.16.9.

Piping arrangement

10.16.11 Pipelines intended to fill the air receivers shall be entirely separated from the starting pipelines.

10.16.12 Each of the starting air receivers specified in 10.16.2 to 10.16.8 shall be capable of being filled from each main compressor specified in 10.16.9 to 10.16.10.

10.16.13 Non-return shut-off valves shall be installed on the discharge pipe of each compressor.

The manifold supplying starting air to each engine shall have a non-return valve fitted before the starting valve.
The check valve may be omitted, if suitable devices preventing the spreading of explosion are provided in the engine design (see 2.11.1).

10.16.14 The pipes shall be led as straight as practicable with a slope for water drainage. The pipes shall not be sloped towards the master starting valve of the engine.

10.16.15 Temperature of air or compressed gases fed to air receivers shall not exceed 90°C. If the temperature exceeds 90°C, air coolers shall be provided.

The compressed air pipes shall not be laid under the machinery space flooring.

10.16.16 Suitable arrangements for draining oil and water accumulations shall be fitted on the pipes between the compressor and the air receivers, unless drain arrangements are fitted on the compressors.

10.17 BOILER FEED WATER SYSTEM

Pumps

10.17.1 Each self-contained boiler of class I or a group of boilers connected during operation shall be provided with at least two independently driven feeding pumps.

For self-contained boilers of class II one feeding pump and injector shall be sufficient.

For waste-heat exhaust gas boiler or a group of boilers which can be free of water when being heated by exhaust gas one feeding pump is sufficient per boiler or a group of boilers.

For boilers with manual feeding control the capacity of each pump shall be not less than 1.5 times the design steam capacity of the boilers, and for automatically controlled boilers — not less than 1.15 times the design steam capacity.

Where more than two feeding pumps are installed, their design capacity shall be such that if any of the pumps is out of operation, the total capacity of the rest is not less than the aforementioned capacity of one pump.

The capacity of each feeding pump of a direct-flow boiler shall be not less than the design steam capacity of the boiler.

10.17.2 Steam-driven feeding pumps shall have a separate live steam line supplied with steam from all boilers fed by these pumps.

10.17.3 Forced-circulation self-contained boilers of class I shall be serviced by not less than two circulating pumps, one of which is a standby pump.

The standby pump is to be automatically actuated.

Piping arrangement

10.17.4 In case of open circuit feeding system it shall be possible for the feeding pumps and injectors to intake water from the heated box, from the outboard and from the feeding water storage tanks.

10.17.5 The feeding system of each self-contained boiler of class I shall be so designed as to enable to feed the boiler or a group of boilers by each of the feeding pumps through two separate feeding lines, i.e. main and auxiliary lines.

For self-contained boilers of class II boilers one feeding pipeline is sufficient.

10.17.6 Design measures shall be taken to prevent the contamination of the feeding water system with oil and oil products.

10.18 STEAM AND BLOW-OFF LINES

Piping arrangement

10.18.1 Where two or more boilers are interconnected, steam pipe of each boiler shall be fitted with a non-return valve before connection to the common line. These valves may be omitted if the boiler stop valves are of non-return shut-off type.

10.18.2 Blow-down and scum valves of two or more boilers may be connected to a common discharge line, if a non-return valve is fitted on the blow-off pipe of each boiler before the connection to the discharge line. Boiler blow-off system shall be fitted with special devices preventing the circulation failure while blowing-off.

10.18.3 The facilities and equipment connected with the steam lines shall be relieved
10.18.4 The steam lines supplying the equipment and arrangements designed for a lesser pressure than the boiler pressure, shall be fitted with reducing valves, and the requirements of 10.2.17 shall be complied with.

10.18.5 The steam line branches intended for steaming out and steam smothering of the fuel tanks and liquid cargo tanks shall be fitted with check valves; the main line of the branches shall be fitted with a shut-off valve located in easily accessible place outside the tanks.

10.18.6 The steam lines in the engine and boiler rooms shall be laid in the upper parts of these spaces, in places accessible for inspection and maintenance.

Steam lines other than boiler heating and blow-off pipes shall not be laid under the floor plates of the engine and boiler rooms.

Steam pipelines shall be laid at a distance of not less than 1 m from fuel tanks.

10.18.7 Live steam lines shall have condensate drain arrangements to protect the equipment against water hammer.

10.18.8 Open ends of the steam blow-off pipes shall be led below the machinery space flooring (see also 10.5.2).

10.19 SYSTEMS WITH HIGH-TEMPERATURE ORGANIC HEAT TRANSFER FLUID

Pumps

10.19.1 At least two pumps, one of which is standby, shall be used to ensure circulation of heat transfer fluid.

10.19.2 Pressure gauge shall be installed on discharge pipeline of each pump.

10.19.3 Transfer pump shall be provided to fill the expansion tank and to pump the high-temperature organic heat fluid.

10.19.4 To ensure circulation of heat transfer fluid, the electric motors of pumps shall be fitted with shut-off devices meeting the requirements of 7.8.2 Part VI of the Rules to shut-off devices of electric motors of fuel and oil transfer pumps and separators.

Expansion tank

10.19.5 Systems with high-temperature organic heat transfer fluid shall have expansion tank placed in the highest point of the system.

Expansion tank capacity shall exceed the increase of volume of heat transfer fluid after heating to operating temperature at least 1.5 times.

10.19.6 The expansion tank shall be equipped with thermometer and level indicator. If transparent insert is used for this purpose, it shall comply with the requirements of 10.10.26.

Level indicator shall have heat transfer fluid low permissible level mark.

10.19.7 In open-type systems the expansion tank considering the applicable requirements of 10.10 shall be equipped with air pipe and overflow pipe brought out to discharge tank. If the discharge tank is not available, the pipe shall be brought out to high-temperature organic heat transfer fluid storage tank.

10.19.8 The expansion tanks shall be equipped with alarm of minimum and maximum levels of heat transfer fluid in the tank. When the alarm of minimum and maximum levels operates, the heating of high-temperature organic heat transfer fluid shall be automatically stopped with simultaneous shut down circulating pump.

10.19.9 The expansion tanks of close-type systems with inert gas in the upper part of the tank shall be equipped with pressure gauges or other pressure monitoring devices in the tank and safety valves. Branch pipe from safety valve shall be connected to discharge tank or heat transfer fluid storage tank.

It shall be possible to operate close-type system in the open-type system mode.
10.19.10 The expansion tank shall be equipped with a device for catching and discharging vapours and gases produced during operation of the system.

Storage tank

10.19.11 Storage tank capacity shall be sufficient for draining all high-temperature organic heat transfer fluid from the system.

10.19.12 When the storage tank is used for draining the high-temperature organic heat transfer fluid in it, this heat transfer fluid shall be drained from system by natural flow.

Air pipes

10.19.13 Air pipes of tanks with high-temperature organic heat transfer fluid shall comply with the requirements of 10.10.1 to 10.10.15.

Devices for collection of leakages and draining high-temperature organic heat transfer fluid

10.19.14 Devices for collection of leakages of high-temperature organic heat transfer fluid shall comply with the requirements of 10.13.17 to 10.13.20 to devices for collection of fuel leakages.

10.19.15 If the shut-off valves specified in 8.20.4.1 have no remote control, the device for draining high-temperature organic heat transfer fluid from the system to the discharge tank or storage tank according to 10.19.12 shall be provided.

10.19.16 Waste-heat boilers-heaters shall have devices preventing ingress of high-temperature organic heat transfer fluid to engine in case of leakages.

Cooling of heat transfer fluid

10.19.17 Systems with high-temperature organic heat transfer fluid provided with waste-heat boilers-heaters shall have a device for cooling heat transfer fluid if the boiler-heater has no bypass channel.

Boilers-heaters of high-temperature organic heat transfer fluid

10.19.18 Boilers-heaters of high-temperature organic heat transfer fluid shall comply with the requirements of 8.20.

Insulation

10.19.19 Insulation of pipelines and equipment of the system shall comply with the requirements of 1.9.2.

Heating of liquid cargoes

10.19.20 Systems with high-temperature organic heat transfer fluid for heating liquid cargoes with flash point of 60°C and less shall be used only if independent intermediate system located within cargo area is used.

Independent intermediate system is not required in the following cases:

- when circulating pump is stopped, the excessive pressure exceeding the static pressure of cargo by at least 0.03 MPa is maintained in the coils;
- the expansion tank of the system with high-temperature organic heat transfer fluid is provided with facilities for detection of flammable vapours of cargo;
- valves of separate heating coils are fitted with interlocking device that ensures that the coils are constantly under the static pressure.

10.19.21 Heat accumulators shall be used in the system for energy conservation. Their design shall comply with the requirements of 1.9.2, 10.19.6 to 10.19.9, as well as applicable requirements of 8.20.

Tests of pipelines of systems with high-temperature organic heat transfer fluid

10.19.22 Pipelines of systems with high-temperature organic heat transfer fluid shall be tested according to 10.6 similarly to fuel pipelines.

10.20 CARGO VAPOUR DISCHARGE SYSTEM

10.20.1 If the ship is equipped with cargo vapour discharge system, the system of cargo
level measurement shall be closed. Semi-closed systems, where only a part of tank limited by the gauge tube communicates with the atmosphere, can be used as a standby level measurement system.

Cargo vapour discharge system shall be arranged so as not to impede normal operation of gas outlet system.

The cargo vapour discharge system shall be designed based on maximum loading efficiency. Pressure drop in the cargo vapours discharge pipeline obtained by hydraulic calculations shall not exceed 80% of opening pressure of any of gas outlet system valves specified in 10.10.21.

10.20.2 Cargo vapour discharge system shall be so designed as to exclude the possibility of mixing the vapours of incompatible cargoes transported on the ship.

10.20.3 Devices for removal of condensate accumulated in the system pipelines shall be provided.

10.20.4 System pipelines shall be electrically conductive throughout the entire length and shall be reliably grounded.

10.20.5 End sections of cargo vapours discharge pipeline shall be equipped with pressure sensor and alarm. The alarm operates when reaching the pressure not higher than the pressure at which high-speed gas-outlet arrangement operates and in case of vacuum. In this case alarm actuation pressure shall be not less than the pressure at which vacuum valve operates.

This requirement does not apply to ships where excessive pressure/vacuum sensor is installed in each cargo tank according to 10.10.22.

10.20.6 Manually operated shut-off valve shall be installed near the connecting branch pipes of end sections of cargo vapours discharge pipeline in a place accessible for maintenance.

10.20.7 Hoses used in the vapour discharge system shall comply with the requirements of 10.2.67.

10.20.8 To exclude incorrect connection of cargo vapours discharge pipeline to the liquid cargo pipeline of shore terminal, pins of 12.7 mm dia and at least 25.4 mm long shall be installed on connecting flanges of end section of cargo vapours discharge pipeline in the uppermost point on the line of coupling bolts as it is shown in Figure 10.20.8-1. End section of the cargo vapours discharge pipeline shall be marked as shown in Figure 10.20.8-2.

Fig. 10.20.8-1. Pin on connecting flange of the end section of cargo vapour discharge pipeline

Fig. 10.20.8-2. Marking of the end section of cargo vapour discharge pipeline

10.21 INERT GAS SYSTEM OF OIL TANKERS

10.21.1 Inert gas system shall ensure supply of gas in the amount of not less than 125% of the maximum rated capacity of cargo pumps and creation of pressure not exceeding 20 kPa in the filled spaces.

10.21.2 Inert gas plant shall have the following:

.1 inert gas generators or equipment drawing off gases from boiler funnel uptakes;

.2 equipment for gas cooling and purifying from solid particles and sulphur combustion products and inert gas drying (gas purifying installations);
.3 fans (steam ejectors) for gas injection; 
.4 piping and valves for gas delivery and gas discharge control in the protected spaces; 
.5 control devices monitoring the volume fraction of oxygen or carbon dioxide, gas temperature and pressure; 
.6 audible and visual alarm on the limit temperature of inert gas supplied to the protected compartments.

The delivery piping of inert gas system shall be fitted with temperature sensors in front of the first branch to the protected space.

10.21.3 Oxygen volume fraction in inert (smoke) gases shall not exceed 5%.

10.21.4 Temperature of the inert gas delivered to the protected spaces shall not be above 40°C.

10.21.5 Gas purifying installations shall be installed from the suction side of fans or from the injection side of steam ejectors.

10.21.6 The inert gas system shall be so designed as to enable blow-down of compartments by air. Air inlet shall be fitted with shut-off valves with indicators “Open” and “Closed”.

10.21.7 Audible and visual alarm shall be actuated resulting from changes of the installation parameters in the following cases: 
.1 rise of inert gas temperature above 40°C — audible and visual alarm is actuated; 
.2 rise of inert gas temperature above 60°C — the fan is switched off or steam supply to the ejector is stopped.

10.21.8 Inert gas system shall be fitted with cooling system. No special pumps may be provided for that purpose.

Piping and valves

10.21.9 Atmospheric pipeline shall be provided for stable operation of the inert gas installation during its preparation for operation or stopping the gas delivery to the protected spaces. Pipe for gas discharge to the atmosphere shall be fitted on the discharge line of inert gas supply to the protected spaces in front of the first shut-off valve.

10.21.10 Gas supply pipelines shall be fitted with bleeder plugs for condensate drainage the devices providing for the piping steaming and cleaning from corrosion products and dirt.

10.21.11 The inert gas system pipeline in front of a branch to the nearest protected space shall be fitted with non-return shut-off valve or similar device preventing from gas entering from cargo compartments to the gas purifying installation (the heat exchanger — the gas cooler) if fans/steam ejectors stop. Where a waterlock is used as a check device, the latter shall be supplied with water simultaneously.

10.21.12 Measures should be taken to prevent the waterlock from freezing but in a such way that its impermeability is not imposed by heating.

10.21.13 If a fan (steam ejector) can create pressure exceeding the permitted value, the inert gas pipeline shall be fitted with a safety device of liquid type or other equivalent type to prevent creation of excessive pressure of more than 20 kPa in the protected spaces.

10.21.14 Pipeline branches for inert gas delivery to the protected cargo spaces shall be arranged in the upper part of the spaces above the oil level as far apart as possible from gas outlet lines and those for gas delivery to spaces adjacent to cargo spaces — in the lower part of the spaces. Each branch shall be fitted with fire barriers and shut-off valves.

The inlet of such outlet pipes may be located either at deck level or at not more than 1 m above the bottom of the tank. The cross-sectional area of inert gas outlet pipe shall be such at to ensure gas rate of at least 20 m/s at the outlet when inert gas is simultaneously fed to any three tanks.

Outlets shall be above the deck level at a height of at least 2 m and a system for their closing shall be provided.

10.21.15 Provision shall be made for devices to connect the inert gas main to external source of inert gas.
10.21.16 Tankers fitted with a fixed inert gas system shall be provided with closed system of liquid level measurement in tanks. Semi-closed instruments can be used as standby level measurement facilities.
11 AUTOMATION

11.1 SCOPE OF APPLICATION TERMS AND DEFINITIONS

11.1.1 Requirements of this Section apply to automation systems and devices and their components used in ships of all types and purposes irrespective of automation symbol in the class of ship. In addition to requirements of this Section the following requirements shall be met: 9.18, 10.21.2.6, 10.21.7 of this Part, 3.4.11, 3.4.17, 3.8.24, 3.9.3, 3.9.14, 3.9.16, 3.9.17, 5 Part III and 3.4, 3.5, 3.7, 4.2.10, Table 4.5.1, 6.1.16, 6.10.8, 7.1.1, 7.2.6, 11.3 to 11.6, 17.6.2, 17.6.3, 17.7.2, 17.7.5 Part VI of the Rules.

11.1.2 The requirements of the present Section shall be met when ships operate with unattended machinery spaces or with attended central control station.

Requirements of 11.7, 11.8.3, 11.9 to 11.12, 11.14 and 11.15 apply to ships of all types and purposes irrespective of automation symbol in the class of ship, unless otherwise specified.

11.1.3 The following definitions are used in this Section.

.1 Actual status indication system means an independent unit or part of automation system which are intended for informing the personnel about accomplishment of the preset commands by control systems and availability of power supply.

.2 Generalized alarm means a signal emitted by an object or a group of objects which parameters are being checked; however, these signals are not passed directly from control sensors to the control panel and are not decoded. Such a signal is generated by the alarm system when at least one of the controlled parameters deviates from the preset range.

.3 Propulsion plant means an executive part of the ship’s power installation where energy of fuel used by the main engines is converted into thrust transmitting movement to the ship’s hull. Generally the propulsion plant comprises main engines, gearings, shaftings and propellers.

.4 Alarm system means a system intended to give visual and audible signals when the preset limits of monitored parameters are exceeded or in the event of abnormal running condition of the power installation components.

.5 Automation system means a complex of elements, appliances and joints intended for performance of assigned monitoring and control functions.

.6 Remote automated control system means a control system which ensures setting up the desired mode of operation of the machinery from a remote control station by single manipulating the control element (e.g. handle) with all subsequent intermediate steps performed automatically.

.7 Remote control system means a control system for which an operator shall manipulate the control elements fitted at a remote control station for performing intermediate steps.

.8 Protection system means a system intended for a specified automatic influence on the plant under control in order to prevent an emergency or restrain its consequences.

.9 Monitoring system means a system which ensures visual control of the proper functioning of supply, control and checking systems as well as clarifying the situations when a parameter ensuring normal operation of the power installation or systems deviates from the safe operation range.
.10 **Automation element** means any hydraulic, pneumatic, electrical or electronic item being a part of automation devices and/or systems (e.g. amplifier, sensor, relay, microchip, logic element etc).

### 11.2 GENERAL REQUIREMENTS

11.2.1 Automation systems shall be so designed that in case of failure of light or sound alarm units the serviceability of other circuits shall remain intact.

11.2.2 Electrical, pneumatic and hydraulic elements, equipment and automation systems shall be operable in service conditions indicated in 2.2 Part VI of the Rules.

11.2.3 Protection class of electrical and electronic automation elements and devices depending on their location shall comply with the requirements of 2.3.6 Part VI of the Rules.

11.2.4 Hydraulic and pneumatic automation systems shall operate reliably under working medium pressure variation within ±20 % of the nominal value.

11.2.5 Automation systems shall be so designed that the replacement of any elements or devices by similar ones neither affects the system serviceability no requires additional adjustment of the system.

11.2.6 In automation systems measures shall be taken to prevent false alarms caused by momentary changes of parameters (see Table 2.2.1 Part VI of the Rules) due to roll and pitch of the ship, activation and deactivation of the onboard machinery.

11.2.7 Automation systems shall be based on the “fail-safe” principle.

11.2.8 Automation systems and devices shall have protection against interferences created by external magnetic and electric fields with consideration of parameters specified in 2.7 Part VI of the Rules and protection against sudden deviations of voltage and current frequency from their rated values specified in 2.2.1 Part VI of the Rules. Automation systems shall be electromagnetically compatible with other electrical and electronic equipment, including communication and navigation facilities. In the course of operation the automation systems shall not create electromagnetic interferences the levels of which exceed the ones in Table 2.7.3-1 and 2.7.3-3 Part VI of the Rules.

11.2.9 Automation systems shall make it possible to activate onboard machinery and installations, automatically or remotely, after they have been switched off by protection devices, only after the protective devices manual have been manually reset to the initial position from the local control station.

11.2.10 It shall be possible to check the automation devices without changing operation mode of onboard equipment.

11.2.11 Provision shall be made for manual adjustment of each of the automatically adjusted parameters. Any damage, failure of automated control system or remote control system shall not bring to failure of the manual control.

11.2.12 It shall be possible to control each remotely controlled technical facility from local control stations, except for the cases specified in 1.5.1.

11.2.13 When remote control of the technical facilities is provided, it shall be possible to control the accomplishment of the given orders.

11.2.14 Piping of hydraulic and pneumatic control systems shall comply with the requirements of 10.2 including their fitting with protection devices. Protection class of electrical control systems shall comply with the requirements of 2.3.6 Part VI of the Rules.

11.2.15 All automation systems and equipment installed in the machinery spaces shall be adapted for unattended operation at least for a period when the machinery space is not attended by the personnel. Single short-term
(up to 2 h) maintenance operations of automation systems and devices are permitted, if these operations are envisaged by respective instructions and their periodicity complies with technical and operating documentation.

11.2.16 Replaced components and devices requiring adjustments, as well as check measurements points (terminals, sockets), shall be arranged in a way to have free access.

11.2.17 Adjustment components shall have protection against inadvertent change of adjustment and have a possibility of repeated adjustment.

11.2.18 Places for input of cables and wires, including the places of connection to moving components and devices, shall be provided with arrangements for tension relief and prevention of cable or wire bending.

11.2.19 Measures shall be taken to exclude the possibility of incorrect replacement of detachable units with plug and socket connectors, as well as measures on their reliable detention in the operating position. If this is required by functional or design features of components and devices, their arrangement ensuring correct installation shall be marked or their design shall be such as to exclude the possibility of their installation in other position.

11.2.20 Actuating mechanisms and devices shall be so designed as to prevent inadvertent change of their preset position.

11.2.21 Measurement range of analogue sensors shall exceed the variation range of the respective measured parameter by at least 20%.

11.2.22 It shall be possible to clean the filters of pneumatic and hydraulic automation systems during operation without stopping the system.

11.2.23 Hydraulic automation systems shall not be combined with other hydraulic systems of the ship.

11.2.24 Feeding pipelines of pneumatic automation systems shall be equipped with safety valves operating when nominal working pressure is exceeded by more than 10%.

Pressure-reducing valves, if any, shall be backed up.

11.2.25 Hydraulic, pneumatic and electrical or electronic components and devices installed together on consoles, cabinets and units shall be separated from each other so that the leakages in pipelines and hoses and in their connections cause no damage of pneumatic, electronic and electrical components and devices.

Consoles, cabinets and units accommodating equipment with fluid working medium shall be equipped with devices for collection of fluid leakages.

11.2.26 Pneumatic and hydraulic components and devices shall remain serviceable in case of short-term (up to 1 min) increase of working medium up to 1.5 of working pressure of this medium.

11.3 POWER SUPPLY

11.3.1 Automated control system of standby component of the power installation shall be supplied independently of the automated control system of the respective main component of the power installation.

11.3.2 Alarm system and protection circuits shall be energized and de-energized automatically at energization and de-energization of the control system of the particular component of the power installation.

11.3.3 Hydraulic and pneumatic automation systems shall be supplied from two sources. Standby source shall be connected automatically in case of supply pressure loss in the main source.

Automation systems may be supplied from the starting air system, if the automatic replenishing of air reservoirs is provided.

11.3.4 If air for supplying pneumatic automation systems requires drying or cleaning, two devices shall be provided. However, one device may be used, if filtering elements can be replaced without interrupting the operation.
11.3.5 Electrical automation systems shall remain serviceable under supply voltage and frequency deviations specified in 2.2.1 Part VI of the Rules. Triple power supply failure with interval of not more than 30 s shall not affect serviceability of automation systems.

11.3.6 Automation systems and devices shall receive power supply from main and emergency power supply sources if such power supply is provided for automated technical facilities.

11.3.7 Power installation electrical control systems shall receive power supply via two independent lines — main and standby— from different boards. The main line shall be connected to the main switchboard; reserve line, to the board feeding power supply to critical consumers or to the nearest switchboard. In case of power supply failure or it further normalization on the buses of main switchboard, the power supply shall be changed over between the lines automatically with transfer of light signal to the control station in the wheelhouse.

11.3.8 Stop of power supply or deterioration of working medium or power supply parameters in automatic or remote control systems shall not cause failure of technical facilities and change of their operation mode.

11.3.9 Alarm and protection systems shall receive power supply from interrupted power supply source; when supply voltage at its input disappears, the alarm signal shall be fed.

Accumulator battery of such source shall ensure power supply of alarm and protection systems for at least 30 min of their continuous operation.

11.3.10 Power supply of generator driving motors control system shall not depend on availability of voltage on the buses of main switchboard.

11.4 CONTROL, ALARM, PROTECTION AND MONITORING SYSTEMS

11.4.1 Each of the control, alarm, protection and monitoring systems shall be independent and perform not more than one of the respective functions. Malfunction or failure of any of the systems shall not affect the operation of the others. Connection of the control, alarm and protection systems including common sensors for alarm and protection systems is permitted if the operability of the systems is provided.

11.4.2 The alarm system shall give visual and audible signals simultaneously. An existing alarm is not to prevent the indication of any further fault. Reception of one signal shall not impede reception of another one. Failure of one component (device) of the system shall not cause failure of the entire alarm system.

Alarm system shall have self-check functions in case of such damages, as short-circuit, circuit opening and ground fault. In case of power supply failure the alarm signal shall also be fed.

Central information panels of the alarm system are to be placed in the central control station or in the wheelhouse. Alarm system shall be equipped with the general alarm subsystem, the units of which shall be placed in:
- machinery spaces if they are not equipped with uninterrupted light sources operated in case of alarm system signal;
- wheelhouse if the central information panels are not placed in the wheelhouse;
- places where the service personnel stays most of the time if the ship has no central control station and wheelhouse.

Audible signal may be generalized for all alarm systems; there shall be a possibility of switching-off such a signal provided that it is ready for operation immediately after it has been switched off, for forthcoming signals about faults. Disabling of sound signal on general alarm units shall not disable sound signal in the central control station.

Visual signals shall indicate the reason of the alarm system actuation and be actuated by means of indicators which correspond to the current situation or fault. When an indicator is actuated in the event of faulty, it shall generate flashing light signal. After acknowledgement the flashing light signal shall be transformed into a signal of permanent light intensity and be extinguished automatically only after
the fault has been withdrawn or the fault mechanism, device, system or the part of the alarm system has been disconnected. Sound and light signals shall be fed simultaneously.

It is allowed to use common monitors instead of individual light signal indicators.

11.4.3 Light signals shall comply with the requirements of 6.1.16 Part VI of the Rules.

11.4.4 Audible signal of the alarm system should differ from other audible signals.

11.4.5 It shall be possible to check the alarm system without changing the operation mode of onboard equipment.

11.4.6 Protection system shall operate automatically for the preset parameters in case of faults which can cause failure of the protected ship machinery. When protection system operates, light and sound signals shall be generated. Protection system indication shall fix the parameter because of which protection operated.

11.4.7 Protection systems of separate components of power installations shall be independent of each other.

11.4.8 Faults after which the system restores its serviceability without repair or intervention of specialist (transient failures) shall be treated by alarm system in away to save the signal until acknowledgment.

11.4.9 Irrespective of the power installation automation and their operation monitoring the alarm system shall generate the signal in the following cases:

1. monitored parameters reach the limit values;
2. protection system operation;
3. no power supply for separate automation systems or start of emergency power sources;
4. change of other parameters or states, the alarm for which is required in accordance with this Part of the Rules.

Fault alarm for technical facilities shall be provided in remote control stations of these facilities.

11.4.10 Alarm system shall be so designed that the signals other than ship control and navigation situation signals are fed first to the consoles (boards) to machinery spaces and central control station. If the machinery spaces (central control station) are unattended, these signals shall be fed to the wheelhouse.

11.4.11 The "personnel in machinery space" alarm shall inform the wheelhouse on safety of an engineer on duty in the machinery space without other personnel.

11.4.12 Manually locked signals shall be indicated on alarm console.

11.4.13 Interlock of alarm and protective functions in some operation modes of the power installation (for example, during start of engines) shall be automatically disabled when the power installation is switched to other operation mode.

11.4.14 Protection cut-off devices shall exclude their inadvertent start. The control consoles of technical facilities shall have a light signal about activation of protection cut-off device.

11.4.15 If the technical facilities are stopped after emergency protection operation, such facilities shall not be started automatically after eliminating the causes of protection operation.

11.4.16 Indication systems shall be so designed that the information is indicated in the units used in the Russian Federation for measured values without conversion.

11.5 GENERAL REQUIREMENTS TO AUTOMATION

11.5.1 By the scope of requirements to automation in this Rules the ships are divided into the following two groups:

Group I — ships without continuous attendance of machinery spaces and central control station by the servicing personnel;

Group II — ships without continuous attendance of machinery spaces by the servicing
personnel and with continuous attendance of central control station;

### 11.5.2 Alarm and protection systems for each group of ships

Table 11.5.2

<table>
<thead>
<tr>
<th>Monitored parameters</th>
<th>Monitored parameter value when the alarm system is actuated</th>
<th>Protection: stop, shut-down</th>
<th>Ship group</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td><strong>1 Main engines, shafting, gears</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Main engines</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Rotational speed</td>
<td>Maximum</td>
<td>Shutdown</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>1.2 Oil pressure in the lubricating system at the engine inlet</td>
<td>Minimum</td>
<td></td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>1.3 Temperature of lubricating oil at the engine inlet</td>
<td>Maximum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>1.4 Temperature of cooling liquid in the inner cycle at the engine outlet</td>
<td>Minimum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>1.5 Cooling liquid level in the inner cooling cycle expansion tank</td>
<td>Minimum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>1.6 Cooling liquid pressure in the inner cooling cycle</td>
<td>Minimum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>1.7 Oil level in lubricating oil circulation tank</td>
<td>Minimum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>1.8 Exhaust gas temperature at the turbine inlet</td>
<td>Maximum</td>
<td>—</td>
<td>R -</td>
<td>For engines with rated power over 400 kW</td>
</tr>
<tr>
<td>1.9 Temperature of exhaust gases in exhaust gas pipeline</td>
<td>Maximum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>1.10 Engine overload</td>
<td>Alarm signal</td>
<td>—</td>
<td>+ R</td>
<td></td>
</tr>
<tr>
<td>1.11 Supply of engine remote automated control system</td>
<td>Absence</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td><strong>Gears, shafting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.12 Oil pressure in gearing</td>
<td>Minimum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>1.13 Oil temperature in gearing</td>
<td>Minimum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>1.14 Temperature of external thrust bearing of shafting</td>
<td>Maximum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>1.15 Water flow at the inlet of water lubricated stern-shaft bearing of shafting</td>
<td>Minimum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td><strong>2 Prime movers of generator units</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Rotation speed</td>
<td>Maximum</td>
<td>Shutdown</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>2.2 Oil pressure at the engine inlet</td>
<td>Minimum</td>
<td>Shuttdown</td>
<td>@ @</td>
<td></td>
</tr>
<tr>
<td>2.3 Oil temperature in the engine lubrication system</td>
<td>Maximum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>2.4 Temperature of cooling liquid in the inner cycle at the engine outlet</td>
<td>Maximum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>2.5 Cooling liquid level in the inner cooling cycle expansion tank</td>
<td>Minimum</td>
<td>—</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>2.6 Cooling liquid pressure in the inner cycle</td>
<td>Minimum</td>
<td>—</td>
<td>+ —</td>
<td></td>
</tr>
</tbody>
</table>
### Monitored parameters

<table>
<thead>
<tr>
<th>Monitored parameters</th>
<th>Monitored parameter value when the alarm system is actuated</th>
<th>Protection: stop, shut-down</th>
<th>Ship group</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.7 Oil level in lubricating oil circulation tank</td>
<td>Minimum</td>
<td>—</td>
<td>+</td>
<td><strong>R</strong></td>
</tr>
<tr>
<td>2.8 Gas temperature at the turbine inlet</td>
<td>Maximum</td>
<td>—</td>
<td><strong>R</strong></td>
<td>—</td>
</tr>
<tr>
<td>2.9 Temperature of exhaust gases in exhaust gas pipeline</td>
<td>—</td>
<td>+</td>
<td>+</td>
<td>For gas exhaust systems where exhaust gases are cooled by water injection</td>
</tr>
</tbody>
</table>

### 3 Fuel systems of main and auxiliary engines

| 3.1 Fuel level in the service tank | Minimum | — | + | + |
| 3.2 Level in leakage and dirty fuel tanks | Maximum | — | + | — |
| 3.3 Fuel leakages from high-pressure pipelines | Available | — | + | + |
| 3.4 Fuel pressure after filter (at the engine inlet) | Minimum | — | + | — |

### 4 Compressed air system

| 4.1 Starting air pressure at the inlet of main starting valve of main engine; | Minimum | — | + | + |
| 4.2 Temperature in compressor cooling system | Maximum | — | + | + |
| 4.3 Oil pressure in compressor lubrication system | Minimum | Shutdown of the compressor | + | + |
| 4.4 Air pressure in air receivers used for starting of main engines and operation of control systems and audible alarms | Minimum | — | + | + |
| 4.5 Air temperature at the compressor output | Maximum | — | + | + |

### 5 Fuel oil fired steam boilers

| 5.1 Flame | Extinction | + | + |
| 5.2 Water level in boiler | Minimum/maximum | Boiler shut down | + | + |
| 5.3 Air supply to furnace | Cutting-off or insufficient supply | + | + |
| 5.4 Steam pressure | Maximum | + | + |
| 5.5 Fuel pressure before burners | Minimum | — | + | + |

### 6 Fuel oil fired hot-water boilers

<p>| 6.1 Flame | Extinction | + | + |
| 6.2 Pressure in boiler | Maximum | Switch-off | + | + |
| 6.3 Water level in expansion tank | Minimum | + | + |
| 6.4 Air supply to furnace | Cutting-off or insufficient supply | + | + |</p>
<table>
<thead>
<tr>
<th>Monitored parameters</th>
<th>Monitored parameter value when the alarm system is actuated</th>
<th>Protection: stop, shut-down</th>
<th>Ship group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td><strong>7 Boilers and systems with high-temperature organic heat transfer fluid</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1 Gas temperature at the boiler output</td>
<td>Maximum</td>
<td>Switch-off</td>
<td>+</td>
</tr>
<tr>
<td>7.2 High-temperature organic heat transfer fluid temperature at the boiler output</td>
<td>Maximum</td>
<td>Shut down (stop of heat supply)</td>
<td>+</td>
</tr>
<tr>
<td>7.3 Heat transfer fluid level in expansion tank</td>
<td>Minimum</td>
<td>Stop of circulating pump</td>
<td>+</td>
</tr>
<tr>
<td>7.4 High-temperature organic heat transfer fluid flow rate at the boiler output</td>
<td>Maximum</td>
<td>Shut down (stop of heat supply)</td>
<td>+</td>
</tr>
<tr>
<td>7.5 High-temperature organic heat transfer fluid leakage</td>
<td>Available</td>
<td>Shut down (stop of heat supply), Stop of circulating pump</td>
<td>+</td>
</tr>
<tr>
<td><strong>8 Bilge system</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1 Bilge water level in bilges of machinery spaces</td>
<td>Maximum</td>
<td>—</td>
<td>+</td>
</tr>
<tr>
<td>8.2 Water in steering gear compartment, thruster compartment, pump room, watertight compartments in passenger ships</td>
<td>Maximum</td>
<td>—</td>
<td>+</td>
</tr>
<tr>
<td><strong>9 Spark-extinguishing system</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.1 Water pressure</td>
<td>Minimum</td>
<td>—</td>
<td>+</td>
</tr>
<tr>
<td><strong>10 Power supply sources</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.1 Temperature of generator stator winding</td>
<td>Maximum</td>
<td>—</td>
<td>+</td>
</tr>
<tr>
<td>10.2 Generator overload</td>
<td>Available</td>
<td>Disconnection of noncritical consumers</td>
<td>+</td>
</tr>
<tr>
<td>10.3 Reverse power</td>
<td>Available</td>
<td>Generator shut down</td>
<td>+</td>
</tr>
<tr>
<td>10.4 Short circuit</td>
<td>Minimum</td>
<td>+</td>
<td>+ Provided by generator protection system</td>
</tr>
<tr>
<td>10.5 Ship mains voltage</td>
<td>Maximum</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>10.6 Current frequency in ship power distribution mains</td>
<td>In case of deviations from rated values by not more than 5%</td>
<td>+</td>
<td>+ Provided by generator protection system</td>
</tr>
<tr>
<td>10.7 Insulation resistance of ship mains</td>
<td>Reduction</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
### End of Table 11.5.2

<table>
<thead>
<tr>
<th>Monitored parameters</th>
<th>Monitored parameter value when the alarm system is actuated</th>
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<th>Ship group</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>11 Tow cable tension automatic adjustment devices</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.1 Length of hauled-off rope</td>
<td>Maximum</td>
<td>—</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>12 Static power converters of electrical propulsion plant</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.1 Temperature of cooling medium</td>
<td>Maximum</td>
<td>—</td>
<td>+</td>
<td>If forced cooling system is available</td>
</tr>
<tr>
<td>12.2 Insulation resistance</td>
<td>Minimum</td>
<td>—</td>
<td>+</td>
<td>For converters with liquid cooling</td>
</tr>
<tr>
<td><strong>13 Other</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.1 Power supply failure of main engine emergency stop devices, emergency protection and alarm systems</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

**Notes.**
1. "+" — warning signal; ☐ — emergency signal; R — recommended.
2. Requirements of 1.5, 1.12, 1.13, 1.14, 1.15 and 2.5 of this Table do not apply to ships of groups I and II with a length less than 25 m or total capacity of main engines of 400 kW and less or dynamically supported ships (hydrofoil craft, hovercraft).

Each engine designed to drive ship machinery or electrical equipment of ships irrespective of "A" symbol in the ship class formula of ship shall have sound and light alarm installed to generate signals when oil pressure in lubrication system of the engine reduces. Alarm devices for the following parameters shall also be installed on this engine:

1. Reduction of pressure in inner cycle of engine cooling system or increase of temperature of liquid circulating in the inner cooling cycle at the engine output;
2. Reduction of oil level in header tank of turbochargers;
3. Increase of temperature of thrust bearing built in the engine.

**11.5.4** In the case of no central control station the general alarm signals of power installation components listed in Table 11.5.2 shall be indicated in the wheelhouse. These signals shall be decoded in the machinery spaces, either centrally or at local control stations. Alarm signals of the main engines, power propulsion plant, diesel generators, boilers, compressors, separators, pumps, compressed air systems, fire fighting and drainage systems for each of the monitored parameters shall be decoded in machinery spaces at local control stations.

**11.5.5** Visual alarm signals at the ship control station shall be as far as possible generalized. Generalization shall comply with the following requirements:

1. For each main engine together with its gear and shafting as well as for each auxiliary engine warning signals and generalized emergency signals shall be separated;
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.2 for each group of auxiliary components of the power installation intended for the same purpose together with their systems one generalized alarm signal may be provided;

.3 signals on the control systems’ supply break-out, fire danger, water presence in the holds, faults of fire protection and spark-extinguishing systems shall not be generalized.

11.5.6 Generalized alarm for Group I ships is to be fitted in spaces attended by responsible personnel (service, public, accommodation spaces etc.); this requirement is recommended for Group II ships.

11.5.7 Changeover of control from the local control of the main components of the power installation to the automatic one and back shall be possible only at local stations; the indication of the station from which the control is being exercised shall be provided in the wheelhouse. Possibility of simultaneous control from a remote station and a local station shall be precluded.

In case of several control stations the central control station shall have a priority with respect to the control station in the wheelhouse. Local control station of main engines shall have a priority with respect to the central control station.

The control can be changed over from one station to another only from the priority station.

When the control is changed over, sound and light signal shall be fed to all control stations. At each control station it is to be indicated which location is in charge.

11.6 PROPULSION PLANT

11.6.1 Main engines and gearings and the entire propulsion plant, including steerable thrusters, shall be controlled from the wheelhouse by means of remote automated control system or remote control system and from the machinery space.

If the ship’s breadth exceeds 10 m, in addition to the main station of the remote automated / remote control system at the ship control station, provision shall be made for side stations of the remote automated / remote control system. The possibility of simultaneous control of propulsion plant components from the specified stations shall be excluded.

For propulsion plants with non-reversible engines with reverse reduction gears the remote automated control systems may be used, which ensure the change of direction and rotation frequency of the reverse reduction gear output shaft by one control device and the engine start-up and shutdown by other control device.

In propulsion plants with engines having output less than 220 kW the engines or the entire propulsion plant can be controlled by the remote control systems.

11.6.2 Remote automated control system of each main engine shall ensure:

.1 remote setting of the required operational modes by a single control device;

.2 execution of the last set command irrespective of the sequence and speed of setting;

.3 start-up of the engine prepared for operation, mode change, shutdown, reversing and automatic execution of intermediate operations according to the set program without the engine and gear overloading;

.4 stepless (smooth) rotation frequency change at all operation modes of the engine;

.5 stable engine operation in the whole working rotation range;

.6 air supply stoppage or electric starter switch-off when the engine reaches the mode ensuring reliable switching over to the fuel consumption as well as in case of start-up failure.

.7 prevention of engine overload under normal standard operating conditions;

.8 generation of alarm signal about unsuccessful engine starting.

11.6.3 Static error of remote automated control system of main engines or propulsion plant with steerable thrusters for rotation speed control circuit shall not exceed +1.5 % of the rated speed of engine shaft or rotation speed corresponding to full power.

11.6.4 No malfunctions or supply failure of the remote automated control system may result in shutdown, rotation frequency in-
crease or change of the propeller’s thrust direction.

11.6.5 All engine control operations shall be carried out from any remote control station in the wheelhouse without any change-over, or the indication indicating which station is used for control shall be provided.

Control handles at remote control stations in the wheelhouse shall move simultaneously independently of the particular station from which control is exercised.

11.6.6 Provision shall be made for switching-off remote control station of the remote automated control system and changeover to the local control regardless of the current position of the remote control handle, with the exception of the remote automated control systems in ships with diesel-electric propulsion plant.

Changeover of control from one station to another one shall not result in changing of the operation mode of the main engines or propellers.

11.6.7 Provision shall be made for devices of immediate remote shutdown of engines independently of the control, alarm and protection systems.

11.6.8 The wheelhouse shall be provided with devices for disabling the automatic protection of the engine, except for rotation speed protection and, in justified cases, protection against minimum pressure of lubricating oil at the engine inlet and “Protection disabled” indication.

11.6.9 Cooling water (liquid) temperature in the inner circuit as well as oil temperature in the cooling system and lubrication system of the main engines shall be regulated automatically.

11.6.10 All control stations of the ships equipped with engine-order telegraphs shall have permanent indication of commands set by an engine-order telegraph.

11.6.11 For the engine using fuel oil the following shall be met: requirements of Table 11.5.2 to minimum scope of control, type of automatic protection and alarm and additionally the requirements of Table 11.6.11. Central station or wheelhouse shall have permanent indication of alarm on engine operation at the parameters stated in Table 11.6.11.

<table>
<thead>
<tr>
<th>Monitored parameter</th>
<th>Measurement point</th>
<th>Alarm operation condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel oil supply</td>
<td>At the engine inlet</td>
<td>Min.</td>
</tr>
<tr>
<td>pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust gas</td>
<td>At the output of each cylinder</td>
<td>Max.</td>
</tr>
<tr>
<td>temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum combustion</td>
<td>In each cylinder</td>
<td>Ditto</td>
</tr>
<tr>
<td>pressure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The valves supplying fuel to engines shall be automatically closed upon alarm operation at the parameters stated in Table 11.6.11. It is recommended to provide alarm on maximum combustion pressure.

11.6.12 Devices for emergency stop of main engines and forced disabling of protection shall be so designed as to exclude their unauthorized start.

11.6.13 Operation modes of main engines set from the wheelhouse shall be indicated in the central control station (if any on the ship) and in the local control stations of main engines.

11.6.14 Remote automated control system of propulsion plant with steerable thrusters shall ensure:

1. possibility of start/stop of main engine by separate control;
2. remote setting of the required operational modes by a single control device;
3. execution of subsequent forthcoming command with cancelling the previous ones in case of quickly alternating commands;
4. change of mode, reversing (for setting with limited angle of thruster turning), turning of thruster to the preset angle and automatic execution of intermediate operations under the given program without engine overload;
5. stepless (smooth) change of rotation speed and turning and direction of propeller thrust;
6 stable engine operation in the whole working rotation range;
7.2 air supply stoppage or electric starter switch-off when the engine reaches the mode ensuring reliable switching over to the fuel consumption as well as in case of start-up failure.
8 impossibility to start propeller drive and thruster turning system if the steerable thruster is not in the operating position;
9 possibility of check of system serviceability.

11.6.15 No malfunctions or supply failure of the remote automated control system shall result in shutdown, rotation speed increase or change of the propeller thrust direction.

11.6.16 Provision shall be made for switching-off remote control station of the remote automated control system of propulsion plant with steerable thrusters and changeover to the local control irrespective of position of the remote control handle.

11.6.17 Remote control system of the propulsion plant with steerable thrusters and remote control system of the thruster shall ensure:
1. possibility of start of propulsion plant main engine and its stop by means of separate control;
2. for the reversible plants equipped with reverse coupling or reverse reduction gear with limited angle of turning of $\pm 35^\circ$ and reversible (fixed) thrusters — change of rotation speed and direction of propeller rotation by means of one control;
3. control of steerable thruster turning by means of separate control;
4. possibility of control of propulsion plant and transverse thruster with disabled (faulty) remote control system from local control station;
5. possibility of stepless smooth change of rotation speed and direction of propeller thrust, change of angle of turning of propulsion plant thruster;
6. impossibility to start propeller drive and steerable thruster turning system if the propulsion plant or transverse thruster is not in the operating position;

11.6.18 Any faults of remote control system shall not stop, increase rotation speed and change direction of rotation of propeller thrust.

11.7 PRIME MOVERS OF GENERATOR SETS

11.7.1 Prime movers of the ship generators shall be equipped with remote control system or remote automated control system from the wheelhouse or the central control station.
Prime movers shall be automatically maintained in the ready-to-work condition.

11.7.2 Interval from the moment of activation of start-up signal to the preparedness for reception of 100 per cent load for the ready-to-work engine shall not exceed 30 s.

11.7.3 It shall be possible to receive load by non-warmed-up prime movers of auxiliary generator in case of emergency start from the remote control station.

11.7.4 Cooling water temperature in the inner cycle of prime movers of generators shall be adjusted automatically.

11.7.5 Control systems of generator units shall provide the following types of control:
1. remote start and shut-down of generator unit;
2. automatic start of standby generator unit, automatic synchronization, reception and distribution of load in the following cases: operating generator / generators reaches / reach maximum permissible load;
3. automatic start of standby generator unit and its start in case of failure of main (at the given moment) operating generator unit;
4. remote start and automatic switching-on of the diesel generators for operating in parallel from the wheelhouse or the central control station (when Group I or Group II ship is equipped with remotely controlled drives of capacity commensurable with that of the generator set);
5.5 remote start, shutdown, synchronization, distribution of load from the central control station or from the main switchboard, when the latter is located in the central control station room (for ships of group II).

11.7.6 Control stations of generator units shall have indicators to indicate readiness of generator units for immediate (automatic) start.

11.7.7 Control system of generator unit primary movers shall ensure preliminary selection of generator units automatic start sequence and their connection to main switchboard busbars.

11.7.8 The start system of high power consumers, the start of which can cause impermissible voltage drop as compared to deviations listed in Table 2.2.1 Part VI of the Rules or de-energizing of main switchboard buses, shall have automatic pre-start of standby generator, synchronization, reception and distribution of load or interlock prohibiting start of such consumers till the moment of connection of standby generator to the main switchboard buses and the appropriate indication.

11.8 FUEL SYSTEMS

11.8.1 Daily service fuel tanks of engines and boilers shall be replenished automatically.

11.8.2 Dual-fuel (diesel oil and heavy fuel) systems of engines’ supply shall provide the following:

.1 remote control of heating-up and pumping of heavy fuel, supply changeover from diesel oil to heavy fuel and vice versa;

.2 automatic maintaining of preset viscosity (temperature) of heavy fuel;

.3 automatic changeover to diesel oil in case of inadmissible increase of viscosity (temperature drop) of heavy fuel as well as at supply break of drives of the dual-fuel system valves and pumps;

.4 automatic maintaining of fuel circulation through the heaters after they have been switched off for a period of time sufficient for the prevention of fuel overheating in the heaters.

.5 installation of alarm sensors for excessive fuel temperature.

11.8.3 Technological operations of start, shutdown, slag and sludge removal processes in heavy fuel purifying installations shall be automated.

11.9 COOLING, LUBRICATION AND COMPRESSED AIR SYSTEMS

11.9.1 In ships of Group I automatic start of stand-by circulating cooling and lubrication pumps of main and auxiliary engines and gears, stand-by pumps of lubrication and pumping of shafting bearings shall be provided in the event of failure of the main pumps.

11.9.2 Preliminary oil circulation pumps of the main engines shall start remotely and switch off automatically after the completion of the engine’s start.

When the turbo-compressor rotor bearings are not provided with separated (independent) lubrication system, preliminary oil circulation pumps shall start automatically at the moment of the engine shutdown signal actuation and stop automatically after the turbo-compressor rotor has been stopped.

11.9.3 Air receivers for starting air, typhoon and domestic needs as well as supply air for automation systems shall be replenished automatically.

It is necessary to provide the possibility of start and shutdown of self-contained compressors from the wheelhouse (for ships of group I) or the central control station (for ships of group II).

Compressor separators shall be blown-off automatically.

11.9.4 Air compressors shall start automatically under pressure drop in the air receivers by not more than 30 per cent of the nominal value and shut-down when reaching 97 to 103 per cent of the nominal pressure.

11.10 BOILERS

11.10.1 The automation system of fuel oil fired steam boilers shall provide:

.1 automatic regulation of the steam pressure, water level in the boiler, pressure of the feed water, fuel pressure at the atomizer inlet;

.2 automatic control of the boiler pumps;
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11.10.2 Each boiler shall have at least two independent water level sensors connected to different sampling points, one of which is used solely for emergency protection.

11.10.3 Automation system of exhaust heat boilers in which steam pressure is regulated by changing the flow direction of engine exhaust gases through the boiler, shall provide automatic switching-over of gas bypass device.

When the steam pressure is regulated by steam bypassing to the condenser, automatic regulation of the bypass device shall be provided.

Water level in the steam separator shall be maintained automatically.

11.10.4 The automation system of fuel oil fired hot-water boilers shall provide:

- automatic regulation which guarantees continuous hot water supply of consumers for their operation in all operation modes;
- ventilation of furnace space with sufficient air change before supplying fuel;
- interlock preventing automatic switching-on of boiler in case of faults for which in Table 11.5.2 protection is provided.

11.10.5 Automation system of exhaust-heat hot-water boilers shall provide automatic switch-over of the device regulating flow direction of exhaust gases through the boiler or directly to the atmosphere depending on the temperature in the boiler.

11.10.6 When two and more boilers operating for the common main are installed on the ship, it is necessary to provide automatic control of single operation under load of each boiler, if envisaged by the design, keeping of standby boilers in ready state and their connection to load, parallel operation of boilers and their disconnection from load.

11.10.7 It shall be possible to disconnect the burning units of self-contained boilers remotely and close the dampers of waste-heat boilers from the continuously attended control station.

11.10.8 Actuation of boilers from cold state after protection operation and in case of unsuccessful ignitions of fuel or flame extinction shall be carried out only from the local control station.

11.11 SHIP GENERAL SYSTEMS

11.11.1 Where remote control and indication of actual opening and closing of shut-off and stop valves of ballast piping, remote indication or water level alarm in ballast compartments are available, valve controls, indicators and alarm devices shall be fitted at local stations.

11.11.2 Tankers shall be fitted with remote indication system or a system signalling on the limit (95%) and emergency (98%) of the liquid level in tanks; indicators or alarm devices shall be located in the wheelhouse or the loading control station. General light and
sound signals about limit and emergency levels of liquid in tanks shall be brought to the open deck.

11.11.3 It is allowed to fit ships of group I with automated drainage system of machinery spaces by means of pumping bilge water to a special tank or overboard where discharge is allowed, if the ship is equipped with system purifying bilge water from oil fractions to the values stated in Table П2.1 and Table П2.2 Appendix 2 of RPPS.

11.11.4 Separate sensor independent from sensors installed for control of bilge pumps shall be provided for alarm about maximum permissible level of bilge waters.

11.12 WHEELHOUSE EQUIPMENT

11.12.1 Control devices, indication and alarm appliances in the wheelhouse shall be fitted at the panels constructed for using by one person.

11.12.2 Control of the main engines, fire pumps, aerosol fire suppression system and spark extinguishing system shall be exercised from the wheelhouse irrespective of the presence of the central control station on the ship.

Moreover in ships of group I the following power installation components and ship machinery which are not started automatically shall be controlled from the wheelhouse:

.1 electric power plant;
.2 self-contained boilers;
.3 compressor units;
.4 bilge pumps;
.5 machinery ensuring operation of main engines.

11.12.3 Visual alarm shall be so designed as not to blind the ship’s operator and be distinctly visible during daylight hours.

Provision shall be made for the regulation of luminescence brightness of actual status indication lamps.

11.12.4 Indication of the following parameters shall be provided:

.1 rotation speed and direction of propellers (rotation speed and position of blades of controllable pitch propellers);
.2 lubricating oil pressure at the main engines’ inlet;
.3 cooling water temperature in the inner circuit at the main engines’ outlet;
.4 air pressure in starting air bottles of the main engines and audible signal air bottle;
.5 pressure of working medium in the remote automated control systems of the main engines and couplings;
.6 voltage and load current of generators.

The indication of the parameters mentioned in 11.12.4.2, 11.12.4.3 and 11.12.4.6 may be dispensed with in the permanently attended central control station.

11.12.5 In case of non-reversible main engines and reversible main diesel-reduction gear sets the indication of crankshaft rotation frequency shall be provided. Indication of rotation frequency and direction of propellers may be dispensed with for non-reversible engines with capacity up to 220 kW inclusive, however, indication of actual reversing shall be provided.

11.12.6 In ships with shaft generators the indication of electric current frequency and voltage shall be provided.

11.12.7 Where side stations of the remote automated control system of the main engines are provided on the ship, the frequency and direction of propellers’ rotation, position of rudders and thrust direction shall be indicated on these stations. On side stations control of steering drives and thruster shall be provided also.

11.12.8 Generalized visual alarm signals of “emergency” category shall be formed according to emergency alarm signals (activation of the emergency protection, necessity of immediate shutdown of machinery, activation of the stand-by equipment etc.)

For alarm signals which shall be led to the wheelhouse, see 11.5.5.

11.12.9 The following visual indication signals shall be led to the wheelhouse:

.1 operation of each diesel generator;
.2 the kind of fuel fed and preparedness for changeover to heavy fuel (for ships equipped with double fuel systems);
.3 start-up of stand-by cooling and lubricating pumps in accordance with 9.10.1;
.4 operation of self-contained compressors;
.5 operation of self-contained pumps of spark-extinguishing system.
.6 the following positions of wheelhouse changing its position in height:
   lower limit position of wheelhouse;
   upper limit position of wheelhouse.
Actual status indication specified in 11.12.9.2 to 11.12.9.4 may be dispensed with in the permanently attended central control station.

11.12.10 Provision shall be made to stop the main engines from the wheelhouse irrespective of the availability of the remote automated control or remote control.

11.12.11 The following automation systems or their components (if envisaged by the ship design) shall be arranged in the wheelhouse:
.1 fire alarm and respective indicator panel or central fire control station (see 1.2.1.29 Part III of the Rules);
.2 automatic fire-extinguishing system control facilities;
.3 fire door indicator panels;
.4 facilities for control of fire door closing;
.5 watertight door indicator panels;
.6 facilities for control of fire door opening and closing;

11.12.12 If the ship is equipped with remote-controlled anchor release device, the device indicating the length of hauled-off anchor chain shall be installed in the wheelhouse on the device control console.

11.12.13 The equipment of control stations on the open bridge wings shall include devices having electrical equipment protection class stated in Table 2.3.6 Part VI of the Rules and adjustable illumination.

11.12.14 The wheelhouse of the ship equipped with propulsion plant with steerable thrusters and transverse thrusters shall be provided with the following indication:
.1 lubricating oil pressure at the engine inlet;
.2 cooling water temperature in the inner circuit at the engine outlet;
.3 air pressures in compressed air starting cylinders if such starting system is provided;
.4 engine crankshaft revolution frequency;
.5 if reverse coupling is available — propeller rotation speed;
.6 current and voltage in the charging circuit and voltage in the discharging circuit of starting accumulator batteries (for engines with electric starting);
.7 working medium pressures in remote automated control system.

11.12.15 If electric motor (performs the functions of propulsion engine) is used as a drive for steerable thrusters and transverse thrusters, the following indication shall be provided on the control console in the wheelhouse:
.1 rotation speed and direction of rotation of propeller;
.2 voltage in power supply circuit and control circuits;
.3 overloads of drive motor.

11.12.16 The following parameters shall be indicated for engines of steerable thrusters turning drive:
.1 for electric motor:
   voltage in power supply circuit;
   overload of steerable thrusters turning motor;
.2 for hydraulic drive:
   pressure in working medium system;
   minimum level of working medium in service tank.

11.12.17 Control stations of main and standby turning drives of steerable thrusters shall be equipped with indicators of thruster position and direction of thrust.

11.12.18 Transverse thruster control console shall be equipped with:
.1 for electric motor:
   indication of voltage in power supply circuit and control circuits;
.2 for hydraulic drive:
   indication of pressure in working medium system;
indication of minimum level of working medium in service tank.

.3 thrust direction indicator.

11.12.19 Indication of operation condition of steerable thrusters or transverse thrusters shall be provided.

11.12.20 Propulsion plants with steerable thrusters and transverse thrusters shall be equipped with alarm and protection system or prepared for its installation in the wheelhouse after propulsion plant installation onboard the ship. The alarm and protection system shall be designed for the following parameters:

.1 for engines:
maximum rotation speed protection (interruptible);
alarm and stop at minimum oil pressure at the engine inlet (interruptible protection);
alarm about maximum oil temperature in lubricating system of the engine;
alarm about maximum temperature of cooling liquid in the inner cycle of the engine;
alarm about engine overload for fully steerable thruster;

.2 for electric motors of electrical or electrohydraulic turning gear of steerable thrusters — device for protection against short-circuit currents only. Protection against minimum voltage and overload is not allowed;

.3 for the electric motors used for driving the propellers and turning the steerable thrusters — alarm about breakage (failure) in the control circuit.

Propulsion plant control station shall be provided with devices signalling about availability of voltage in the supply circuit of the steerable thruster turning gear. Overload signal shall be light and sound one.

11.12.21 Hydraulic units of steerable thrusters and transverse thrusters shall have alarm about minimum oil level in the service tank.

11.12.22 Electric drive of thrusters shall have short circuit protection.

11.13 EQUIPMENT OF PERMANENTLY ATTENDED CENTRAL CONTROL STATION

11.13.1 The central control station shall be equipped with control devices, remote indication devices, communication and automation means, alarm and actual status indication for the equipment installed in the machinery spaces.

Control devices of the main engines may be dispensed with in the central control station. Composition of remote indication devices for the power installation components with the exception of the main engines, which shall be provided in the central control station, shall be specified depending on the ship purpose and type of the power installation.

11.13.2 Main switchboard of the ship’s power plant in the central control station or in its close vicinity.

If the main switchboard is situated beyond the range of visibility from the central control station, the latter shall be equipped with alarm devices indicating the position of generator circuit breakers of the main switchboard.

11.13.3 If remote control of the main engines is performed from the central control station pneumatically, hydraulically, electrically or in combination, the remote automated control system of the main engines from the wheelhouse shall be independent of control system from the central control station.

11.13.4 If control of the main engines is transferred to the central control station, the alarm shall actuate at the control station in the wheelhouse from which control has been carried out before.

11.14 INDICATION SYSTEM, ALARM AND PROTECTION OF SHIPS WITH STEERABLE THRUSTERS AND TRANSVERSE THRUSTERS

11.14.1 Local control station of propulsion plant with steerable thrusters shall be provided with:
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11.14.1 Indication of the following parameters shall be provided for the engine on the local control station of the propulsion plant:
- oil pressure at the engine inlet;
- temperature of the inner cycle cooling water at the engine outlet;
- engine crankshaft revolution frequency;
- current and voltage in the charging circuit and voltage in the discharging circuit of starting accumulator batteries (for engines with electric starting).

11.14.2 Local control station of the steerable thrusters shall be provided with:
- indication of voltage in power supply circuit and control circuits;
- control station changeover switch;
- ammeter;
- thrust direction indicator.

11.15 REQUIREMENTS TO COMPUTERS AND COMPUTER SYSTEMS

Scope of application

11.15.1 These requirements apply to computers and computer systems designed for control of the ship, monitoring and control of ship machinery and equipment ensuring safety of ship running and operation, as well as computers and computer systems ensuring domestic needs of the crew and passengers or used for providing access to Internet for passengers of the ship.

11.15.2 Onboard the ships the use can be made only of computers and computer systems with protection class complying with the requirements of 2.3.6 Part VI of the Rules and tested for electromagnetic compatibility and safety of operation under conditions of the ship according to requirements of 2.7 Part VI of the Rules and Appendix 15 of RTSC.

11.15.3 Computers and peripheral devices shall be serviceable under operating conditions described in 2.2 Part VI of the Rules, unless other operating conditions are specified in the relevant Sections of this Part of the Rules for the ship objects serviced by them.

11.15.4 Design of computers and computer systems shall ensure easy access to components and units to be replaced for repair and maintenance.

11.15.5 All replaced components shall be designed in a way to exclude their incorrect connection and installation. When this is impossible, the appropriate marking shall be made.

11.15.6 Computers, which are not used as a part of other installation, and peripheral devices shall have protection class not less than the one specified in 2.3.6 Part VI of the Rules.

General technical requirements to design of monitoring and controls computer systems

11.15.7 Computer automation systems shall meet proper functional requirements of the design specification under all operating conditions, including emergency ones, to provide the following:
- safety of people;
- preventing equipment damages or emergencies;
- convenience of servicing;
- serviceability of other devices and systems.

11.15.8 It shall be impossible for the personnel of the ship to modify the programs.

11.15.9 For the installations equipped with computers any change of user programs influencing fulfillment of installation functions is considered to be a design change and it shall be agreed with the River Register.

11.15.10 Any disconnection of peripheral devices from the computer or computer system and restart of computer system shall not
cause uncontrolled execution of commands causing critical or undefined state.

11.15.11 Computer system shall operate quickly to ensure fulfilment of all functions in accordance with the technical documentation within a preset time considering maximum load and maximum number of simultaneously solved tasks, including data rate in the network, under normal and emergency conditions.

11.15.12 Incorrect actions of operator shall not cause damage of computer, deleting or change of information stored in the computer.

11.15.13 Programs and data required for operation of computer system shall be stored in non-volatile memory.

11.15.14 Software in monitoring, control and alarm computer systems shall not be lost or damaged due to fluctuation of voltage and current frequency in the network.

11.15.15 If forced ventilation or air conditioning is required during operation of computers and computer systems, provisions shall be made for indication or alarm on exceeding permissible limit values of climatic parameters.

Configuration, operation check, self check and alarm on faults

11.15.16 Computer systems and software shall have hierarchic structure.

11.15.17 Computer system components shall be so selected as to ensure safe operation of the controlled equipment.

11.15.18 It shall be possible to check all functions of the computer with use of special programs, if required.

11.15.19 Computer systems shall have built-in self check function ensuring appropriate alarm in case of fault.

11.15.20 Faults in computers and computer systems shall not cause faults of serviced equipment and the entire ship.

11.15.21 Failure of peripheral devices shall not affect operation of other peripheral equipment of the computer system. Fault alarm shall be provided.

11.15.22 Software shall have detailed technical description of all possible functions.

11.15.23 Information transfer channel shall have means for continuous self check for detection of data transfer faults and failures in the channel itself. When a failure occurs in one network, an alarm is to be activated.

Additional requirements to computers for controlling ship power installations and their components

11.15.24 Structure of integrated automation systems shall ensure back-up of all controlling functions (by means of computers or standard automation means) in case of faults in separate computers or in communication lines between them.

11.15.25 It is allowed to use functional units of one system with a computer as a back-up one for another computer system.

11.15.26 Computers or computer systems shall be used in protection systems only if automatic operation of protection system in a standard way in case of computer failure is provided. If the computers have a back-up, fulfilment of this requirement is not required.

11.15.27 When systems under control are required to be duplicated and in separate compartments, this is also to apply to control elements within computer based systems.

11.15.28 Computers used for control and (or) setting of ship power installations and systems shall operate without delay and perform monitoring and protection functions in real time.

11.15.29 Faulty peripheral devices required for operation of the system shall be replaced with back-up devices having the same connection conditions.

11.15.30 If monitors are used for display of processes, the fault alarm of power installations and systems shall instantaneously appear on the screen. It is not allowed to separate
acknowledged signals from unacknowledged ones only by change of colour.

11.15.31 If monitors are used for visual indication of emergency states, it is necessary to provide back-up displays or means for indicating the alarm in other form (lamps, light-emitting diodes, etc.).

Installation of computers and computer systems onboard the ships

11.15.32 Layout of data input/output devices shall ensure the possibility of free access to them for maintenance. Connection routes in computer systems with constant redundancy shall be backed up and arranged as far as possible from each other.

11.15.33 During installation of computers and laying of cable routes provisions shall be made to ensure electromagnetic compatibility between assembled computer system and other systems on the site.

11.15.34 Power supply sources shall have proper serviceability check. Alarm signal shall be generated in case of fault, deviation of parameters, or any power supply failure.

11.15.35 Back-up computer systems shall receive power supply via separate lines protected by independent short circuit and over-load protection devices.

User interfaces

11.15.36 Each computer system shall have user manual comprising the following:
- purpose of functional buttons and indicators;
- description of screen menus;
- operator actions for system operation.

11.15.37 Input devices shall be safe at all operation conditions of the ship. When data are input by the operator, the input check shall be provided (for example, with the help of monitor, printer).

11.15.38 Computer system control panels in the wheelhouse shall be equipped with independent adjustable illumination.

11.15.39 The state of computer system and equipment controlled by it shall be clear for operator at any moment of time.

11.15.40 Size, colour, density of text and graphic information on the monitor screens shall make it possible to read the information from the operation station under all light conditions in the room. For proper reading of information under all light conditions the image brightness and image control shall be provided.

11.15.41 When colour monitors are used, the change of colour shall not affect reliability of transmitted information.

Test and checks

11.15.42 Computer systems shall be designed, manufactured and tested for compliance with requirements of this Section and 2.2, 2.3 and 2.7 Part VI of the Rules.

11.15.43 The computer system shall be tested and checked to confirm correctness of operation and quality of equipment.

11.16 REQUIREMENTS TO PROGRAMMED ELECTRONIC SYSTEMS

11.16.1 The requirements of this Section apply to programmed electronic systems used in ship control, alarm, monitoring and protection systems.

Data links

11.16.2 Data links of programmed electronic systems shall ensure automatic recovery of data link if a single failure of any component results in loss of communication.

11.16.3 Failure of any communication link shall not affect the possibility of control of critical consumers with the help of alternative means.

11.16.4 Means ensuring data integrity and recovery of damaged or unreliable data.

11.16.5 The data transmission is to be self-checked, regarding both the network transmission medium and the interfaces / connec-
tions. When failure is detected, alarm signal shall be fed.

**Protection against changes**

11.16.6 Programmed electronic systems shall be protected against program changes by the user.

11.16.7 Changes of systems parameters by the manufacturer shall be agreed with the River Register.

11.16.8 Any changes in design or software of programmed electronic system after its tests under technical supervision of the River Register shall be documented.
12 VIBRATION OF SHIP MACHINERY AND EQUIPMENT

12.1 CONSIDERATION OF SHIP MACHINERY AND EQUIPMENT VIBRATION AT THE SHIP DESIGN STAGE

12.1.1 This Chapter outlines the vibration standards for ship machinery and equipment at the place of their installation onboard the ship. These standards shall be taken into consideration at the design stage to ensure vibration protection of the machinery and equipment producing no continuous vibration. Parameters of vibration of ship structures set out in 2.6 Part I of the Rules shall not exceed these standards. If vibration parameters in the place of installation of ship machinery and equipment exceed the standards set out in this Chapter, such machinery and equipment shall be protected with the help of vibration isolators.

12.1.2 For operating internal combustion engines the standardized parameter of vibration is the amplitude of horizontal-transverse oscillations which shall not exceed 0.5 mm atop of the engine.

12.1.3 For centrifugal pumps, fans and air-conditioners the vibration is limited by amplitude of oscillations depending on their power stated in Table 12.1.3.

<table>
<thead>
<tr>
<th>Frequency, N, in qty/min</th>
<th>Oscillation frequency N, in mm/s</th>
<th>Permissible amplitude a, in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 15</td>
<td>400 ≤ N ≤ 2000</td>
<td>(0.2±6.5)·10⁻⁷N</td>
</tr>
<tr>
<td></td>
<td>N &gt; 2000</td>
<td>(0.3±9.5)·10⁻⁷N</td>
</tr>
<tr>
<td></td>
<td>—</td>
<td>(0.28±10⁻⁶)·N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(18±57)·10⁻²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(28±90)·10⁻²</td>
</tr>
</tbody>
</table>

12.1.4 For piston pumps and compressors the standardized parameter of vibration is the amplitude of oscillations the permissible values of which shall comply with Table 12.1.4.

<table>
<thead>
<tr>
<th>Attachment point</th>
<th>Permissible amplitude of oscillations, in mm, at a height H of rotation axis of pump or compressor relative to attachment plane of its supports, in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastic</td>
<td>17 24 30</td>
</tr>
<tr>
<td>Rigid</td>
<td>14 20 25</td>
</tr>
</tbody>
</table>

12.1.5 The equipment of galleys and sick-bays is installed without limitations if the equipment specifications have no limitations. This requirement applies also to electrical equipment.

12.1.6 If vibration parameters in the place of installation of instruments having vibration level limitations exceed the permissible standards specified in technical documentation, such instruments shall be installed on vibration isolators. Rigidity of vibration isolators is determined by the following formula:

\[ c = \frac{m_0^2}{\omega^2 \left( 1 - \sqrt{\left( \frac{w}{\gamma} - 1 \right)^2} \right)} \]

where \( m_0 \) — weight of the device, in kg;
\( \omega \) — frequency of forced oscillations in the place of device installation, in s⁻¹;
\( w \) — ratio of permissible acceleration in the place of sensor installation;
\( \gamma \) — coefficient of in-depth energy deposition equal to:
- for rubber: 0.032±0.19
- for springs: 0.002±0.005

12.1.7 Standards of vibration generated by various ship machinery during operation are specified in 12.2.
12.2 STANDARDIZATION OF VIBRATION OF SHIP MACHINERY AND EQUIPMENT DURING SHIP CONSTRUCTION AND OPERATION

Measurement and standardization of ship machinery and equipment vibration

12.2.1 This Chapter outlines limit permissible vibration levels (vibration standards) of ship machinery and equipment.

The standards are used for estimation of permissible actual vibration levels of ship machinery and equipment of ships under construction (after repair) and ships in service by results of measurements of their vibration parameters. The standards distinguish three categories of technical condition of ship machinery and equipment of ships:

A — condition of machinery and equipment after manufacture (ship construction) or repair at the time of commissioning;
B — condition of machinery and equipment at the time of normal operation;
C — condition of machinery and equipment requiring maintenance or repair.

The standards determine upper limits for categories A and B.

12.2.2 Vibration of ship machinery and equipment is measured during construction of the ship as per the program agreed with the River Register.

12.2.3 During ship construction (or after repair) the vibration of ship machinery and equipment shall not exceed the level of upper boundary of category A.

During further service of the ship the vibration of ship machinery and equipment shall not exceed the level of upper boundary of category B, which ensures vibration strength and reliability of operation of ship machinery and equipment.

12.2.4 The results of measurement of vibration parameters shall be compared to the permissible vibration levels (standards) specified in this Section.

If the vibration exceeds the specified standards, measures aimed at reduction of vibration parameters to the specified permissible levels shall be developed and implemented.

12.2.5 Vibration levels of ship machinery and equipment shall not exceed the standards both when the ship is at berth and in operation in ahead running modes recommended by the manufacturer at different engine loads.

In ahead running modes not recommended by the manufacturer and in astern running modes the vibration exceeding the specified standards is considered harmless if the duration of these modes does not exceed 30 minutes.

Standardized vibration parameters

12.2.6 The main parameter characterizing vibration level of ship machinery and equipment is the mean square value of vibration speed measured in third-octave frequency band (preferable) or in octave frequency bands. Root-mean-square value of vibration acceleration is to be measured along with vibration velocity.

12.2.7 Vibration parameters are measured in absolute units or in decibels relative to standard threshold (reference) values of oscillating speed or acceleration equal to 5·10^{-8} m/s or 1·10^{-6} m/s², respectively.

12.2.8 When measuring vibration in octave frequency bands the permissible values of measured parameter can be increased 1.41 times (by 3 dB) as compared to the values specified in 12.2.11 to 12.2.19 for the bands with root mean square frequencies 2, 4, 8, 16, 31.5, 63, 125, 250 and 500 Hz.

12.2.9 Vibration of ship machinery is measured in three mutually perpendicular directions relative to ship’s axes: vertical, horizontal transverse and horizontal longitudinal. Vibration measurement points are shown in Figure 12.2.9. Points and directions of vibration measurement are shown with dots.
Vibration standards for engines

12.2.10 Vibration standards apply to engines of 55 kW and more with rotation speed of 3000 min⁻¹ and less.

12.2.11 Vibration of engines and units including the engines is considered permissible for categories A and B if root mean square values of vibration velocity or vibration acceleration do not exceed the values stated in Table 12.2.11.

12.2.12 Vibration of units and devices hung on engine shall not exceed the levels specified in 12.2.11.

12.2.13 Vibration of turbocompressors measured on bearing body is considered permissible for categories A and B if root mean square values of vibration velocity or vibration acceleration do not exceed the values listed in Table 12.2.13.

Vibration standards for rotor type auxiliary machinery

12.2.14 Vibration of vertical pumps of 15-75 kW and their electric drives is considered permissible for categories A and B if root mean square values of vibration velocity or
Table 12.2.13

<table>
<thead>
<tr>
<th>Technical condition categories</th>
<th>Root mean square frequencies of third-octave bands (Hz)</th>
<th>mm/s</th>
<th>dB</th>
<th>mm/s</th>
<th>dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 300</td>
<td>From 300 to 700</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>4 98</td>
<td>6.6</td>
<td>101</td>
<td>4 98</td>
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<tr>
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<td>4 98</td>
<td>6.6</td>
<td>101</td>
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<td>5.6 101</td>
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<tr>
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<td>6.6</td>
<td>101</td>
<td>4 98</td>
<td>5.6 101</td>
</tr>
<tr>
<td>3.2</td>
<td>4 98</td>
<td>6.6</td>
<td>101</td>
<td>4 98</td>
<td>5.6 101</td>
</tr>
<tr>
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<td>4 98</td>
<td>6.6</td>
<td>101</td>
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<td>5.6 101</td>
</tr>
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<td>102</td>
<td>5.6 101</td>
<td>8.0 104</td>
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<td>5.6 101</td>
<td>8.0</td>
<td>104</td>
<td>7.1 103</td>
<td>10 106</td>
</tr>
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<td>8</td>
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<td>10 1-6</td>
<td>8.9 105</td>
<td>12.5 108</td>
<td></td>
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<td>10</td>
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<td>108</td>
<td>11 107</td>
<td>16 110</td>
</tr>
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<td>16 110</td>
<td>14 109</td>
<td>20 112</td>
<td></td>
</tr>
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<td>20 112</td>
<td>16 110</td>
<td>22 113</td>
<td></td>
</tr>
<tr>
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<td>16 110</td>
<td>20 112</td>
<td>16 110</td>
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<td>2.6 94</td>
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<td>400</td>
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<td>2.9 95</td>
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<td>2.9 95</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>1.7 91</td>
<td>2.3 93</td>
<td>1.7 91</td>
<td>2.3 93</td>
<td></td>
</tr>
</tbody>
</table>

Vibration standards for centrifugal separators is considered permissible for categories A and B if root mean square values of vibration velocity and vibration acceleration do not exceed the values stated in Table 12.2.14.

Vibration standards for radiator coolers is considered permissible for categories A and B if root mean square values of vibration velocity or vibration acceleration do not exceed the values stated in Table 12.2.14.

Vibration standards for pumps of 2–15 kW with vibration standards for categories A and B are taken 3 dB less as compared to the standards for pumps of 15–75 kW, and for the pumps of 75–300 kW these standards are increased by 2 dB. Vibration standards for horizontal pumps of the above mentioned capacities are taken 2 dB less.

Vibration standards for fans and gas blowers of inert gas systems is considered permissible for categories A and B if root mean square values of vibration velocity and vibration acceleration do not exceed the values stated in Table 12.2.14.

Vibration standards for ship machinery and auxiliary equipment not specified in 12.2.11 to 12.2.19 shall be taken according to 12.2.19.
## Table 12.2.14

<table>
<thead>
<tr>
<th>Technical condition categories</th>
<th>Root mean square fre-</th>
<th>Permissible root mean square values of vibration velocity and (or) vibration acceleration of</th>
<th>Technical condition categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>quencies of third-octave</td>
<td>pumps with capacity of 15–75 kW</td>
<td>centrifugal separators fans</td>
</tr>
<tr>
<td>bands (Hz)</td>
<td>mm/s dB</td>
<td>mm/s dB</td>
<td>mm/s dB</td>
</tr>
<tr>
<td>1.6</td>
<td>1 86</td>
<td>1 86</td>
<td>1 86</td>
</tr>
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<td>1 86</td>
<td>1.2 88</td>
<td>1 86</td>
</tr>
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<td>1.3 88</td>
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</tr>
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<td>3.2 96</td>
</tr>
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<td>80</td>
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</tr>
<tr>
<td>100</td>
<td>4.3 99</td>
<td>6.3 102</td>
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</tr>
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<td>3.2 96</td>
</tr>
<tr>
<td>200</td>
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<td>3.3 96</td>
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<td>1.4 89</td>
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<td>1.6 90</td>
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<tr>
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<tr>
<td>500</td>
<td>— — —</td>
<td>— — —</td>
<td>— — —</td>
</tr>
</tbody>
</table>
Part V

SHIP ARRANGEMENTS AND OUTFIT
1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION
1.1.1 The present Part of the Rules applies to ship arrangements, deck machinery, equipment and outfit of ships of all classes.

1.1.2 Requirements of the present part of the Rules do not apply to arrangements, equipment and outfit intended for special and technological purposes of industrial ships (for example, cross dredging arrangements of suction-tube dredgers, door lifting devices on scows).

1.2 TERMS AND DEFINITIONS
1.2.1 Terms related to the Rules general terminology and their definitions are stated in Section 2, Part 0 of the Rules. The following terms are used in the present Part of the Rules:

.1 **Tug-and-push boat** is a ship fitted with towing and coupling arrangements and intended for towing and convoying other ships and floating structures by pushing;

.2 **Towing equipment** is towing winches, hooks, bollards, towing arches, blocks, towing chock ports, bits, shackles, stoppers, rope retainer and limiters, reels, raised platforms, guide ropes, fenders, fender guards, lifeline guns;

.3 **Upper structure of the floating crane** is a cargo-handling device installed on a specially designed pontoon. Slewing device foundation is the boundary between the upper structure and the pontoon;

.4 **Jib radius** is the horizontal distance between the axis of the derrick rotation and the vertical axis of the gripping device without load determined when pontoon (ship) heeling and trim are precluded;

.5 **Height above the hull** is a height above the uppermost deck in the place of signalling means installation;

.6 **Immersion suit** is a suit made of watertight material intended for protection of the body of a person wearing it against overcooling in cold water;

.7 **Cargo boom** is a cargo-handling appliance intended for holding and transferring the cargo by means of the system of blocks and ropes attached to the derrick structure and outside it (to masts, posts, decks and winches);

.8 **Cargo-gripping devices** are all devices by means of which cargo can be attached to the cargo-handling appliance but which are not integral part of the cargo-handling appliance or cargo, for example grabs, container spreaders, cargo-lifting electromagnets, lifting beams, platforms, frames, cables, buckets, slings, cargo nets and other devices belonging to the ship. Cargo-gripping devices shall be considered as loose gear;

.9 **Cargo-handling appliance** is a ship’s device for cargo lifting and handling (crane, ship’s derrick and lift);

.10 **Lifting capacity** is the greatest permissible cargo mass to be lifted and handled by a cargo-handling device in the determined working conditions including the mass of the loose cargo-gripping gear;

.11 **Range of visibility** is a distance from which navigation lights are visible on a dark night during fair weather;
12 **Range of audibility** is a distance from which an audible signal is heard when the tailwind velocity is up to 3 m/s;

13 **Rescue boat** is a life-saving appliance which is carried on board in a state of continuous readiness for immediate use to rescue persons fallen into water, persons from a ship in distress as well as for marshalling and towing of liferafts;

14 **Actual loads** are static and dynamic loads determined by the gravity force, inertia, wind pressure, heeling and trim, ship’s motions, temperature strains, impact effects, pushes as a result of crane track movement and swinging on a flexible suspension, etc;

15 **Components** are the components of cargo-handling appliances intended to transmit forces and to provide kinematic connection except parts of machinery;

16 **Length and width of a ship** are design length and width of a ship, unless otherwise provided in the present part of the Rules;

17 **Safe working load (SWL)** is the maximum allowable static load applied to each individual component of the cargo-handling appliance;

18 **Standby steering drive** is an equipment intended for wheellover or steerable nozzle reversal with purpose of the ship steering in case of failure of the main steering drive;

19 **Individual life-saving appliances** are a lifebuoy, a lifejacket, an immersion suit;

20 **Individual thermal protective aid** is a bag or suit made of waterproof material with low thermal conductivity intended for restoring the body core temperature of the person having been in cold water;

21 **Collective life-saving appliances** are life and rescue boats, liferafts (rafts intended for accommodation of persons outside the water), life buoyancy aids (light rafts, tables, benches intended for supporting of persons on the water surface);

22 **Limit switch** is an electric device to be used in control system as a sensor which automatically gives a signal or disconnects or switches the power circuit of the appliance, gear at a mechanical contact of pair of any parts of this appliance, gear. The limit switch is used for limiting movement of any gear, assembly, appliance or any of its part (also movement of cargo in the cargo handling appliance) by disconnecting the drive of this gear, assembly, appliance in extreme positions;

23 **Safety factor** is the ratio of the minimum breaking load to the safe working load;

24 **Crane** is a cargo handling appliance intended for lifting and handling the cargo by means of a gripping device without any blocks and ropes attached outside its own structure;

25 **Drum winch** is a winch provided with a drum for winding the ropes;

26 **Metal structures** include derricks, gauge heads, rigid guy ropes, slewing cargo platforms, posts, bridges, portals, foundations, supporting drums and other structures taking up loads on the cargo handling appliance;

27 **Machinery of a cargo handling appliance** includes cargo lifting, jib luffing, boom-out and slewing appliances;

28 **Fixed parts** include items attached permanently to the cargo handling appliance load-bearing structures or to the ship’s hull;

29 **Normal operation** is designed operating limits and conditions of the vessel, ship technical facilities, systems and their components including operation at all operating modes, bunkering, maintenance, repair and other activity as related to the above mentioned;

30 **Cargo turning moment limiter** is a device that automatically switches off the lifting of the cargo and luffing in case when the cargo which mass exceeds the determined one for this boom-out is being lifted (see 6.8.3);
.31 **Lifting capacity limiter** is a device that automatically switches off all the working movements of the cargo-handling appliance except cargo lowering and movements which lessen the tipping moment when the cargo of exceeding mass is lifted (see 6.8.4);  
.32 **Main steering drive** means mechanisms, power plants of the steering drive, if any, auxiliary equipment and means for torque transfer to the rudder pin or the steerable nozzle (for example, tiller or sector) for the purpose of the ship steering at normal operating conditions;  
.33 **Rudder blade width** is a width calculated as a mean of \( b_1 \) and \( b_2 \) as shown in Fig.1.2.33.

![Fig. 1.2.33. Calculation of a rudder blade width](image)

.34 **Deck machinery** means windlasses, capstans, winches, locks, tensioning stations, force and torque transfer means, limiters and other machinery which are the parts of steering, anchoring, mooring, towing, coupling, cargo devices, and also hoisting arrangements of the wheelhouse, masts etc;  
.35 **Floating crane** – see 2.2.43 Part 0 of the Rules;  
.36 **Design loads** are combinations of actual loads determined separately for working and non-working conditions of the cargo-handling appliance;  
.37 **Design load** \( P_p \) is a force due to action of the design torque;  
.38 **Design bending moment** \( M_p \) is a maximum bending moment due to external forces (including inertial ones), acting in a horizontal plane relatively to the vertical axis of the coupling passing on the line of intersection of the coupling joint plane with the centre line plane of the convoy;  
.39 **Luminous intensity** is a ratio of luminous flux to solid angle in which this flux is being spread;  
.40 **Launching (launching and recovery appliances)** are davits and other onboard arrangements intended for launching and recovering of life and rescue boats and liferafts;  
.41 **Ship’s derrick** is a crane installed on board dry cargo ship;  
.42 **Coupling equipment** means locks, tensioning stations, winches etc;  
.43 **Loose gear** includes items attached to a cargo-handling gear by means of loose joints. These are blocks, hooks, chains, shackles, swivels as well as accessories, such as lifting beams, frames and others;  
.44 **Pushed convoy** is a rigid or bendable single-thread convoy or a composite cargo motor vessel. Pushboat is a part of the pushed convoy. The term “bower anchors” is related to barges of the convoy, the term “stern anchors” is related to the pushboat;  
.45 **Rope** is a common term for twisted and twined cordage made of natural and artificial fibre materials as well as steel wire. The rope is a synonym for the term “line”;  
.46 **Angle backlash of the coupling arrangement** is a mutual turn angle of ships within the range of free clearances of connections while changing the direction of the turning moment;  
.47 **Lifting capacity indicator** is a device to indicate automatically and visually (no matter whether the cargo is suspended or not) the maximum allowable design load for a particular crane at different jib radii;  
.48 **Safety devices** are devices intended to provide safety operation of the cargo-handling machinery such as: working movements and lifting capacity limiters, hoisting capacity and boom angle indicators, dangerous voltage warning and wind shielding devices, anti-stealing devices, stops, buffers,
traps, speed limiters of lifts, safety devices on hooks and other similar devices;

**.49 Authorized crew person** is a member of the crew having an authority to perform functions related to operation of the ship, its components or ship’s technical facilities according to the applicable law of the Russian Federation.

1.2.2 Stresses mentioned in the present Part of the Rules are interpreted as equivalent stresses \( \sigma_{eq} \), MPa, calculated by formula 1.2.2.

\[
\sigma_{eq} = \sqrt{\sigma^2 + 3\tau^2},
\]

where \( \sigma \) — normal stresses in the section under consideration, MPa;

\( \tau \) — tangential stresses in section under consideration, MPa.

Strength conditions shall be checked by these stresses.

1.2.3 In the present part of the Rules, permissible stresses which shall be compared with the stresses calculated while checking the strength conditions of ship appliances and deck machinery components are established as portions of the yield point of used material; Here, unless otherwise established by the present part of the Rules, the yield point shall not be taken more than 0.7 of the tensile strength of the same material.

1.2.4 Requirements to ships of М-СII class apply also to ships of М-СII4,5 class, unless otherwise required by the present part of the Rules.

1.3 OPERATING CONDITIONS

1.3.1 Ship appliances, deck machinery and equipment shall be designed to maintain their serviceability at heel and trim values as specified in 1.3 Part IV of the Rules as well as at ambient air temperatures given in Table 1.3.1.

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<th>Table 1.3.1</th>
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<td>Ambient temperature (°C)</td>
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<tr>
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</tr>
<tr>
<td>Exposed decks</td>
<td>–20 to +40</td>
</tr>
</tbody>
</table>

1.4 MATERIALS

1.4.1 Elements of arrangements and outfit given in Table 1.4.1 shall be made of materials specified in the Materials column (Table 1.4.1) and comply with requirements of Part X of the Rules.

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<thead>
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<td>Material</td>
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<td>1.1 Steerable nozzle and rudder stocks</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>1.10 Drive shaft</td>
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</tr>
<tr>
<td>1.11 Pinions, gear-wheels, gear rings</td>
<td>Steel forgings, castings, cast iron</td>
</tr>
<tr>
<td>1.12 Fasteners (bolts, nuts)</td>
<td>Steel forgings</td>
</tr>
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</table>

2 Anchoring, mooring, coupling and towing devices

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<tr>
<th>Table 1.4.1</th>
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### End of Table 1.4.1

<table>
<thead>
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<tr>
<td>2.10 Fasteners (bolts, nuts)</td>
<td>Steel forgings</td>
<td>2.6</td>
</tr>
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</table>

### 3 Hydraulic drives

<table>
<thead>
<tr>
<th></th>
<th>Material</th>
<th>Chapters of Part X of the Rules</th>
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<tbody>
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<td>Steel forgings, castings, copper alloy</td>
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<tr>
<td>3.5 Pinions</td>
<td>Steel forgings, castings, cast iron, copper alloy</td>
<td>2.6, 2.7, 2.11 to 2.13, 3.1</td>
</tr>
</tbody>
</table>

### 1.5 STEEL WIREropes, Natural AND SYNTHETIC FIBRE ROPES

#### General requirements

1.5.1 Ropes shall be made and tested in accordance with national standards in organizations having the River Register's Recognition Certificate. Testing results shall be included into manufacturer's quality control document (see 1.2.1.2 Part X of the Rules).  

1.5.2 For running rigging the steel wire ropes with one organic core shall be used, the number of wires being not less than 114. Ropes with more than one organic core may be used subject to technical justification. It is recommended to use the ropes with the calculated tensile strength from 1275 to 1770 MPa with the diameter of wires in external strands of not less than 0.6 mm.  

For standing rigging steel wire ropes with one or more organic cores shall be used with the diameter of wires in external strands of not less than 1 mm, the number of wires being not less than 42. It is recommended to use the ropes with the calculated tensile strength from 1275 to 1670 MPa.  

The wires of running and standing rigging shall be provided with zinc coating.  

1.5.3 Wire splicing is not permitted.  

1.5.4 The ropes shall be marked in accordance with national standards.  

#### Steel wire ropes

1.5.5 For the manufacture of ropes wire of round cross-section shall be used with anti-corrosive coating and a tensile strength of 1180 to 1770 MPa.  

1.5.6 The organic fibre core of ropes shall be manila, sizal, hemp or synthetic fibre. Ropes with the nominal diameter exceeding 12 mm shall have at least three-strand core.  

1.5.7 The wires of a finished rope shall be covered with a lubricant.

---

1. GOST 30055, GOST 3069, GOST 3241.
Cores of organic fibre shall be impregnated or lubricated with anti-corrosive and anti-rot substances non-soluble in water and containing no acids or alkalis. The lubricant for the ropes and the impregnant for the organic-fibre cores shall be compatible by their physical and chemical properties.

1.5.8 After manufacture each rope shall undergo the breaking test throughout its length. The breaking test as a whole shall be performed on a tearing machine with the distance between the clamps not less than 50 rope diameters. If during testing the rope breaks less than 50 mm away from the clamp the test shall be repeated.

The test results shall comply with the requirements of GOST 3069 and GOST 3241.

1.5.9 If the breaking load cannot be reached due to insufficient power of the tearing machine during breaking tests for a rope as a whole the tensile strength may be determined based on tensile tests for all rope wires. In such a case, breaking strength of a rope as a whole is determined by the following formula:

\[
F = \sum_{i} \left[ \left( \sum_{m} F_m \right) \frac{n}{z} \right],
\]

where

- \( c \) — wire efficiency factor for the rope which is adopted on the basis of GOST 3069 and GOST 3241 or calculated as the ratio of the breaking load of the rope as a whole required by specified national standards to the total breaking load of all the rope wires;
- \( i \) — number of groups of wires of the same diameter;
- \( m \) — number of tensile tested wires from each group of a particular diameter, subjected to tensile testing with test results meeting requirements of GOST 3069 and GOST 3241;
- \( F_m \) — the maximum load preceding breaking of the specimen when performing tensile test of one wire, kN;
- \( n \) — number of wires in each group of a particular diameter;
- \( z \) — number of wires from each group of a particular diameter subjected to tensile testing.

1.5.10 The rope diameter shall not exceed the nominal value by more than 6%.

The rope diameter shall be measured on a slack rope perpendicular to its axis between two opposite strands in two positions.

1.5.11 Twisting and bending of strands, falling back, crossing, corrosion and breaking of wires in strands that prevent using the rope according to its intended purpose are not permitted.

When bends or burn-off spots are removed from the ends of non-spinning ropes the strands and wires therein shall not uncoil.

Ropes of natural and synthetic fibre

1.5.12 The breaking strength is determined during test for a rope as a whole or based on tensile tests of all fibres in the rope. In a latter case, breaking strength of a rope as a whole is determined by the following formula:

\[
F = c n \sum_{m} \frac{F_m}{z},
\]

where

- \( c \) is fibre efficiency factor for the rope which shall be adopted based on GOST 30055 or calculated as the ratio of the required by specified national standard breaking strength of the rope as a whole to the total breaking strength of all fibres in the rope;
- \( m \) — number of tensile tested fibers subjected to tensile testing with test results meeting requirements of GOST 30055;
- \( F_m \) — the maximum load preceding the destruction of the specimen at tensile testing of a single fibre, kN;
- \( n \) — number of fibres in the rope;
- \( z \) — number of fibres subjected to tensile testing which is taken to be equal to: 0.5\( n \) — for rope with circumference of up to 80 mm; 0.3\( n \) — for ropes with circumference from 80 to 115 mm; 0.1\( n \) — for ropes with circumference over 115 mm.

1.5.13 Ropes of synthetic fibre shall undergo testing to determine elongation at the breaking.

The percentage elongation of a rope at the breaking \( A, \% \), is determined by the formula:
\[ A = 100 \left( \frac{l_p - l_0}{l_0} \right), \]  
where \( l_0 \) — initial length of tested rope specimen, cm; 
\( l_p \) — length of the same rope specimen under the load equal to the breaking strength on the rope as a whole, which is specified in GOST 25552, cm.

1.5.14 On the surface of a finished rope no brown spots, mould, fused areas and smell of fume or rot shall be detectable.

The colour of the rope shall be uniform along its whole length and shall correspond to that of the yam or synthetic fibre of which the rope is manufactured.

1.6 REQUIREMENTS TO DECK MACHINERY

1.6.1 Construction and design of the deck machinery shall provide the ship’s operation under operating conditions specified in 1.3 Part IV of the Rules and in 1.3.1.

1.6.2 The deck machinery of oil tankers shall be located above dry compartments with gas-tight enclosures.

1.6.3 Elements of breaking devices of the deck machinery shall be resistant to water and oil products exposure. Brake pads shall be heat resistant up to the temperature 250°C. Permissible heat-resistance of connections between the brake pad and the supporting structure shall exceed the heating in the connection in all possible operating modes of the mechanism.

1.6.4 Fasteners of moving parts of mechanisms and devices, and also fasteners installed in hardly accessible places shall have fittings or be so designed as to prevent its spontaneous slackening and unravelling. Moving parts of the machinery shall be closed by protecting housings.

1.6.5 The structure and material of the deck machinery elements (locking devices, brake blocks etc.) installed in explosive spaces and areas (see 1.4 Part III of the Rules), shall preclude spark formation.

1.6.6 Rubbing assemblies of moving part of machinery and appliances shall be provided with lubrication devices. These devices shall be accessible and safe for maintenance during the operation of the machinery.

1.6.7 Safety and protective devices shall be so designed and installed so that in case of their actuation they are not hazardous both as regards fire and for the attending personnel.

1.6.8 Heating surfaces of the machinery with the risk of fire shall be fitted with fire-retardant insulation, or design measures shall be taken to prevent the ingress of fuel and oil on them.

Heat insulation shall be covered by metallic housing or fuel- and oil-proof composition.

1.6.9 Parts of machinery contacting with environment stimulating corrosion shall be manufactured of anti-corrosion material or protective corrosion-resistant coatings shall be applied to their surfaces.

Units and parts of mechanisms which are made of materials with different electric potentials and which may contact with aggressive media, shall be protected against electrolytic corrosion.

1.6.10 Machinery control devices, remote and automatic control systems shall meet the requirements of Part IV of the Rules.

1.6.11 Deck machinery control devices shall be so designed that lifting is executed by rightward rotation of the handwheel or by forward movement of the lever and lowering — by leftward rotation of the handwheel or backward movement of the lever.

Brakes shall be locked by rightward rotation of handwheels and unlocked by leftward rotation.

1.6.12 Machinery driven from a power source and manually driven shall be equipped with an interlocking device preventing simultaneous operation of the drives.

1.6.13 Hand forces required for movement of control levers and handwheels shall be set
depending on the frequency of application of manual drives.

If the control devices are being used for a short time, the hand force shall be not more than 160 N and the foot force – not more than 300 N. Force up to 490 N (for example, for the uncoupling device) is allowed as maximum valid for one-time force applied by one person in the vertical direction to the lever handles.

1.6.14 Winches shall provide the required nominal tractive force when the rope is positioned at the middle layer of coiling.

Their safety margin specified in these Rules shall be determined for the nominal tractive force for the rope position on the middle layer of coiling. In other cases, the safety margin shall be not less than as big as twice.

1.6.15 Manual-driven winches shall reach the nominal tractive force in the rope under action of the hand force of 160 N for each operator. When the hand force is as great as five and the rope is on the lower layer of coiling, the tractive force shall not exceed 85% breaking strength at the lowest layer of coiling.

1.6.16 The drums shall have ledges which shall be extended above the upper layer of coiling for not less than 2.5 times the rope diameter and not less than 1.5 the rope diameter above the last layer of coiled rope.

1.6.17 Hydraulic drives shall be protected by means of safety valves with the actuation pressure from 1.1 to 1.5 times the working pressure set by the manufacturer. Safety devices shall be so designed that their sealing is possible. The working fluid drained from the safety valve shall be directed to the suction pipeline or to the hydraulic reservoir.

1.6.18 The elements of hydraulic drives being under load shall be strength-checked for the application of forces corresponding to the working pressure, here, the equivalent stresses in the elements shall not exceed 0.4 of the yield point of the element.

1.6.19 Stresses in structural elements of the working cylinders induced by internal pressure shall not exceed 0.33 of the yield point of the material.

Safety margin at longitudinal bending shall be at least 5 at flexibility ratio above 60.

1.6.20 Devices for full deaeration shall be provided while hydraulic drive is being filled with the working fluid and also for its leakage replenishment and drainage.

The inner chamber of the hydraulic reservoir shall be open to atmosphere only through a filter (breather).

1.6.21 A level indicator of the lower and the upper level marks and a minimum level gauge shall be fitted on the hydraulic reservoir for the control of the working fluid level.

1.6.22 The hydraulic systems shall be provided with filters in order to remove resins and mechanical impurities from the working fluid.

It shall be possible to clean filters without stopping the working fluid circulation for permanently operating hydraulic systems providing the safe motion of a ship.

1.6.23 Suction and drainage pipelines of the main and standby pumps shall be located in the hydraulic reservoir so that the standby pump is capable to operate in the event of unintended drainage of the working fluid.

1.6.24 Drip trays shall be provided at places of possible leakage of the working fluid from the hydraulic equipment.

1.6.25 Hydraulic systems and pipelines shall meet requirements of 10.2 Part IV of the Rules.

1.6.26 After manufacture, elements of deck machinery and hydraulic drives shall be subject t hydraulic tests in accordance with 7.2.13 to 7.2.16 of RTSC.

1.7 EQUIPMENT NUMBER

1.7.1 Equipment number $N_{eq}$ is calculated by the following formula, $m^2$:

$$N_{eq} = L(B + H) + k \sum_{i=1}^{n} (l_i h_i), \quad (1.7.1-1)$$
where $L$, $B$, $H$ — design dimensions of the ship, m;
$k$ — coefficient assigned in accordance with 1.7.2 to 1.7.3;
$l$ — length of separate superstructures and deckhouses, m;
$h$ — average height of separate superstructures and deckhouses, m.

Equipment number of catamaran-type ships shall be determined by the following formula:

$$N_{eq} = 2L(B_{hull} + T) + (L + B_{ship})(H - T) + k \sum_{i=1}^{n} (l_i h_i),$$

(1.7.1-2)

where $B_{hull}$ — width of one hull body, m;
$B_{ship}$ — width of a ship, m;
$H$ — side depth, m;
$T$ — load draught, m.

1.7.2 Coefficient $k$ shall be assumed equal to 1.0 for ships with the total length of superstructures and deckhouses, located on all decks, exceeding a half of the ship’s length and 0.5 for ships with the total length being in the range of 0.25 to 0.5 of the ship’s length. The superstructures and deckhouses may be neglected for calculation of equipment number at the total length of the superstructures and deckhouses less than 0.25 of the ship’s length.

1.7.3 For hydrofoil craft, hovercraft and skimming ships the value of coefficient $k$ shall be assumed as less as twice comparing to those given in 1.7.2. Hydrofoils are neglected when determining the equipment number.

Note. For hydrofoil craft and hovercraft when there is no freeboard deck a superstructure is considered as a part of the ship above the lower edge of window cuttings.

1.7.4 For ships carrying cargoes on deck parameter $\sum_{i=1}^{n} (l_i h_i)$ in the formula (1.7.1-1) shall be calculated by multiplication of the side projection length of cargo stowed on the deck together with cargo limiting structures by its average height, and coefficient $k$ shall be assumed equal to 0.5 for ships intended for transportation of bulk cargoes only, and 1.0 for transportation of other deck cargoes.

1.7.5 In mud dredgers the towers, bucket frames and chutes secured for voyage shall be considered in the equipment number as deckhouses which side surface area is determined along the overall contour.
2 STEERING GEAR

2.1 GENERAL REQUIREMENTS

2.1.1 Requirements of the present Section of the Rules apply to steering gears with rudders (simple, balanced, semi-balanced), nozzles (turning, non-turning), and also to thrusters, steering means of pod drives, waterjet and vertical axis propellers.

2.1.2 All self-propelled ships shall be equipped with a steering gear. Non-self-propelled ships intended for towing by rope shall be equipped with fixed stabilizers.

Stabilizers may be omitted in floating objects and non-self-propelled ships intended for navigation only by pushing.

2.1.3 Steering gears shall provide manoeuvrability parameters as specified in Part II of the Rules.

2.1.4 In case of failure in main drive or main power source, the time of transition to the standby drive or the time of power supply pause shall not exceed 5 s.

2.2 RUDDER AND NOZZLE

2.2.1 The rudder blade and the nozzle shall be made of steel with carbon content not more than 0.22%.

Construction of the nozzle may be either welded or cast-welded. The carbon content in forgings and castings shall be not more than 0.25%.

2.2.2 The plate thickness of streamlined rudder blade casing $t$ shall be not less than determined by formula, mm.

$$t = s a \sqrt{\frac{p}{R_{eH}}} + \Delta s,$$

where $s = 32.6 - 7.56 \left( \frac{a}{b} \right)^2$;

$b$ — distance between horizontal stiffeners or vertical diaphragms, whichever is less, m;

$a$ — distance between horizontal stiffeners or vertical diaphragms, whichever is less, m;

$p$ — design pressure on a rudder blade plating, kPa, determined in accordance with 2.2.3;

$R_{eH}$ — the yield stress of the rudder plating material, in MPa.

$\Delta s = 0.6$ — corrosion allowance, mm.

2.2.3 Design pressure on a rudder blade plating, $p$, kPa, shall be taken equal to the greater value of pressures on the pressure ($p_{ps}$) and suction ($p_{ss}$) side of the rudder profile:

for a plating area falling into the propeller jet and located within 0.35 the rudder blade width from its leading edge

$$p_{ps} = 0.5 (1.706C_1 + 1.538) \rho V_A^2 + 9.81 T$$

$$p_{ss} = 0.5 (5.505C_1 + 0.939) \rho V_A^2$$

(2.2.3-1)

for a plating area falling into the propeller jet and located within 0.65 the rudder blade width from its trailing edge

$$p_{ps} = 0.5 (0.734C_1 + 0.662) \rho V_A^2 + 9.81 T$$

$$p_{ss} = 0.5 (2.369C_1 + 2.622) \rho V_A^2$$

(2.2.3-2)

for a plating area not falling into the propeller jet and located within 0.35 the rudder blade width from its leading edge

$$p_{ps} = 0.5 \rho V_A^2 + 9.81 T$$

$$p_{ss} = 2.5 \rho V_A^2$$

(2.2.3-3)

for a plating area not falling into the propeller jet and located within 0.65 the rudder blade width from its trailing edge

$$p_{ps} = 0.25 \rho V_A^2 + 9.81 T$$

$$p_{ss} = 1.25 \rho V_A^2$$

(2.2.3-4)
where \( C_T = 8 T_p \left( \frac{\rho V_A^2 \pi D^2}{2} \right) \) — propeller loading factor;

\( T_p \) — propeller thrust, kN;

\( \rho \) — water density, t/m\(^3\);

\( V_A = V (1 - W_f) \) — propulsion and steering system inflow velocity, m/s

\( V \) — design speed of a ship in loaded condition (for pushboats — together with the convoy), m/s;

\( W_f \) — wake factor for straight motion of the ship by calculation of propulsion ability;

\( D \) — propeller diameter, m;

\( T \) — ship draught, m.

Pressure \( p_{ss} \) shall not be taken to be more than 96.9 kPa.

Jet diameter is taken to be equal to propeller diameter.

2.2.4 In order to prevent resonance, natural oscillation frequencies of the first tone of the rudder plating plates shall exceed the propeller blade frequency which is the product of a number of propeller blades by shaft revolution frequency by at least 50%.

Natural oscillation frequencies of the first tone of the rudder plating plates shall be determined in accordance with requirements of 2.6.10 and 2.6.11 Part I of the Rules as for the plate washed by liquid from one side.

2.2.5 The edge plate thickness of the rudder blade and stabilizer shall be not less than 1.3 times the shell thickness determined according to 2.2.2.

2.2.6 The plate thickness of lamellar rudder blade casing \( t_{\text{lam}} \) shall be not less than determined by formula, mm:

\[
t_{\text{lam}} = k d_0 + 4, \quad (2.2.6)
\]

where \( k \) — factor taken equal for ships of classes:

- M-СП, М-ПР and М 0.080
- O and О-ПР 0.055
- P, Л 0.030

\( d_0 \) — rudder stock diameter, mm, determined according to 2.3.1 or 2.3.3 at \( R_eH = 260 \) MPa.

The least thickness of nozzle internal plating \( t_3 \) shall be not less than determined by formula, mm:

\[
t_3 = 1.25 t_1. \quad (2.2.7-2)
\]

2.2.8 Inner plating of the hollow nozzle in the middle part \( t_3 \) shall have a strengthened belt with thickness not less than determined by formula, mm:

\[
t_3 = 2 t_2. \quad (2.2.8)
\]

Plates of the strengthened belt are recommended to be made of stainless steel.

2.2.9 The plating thickness of streamlined rudder blade, hollow nozzle and its stabilizer shall be not less than shell plating thickness of the ship’s aft extremity.

2.2.10 The plating thickness of the rudder blade and the nozzle with stabilizer for ships with ice strengthening shall be increased by 20% as compared with that determined in accordance with 2.2.2, 2.2.3, 2.2.5 to 2.2.9.

2.2.11 The plating of the rudder blade and the stabilizer shall be strengthened from the inside by vertical stiffeners and horizontal diaphragms.

2.2.12 The nozzle plating shall be strengthened from the inside by longitudinal stiffeners and circular diaphragms.

At least four longitudinal diaphragms uniformly distributed along the circumference of the nozzle shall be provided.

2.2.13 Stiffener and diaphragm thickness shall be not less than plate thickness of streamlined rudder (stabilizer) or the nozzle shell plating.

2.2.14 Cut-outs shall be provided in stiffeners and diaphragms.
2.2.15 Plugs made of anti-corrosion material shall be provided in the rudder blade edge plates, in the lowermost and the uppermost points of the nozzle.

2.2.16 The rudder blade and the nozzle shall not protrude beyond the ship overall dimensions. When it is impracticable, protective arrangements shall be provided (housings, crinolines).

2.2.17 The rudder and the nozzle shall be so located as to prevent their damage due to stroke on ground when ship sails with the maximum design stern trim.

Note. The rudder and the nozzle intended for work on shallow water are to be designed with the lower support.

2.2.18 The plating thickness of fixed stabilizer installed instead of the rudder shall be determined in accordance with the requirements of 2.2.2, 2.2.3, 2.2.5, 2.2.9, 2.2.10. The design of fixed stabilizer shall meet the requirements of 2.2.11 to 2.2.14, 2.2.16.

2.3 RUDDER STOCK AND RUDDERPIECE

2.3.1 The diameter of the rudder stock and the nozzle in the area of lower supporting bearing shall be proved by the calculation carried out in accordance with requirements of the present Section. Hydrodynamic loads, bending moments, shear forces and support reaction forces acting in the stock-rudder system are to be calculated in accordance with Appendix 1.

2.3.2 The full ahead speed shall be taken as the design speed: for self-propelled ships — not less than 3.5 m/s, and for non-self-propelled ships — not less than 3.0 m/s.

The design astern speed shall be taken not less than 60% of the design ahead speed.

2.3.3 If there are no hydrodynamic calculations, the rudder stock diameter in the area of lower supporting bearing shall be not less than determined by formulas, mm:

for suspended rudder (Fig. 2.3.3-1)

\[ d_0' = 46.2 \cdot \sqrt[3]{k_2 M_{\text{torque}}^2 + M_b^2 / \left(9.81 \cdot 10^{-3} R_{\text{eh}}\right)} \]  

(2.3.3-1)

for rudder with lower support on sternframe heel (Fig. 2.3.3-2)

\[ d_0'' = 46.2 \cdot \sqrt[3]{k_2 M_{\text{torque}} / \left(9.81 \cdot 10^{-3} R_{\text{eh}}\right)} \]  

(2.3.3-2)

for rudder with pins on sternframe hinges

\[ d_0''' = 46.2 \cdot \sqrt[3]{k_2 M_{\text{torque}} / \left(9.81 \cdot 10^{-3} R_{\text{eh}}\right)} \]  

(2.3.3-3)

where \( k_2 \) — safety factor of the rudder stock material taken equal for ships of classes: M-ПР, О-ПР, М and О 2.5
2.3.4 Minimum permissible external diameter of hollow rudder stock, mm, is determined by the formula:

\[ d_{\text{outer}} = \alpha d_0, \]  

(2.3.4)

where \( \alpha \) — coefficient taken from Table 2.3.4 depending on the set ratio of the rudder stock wall thickness to the external diameter \((\delta/d_{\text{outer}})\).

**Table 2.3.4**

<table>
<thead>
<tr>
<th>( \delta/d_{\text{outer}} )</th>
<th>( \alpha )</th>
<th>( \delta/d_{\text{outer}} )</th>
<th>( \alpha )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
<td>1.00</td>
<td>0.15</td>
<td>1.10</td>
</tr>
<tr>
<td>0.25</td>
<td>1.02</td>
<td>0.10</td>
<td>1.20</td>
</tr>
<tr>
<td>0.20</td>
<td>1.05</td>
<td>0.08</td>
<td>1.26</td>
</tr>
</tbody>
</table>

\( d_0 \) — rudder stock diameter determined according to 2.3.1 or 2.3.3, mm.

2.3.5 Permissible stresses shall be taken according to Table 2.3.5 while calculating the steering gear element dimensions.

**Table 2.3.5**

<table>
<thead>
<tr>
<th>Kind of stressed state</th>
<th>Permissible stress in portions of the material yield point ( R_{\text{yH}} ) for ships of classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-HP, O-HP, M and O</td>
<td>0.30</td>
</tr>
<tr>
<td>P and J</td>
<td>0.40</td>
</tr>
<tr>
<td>M-HP</td>
<td>0.55</td>
</tr>
<tr>
<td>O-HP</td>
<td>0.40</td>
</tr>
<tr>
<td>M</td>
<td>0.60</td>
</tr>
<tr>
<td>P</td>
<td>0.75</td>
</tr>
<tr>
<td>and J</td>
<td>0.80</td>
</tr>
<tr>
<td>M</td>
<td>0.60</td>
</tr>
</tbody>
</table>

2.3.6 The rudder stock strength shall be checked for maximum forces induced by steering machines in case of rudder or nozzle seizure.

In this case, the design stresses shall not exceed \( 0.8R_{\text{yH}} \) or \( 0.6R_m \), where \( R_m \) is tensile strength of rudder stock material.

2.3.7 For ships intended for navigation in broken ice the diameters of the rudder stock design cross-sections calculated in accordance with 2.3.1 and 2.3.3 shall be increased by 15%.

2.3.8 Rudder stocks and rudder pieces may be forged or welded.
Cast-welded and cast-forged constructions are permissible, with the diameter of cast part of the rudder stock being increased by 15% as compared with the design diameter of forged rudder stock.

For ships less than 25 m in length the rudder stocks and rudder pieces may be made of rolled steel.

2.3.9 The rudder piece cross-section area in the upper part shall be equal to the rudder stock cross-section area. The rudder piece cross-section area below the upper edge of the rudder blade may be smoothly reduced down to 50% of cross-section area in the upper part.

Connection of the rudder stock with the rudder blade or steerable nozzle shall be equal in strength to the rudder stock.

2.3.10 Streamlined hollow rudders may have no rudder piece.

In this case the constructions substituting the rudder piece are continuous vertical diaphragms of the rudder blade with adjacent plating of rectangular or tubular cross-section as shown in Fig. 2.3.10.

\[ F = 0.3d^2 \]

where \( d \) — rudder stock diameter determined according to 2.3.1 or 2.3.3, mm.

2.3.11 The rudder blade or steerable nozzle with the rudder stock shall be connected by means of a horizontal flange or other structure (conic, stirrup etc.) which ensures the required connection properties.

For ships with a length of 10 m and less with manual steering drive the connection of the rudder stock with the rudder blade may be welded.

2.3.12 Connecting bolts (studs) shall be tightly fitted. The number of tightly fitted bolts shall be at least two for keyed joints. Minimum permissible total cross-section area or all bolts is determined by the formula, mm²:

\[ F_d = 0.3d_o^2 \]

2.3.13 Fastening joints of the rudder stock and the rudder blade or steerable nozzle shall be reliably locked to prevent spontaneous unscrewing.

2.3.14 The distance from the edge of bolt hole to the outer edge of connecting flange shall be not less than 0.65\( d_o \), where \( d_o \) is the bolt diameter.

2.3.15 Flange thickness shall be not less than the connecting bolt diameter.

2.3.16 A radius of the fillet at the junction of the rudder stock with the flange shall be not less than 0.12\( d_o \) (\( d_o \) — see 2.3.12).
For conic connection of the rudder stock with the rudder blade or the nozzle the length of cone shall be not less than 1.5 the rudder stock diameter, and the conicity – not more than 1:10. The conic part of the rudder stock shall change into the cylindrical part without a shoulder.

A key shall be placed in the conic connection which dimensions shall be calculated for the case of maximum hydrodynamic torque transfer acting on the rudder stock or steerable nozzle. The key slot shall have skishaped exits.

Plain bearings or rolling bearings may serve as the rudder stock supports.

Plain bearing sleeve height \( h_{\text{bush}} \), mm, shall be determined by the formula:

\[
h_{\text{bush}} = 1000B_H/(pd_1),
\]

(2.3.19)

where \( B_H \) — assumed reaction of the rudder stock support while calculating the rudder stock – rudder piece bar for bending determined according to 2.3.20, kN;

\( p \) — permissible contact pressure for bearing materials taken from Table 2.3.19, MPa;

\( d_1 \) — diameter of the rudder stock in the support (including facing, if any), mm.

In any case, the rudder stock bearing sleeve supporting surface height shall be not less than 0.8\( d_1 \).

Minimum assumed design reaction from the rudder stock side shall be determined by the formula, kN:

\[
B_{\text{low}} = R \left( 0.5I_{10} + I_{30} + I_{40} \right)/I_{40} ;
\]

(2.3.20-1)

for the rudder with lower support

\[
B_{\text{low}} = 0.549 R .
\]

(2.3.20-2)

Here \( R, I_{10}, I_{30}, I_{40} \) shall be taken in accordance with 2.3.3.

Standard rolling bearings may be used for the rudder stock supports provided their reliable lubrication and protection against water.

The rudder stock sealings shall be designed to prevent leakage of lubricants from supporting units of bearings.

Measures shall be taken to prevent leakage of lubricants from supporting units of bearings.

The helmport tube shall be so designed as to prevent the ingress of sea water into the ship’s hull.

Glands situated above the load waterline shall be accessible for inspection and service afloat.

The elements of the helmport tube subject to loads of rudder stock or steerable nozzle shall be sized so that the occurring stresses do not exceed 0.35 \( R_eH \).

The height of bosses of easily put-on quadrants and auxiliary tillers shall be not less than 0.8 times the diameter of the rudder stock head.

The boss external diameter shall be not less than 1.6 times the diameter of the rudder stock head.

Split bosses shall be fixed from both sides with at least two bolts and have two keys. The keys shall be arranged at the angle of 90° to the jointing plane.

Connection of the steering machine or transmission gear with parts attached to the rudder stock shall be such as to prevent damage of the steering drive at axial displacement of the rudder stock by not more than 0.1 times the rudder stock diameter.

Lower journal of rudder stock for ships of M-CTI class shall be protected with
lining coating made of stainless steel, copper alloys or other method of corrosion protection.

Keyed taper connection of rudder stock with rudder blade or steerable nozzle shall be protected from corrosion.

2.4 STEERING DRIVES

Steering devices available with steering drives

2.4.1 The ship steering gear shall be fitted with two drives: main drive and standby drive.

2.4.2 A standby drive may be omitted in ships with several rudders or nozzles driven by separately controlled machines.

2.4.3 Main and standby steering drives shall be so arranged that any one of them can work despite the damage of the other. It is allowed to have common parts of a power drive to the rudder stock (tiller, quadrant, cylinder block).

2.4.4 The main steering drive control system shall be independent of the standby steering drive control system. It is allowed to have common steering wheel or control handle.

2.4.5 The main and standby drives may be manually controlled. In this cases, requirements of 2.4.14 to 2.4.17 shall be met. In all other cases the steering drive shall be driven from the power source.

2.4.6 The standby steering drive shall provide the rudder or steerable nozzle being put over to the same maximum angle as the main steering drive.

2.4.7 Rope for steering line pilotage shall be flexible, galvanized, cross-twisted and unravelling.

2.4.8 Main and standby steering drive control stations shall be fitted with rudder (steerable nozzle) position indicators.

2.4.9 If main and standby drives are hydraulic, each of them shall have a pump with independent motor and the drive pipelines shall be laid apart as far as practicable.

2.4.10 If main and standby drives are electric, their supply and control systems shall be independent of each other. Each of these two drives shall have its own electric motor.

Drive power

2.4.11 The power of the main steering drive shall be sufficient to put the rudder stock (steerable nozzles) over to the angle from 35° of either side to 35° of the other side in not longer than 30 s at maximum speed with the ship running ahead and the draught corresponding to the load waterline.

2.4.12 The power of the standby steering drive shall be sufficient to put the rudder stock (steerable nozzles) over to the angle from 20° of either side to 20° of the other side in not longer than 60 s at ahead speed equal to 0.6 times the maximum one and the draught corresponding to the load waterline.

2.4.13 Steering drive motors shall allow an overload by torque equal to 1.5 times the design torque for 1 min.

Manual and standby steering drives

2.4.14 The main manual steering drive shall be of self-braking design or be fitted with an automatic brake.

The main manual steering drive shall provide the requirements of 2.4.11 when being operated by one person who produces a force on the steering wheel handle not more than 120 N with not more than 25 revolutions per one wheel turn.

2.4.15 The main manual steering drive shall be of self-braking design or be fitted with an automatic locking device.

The standby manual steering drive shall comply with the requirements of 2.4.12 when operating with a force on the handle not more than 160 N per each operator with not more than 25 revolutions per one wheel turn.

2.4.16 The standby steering drive shall be independent of the main steering drive and shall act directly on the rudder stock if possible.
2.4.17 The steering wheels of the main and standby manual non-self-braking drives shall have external rims.

**Mechanical steering drives with remote control**

2.4.18 Chain cables, pull rods and galvanized steel ropes which are included in the steering line convoy pilotage shall be fitted with devices for taking slake of a rope; moreover, tightening springs shall be fitted on each side in the steering line pilotage.

2.4.19 Rudder indicators (supports, transmissions, joints, couplings) shall be designed so as to prevent seizure or damage of their parts due to the hull deformation because of cargo movement or waves.

2.4.20 Transmissions of mechanical steering gears of oil tankers intended for transportation, pumping and storage of liquids with a flash point of 60 °C and below shall be led above the deck in chutes or ducts. Construction of rubbing units and parts of these drives shall prevent spark formation.

**Hydraulic steering drives**

2.4.21 Hydraulic systems of main and standby steering drives and their pump units shall be independent of each other. When the pump of the standby steering drive is operated by an auxiliary motor which is not continuously in operation, the operation of this pump shall be provided by a buffer system during the motor start.

2.4.22 Main and standby steering drive systems may have common parts, as a rule, cylinders provided that such systems may operate independently of each other. Each hydraulic steering system shall be provided with a separate hydraulic tank equipped with low oil level indicator and alarm in accordance with 1.6.21.

2.4.23 Hydraulic steering systems shall not be connected with other hydraulic systems.

Flexible hoses shall be used if required for dampening of vibrations and providing for free motion of the hydraulic system components. In this case flexible hoses shall comply with requirements of 10.2.22 Part IV of the Rules and be designed for pressure at least 1.5 of the working pressure.

2.4.24 Connection of the started pump and its switch-off without any valve reversal shall be provided in the hydraulic drive of the steering device.

**Protection against overload and reverse rotation**

2.4.25 The manual steering drive may be fitted with buffer springs instead of overload protection devices.

When the manual steering drive is used as a standby drive, overload protection need not be fitted.

2.4.26 In ships of M-CP1, M-PIP, M, O-PIP and O class shock absorbers rated for at least twice nominal load shall be included in all steering drives other than hydraulic ones.

2.4.27 Hydraulic steering drives shall be equipped with overload protection devices. The safety valves specified in 1.6.17 may be used as overload protection devices.

2.4.28 Pumps of hydraulic steering machines shall be fitted with either protection devices preventing the reverse rotation of switched-off pump or automatically operating device preventing the liquid flow through the switched-off pump.

**Braking device**

2.4.29 The steering gear shall be fitted with a brake or other device providing the rudder (steerable nozzle) confinement in place in any position under the action of torque from the rudder side not taking into account the friction in the rudder stock bearings.

2.4.30 A special braking device may be omitted for hydraulic steering drives if their pistons or blades may be locked by closing of oil line valves.

**Limit switches, rudder limiters, rudder (steerable nozzle) position indicators**

2.4.31 Each mechanical steering drive shall be fitted with a device (limit switch) stopping
its operation before the rudder reaches the rudder turn limiters. Limit switches shall be adjusted for putting the rudder over to an angle not less than 35° and for rotating the steerable nozzle to an angle not less than 30°.

2.4.32 Steering gears shall be fitted with rudder and steerable nozzle turn limiters. The limiters shall provide for putting the rudder over and rotating the steerable nozzle to an angle greater by 1.5° than the angle to which the limit switches are adjusted.

2.4.33 All parts of limiters including those which are parts of the steering drive, shall be designed for forces corresponding to the maximum back moment determined by the formula, kN-m:

\[ M_{\text{max}} = 1.132 \cdot 10^{-7} d_{\text{rad}}^3 R_{\text{st}}, \]

(2.4.33)

where \( d_{\text{rad}} \) — rudder stock diameter in the least cross-section, m;

\( R_{\text{st}} \) — yield point of the rudder stock material, MPa.

Stresses in the limiter parts shall not exceed 0.95 times the yield point of the material.

2.4.34 In ships of M-СП, M-ПП, M, O-ПП and O class a fixing device shall be installed to prevent spontaneous turning of the rudder and steerable nozzle disconnected from the steering machine.

2.4.35 Steering machinery shall be fitted with remote indicators of the rudder position. The scale for the determination of actual rudder position with scale factor not more than 1° shall be fitted on the steering drive quadrant, on parallels of the hydraulic steering machine or on parts rigidly connected with the rudder stock.

2.4.36 Strength of parts of main and standby steering drives being under load shall be checked when subject to forces corresponding to the design torque. Stresses in the parts shall not exceed 0.4 of tensile strength of the part material (\( R_{\text{ut}} \)).

2.4.37 Stresses in parts common for main and standby steering drives (tiller, quadrant, reduction gear) shall not exceed 0.8 times the stresses allowed by 2.4.36.

2.4.38 Parts of steering drives which are not protected against overload by safety devices provided in 2.4.25 to 2.4.28 shall have the strength indices not less than the rudder stock strength indices.

2.4.39 In case stipulated in 2.4.27 the strength of the parts shall be checked when the forces corresponding to the safety valve opening pressure are applied; in this case equivalent stresses in the parts shall not exceed 0.95 times the yield point of the part material.

2.5 THRUSTER

2.5.1 Passenger and self-propelled cargo ships with the lateral area on the centreline exceeding 800 m² shall be equipped with thrusters.

Note. The lateral area of the ship includes lateral areas of the hull above and below the waterline, as well as of deck cargo.

Specific thrust of a thruster of passenger and self-propelled cargo ships shall be not less than specified in accordance with 6.9.3 Part III of the Rules.

2.5.2 The thruster shall be so located as to produce thrust in all possible cases of the ship loading.

2.5.3 Thruster compartments shall be watertight.

2.5.4 Thrust direction indicator shall be fitted on the thruster control panel.

2.6 CONTROL OF THRUSTERS, WATER-JET AND VERTICAL AXIS PROPELLERS

2.6.1 The independent main and standby drives shall be provided for the device which adjusts the direction of thrust of thrusters, water-jet propellers, vertical axis propellers and bowthrusters with electric, hydraulic or pneumatic remote control. These drives shall comply with requirements of 2.1 and 2.4.14 to 2.4.17.
2.6.2 The requirement 2.6.1 is not applicable if pod drives, propulsors, thrusters are not required to ensure turning capacity, directional stability and manoeuvrability with propellers not in operation and under wind conditions in accordance with requirements of Part II of the Rules. The requirement 2.6.1 is also not applicable if pod drives, propulsors, thrusters are required along with the main function to ensure manoeuvrability parameter only — stopway in case of an emergency stop of the ship.

2.6.3 In case of failure of the main drive of the thrust direction adjustment system (steering control) of the thruster the duration of switch to the standby drive shall not exceed 5 seconds.

If the ship is fitted with two or more thrusters, the standby drive is not required.

2.6.4 If the ship is fitted with two or more fully steerable thrusters, then a separate control is to be provided for each thruster. If the ship is fitted with two or more thrusters with limited angle of rotation, then it is allowed to use both separate and joint control of the thrusters.
3 ANCHOR ARRANGEMENT

3.1 GENERAL REQUIREMENTS

3.1.1 The present Section of the Rules covers standards of anchor equipment and anchor chain cables, as well as requirements to the machinery and elements of anchor arrangements.

3.1.2 Every ship other than mentioned in 3.1.3 shall be equipped with an anchor arrangement for holding the ship at the place when she is anchored.

3.1.3 Floating objects, as well as pushed non-self-propelled ships of P and J class may not be fitted with an anchor arrangement provided that the holding power (see 3.1.4 and 3.3.6) of tugboat/pusher's anchor arrangement is provided as specified in 1.4.2, Appendix 8 of RTSC, and provided that a shipowner follows the requirements specified for anchoring of convoys and safety of mooring at berthing facilities and on outer roads.

3.1.4 Holding power \( T_{\text{hold}} \), N, of the mooring pontoon used for anchoring of convoys or individual barges (sections) on outer roads shall be determined by the following formula:

\[
T_{\text{hold}} = 3.5g \sum m_{\text{anch}},
\]

(3.1.4)

where \( g \) — acceleration due to gravity, \( \text{m/s}^2 \);

\( \sum m_{\text{anch}}, \text{kg} \), — total mass of bower anchors of the greatest pushed convoy calculated by formula (3.3.2).

3.1.5 Anchor equipment of floating docks, floating cranes, oil-transfer stations shall be substantiated in a ship design depending on nature and features of her service.

The required conditions (depth, flow speed, wind speed), at which anchoring of any of the above ship types shall be provided, are assigned by the design specification.

3.1.6 The requirements of the present Section, unless otherwise stated, apply to Hall's anchors (GOST 761) which are normal holding power anchors.

When using Matrosov anchors (GOST 8497) their weight shall be taken equal to a half of the weight calculated in accordance with GOST 25496.

When increased holding power anchors (GOST 25496) their weight shall be taken equal in accordance with GOST 25496.

Sizes of chains are determined in accordance with 3.2.8 to 3.2.9 for a weight of an anchor calculated in accordance with 3.2.1.

3.1.7 Cable chain lockers of oil tankers (when located in explosive spaces and areas) shall be gas-tight and be fitted with arrangements for water filling.

3.2 ANCHOR, ANCHOR CHAIN

AND WIRE ROPE OUTFIT

3.2.1 Total weight of bow anchors \( \Sigma m_{\text{anch}} \) with normal holding power (see 3.1.6) for self-propelled, non-self-propelled and towing displacement ships shall be determined by the following formula:

\[
\Sigma m_{\text{anch}} = k_1k_2N_{\text{eq}},
\]

(3.2.1)

where \( N_{\text{eq}}, \text{m}^2 \), — equipment number (see 1.7);

\( k_1 \) — coefficient which accounts for forces acting on the ship when anchored to be taken based on data or determined by formulas given in Table 3.2.1-1.

\( k_2 \) — coefficient which accounts for requirements to anchor equipment due to water basin category to be taken based on data or determined by formulas given in Table 3.2.1-2.

The calculated values of \( \Sigma m_{\text{anch}} \) are rounded to the nearest greater value of weight \( M_{\text{anch}} \) for industry manufactured anchor of dimension-type series regulated by national standards\(^1\).

\(^1\) GOST 761, GOST 25496.
The calculated values of $m_{anch}$ are rounded to the nearest greater value of weight $M_{anch}$ for industrial anchor of dimension-type series regulated by GOST 8497.

### 3.2.3 Dredgers may be fitted with one bowing anchor of a weight equal to at least one half of a total weight determined in accordance with 3.2.1. On self-propelled dredgers anchor arrangement shall be fitted in the bow end and on non-self-propelled dredgers - in the extremity which is opposite to that where the main dredger working arrangement is fitted (dredging pipe, bailer frame etc.).

### 3.2.4 Stern anchor arrangements of ships other than tug-and-pushboats (see 3.2.5) and self-propelled ships (see 3.2.6) are installed at shipowners' option.

Where bower anchor arrangement cannot be located in ships with a length less than 25 m other than tug-and-pushboats, such
ships may be fitted with aft anchor arrangement only.

3.2.5 In tug-and-push boats fitted with the bow anchor arrangement according to standards for common towing vessels (see 3.2.1), aft anchor arrangement shall be also provided (see 3.3).

3.2.6 Self-propelled ships with equipment number of 1000 m² (see 1.7) and over shall be fitted with the stern anchor arrangement in addition to the bower anchor arrangement, when:

1. navigation area of those ships includes areas without current or with a low current rate. Weight of the aft anchor for such ships shall be not less than 0.25 of total mass of bow anchors;

2. navigation area of those ships includes numerous fairway sections which do not allow the ship for turning to come to bow anchors against the current due to its width. The stern anchor weight in this case shall be at least 0.4 of the total weight of bow anchors;

3. ship is of Ì-ÑÏ class. The stern anchor weight of such a ship shall be at least 0.25 of the total weight of bow anchors.

3.2.7 Weight of each of two installed bow anchors shall be equal to a half of a total weight of bow anchors

3.2.8 Length $L_{anch}$ of the anchor chain of one bow anchor is determined as follows;

1. The approximate total length of bow anchor chains is calculated by the following formula:

$$L_{anch} = \alpha \left[ b + c \ln \left( \frac{N_c}{N} \right) \right],$$

where $k$ — coefficient equal to:

1.25 for ships of M class;

1 for ships of other classes;

$b$ and $c$ — coefficients to be taken from Table 3.2.8.

2. Obtained value $L_{anch}$ shall be rounded for ships equipped with two bow anchors (see 3.2.1) to the nearest greater value $L_{anch}$, multiple of shot length (25 m), and for ships equipped with one bow anchor to the nearest value $L_{anch}$, from the range of 25, 30, 40, 50, 60 and 75 m.

For ships of M-ΠP and O-ΠP class with equipment number of 1000 m² and over except tugboats, the total length of anchor chains shall be increased by one shot length;

3. If total length of anchor chains of two bow anchors is characterized with odd number of shots, then chain length of one bow anchor $L_{anch}$ is taken equal to one half of $L_{anch}$.

If total length of anchor chains of two bow anchors is characterized with odd number of shots, then length of one of chains shall be taken one shot more and connected to a heavier anchor if anchors are different in weight.

The anchor chain cable length for self-propelled ships equipped with stern anchor arrangement in addition to bow anchor arrangement shall be at least 75% of the shorter chain length of the bow anchors.

3.2.9 Anchor chain diameter shall be determined as follows;

1. The approximate value $k_{str}$ of anchor chain diameter is calculated:

$$k_{str} = c + d M_{anch} + e M_{anch}^2 + f M_{anch}^{1.5},$$

(3.2.9.1-1)

where $M_{anch}$ — weight of an anchor to be fitted on the ship (see 3.2.1), for which the anchor chain is intended, kg;

<table>
<thead>
<tr>
<th>Type of a ship</th>
<th>Class of a ship</th>
<th>$b \cdot 10^2$</th>
<th>$c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-propelled</td>
<td>M-ΠP, M-ΠP, M</td>
<td>0.275</td>
<td>0.172</td>
</tr>
<tr>
<td></td>
<td>O-ΠP, O</td>
<td>0.364</td>
<td>0.229</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.566</td>
<td>0.263</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>0.670</td>
<td>0.329</td>
</tr>
<tr>
<td>Non-self-propelled</td>
<td>M-ΠP, M-ΠP, M</td>
<td>0.305</td>
<td>0.172</td>
</tr>
<tr>
<td></td>
<td>O-ΠP, O</td>
<td>0.417</td>
<td>0.233</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.719</td>
<td>0.250</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>0.915</td>
<td>0.280</td>
</tr>
<tr>
<td>Tugboat</td>
<td>M-ΠP, M-ΠP, M</td>
<td>0.240</td>
<td>0.180</td>
</tr>
<tr>
<td></td>
<td>O-ΠP, O</td>
<td>0.303</td>
<td>0.231</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.599</td>
<td>0.205</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>0.779</td>
<td>0.263</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of a ship</th>
<th>Class of a ship</th>
<th>$b \cdot 10^2$</th>
<th>$c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-propelled</td>
<td>M-ΠP, M-ΠP, M</td>
<td>0.275</td>
<td>0.172</td>
</tr>
<tr>
<td></td>
<td>O-ΠP, O</td>
<td>0.364</td>
<td>0.229</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.566</td>
<td>0.263</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>0.670</td>
<td>0.329</td>
</tr>
<tr>
<td>Non-self-propelled</td>
<td>M-ΠP, M-ΠP, M</td>
<td>0.305</td>
<td>0.172</td>
</tr>
<tr>
<td></td>
<td>O-ΠP, O</td>
<td>0.417</td>
<td>0.233</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.719</td>
<td>0.250</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>0.915</td>
<td>0.280</td>
</tr>
<tr>
<td>Tugboat</td>
<td>M-ΠP, M-ΠP, M</td>
<td>0.240</td>
<td>0.180</td>
</tr>
<tr>
<td></td>
<td>O-ΠP, O</td>
<td>0.303</td>
<td>0.231</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>0.599</td>
<td>0.205</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>0.779</td>
<td>0.263</td>
</tr>
</tbody>
</table>
coefficients to be taken from Table 3.2.9.1 for stud link anchor chains;

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Value of coefficient for ships of class</th>
<th>for the chain strength category</th>
<th>1</th>
<th>2</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>c</td>
<td>17.890</td>
<td>M-СП, M-ПР, М, О-ПР, О, П and Λ</td>
<td>12.529</td>
<td>12.455</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>0.0196</td>
<td></td>
<td>0.0226</td>
<td>0.0168</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e \times 10^6</td>
<td>-2.541</td>
<td></td>
<td>-3.627</td>
<td>-2.219</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f</td>
<td>-1560.571</td>
<td></td>
<td>-1884.867</td>
<td>-99.875</td>
<td>-1101.673</td>
<td></td>
</tr>
</tbody>
</table>

for studless anchor chains, mm,

\[ k_{str} = a_1 + b_1 \frac{M_{anch}}{f(M_{anch})}, \]  
(3.2.9.1-2)

for ships of П and Λ class \( a_1 = 5.071, \) \( b_1 = 0.234 \) shall be taken, for ships of М-СП, М-ПР, О-ПР, М and О: \( a_1 = 6.197, \) \( b_1 = 0.253; \)

.2 The approximate values of anchor chain diameter shall be rounded to the nearest value from dimension-type range of diameters regulated by GOST 228.

The anchor chain diameter for ships of М-СП 4.5 class when a weight of an anchor is 2500 kg and less shall be set according to Table 3.2.9.1 similarly to ships of М-СП class. For the larger weight of anchor, stud link chains of strength category 2, with diameter of 46, 48, 50 and 52 shall be used when anchor weight is 2700, 3000, 3300 and 3600 kg, correspondingly.

3.2.10 When using cast chain cables instead of welded ones, their diameter may be reduced by 12%.

3.2.11 Using of steel, synthetic or hemp ropes instead of chains except for dynamically supported craft, where chain cables can be replaced with steel wire ropes, is allowed in ships of О and М class only for stern anchors and in ships of О class less than 25 m in length and ships of Λ and П class — for bow anchors provided that the following conditions are met:

.1 chain cable diameter to be replaced by a steel or synthetic rope shall be not over than 22 mm, and a chain cable diameter to be replaced by a hemp rope — not over than 14 mm;

.2 ropes shall be flexible and of the same strength as the chain cable of the required diameter, their length shall be at least 20% greater than that of the anchor chain to be replaced;

.3 steel wire ropes shall be galvanized and hemp ropes shall be tarred;

.4 the rope shall be connected to the anchor by means of a chain cable section of the same strength as the rope and of a length sufficient for securing the anchor for voyage by means of chain stopper. The chain cable section is not required, if a design of the anchor arrangement provides other stopper device for securing the raised anchor.

3.2.12 In tug-and-push boats with capacity up to 590 kW inclusive equipped with towing winches, anchor chain cables may be replaced with steel wire ropes in the stern anchor arrangement.

On non-self-propelled industrial ships of all classes equipped with bower winches which ensure rope slippage at loose drum anchor, chain cables of a diameter up to 31 mm may be replaced with steel wire ropes. In both cases the requirements of 3.2.11.2 and 3.2.11.4 shall be met.

3.2.13 For ships with equipment number of 1000 m² and over engaged on coastal navigation of the Kara Sea, weight of anchors determined in accordance with 3.2.1 shall be increased by 20% and length of anchor chain cables determined in accordance with 3.2.8 — by 25%.

3.2.14 Anchor equipment of О class ships navigating in Obskaya Guba up to the Novy Port shall be determined according to 3.2.1 for ships of М class.

3.2.15 For ships of О class navigating on estuaries of the biggest rivers (the Amur, the Enisey) the length of anchor chain cables shall be increased as compared to that determined according to 3.2.8 by at least one shot.

3.2.16 For ships of П class intended for navigation in basins with the current velocity
of 6 to 9 km/h, the total weight of anchors shall be increased by 25% as compared to that determined according to 3.2.1, and with the current velocity over 9 km/h — by 55%. Here, total length of anchor chains for ships with the equipment number of 500 m² and over shall be increased by one shot.

3.2.17 For ships of Ï class intended for navigation in basins with the current velocity of 6 to 9 km/h, the total weight of anchors shall be increased by 15% as compared to that determined according to 3.2.1, and with the current velocity over 9 km/h — by 45%. Here, total length of anchor chains for ships with the equipment number of 500 m² and over shall be increased by one shot.

For all ships of Ï class being operated on river channels and reaches with the current velocity up to 2 km/h, the weight of anchors may be assigned by rounding the calculated weight \( m_{anch} \) to the nearest value from dimension-type range regulated by national standards\(^1\), here, the length of anchor chain may not exceed 25 m.

For self-propelled ships of Ï class with the equipment number of 450 m² and less, navigating on river channels and reaches with the current velocity up to 2 km/h, there may be provided one bow anchor the weight of which shall be not less than 0.5 of the calculated weight of two anchors.

The anchor weight may be similarly reduced in ships operating on ferries or permanently engaged on carriages within a port or jetty water areas related to P and Ï categories in a distance of not more than 5 km from the port or jetty.

3.2.18 For hydrofoil craft, hovercraft and skimmers of M class the anchor weight, chain cable length and breaking load of a rope shall be increased by 25% in comparison with those taken in accordance with 3.2.2 for ships of O class.

3.2.19 For hydrofoil craft, hovercraft and skimmers navigating on river parts with current velocity over 6 km/h and with stone ground the anchor weight shall be twice increased in comparison with that determined according to 3.2.2.

3.2.20 The anchor chain cable length for dynamically supported craft shall be determined as follows:

\[
l_{anch} = a_3 + b_3 N^c_3,
\]

where \( a_3, b_3, c_3 \) — coefficients adopted from Table 3.2.20.1.

<table>
<thead>
<tr>
<th>Class of a ship</th>
<th>( a_3 )</th>
<th>( b_3 )</th>
<th>( c_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>-42.526</td>
<td>40.493</td>
<td>0.230</td>
</tr>
<tr>
<td>P</td>
<td>-3.413</td>
<td>15.683</td>
<td>0.305</td>
</tr>
<tr>
<td>Ï</td>
<td>-1.968</td>
<td>10.771</td>
<td>0.324</td>
</tr>
</tbody>
</table>

The obtained value \( l_{anch} \) shall be rounded upwards and designated as \( L_{anch} \).

When determining breaking strength of the anchor chain cable the anchor weight shall be taken twice as that determined in accordance with 3.2.2.

3.3 ANCHOR EQUIPMENT OF PUSHED CONVOYS

3.3.1 When assigning anchor equipment of pushed convoys, a dead-water pushed convoy formed according to scheme T+1+1 (pushboat + barge + barge) is taken as a design convoy.

3.3.2 Total weight of bow anchors \( \sum m_{anch} \), kg, of a pushed convoy is defined by the following formula:

\[
\sum m_{anch} = k_c k_{str} \left[ L(B + H) + k \sum_{i=1}^{n} (l_i h_i) \right],
\]

where \( L \) and \( B \) — dimensions of a convoy in the waterline plane, m;

\( H \) — design depth (for the greatest barge of the convoy), m;

\( n \) — number of barges in the convoy;

\( k \) — coefficient for the case of a barge without the equipment.

\( L \) and \( B \) are determined according to the formula:

\[
L(B + H) = \frac{a}{b} \left[ \frac{a}{b} + \frac{b}{c} \right] + \frac{b}{c},
\]

where \( a, b, c \) — coefficients from Table 3.2.20.1.

1 GOST 761, GOST 8497
and breadth of side silhouette of a cargo on deck, m;

- \( k \) — coefficient taken equal to 0.5 for carriage of bulk cargoes and to 1.0 for carriage of other deck cargoes;
- \( k_c \) — coefficient assigned according to 3.3.3;
- \( k_{str} \) — coefficient assigned according to 3.3.4.

### 3.3.3 Coefficient \( k_c \) for pushed convoys

Coefficient \( k_c \) for pushed convoys shall be taken according to Table 3.3.3.

<table>
<thead>
<tr>
<th>Basin category</th>
<th>Current velocity, km/h</th>
<th>( k_c )</th>
</tr>
</thead>
<tbody>
<tr>
<td>O and J I</td>
<td>Any</td>
<td>0.60</td>
</tr>
<tr>
<td>P and J I</td>
<td>&gt; 6</td>
<td>0.51</td>
</tr>
<tr>
<td></td>
<td>( \leq 6 )</td>
<td>0.38</td>
</tr>
</tbody>
</table>

### 3.3.4 Coefficient \( k_{str} \)

Coefficient \( k_{str} \) shall be taken depending on the height \( z_{str} \), m, of the windage centre above the water surface, basin category and current velocity.

For \( 1.25 \, \text{m} \leq z_{str} \leq 4.0 \, \text{m} \) coefficient \( k_{str} \) shall be determined by the following formula:

\[
k_{str} = 1 - A \left( 4.0 - z_{str} \right),
\]

where \( A \) — coefficient taken according to Table 3.3.4

For \( z_{str} < 1.25 \, \text{m} \) coefficient \( k_{str} \) shall be determined by formula (3.3.4) where \( z_{str} \) is taken equal to 1.25 m.

For \( z_{str} > 4.0 \, \text{m} \) coefficient \( k_{str} \) shall be taken equal to 1.0.

<table>
<thead>
<tr>
<th>Basin category</th>
<th>Current velocity, km/h</th>
<th>( A )</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Any</td>
<td>0.09</td>
</tr>
<tr>
<td>P</td>
<td>( \leq 6 )</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>&gt; 6</td>
<td>0.04</td>
</tr>
<tr>
<td>J I</td>
<td>( \leq 6 )</td>
<td>0.15</td>
</tr>
<tr>
<td></td>
<td>&gt; 6</td>
<td>0.06</td>
</tr>
</tbody>
</table>

### 3.3.5 When assigning weight of each of two bow anchors and two stern anchors, refer to 3.2.1 to 3.2.3, 3.2.6, 3.2.7, 3.2.16 to 3.2.19.

### 3.3.6 Total weight of stern anchors (anchor) of a pushboat shall be taken equal to 0.8 of the weight of bow anchors of the pushed convoy.

### 3.3.7 Aft and middle sections of a convoy may be equipped with one bow anchor with weight equal that of one bow anchor of the head section.

### 3.3.8 A length of each bow and aft chain cable of a pushed convoy shall be equal to a total length of the pushboat and one barge of the pushed convoy, but not less than 50 m and not more than 150 m.

### 3.3.9 In pushed convoys operating in estuaries of the rivers Ob, Lena and Amur of O category, the chain cable length shall be increased in comparison with design length at least by one shot.

### 3.4 SECURING ATTACHMENTS FOR ANCHORS AND ANCHOR CHAIN CABLES

#### 3.4.1 Two stoppers shall be provided for each anchor chain cable: one for securing of the chain cable at anchorage and the other one for securing of the raised anchor. An anchor hoisting gear brake may be used as the stopper device for securing the chain cable at anchorage.

Cam, friction or chain anchor stoppers shall be used for securing of raised anchor. For Matrosov anchors up to 25 kg and Hall’s anchors up to 50 kg one stopper device is permissible ensuring riding the ship at anchor. Bollards and cleats may be used as stoppers.

#### 3.4.2 Inboard shots of anchor chains or bitter ends of ropes shall be securely attached to the hull and fitted with detachable joints in order to enable releasing of these ends from easily accessible place at tight chain cable or rope.

Attachment elements of the chain cables and ropes connection and of their detachable joints shall be of the same strength as the chain cable or the rope.

The capacity of chain lockers shall be sufficient for free arrangement of the whole anchor chain.

In ships less than 25 m in length bitter ends of synthetic or hemp ropes need not be fitted with detachable joints.
3.4.3 Anchor hawses and their location shall comply with the following requirements:
1. inner hawse pipe diameter shall not be less than 10 chain cable diameters and the wall thickness shall not be less than 0.4 of the chain cable diameter;
2. easy entering of the anchor shank into the hawse pipe and easy taking off the hawse pipe when the chain cable is released due to the gravity force shall be provided;
3. bend of the chain cable when passing through the stopper and the hawse pipe shall be minimal. If the small bend is not practicable, lead roll may be fitted.

3.5 ANCHOR MACHINERY

General requirements
3.5.1 When dropping and hoisting the anchors having a weight of 50 kg and over as well as holding the ship at anchorage a capstan or windlass shall be provided. When anchor weight is 150 kg and over that machinery shall be fitted with chain sprockets.
3.5.2 When chains are replaced by ropes, anchor winches may be used. Towing winches may be used as anchor hoisting gear.
3.5.3 Hydraulically driven anchor machinery shall comply with the requirements of 1.6.17 to 1.6.26.

Drive
3.5.4 The drive engine power of the anchor machinery arrangement shall be sufficient for hauling the ship to the anchor, breaking out and hoisting of any of the anchors at a speed not less than 0.12 m/s with the nominal pull on the sprocket, H equal to:
\[ F_t = 22.6m d^2 \]
where \( m \) — strength factor taken equal for:
- standard stud link chains 1
- studless link chains 0.9
\( d \) — the chain diameter, mm.
3.5.5 The drive shall provide heaving-in of the anchor chain at a speed and pull specified in 3.5.4 for a period at least 30 min without interruption and dropping of one anchor for the design anchorage depth.
3.5.6 The starting moment of the anchor machinery drive shall create a pull on the sprocket at still anchor chain of at least \( 2F_t \).
3.5.7 As the anchor approaches the hawse, the drive shall provide for heaving-in speed max. 0.12 m/s.
3.5.8 The anchor machinery drive shall provide for simultaneous hoisting of freely suspended anchors from one-half of the design anchorage depth.
3.5.9 The manual drive shall provide heaving-in speed of at least 0.042 m/s with a pull on the sprocket according to the requirements of 3.5.4. The pull applied to handles shall be max. 160 N per one operator.
When using reciprocating manual drives the pull shall be max. 200 N per one operator.
3.5.10 Piping of hydraulic systems of anchor machinery connected with piping of other hydraulic systems shall be served by two independent pump sets; each of the pump sets shall ensure the operation of anchor machinery with the nominal pull and the nominal heaving-in speed of the anchor chain.
3.5.11 If the machinery drive is capable of developing a torque bringing to stresses in the machinery elements exceeding 0.95 of the yield point, protection shall be provided against exceeding the mentioned torque which shall be fitted between the drive and the machinery.
3.5.12 Anchor machinery of ships of M-C1 class shall provide simultaneous hoisting of two freely suspended bow anchors from 33 m depth with a chain diameter up to 16 mm inclusive and from 40 m depth with a chain diameter over 16 mm.

Brakes and clutches
3.5.13 The anchor machinery shall be fitted with disengaging clutches arranged between the sprocket and its drive shaft. The anchor machinery shall be fitted with brakes.
The anchor machinery with electrical or diesel drive shall be fitted with automatic
brakes arranged on the drive shaft and being actuated when the power is switched off or the drive fails.

In case of self-braking gear no automatic brakes are required.

3.5.14 An automatic brake shall ensure a breaking torque corresponding to a force on the sprocket of at least \(2F_1\) where \(F_1\), see 3.5.4.

3.5.15 Each chain sprocket shall be fitted with a brake, the braking torque of which shall correspond to a force in the chain on the sprocket of at least \(0.3F_{\text{test}}\) (\(F_{\text{test}}\)— testing load of the anchor chain cable), and for manually-driven machinery – at least \(2F_1\).

The force applied to the brake drive handle shall not exceed 490 N.

**Chain sprockets**

3.5.16 Chain sprockets shall have at least five cams.

For horizontal shaft sprockets the wrapping angle shall be not less than 115°, while for vertical shaft sprockets – not less than 150°.

3.5.17 The chain sprockets shall ensure passing of joining links in both horizontal and vertical positions.

The chain sprockets of vertical anchor winches shall ensure passing the joining links in the vertical position.

**Strength checking**

3.5.18 The machinery elements subject to loading shall be checked for strength when being affected by forces corresponding to the drive maximum torque or the moment of the extreme protection setting. The reference stresses in the elements shall not exceed 0.95 of the yield stress of the element material.

At the action of the nominal pull force the stresses shall not exceed 0.4 of the yield stress of the element material.

3.5.19 The anchor machinery elements being loaded at braked sprocket shall be checked for strength under action of breaking load of the chain cable. Stresses shall not exceed 0.95 of the yield stress of the element material.

**Additional requirements**

3.5.20 Anchor machinery intended for mooring operations, the requirements of the present Chapter as well as requirements of 4.3 shall be met.

**3.6 REMOTE-CONTROLLED ANCHOR RELEASE DEVICE**

3.6.1 In self-propelled ships over 60 m in length, non-propelled pushed ships intended for carriage of inflammable liquids and pushboats, the hoisting gear break of bow starboard anchor, and on pushboats also the break of stern anchor shall be fitted with a remote-controlled anchor release device. The remote-controlled release device shall prevent from spontaneous anchor release.

3.6.2 The remote-controlled anchor release device shall provide the following:

1. control from the wheelhouse (on non-self-propelled ships — from the pushboat wheelhouse) of release of the bow starboard anchor and for pushboats — also stern anchor as well as indication of the released chain cable;
2. stopping the anchor chain from the wheelhouse at any released chain cable;
3. the duration of the anchor chain from the wheelhouse at any released chain cable;

3.6.3 Stoppers and other anchor equipment for which remote control is provided shall also be fitted with means of local manual control.

3.6.4 Anchor appliances and the associated means of local manual control shall be designed to ensure normal operation of anchor arrangement in the event of failure of separate elements or the whole remote control system.

**3.7 ANCHOR CHAIN CABLES AND THEIR ACCESSORIES**

3.7.1 Anchor chain cables and their accessories shall be made of rolled steel manufac-
tured and tested in accordance with requirements of 2.5 Part X of the Rules. The material of forged chains and accessories shall comply with the requirements of 2.6, and that of cast chain cables — with the requirements of 2.7 Part X of the Rules.

Chains and accessories shall be tested in accordance with requirements of Appendix 2. The design and dimensions of chain links and its accessories shall comply with GOST 228.

3.7.2 Chain links are manufactured from rolled steel bars by flash butt welding; they may be manufactured also by drop forging or steel casting.

Studless links of 26-mm diameter and less may be manufactured by pressure contact butt welding.

3.7.3 Accessories, kenter and joining shackles, swivels and swivel shackles shall be forged or cast and shall comply with requirements at least for steel of grade 2 according to GOST 228.

The above accessories may be also manufactured by welding.

3.7.4 According to the grade of steel, condition of supply of chain cables and accessories shall comply with Table 3.7.4.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Supply condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 3</td>
<td>Not specified (any)</td>
</tr>
<tr>
<td></td>
<td>Normalized, normalized and tempered or quenched and tempered</td>
</tr>
</tbody>
</table>


The heat treatment of chain links and accessories shall be performed prior to breaking load and proof load testing.

3.7.5 The studs shall be made of rolled, forged or cast carbon steel similar to that of the given chain links. The studs must be located in the link centrally and perpendicular to longitudinal axis of the link. The studs of the final links at each end of any length may also be located off-centre to facilitate the insertion of joining links and shackles. The following tolerances are permitted provided that the stud fits tightly and its ends lie practically flush against the inside of the link: maximum off-centre distance \( X = 0.1d \), angle \( \alpha \) a not exceeding 4°.

Tolerances are determined according to Fig. 3.7.5.

![Fig. 3.7.5 Tolerances for fitting of studs](image)

\[
X = 0.5(A - a)
\]

3.7.6 Allowable tolerances of a shot length measured over a length of any 5 links shall not exceed +2.5 % of the nominal length. Measurements shall be performed on the chain under tension after proof load testing.

The following tolerances are allowed for chain accessories: for diameter +5%, -0; for other dimensions ±2.5%.

3.7.7 The welding of studs shall be carried out in accordance with procedure approved by the River Register with regard to the following conditions:

- studs shall be made of steel specified in 3.7.5;
- the studs shall be welded at one end only, which is opposite to the link weld. The stud ends must fit the inside of the link without appreciable gap;
- welding is performed preferably in the downhand position by qualified welders having the Approval Certificate using welding consumables required by the procedure;
- welding is performed prior to the final heat treatment of the chain cable;

3.7.8 The mechanical properties of finished chain shall comply with Table 3.7.8 and be specified in the quality control document.
### Table 3.7.8

Mechanical properties of finished chain

<table>
<thead>
<tr>
<th>Grade</th>
<th>$R_m$, MPa</th>
<th>$R_m^*$, MPa</th>
<th>$A_s$, %</th>
<th>$Z$, %</th>
<th>Impact test$^1$ $K_V$</th>
<th>Elongation</th>
<th>Impact test$^2$ $K_V$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>min.</td>
<td>Temperature, $^\circ$C</td>
<td>Min. absorbed energy, J</td>
<td></td>
<td>Temperature, $^\circ$C</td>
<td></td>
<td>Min. absorbed energy, J</td>
</tr>
<tr>
<td>1</td>
<td>≤ 490</td>
<td>--</td>
<td>25</td>
<td>--</td>
<td>--</td>
<td>25</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>490 to 690</td>
<td>295</td>
<td>22</td>
<td>0</td>
<td>47</td>
<td>18</td>
<td>0 (–20)</td>
</tr>
<tr>
<td>3</td>
<td>≥ 690</td>
<td>410</td>
<td>17</td>
<td>40</td>
<td>0 (–20)</td>
<td>14</td>
<td>0 (–20)</td>
</tr>
</tbody>
</table>

1 Impact tests of material for grade 2 chain cables may be omitted if the chain cable is subject to heat treatment.
2 Percentage reduction of cross-sectional area is not regulated.
3 Impact tests for chain cable of grade 3 may be carried out at $–20$ $^\circ$C.

3.7.9 Marking of the chain shall be made on the outermost links of each shot length; it shall include the certificate number, chain grade and the River Register brand. The arrangement of the marking symbols shall be as in Fig. 3.7.9. Marking of the chain accessories shall be made on each item; it shall include the certificate number, grade and the River Register brand.
4 MOORING ARRANGEMENT

4.1 GENERAL PROVISIONS

4.1.1 Every ship shall be fitted with mooring arrangements for warping to shore or floating berths structures and reliable attachment of the ship to them.

4.1.2 Selection of number, type of machinery and elements of the mooring arrangements, and also their arrangement on board shall be carried out by a designer in accordance with design features and the ship purpose subject to the requirements of present Section of the Rules.

4.2 MOORING EQUIPMENT

4.2.1 Mooring bollards shall be made of steel or cast iron. For small ships equipped only by natural fibre or synthetic fibre ropes, bollards made of light alloys may be used.

4.2.2 The outside diameter of the bollard column shall be not less than ten diameters of the steel wire rope or at least one circumference of a natural fibre or synthetic fibre rope.

4.2.3 Bollards shall be installed on foundations which shall be fixed on the deck and be attached to the ship framing. It is allowed to weld bollards to strengthened plates of the deck flooring. No side bollards welded to the deck flooring are allowed in cargo ships.

Securing of the side in these ships shall be calculated for forces arising while towing and pushing ships by two wads.

4.2.4 Bollards, mooring chocks and other elements of mooring equipment as well as their foundations shall be so designed that stresses in the elements do not exceed 0.95 times the yield point of their material due to acting of force equal to the breaking strength of the mooring rope for which they are intended.

4.2.5 Mooring bollards located in explosive spaces and areas (see 1.4 Part III of the Rules), shall be installed on foundations designed so as to provide natural air circulation under the bollards.

4.2.6 Hull structures in way of the mooring equipment installation shall be supported by ordinary framing or stiffeners.

4.2.7 For hauling mooring ropes the mooring machinery may be used (mooring capstans, mooring winches etc.) or other deck machinery (windlasses, cargo winches etc.) fitted with mooring drums.

4.3 MOORING MACHINERY

Drive

4.3.1 A drive of the mooring machinery shall provide continuous hauling of a mooring rope for at least 30 min at a nominal tractive force and nominal speed specified in the manufacturer's technical documentation. Hauling speed of a mooring rope shall not exceed 0.3 m/s at the nominal tractive force. Moreover, it shall be possible to haul a mooring rope with a speed not exceeding 0.15 m/s.

4.3.2 The drive of the mooring machinery shall be able to create force as great as twice and more of the nominal tractive force for 15 s.

4.3.3 When the drive maximum moment can induce stresses in elements of the mooring machinery exceeding those indicated in 4.3.6 to 4.3.7, the overload protection shall be provided.

Brakes

4.3.4 Mooring machinery shall be equipped with an automatic normally closed brake. The brake shall hold the mooring drum in fixed
condition while a static force not less than 1.5 times of the mooring machinery tractive force is being applied to the rope.

4.3.5 Automatic mooring winches shall be equipped with brakes installed on the drum which are capable to withstand the rope breaking load.

**Strength checking**

4.3.6 Strength of loaded elements of the mooring machinery shall be checked under action of forces corresponding to the drive maximum moment or a moment corresponding to limit protection setting. The equivalent stresses shall not exceed 0.95 the yield point of the material. When the nominal tractive force is applied, stresses in the elements shall not exceed 0.4 of the yield point of the material.

4.3.7 The shaft (rudder stock) of the mooring machinery, its supports, fastening devices for its attachment to the foundation shall be checked by strength calculation for the case when bending force acts on the mooring drum and is equal to the rope breaking load. Here, the stresses occurred shall not exceed 0.95 times the yield stress of the material.

**Automatic mooring machinery**

4.3.8 Automatic mooring machinery shall be capable of being manually controlled as well.

4.3.9 Automatic mooring machinery shall be equipped with:

.1 audible warning alarm which is actuated at maximum permissible length of hauled-off rope;

.2 an indicator of actual value of the tractive force applied to the mooring rope during the automatic mode of operation of the machinery.

4.3.10 Strength of parts of the automatic mooring machinery being under load at braked drum shall be checked for action of the rope breaking load. Here, stresses in the parts shall not exceed 0.95 of the yield point of the material.

**4.4 MOORING ROPES**

4.4.1 Mooring ropes may be made of steel, natural fibres or synthetic fibres.

4.4.2 Breaking load $F_{br}$, kN, of the mooring rope shall be not less than:

- for ships with equipment number of 100 to 1000
  \[
  F_{br} = 0.147 N_e + 24.5
  \]
  \[(4.4.2-1)\]

- for ships with equipment number more than 1000
  \[
  F_{br} = 171 + 3.92 \times 10^{-2} (N_e - 1000)
  \]
  \[(4.4.2-2)\]

where $N_e$ — equipment number calculated in accordance with 1.7.

4.4.3 Number and length of mooring ropes shall be selected depending on the ship type and operating conditions. However, there shall be at least three mooring ropes on the ship:

- length of the first rope shall be at least $L + 20$ but max. $100$ m, where $L$ is the design length of a ship, m;

- length of the second rope shall be at least two thirds the length of the first rope;

- length of the third rope shall be at least one third the length of the first rope.

For ships with length $L$ less than $20$ m, the third rope is not required.

4.4.4 Steel wire mooring ropes shall not be used or stored in explosive spaces and areas (see 1.4 Part III of the Rules).

4.4.5 For non-crewed non-self-propelled ships, mooring ropes may be stored on tugboats and pushboats engaged on operations with them. In this case, tugboats and pushboats shall be completed with mooring ropes according to 4.4.3, mooring ropes of non-self-propelled ships are not taken into account.
5 TOWING AND COUPLING ARRANGEMENTS

5.1 TOWING ARRANGEMENT

5.1.1 Towing arrangement of tugs and tug-and-push boats shall include:
.1 at least two devices for towing rope securing: the main device and the reserve one. Towing rope may be also secured by means of:
  towing winch and towing hook;
  towing hook and towing bollards or bitts;
  towing winch and towing bollards or bitts;
  towing rope;
  towing arches and other rope guides;
  towing rope limiters.

Notes: 1. Towing hooks may be used instead of towing bollards or bitts, and towing winch — instead of towing hook.
  2. Where two towing winches of the same type or two towing hooks of the same type are installed in a tug, one of them is considered as the main and another — as the reserve one.

5.1.2 Tugs and tug-and-push boats of M class with main engines with output over 300 kW, of O, P and J class with main engines with output of 440 kW and over shall be fitted with mechanically driven towing winches.

5.1.3 Tugboats of M class with main engines with output over 440 kW shall be fitted with automatic towing winches.

5.1.4 Ships of all other types with main engines with output over 300 kW, with towing arrangements and not equipped with towing winches, shall be fitted with arrangements for hauling and laying of towing ropes.

5.1.5 Number and arrangement of towing bollards, bitts, mooring chocks, guiding blocks, stops shall correspond to the design features and general arrangement of the main towing equipment (winches, hooks).

5.1.6 Every self-propelled and non-self-propelled ship shall be fitted with arrangement allowing its towing, including the following equipment:
.1 two towing bollards or bitts situated in the fore and aft ship extremities;
.2 towing hawses for passing the towing ropes through the bulwarks.

5.1.7 Floating cranes, landing stages, industrial ships and other ships with transom extremities shall be fitted with two pairs of bollards or bitts installed in the extremities on either side.

5.1.8 It is allowed to replace towing hawses with roller fairleads or guiding bollards.

5.1.9 Tugboats of М-СП, М-ПР and О-ПР class shall be fitted with automatic towing winches with a towing rope at least 500 meters long.

5.2 TOWING WINCHES

5.2.1 Towing winches shall be fitted with brake with a holding capacity less than the breaking load of a towing rope.

5.2.2 Strength of the load-carrying parts of the towing winch shall be checked when the maximum drive moment is applied. Here, stresses in the parts shall not exceed 0.95 of the yield point of the material.

When the nominal tractive force is applied to the middle layer of rope coiling on the drum, stresses in the parts shall not exceed 0.4 the yield point of the material.

5.2.3 Strength of parts of the towing winch being under load at locked rope drum shall be checked when the load equal to the breaking load of the towing rope is applied on external layer of coiling.
Here, stresses in the parts shall not exceed 0.95 of the yield point of the material.

5.2.4 Automatic mooring winches shall be equipped with:

.1 automatic adjustment device of the towing rope tension This automatic device shall ensure release of the rope when tractive force on the winch exceeds the maximum permissible value; hauling of the rope when the tractive force is reduced below the minimum permissible value and holding of the rope for tractive forces within the specified range of permissible values from maximum to minimum. The indicator of a current tractive force applied shall be installed near the winch and in the wheelhouse;

.2 automatic normally closed brake (see 4.3.4);

.3 towing winch remote control device/system ensuring the following operations: control from the wheelhouse: speed and direction of rotation; towing drum activation/deactivation; release of the towing rope; emergency stop; emergency drop of the towing rope; control/indication of parameters from remote control station; length of hauled-off rope; rope tension.

5.2.5 Audible warning alarm shall be provided which is actuated at maximum permissible length of hauled-off rope.

5.2.6 It shall be possible to slacken the towing rope freely both from the local control station and from the wheelhouse.

5.2.7 Winch drums shall be equipped with a cable layer.

5.2.8 Drum brake driven by any energy source shall be manually operated as well.

5.3 TOWING HOOKS

5.3.1 A ship may be fitted with standard folding towing hooks of opened and closed types, with spring shock absorbers and without them, with mechanical and hydraulic locks.

Tugboats and tug-and-push boats of M and O class, and also tugboats of P and J class with main engines with output over 300 kW shall be fitted with hooks of folding type with spring shock absorbers when the towing hooks are applied as main means.

Hooks of non-folding type may be used as the main means for securing of the towing rope on towed ships and as reserve means in tugboats.

5.3.2 All carrying elements of the towing hook and parts securing it to the hull shall be designed for the breaking load of the towing rope taken by calculation. Stresses in these shall not exceed 0.95 the yield point of the material.

5.3.3 Load at which the shock absorber spring is compressed against the stop shall be not less than 1.3 times the nominal traction on the hook.

5.3.4 The cramp irons of the towing hooks shall be solid-forged. Relative elongation of the hook material shall be not less than 18% on five-fold sample and the yield point — not less than 245 MPa.

5.3.5 Prior to installation on board the ship, the towing hooks shall be tested by test load equal to doubled design tractive force on the hook determined for ships in mooring mode.

5.3.6 Attachment of the towing hook to the ship structures shall be of such design that at any possible towing angles the hook is not subject to the bending forces in the horizontal plane and does not touch any hull structures within the set angle of side stops, directly or by the rope thimble.

5.3.7 When in non-working position, the towing hook shall be secured for voyage.

5.3.8 Towing rope release shall be possible from two stations:

.1 from the wheelhouse (remote control);

.2 from the local station located in the immediate vicinity of the towing hook in a safe area.
5.3.9 Towing rope releasing arrangement shall operate in the range of loads on the hook from zero to the breaking load at any possible rope deviation from the centreline.

5.4 TOWING EQUIPMENT

Bollards, bitts, rope locks

5.4.1 Bollards, bitts and towing arrangement machinery shall be installed on foundations which shall be fixed on the deck and connected with the hull framing.

Deck shall be strengthened in way of installation of the foundations.

Bollards located in explosive spaces and areas of the second category of explosion risk shall be installed on foundations so designed as to provide natural air circulation under the bollards.

5.4.2 The outside diameter of the bollard or bitt column shall be not less than ten diameters of the steel wire rope or not less than one circumference of the natural fibre rope.

5.4.3 Rope locks shall be designed so as to withstand a load equal to a half of design tractive force on the hook.

Towing arches

5.4.4 In the after part of tugboats in way of possible displacement of the towing rope towing arches shall be installed in the transverse direction of the ship from side to side or other structures guiding the rope. The number of towing arches shall be determined for each tug depending on the length of its after part.

5.4.5 The height of the towing arches and protective rails shall ensure the safe work and movement of the crew in way of possible displacement of the towing rope.

5.4.6 The towing arches, supporting counterforts and other parts of the towing arrangement being touched by the towing rope are to be made of pipes or other proper profile with the rounding radius not less than the towing rope diameter.

5.4.7 In all ships equipped with the towing arrangement the side limiters of towing rope shall be fitted.

5.4.8 The side limiters of the towing rope shall be designed to take the load equal to the breaking load of the towing rope. Stresses in carrying elements of the limiters and also in the fastenings securing them to the ship’s hull or other structures shall not exceed 0.95 times the yield point of the material.

5.5 TOWING HOOKS

5.5.1 Strength characteristics of the towing ropes shall be determined depending on the design tractive force on the hook in the mooring mode established by hydrodynamic calculation or agreed by the River Register or by prototype and the results of trials of lead ships. If such calculations are not performed or a prototype is not available, the tractive force on the hook \( F \), kN, shall be assumed not less than the value calculated by the following formula:

\[
F = 0.16P_e, \quad (5.5.1)
\]

where \( P_e \) — the total output of main engines, kW.

5.5.2 Minimum permissible breaking load, kN, of the rope as a whole used for towing on the hook shall be not less than determined by the following formula:

\[
F_0 = kF, \quad (5.5.2)
\]

where \( F \) — design tractive force on the hook, kN;

\( k \) — safety factor equal to:

- for design tractive force on the hook up to 120 kN 5
- for design tractive force on the hook of 120 kN and more 4
- for ropes of automatic towing winches 3
- for ropes of natural and synthetic fibre 6

Note. For tug-and pushboats, safety factor \( K \) shall be at least equal to for design tractor force on the hook:

- less than 120 kN 4
- 120 kN and more 3
5.5.3 The length of the towing rope is selected depending on the area of navigation, but shall be not less than 180 m for ships of M class, 100 m for ships of O class and 60 m for ships of P and J class.

5.5.4 Steel wire ropes used for towing shall have not less than 144 wires and 7 fibre cores, and when using automatic towing winches — 216 wires and 1 fibre core with tensile strength of wires of 1177 to 1373 MPa.

Ropes must be untwistable in all cases. Wires shall be galvanized.

5.5.5 Manila ropes with increased strength may be used as the towing ropes. It is allowed to use three-rowed, ordinary and special tarred hemp ropes, and also ropes made of synthetic fibres — three-rowed, with circumference up to 200 mm.

5.5.6 Each rope shall be provided with a splice from one end, either with a thimble or without it, or a mark (on one end or both ends). A splice without thimble is allowed only when the towing rope is being fixed on the columns of a bollard or a bitt.

5.5.7 No steel towing ropes may be used or stowed in explosive spaces and areas.

5.6 COUPLING ARRANGEMENTS

5.6.1 Coupling arrangements of the pushed convoys shall have sufficient strength to operate at standardized wave height corresponding to a category of operating basin, maximum permissible operating rolling and pitch amplitudes to be determined in accordance with 2.4 Part II of the Rules, maximum speed of putting the rudder or other means of ship steering (for example, steerable nozzle, steering column, waterjet damper) from side to side at full speed of the convoy at any azimuth to rolling as well as for different loading conditions.

5.6.2 Calculations for the determination of bending moment due to the joined action of hydrodynamic forces due to wheellover, rolling and side wave pressure, and also for determination of the design loads \( P_d \) acting in connections of the coupling arrangements shall be submitted to the River Register for review.

5.6.3 Strength calculation of elements of the coupling arrangement shall be carried out by permissible stresses which shall be taken equal to 0.63 times the yield point of the material of the elements. Breaking load of ropes shall be at least 1.5\( P_d \).

5.6.4 The test load for bench tests of the coupling arrangement shall be not less than 1.5\( P_d \).

5.6.5 The prototype model of the coupling arrangement shall be tested on the bench with the test load of 1.5\( P_d \) and instrument measurements (strain-gauging) of the essential elements.

The prototype model is considered suitable for carrying out on board operational tests, if the stresses in the elements during testing by the test load does not exceed 0.95 times the yield point of the material.

5.6.6 The requirements of 5.6.7 to 5.6.12 applicable for two-hinged design of coupling arrangement of pushed convoys, ships of M-СП, М-ΠР and О-ΠР class operating with restrictions of a wave height \( 3.5 \text{ m} \geq h \geq 2.0 \text{ m} \).

Two-hinged design of coupling arrangement is such design that a pusher coupled with a barge can move freely with one degree of freedom relatively to the barge (turning of the convoy vessels relatively to horizontal axis being perpendicular to the centre line of the convoy).

5.6.7 Coupling devices of pushed river-sea navigation convoys shall possess sufficient strength for operation in sea areas at maximum speed of putting rudders or steerable nozzles from side to side at the maximum speed of a convoy and any azimuth to rolling.
5.6.8 Design loads applied to hinged coupling device shall be not less than those calculated by formulas, kN:

for longitudinal load

\[ P_x = 5C_x \rho g h \frac{L}{\sqrt{b}} \lambda^2 (1 + 5 Fr) \times \left[ 1 + 0.8 \left( \sin 2 \epsilon + \sin \epsilon \right) / \sqrt{b} \right], \]

(5.6.8-1)

for transverse load

\[ P_y = C_y \rho g h \frac{L}{\sqrt{b}} \lambda^2 (1 + 5 Fr) \sin^3 \epsilon / \sqrt{b}, \]

(5.6.8-2)

for vertical load

\[ P_z = 5C_z \rho g h \frac{L}{\sqrt{b}} \lambda^2 (1 + 9 Fr) \times \left[ 1 + 0.35 \left( \sin 2 \epsilon + \sin \epsilon \right) / \sqrt{b} \right], \]

(5.6.8-3)

where \( C_x, C_y, C_z \) — coefficients of longitudinal, transverse and vertical loads determined by formulas of Table 5.6.8 with regard to parameters \( h, \lambda \) and \( l_{hin} \):

- \( \rho \) — water density, t/m³;
- \( g \) — acceleration due to gravity:
  \( g = 9.81 \text{ m/s}^2 \);
- \( h \) — wave height, m;
- \( L, B, T, D \) — relative length, breadth, draught and water displacement of a pushed convoy determined by the formulas:
  \[ L = L_1 + L_2 \]  \[ B = B_1 + B_2 \]  \[ T = T_1 + T_2 \]  \[ D = D_1 + D_2 \]

(5.6.8-4)

\( L_1, B_1, T_1, D_1 \) — length, breadth, draught at design waterline of a barge respectively, in meters, and its water displacement, in m³;

\( L_2, B_2, T_2, D_2 \) — length, breadth, draught at design waterline of a tugboat respectively, in meters, and its water displacement, m³;

\( \lambda \) — wavelength, m;

\( \epsilon \) — azimuth (0° to 89°—following sea; 91° to 180°—head sea);

\( Fr = V / \sqrt{g(L_1 - L_2)} \) — Froude number;

\( V \) — speed of a pushed convoy, m/s;

\( 2b \) — distance between hinged coupling devices, m;

\[ l_{hin} = l_{m2} / (l_{m1} + l_{m2}) \] — relative value of position of the hinged coupling device for pushed convoys 0.10 ≤ \( l_{hin} \) ≤ 0.35;

\( l_{m1}, l_{m2} \) — distance between the hinged coupling device and the centre of gravity of a barge and a tugboat respectively, m.

5.6.9 When design of coupling arrangement of a pushed convoy is other than two-hinged, calculation of design loads on its structural members is performed based on procedures agreed upon with the River Register for compliance with requirements of the Rules.

5.6.10 Strength calculations of coupling arrangement elements shall be done on the basis of permissible stresses which shall be taken equal to 0.63 of the yield stress of the material.
5.6.11 Test load for bench tests of coupling arrangements shall be at least 1.5 of the design load.

When test load is applied, the greatest stresses in the coupling arrangement elements shall not exceed 0.95 of the yield stress of the material.

5.6.12 When parameters $h \lambda$ and $\bar{p}$ are other than prescribed by the Rules, design loads on a coupling arrangement may be determined by calculated method based on procedure agreed upon with the River Register for compliance with requirements of the Rules.

Design of coupling arrangements

5.6.13 Materials used for manufacture of coupling arrangements shall comply with requirements of Part X of the Rules.

Carbon steel for welded parts of the coupling arrangements shall contain no more than 0.22% of carbon. Weldability of low-alloy steels shall be documented by the manufacturer.

5.6.14 All steel forgings and castings as well as essential parts with intersecting welds or welds being apart from each other for 5 times thickness of the welded part or less, are subject to heat treatment after manufacture. The heat treatment type is established depending on the chemical composition, purpose and dimensions of the item according to RTSC.

5.6.15 Coupling arrangement shall provide the convoy coupling when the barge is non-attended. The coupling shall be performed from the local control station or remotely from the wheelhouse of the pushboat.

5.6.16 The coupling arrangement shall provide discoupling of vessels in the convoy at the rated waves when any one compartment of a barge is flooded and is at static heel of 15°.

5.6.17 When navigating on waves with height corresponding to operating basin category, the contact between hull structures of convoy sections shall be excluded.

5.6.18 Free clearances in connections shall not allow angular backlash of coupling arrangement more than 0.06°, when shock absorbers are not available, and 0.10° when they are available.

5.6.19 Bolt connections of the coupling arrangement with foundations shall comprise elements (templet bolts, pins, wedge rests etc.) taking shearing forces. Bolts shall be so tightened as to prevent discoupling of the connection when the design shear forces are applied. Nuts of the foundation bolts shall be locked to prevent self-unscrewing.

5.6.20 Coupling locks, tightening arrangements and other coupling equipment with shock absorbers shall remain workable at the momentary unloading of fully compressed shock absorber.

5.6.21 Coupling locks of falling type shall be fitted with locks for their securing for voyage.

5.6.22 Main parts of hull structures of the coupling arrangement (stops, coupling girders, supporting members, foundations) shall have smooth transition with solid hull structures.

5.6.23 Thickness of contact surfaces of thrust members shall be assigned depending on the design force according to Table 5.6.23. Edges of the contact members shall be rounded.

<table>
<thead>
<tr>
<th>Design load, kN</th>
<th>Minimum plate thickness, mm</th>
<th>Design load, kN</th>
<th>Minimum plate thickness, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>6</td>
<td>2000</td>
<td>18</td>
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<tr>
<td>250</td>
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</tr>
<tr>
<td>500</td>
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<td>22</td>
</tr>
<tr>
<td>1000</td>
<td>14</td>
<td>$\geq 5000$</td>
<td>24</td>
</tr>
<tr>
<td>1500</td>
<td>16</td>
<td></td>
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</tbody>
</table>

Thrust girders and thrusts shall be designed as plates with bearing surfaces.

5.6.24 Coupling device shall not be extended beyond the plane of the fender bars to prevent touching the structural elements of other ships and quays at mooring and locking. Fender bars enclosing the coupling arrange-
ment from the board side, and also extending girders located between the stops are recommended to be installed on shock absorbers or be made of damping material.

5.6.25 The coupling arrangement shall provide emergency discoupling of ships when the load in the members exceeding working load \( P_w \).

Note. For two-locked couplings, ships may be discoupled when the load is less than design load in the members.

5.6.26 Locks of the automatic coupling device shall close automatically when the ship is touched by another ship and open by manual drive from the local control station. In pushboats a device for the lock opening shall be provided in the wheelhouse.

5.6.27 Lock movement limiters shall be provided at the lower end of vertical coupling and guiding girders.

5.6.28 Where the coupling system is hydraulically driven, the drive when in closed position shall be stopped by mechanical brake equipped with remote indication of its actuation at the coupling device local control station and at the control station in the wheelhouse of the pushboat.

5.6.29 Two-hinged coupling arrangements for ships of М-СП, М-ПР and О-ПР class shall be located as far as practicable from the centreline of a convoy in order to reduce stresses in coupling joints.

5.6.30 The coupling arrangement shall allow for discoupling of vessels in the convoy under wind and waves conditions at loads not less than working loads.

5.7 INTERLOCKING ARRANGEMENTS

General requirements

5.7.1 Requirements of the present Chapter apply to end interlocking arrangements with longitudinal flexible members and longitudinal rigid connections.

5.7.2 Any interlocking arrangements at all possible operating loads shall provide for rigid connection of ships in a convoy and prevent longitudinal and transverse displacement of ships relative to each other so that this group of ships may be considered as a single shipping unit.

5.7.3 Pushboats, cargo pushboats and barges in the pushed convoy in front of which the other barges are located shall be provided with interlocking arrangement in the bow part.

The pushed barges shall be provided with interlocking arrangement in their after part.

5.7.4 Provision shall be made for connection of a ship with both loaded and light barges.

5.7.5 Interlocking arrangement elements shall not protrude beyond the overall hull breadth.

5.7.6 Interlocking and tension arrangements shall be designed and equipped so that the personnel shall be able to connect the pushboat and barges without errors and undue efforts and time consumption.

The pushboats shall be provided with pushing arrangement in their front part designed and equipped to allow the pushboat to take a specified position relative to the pushed barges from the start of interlocking manoeuvres.

The ships shall be interlocked to provide a safe passage for the personnel from one ship to another.

The interlocking arrangement and its connecting members shall withstand forces which may occur when the ship is navigating in the water basins where its operation is allowed and transmit the load from these forces on strong hull members.

5.7.7 Provision shall be made for an adequate number of coupling joints to comply with requirements of 5.7.2 and 5.7.6.

Coupling forces and dimensions of interlocking arrangement elements

5.7.8 Dimensions of longitudinal flexible and rigid members of interlocking arrangements specified in 5.7.1 for convoys and
groups shall be determined with regard to adequate safety margin and coupling forces applied (Fig. 5.7.8), kN, calculated by the following formulas:

1. coupling joint is located between the pushboat and barges or other ships:
   \[ F_{sb} = C_s P_e \cdot 10^{-3} L_s / B_s \]  \hspace{1cm} (5.7.8.1)

2. coupling joint is located between self-propelled cargo pushboat and pushed ship:
   \[ F_{st} = C_{pB} P_e \cdot 10^{-3} L_s / H_k \]  \hspace{1cm} (5.7.8.2)

3. coupling joint is located between pushed ships:
   \[ F_{sl} = C_{pb} P_e \cdot 10^{-3} L_s / H_k' \]  \hspace{1cm} (5.7.8.3)

where
- \( F_{sb}, F_{st}, F_{sl} \) — longitudinal member coupling force;
- \( C_s = 130 \div 270 \) — empirical factor determined in accordance with basin category and operating conditions;
- \( C_{pB} = 60 \div 80 \) — empirical factor determined in accordance with basin category and operating conditions;
- \( P_e \) — the total output of main engines, kW;
- \( L_s \) — distance between the pushboat aft and coupling joint, m;
- \( L'_s \) — distance between the pushboat aft and coupling joint located between the first pushed ship and coupled ships directly in front of it, m;
- \( H_k, H'_k \) — longitudinal member lever arm, m;
- \( B_s \) — pushboat breadth, m.

5.7.9 As a basis for determining dimensions of other longitudinal members in the coupling joints between pushed ships, the coupling force shall be used which is calculated by formula (5.7.8.3).

5.7.10 There shall be at least two coupling joints for longitudinal coupling of individual ships.

Fig. 5.7.8. Coupling force and lever arm of interlocking arrangement longitudinal member
Each coupling joint shall be sized so that it is capable of withstanding coupling forces calculated by formulas (5.7.8.1), (5.7.8.2) and (5.7.8.3).

Coupling joints shall be located as far as practicable from the centre line of a convoy in order to reduce forces in coupling joints.

In case of rigid connection one coupling joint is allowed provided that it ensures reliable connection between ships.

5.7.11 Strength in each rope used for ship interlocking is to be determined with regard to rope arrangement in a lash. The total breaking strength of ropes shall be at least 1.5 the load acting in the coupling joint members.

Each rope being used shall be laid on bollards or similar equipment max. by three turns and shall be capable of being hauled for different ways of its expected use.

5.7.12 In case of pushboat designed for pushing of several barges in a convoy with a single pushed barge, design coupling force is to be calculated by formula (5.7.8.2).

5.7.13 The ships designed for supporting motion of interlocked group shall be equipped with bollards or similar arrangements which quantity and layout ensures compliance with requirements of 5.7.2. Mooring bollards and other similar equipment for ships interlocking shall be used only if they withstand coupling forces applied to them in an extreme case and their quantity is adequate for unhampered normal mooring operations.

5.7.14 The towing arrangement of pushed barges shall comply with requirements of 5.1 to 5.5.

Special requirements to coupling arrangements for bendable convoys

5.7.15 A coupling arrangement for bendable convoys shall allow for rigid connection of ships.

5.7.16 A coupling arrangement for bendable convoys shall be equipped with a drive allowing for bending of a convoy. The coupling arrangement drive shall also provide for fail-safe return of the convoy to position before bending or in the straightened position.

5.7.17 Where the drive from power source (including hydraulic or electric) is used in a coupling arrangement, provision shall be made for an independent standby drive or power source.

5.7.18 Where the main drive is hydraulic and the standby is a manual hydraulically operated drive, each drive shall operate independently.

Where main and standby drives are hydraulic, provision shall be made for a pump with independent power source for each drive.

Piping, valves, controls of both drives shall be independent. However, these two drives may have common structural elements, for example, cylinder block.

5.7.19 If main and standby drives are electric, their supply and control systems shall be independent of each other. Each of these two drives shall have its own electric motor.

5.7.20 Where electric motor or coupling arrangement standby drive pump is fed from auxiliary engine and its startup operation requires more than 5 s, the buffer device shall ensure operation of electric motor or standby drive pump for the period of startup of auxiliary engine.

5.7.21 Provision shall be made for monitoring and control of coupling arrangement for bendable convoys from the wheelhouse at least for bending and straightening operation.

The control stations shall be provided with visual alarm indicating the operation of coupling arrangement drive and allowing for determination what drive is activated.

Visual and audible signals shall be provided to the control station in case of accidental trip or failure in a coupling arrangement power-operated drive.
6 CARGO HANDLING APPLIANCES

6.1 GENERAL PROVISIONS

6.1.1 The present part of the Rules applies to cargo handling appliances designed for loading, unloading and transfer of cargo:
1. upper structures of the floating cranes;
2. ship’s derricks;
3. cranes mounted on floating docks;
4. cargo booms;
5. electrically-driven lifts with load capacity of 250 kg and above intended for lifting and lowering of cargoes in a cabin which is moved by means of cables (ropes) with the speed not exceeding 1.0 m/s.

6.1.2 The requirements of the present Section are not applied to the cargo-handling machinery intended for operations with fishing tools and handling of fishery, for loading and discharging of ship equipment, supply and ship’s stock equipment, for hydraulic, dredging and ship lifting operations; they are not also applied to the handling devices of a group of special equipment (warping, cross-dredging, frame-hoisting, grabbing winches, etc.), hand tackles of machinery spaces, grabbing devices (grabs, platforms, cargo nets, slings, etc.), lifts with load capacity of less than 250 kg, as well as auxiliary devices which are not parts of lifts: turnbuckles, hooks, sockets, turnpikes.

6.2 GENERAL TECHNICAL REQUIREMENTS

6.2.1 The cargo handling appliances installed on the open decks shall be so designed as to provide their safe operation in the range of ambient temperatures from minus 20 to plus 40 °C, unless otherwise provided in technical documentation.

The cargo handling appliances shall be designed for operation with the ship listed to 5° and trimmed to 2° at the maximum jib radius.

6.2.2 The fixed axles supporting the drums, blocks, wheels, rollers and other rotating parts shall be fastened and locked.

6.2.3 All bolt, key and wedge connections of the cargo handling gear shall be locked against inadvertent loosening and disconnection.

6.2.4 Loose gear and cargo-gripping devices shall be attached so that any bending or twisting is excluded and swivels may be used to prevent this.

The swivels may be arranged with a ball or roller support to enable regular lubrication.

6.2.5 The ends of ropes attached to the metal structures or components shall be fitted with thimbles or be built in the rope sockets or clamps. The ends of ropes attached to the winch drums may be without thimbles or sockets. The rope shall be secured on a drum. Pressing devices using force of friction shall be at least two.

6.2.6 The controls of the machinery of the cargo handling appliances shall be so made and fitted that the direction of movement of the handles, levers or wheels is correspondent to the resultant movement of the load, for example pulling the upright lever, lifting the slanted lever, turning the control wheel clockwise shall correspond to lifting the load; turning the control wheel clockwise or shifting the lever to the right shall correspond to the right-hand slew; pulling the upright lever, lifting the slanted lever, turning the control wheel clockwise shall correspond to decrease of jib radius.

Handles, levers or wheels shall be marked and be easy in use and provided with means of fixing them in the neutral position and when step-controlled, in the operational position. The term “fixing” means keeping the handle in definite positions when the force
required for shifting the handle out of these positions is greater than the force required for moving the handle between the fixed positions.

The force to be applied for operation of controls shall not exceed 120 N in case of manual drive and 300 N in case of foot drive.

The force required for change of predetermined positions of control handles, wheels, pedals and other controls shall not exceed 40 N (see also 1.6.13).

The machinery and installation controls shall be marked with their function.

The wheels shall be provided with inscription and symbol (arrow) indicating direction of their revolution for opening and/or operating the equipment.

The travel of the control lever, mm, shall not exceed:

- for manual control 600
- for foot control 250

The push-buttons shall be provided with spring-loaded or other means for self-return to "stop" position when the operator removes his hand or relaxes its force. This means shall not require application of forces which can cause tiredness of the operator.

6.2.7 The controls of the cargo handling appliances (controllers, knife-switches, push-buttons) designed for transportation of dangerous cargoes (explosives, acids, radioactive substances and other substances covered by definition in 2.2.33 Part 0 of the Rules), as well as controls used in the portable remote control shall be provided with means for self-return to zero (neutral) position. Cargo-handling appliances intended for any purpose shall be provided with self-return controls.

If, with remote control, the operator does not see the winch drum, provision shall be made for arrangements ensuring the correct reeling of the rope onto the drum.

6.2.8 The valves connecting the deck steam line to cargo machinery shall be arranged close to the latter, be accessible at any time and easily closed by hand.

6.2.9 Power, hydraulic and steam drives, machinery, gear drives, systems and piping and electrical equipment, components, as well as loose ones, shall comply with the requirements of this and the other Parts of the Rules.

6.2.10 The cargo-handling cranes shall be provided with safety devices to prevent the falling of the load or uncontrolled movement of the derrick or crane when switching the crane machinery and disconnecting machinery from the drives or in case of power supply interruption of power drives and control circuits.

6.2.11 The hoisting and topping machinery shall be so made that lowering the cargo or the boom is possible with the help of the drive only. In the emergency, provision shall be made for means enabling safe lowering and stopping the cargo.

6.2.12 All the machinery of the cargo handling appliance except for the screw-driven machinery with self-braking or machinery driven with hydraulic cylinders provided with the pilot controlled check valves shall be equipped with the automatic brake providing braking with the safety factor as specified in the relevant paragraphs of the present Section of the Rules.

The safety factor of braking is the ratio of the torque exerted by the brake to the static torque created on the braking shaft by the maximum design tension in the rope (for machinery performing hoisting and luffing crane jibs) and for machinery with the rigid kinematic coupling by the design value of the inertia loads (the machinery used for turning and moving cranes and for luffing crane jibs).

Design shall be such that the operating solenoid could not be excited by the return electromotive force from any engine, by parasitic or stray currents or by the puncture of insulation. In emergency, when power supply of electric drives of the hoisting machinery is interrupted, provision shall be made for manual release of brakes.

Brakes shall be of the closed-band type, unless otherwise specified in the relevant paragraphs of the Rules. Brakes shall be applied smoothly, without shocks, be provided
with means of adjustment and enable replacement of the friction parts.

Forces applied to the adjustable brakes shall not exceed 160 N on the handle or lever and 310 N on the brake pedal. For brakes used regularly in the normal duty cycle, the above stated forces shall be reduced at least by two times. Brake pedals shall have a non-slip surface.

Where several items of machinery are served by one drive, brakes shall be fitted on each item.

If there is a brake between the motor and the drive it shall be placed from the side of the drive. Means shall be provided for keeping the adjustable disconnected brakes in the closed position. The braking forces induced by brake loads are not permitted.

The brake springs shall be of a push type and provided with the guides such as bushes or holders.

The brake drum (pulley) shall be protected against water, snow, ice, oils or fats unless the brake is designed for operation without such protection.

6.2.13 The hoisting and topping machinery of the cargo handling appliances, designed specially for loading, unloading and transportation of dangerous cargoes shall be provided with two independent of each other brakes of the closed-band type ensuring the holding of cargo (boom) in stopping the power supply.

The brakes can be designed for consecutive operation.

When there is a coupling between motor and reduction gear one brake shall be fitted on the half-coupling located from the side of the reduction gear or on the shaft of reduction gear. The second brake may be placed on the motor shaft or at any point of the driving mechanism. The brakes shall be located in such a way that in order to check reliable operation of the brake the other brake may be disconnected.

6.2.14 The width of winch drums shall be such that the number of rope layers reeled up onto the drum shall not be more than three. For winches equipped with cable layers or rope clamps with grooves, drums capable of reeling on more than three layers may be used.

In calculating the winch strength, the tensile strength of the rope upper layer shall be used for determination of the torque. Diameters of drums shall be not less than 18 rope diameters. The drums of the motor-driven winches where the rope is reeled onto the drum in a single layer, shall have screw-shaped grooves. Flanges of drums and those of grooved multi-layered drums shall have such outside diameters that will permit the flange to extend at least 2.5 rope diameters above the upper layer of the rope.

Angle of feeding the rope on the drum yoke shall not exceed 4° to the plane perpendicular to the longitudinal axis of the drum.

With the cargo-gripping device at the lowest operating position, there must remain not less than three turns of rope on the drum; this also relates to the drums of the luffing crane jibs machinery in their respective extreme positions. For drums where the rope is reeled onto the drum in a single layer, at least two turns shall remain.

6.2.15 In electrically-driven cargo handling appliances the power supply to motors after interruption shall not be possible until the corresponding handles, wheels, and levers of control stations are set in zero (neutral) position. It is recommended that means for signalling availability of voltage in the power line as well as for visual signalling of switching on and switching off the electric drive are provided on the control post or near it.

Hydraulic and pneumatic drive control systems shall be equipped with arrangements preventing power supply after the outage to the hydraulic and pneumatic systems (power cylinders) until the controls are set in zero (neutral) position. It is recommended that means for signalling availability of voltage in the power line (ambient pressure) and switching on and switching off drives are provided.

6.2.16 Faults in the control system of the electric drives shall not cause unauthorized starting or continuation of running of the drives (instead of immediate stopping), changing the direction of their rotation or di-
rection of motion of actuators or releasing the brakes, or their remaining released.

6.2.17 The control circuits of the independent electric drives of topping winches and preventer guy winches shall be such that any possibility of switching on or continuing the operation of the drives with the load hooked is excluded.

6.2.18 A safety button or an emergency switch for disconnecting the electric drive main circuit shall be provided within reach of the operator's hand, immediately at the control station of the cargo handling appliance. They shall be painted red and bear an inscription “Stop”.

6.2.19 A switch may be provided in the main circuit of the cargo handling gear accessible for authorized persons from the ship’s staff only, otherwise, a means shall be provided for locking the switch in the “off” position.

6.2.20 It is not permitted to use bare trolley wires for feeding current to travelling cargo-handling appliances.

6.2.21 Any possibility of switching on the electric drive inadvertently shall be excluded. The motor of each machinery or hydraulic pump shall start as soon as the control handle moves from the neutral position.

6.2.22 Electric drives of the cargo handling appliances fitted with artificial ventilation shall be provided with locking arrangement shall be provided not to make the drive starting or continuing its running possible when the ventilation is cut off.

6.2.23 To prevent spark formation during cargo handling operations on board of oil tankers, oil recovery vessels, ships carrying hazardous cargoes, the loose gears (cargo hooks, shackles, swivels, chains, etc.) shall be of a sparkproof type.

6.2.24 Pivoting part of the ship’s derricks except the boom shall not project outboard the ship’s hull.

Ship’s derricks shall be positioned so as to avoid cargo transferring above the stationary accommodation ladders and their gangway platforms.

6.3 MATERIALS, HEAT TREATMENT AND WELDING

6.3.1 The materials used in the manufacture of the stress-bearing metal structures, parts and machinery of cargo handling appliances, as well as lifts, heat treatment of forgings and castings, as well as welding, shall comply with the requirements of Part X of the Rules.

6.3.2 All stress-bearing elements of metal structures, machinery and gear except for those specified in 6.3.3, shall be manufactured from steel.

6.3.3 Cast iron and steel may be used for manufacture of the following items:

1. toothed, worm and travelling wheels (cast iron is permitted only for the hand-operated cargo handling appliances);
2. worm wheels with a bronze rim;
3. load drums and whipping drums of winches, gear boxes and sheaves of blocks;
4. brake shoes, drum brackets and bearing bodies;
5. cable sheaves and wedges of pressed clips of the ropes in lifts.

6.3.4 Steel grade depending on ambient temperature shall be selected in accordance with the Fig. 6.3.4.

6.3.5 The killed steel shall be used for stress-bearing elements of gear. The quality grade of steel shall ensure operation of the cargo handling appliances on the open decks at the temperatures below zero. Steel for stress-bearing elements of loose gear shall have the certified elongation after testing five samples not less than 20%.

6.3.6 Steel used for manufacture of chains for cargo handling appliances intended for operation at temperatures below minus 20 °C shall meet the requirements for steel grade 2 or 3 referred to in Table 2.5.7, Part X of the Rules.
Selection of steel grade

The chains for which no heat treatment is required for improvement of quality or increase of strength shall be normalized after manufacture.

6.3.7 All steel castings and forgings as part of gear of cargo handling appliances, as well as welded items with stressed intersecting welded joints or those max. 20 mm apart shall be subject to heat treatment for stress relieving (castings from alloyed steels shall be quenched and tempered, castings and forgings from carbon steels shall be quenched and tempered or normalized and electrically welded items shall be annealed).

Heat treatment of gear shall be carried out in enclosed (muffle) furnaces. The heat treatment procedure is established depending on the grade of steel, purpose and dimensions of gear.

Heat treatment shall be confirmed by the manufacturer’s document.

6.3.8 Higher strength materials (see 2.2 Part X of the Rules) for components and fixtures are allowed with regard to the prescribed operating temperatures. It shall be ensured that the relative elongation of the final product material at the normal temperature shall be not less than 12%.

6.3.9 The dimensions of the fillet welds shall be set as small as possible by reasons of strength or process conditions. The leg length of the fillet weld shall not be less than 4 mm and max. 1,2 of the least thickness of the welded items. The length of the fillet weld shall be not less than 50 mm.

Fillet welds up to 300 mm long used for tee-joints of the essential items are subject to non-destructive testing along the whole length (see 8.3 Pat X of the Rules).

6.3.10 Round- and ring-shaped items of small diameter (chains, rod shrouds) shall be joined by resistance welding.

6.3.11 Butt welded joints of tubular, box-shaped elements shall be made with complete penetration to the weld joint root but when the welded joints are not accessible this shall be made using the steel gasket plate.

6.3.12 In structures with enclosed circuit where access from inside is not provided the use of plug welds is permitted for fastening the closing plate on the inside framing (diaphragms).

6.4 CALCULATIONS, DESIGN LOADS AND STRESSES

6.4.1 Methods of calculation of forces and stresses in elements of the cargo handling appliances are developed by the designer and approved by the River Register.

6.4.2 The design load of the ship’s derricks and floating cranes is determined by summing up the following:

1. load weight of lifted cargo and the loose gripping gear;
2. self-weight of crane structures;
3. wind load acting on the deck crane and cargo in the longitudinal and transverse directions. Wind load is determined in accordance with the national standards\(^1\) and depends on the dynamic wind pressure assumed due to

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\(^1\) GOST 25938, GOST 1451.
the combinations of upper structures design loads (see 6.4.12 and 6.4.13). Stress calculations for the components of the crane shall include angles of inclinations specified in 6.4.6. For cranes intended for operation at rolling the design loads shall meet the requirements of 6.4.7, 6.4.12 and 6.4.13;

4 loads due to the swinging of the cargo and inclination of the ship (pontoon).

6.4.3 In calculating the wind load, the wind side of the crane is assumed as the surface area perpendicular to the horizontal direction of the wind due to the design features of the crane. For continuous-sided constructions it is the area outlined by the contour of the construction, and for latticed constructions it is the area outlined by the contour of the construction and diminished by the area of gaps between the beams.

For cranes with equally high beams running at different levels (continuous-sided and latticed), one behind another, and with the distance between the beams less than the beam height, the wind side shall be assumed as the total area of the front beam; if the distance between the beams is equal to the height of the beam or more, but less than its double height, the wind side shall be the total area of the front beam and 50 per cent of the area of each sequent beam; if the distance between the beams is equal to the double height of the beam or more, the wind side shall be the total area of all the beams. Portions of rear beams not covered by the front beam shall be fully included in calculations.

For tubular constructions the design wind side may be reduced by multiplying it by the correction factor of 0.75.

The design wind area of the load \( A \) is the actual area outlined by the contour of the load to be lifted with the crane. It can also be assumed due to the static data. With no data available the following formula may be applied, m²:

\[
A = -0.881 + 3.726Q - 0.63Q \ln Q + 0.0028Q^2 - 1.595\sqrt{Q} \ln Q,
\]

where \( Q \) — lifting capacity, t.

The formula (6.4.3) is applicable in the range of lifting capacity varying from 0.05 to 100 t.

6.4.4 A combined allowance for sheave friction and wire rope stiffness shall be taken as equal to 5% per plain sheave and to 2% per roller bearing.

Variation of forces in the structural components of the cargo gear when the ropes are being pulled through the blocks shall be considered for the motion or motions that are the most unfavourable for the gear (hoisting or lowering the load or topping the boom).

6.4.5 Where special measures, for example ballasting of the ship, are provided to reduce the heel angles when working with heavy-lift derricks, these measures shall be taken into consideration in calculating the resultant load on the guy.

6.4.6 Stress calculations for structural members of ship's derricks and floating cranes shall be made both at static angles of heel and trim of 5° and 2°, respectively, and during the work in sea. If, under conditions of service, the angles of heel and trim are greater than those stated above, the actual values shall be taken for calculation.

6.4.7 Stress calculations for structural members of ship's derricks and floating cranes shall be made also when the possibility of rolling in still water as a result of wind gusts or dropping of the load is taken into consideration.

6.4.8 The absence of a risk of jack-knifing of the derrick crane booms on rope suspension to the side opposite to its outreach shall be confirmed by the calculations or the functional test.

The jack-knifing is unlikely to occur if there is a positive tension (more 30 min) in the boom ropes when the outreach of the boom is minimum and the inclination of the boom to the side opposite to its outreach is the least that could occur in service (but not less than angles of heel and trim of 5° and 2°, respectively), the wind pressure from the side of the outreach being as specified in 6.4.2.3.
6.4.9 In calculating stresses in the compressed beams and compressed beams with the applied bending moment, the effect of the longitudinal forces shall be considered with due degree of precision allowing for the eccentricity of their application, structural flexure and initial camber due to their self-weight per stress value.

6.4.10 The design modulus of elasticity for steel wire ropes shall be taken equal to 98 GPa.

6.4.11 In calculating the strength of the riveted or bolted structures, the cross-sectional areas and section moduli shall be determined with regard to surface area covered by holes. In stability calculations the surface area covered by holes shall not be taken into account.

6.4.12 The design loads for the upper structures shall be taken as follows:

.1 load weight of lifted cargo and loose gripping gear;
.2 self-weight of structures and equipment arranged on these structures;
.3 wind load (due to dynamic wind pressure on the load and metal structures) shall be taken not less than 400 Pa for maximum loads in working condition, not less than 125 Pa for load drop and not less than 2000 Pa for maximum load in non-working condition. The design dynamic wind pressure in non-working condition may be reduced if data on wind load of the water area and actual conditions of service of the upper structures of the floating crane is submitted, but in all cases, it is taken at least 1000 Pa;
.4 inertia forces, resulting from hoisting (lowering) the load with the hoisting device, when operating in acceleration (deceleration) duty. Dynamic load factor shall be calculated by a method approved by the River Register for compliance with requirements of the Rules; in any case, its value for the upper structures shall be not less than 1.15, when operating in still water, and not less than 1.4 when operating at rolling;
.5 inertia forces arising from deceleration (acceleration) of jib luffing, slewing or machinery travel as well as load swinging in still water and at rolling. These forces are taken into account based on data on angles of deviation of load, determined by method approved by the River Register for compliance with requirements of the Rules; in all cases, the angles shall be not less than 3° far and wide the boom at a time. The angles shall be counted off from the vertical with maximum dynamic heel of the upper structure;
.6 centrifugal inertia forces resulting from the upper structure turn;
.7 vertical inertia forces acting on the load in case of rolling. These forces are considered by means of dynamic load factor, determined by a method approved by the River Register for compliance with requirements of the Rules. In all cases the value of dynamic load factor shall be taken at least 1.25.

6.4.13 The combinations of design loads of the upper structures shall be taken as follows:

.1 normal loads in working condition. The loads to be included in the calculations are: weight load of lifted load masses and cargo-gripping devices, mass of components of cargo-handling appliance, inertia forces in case of smooth starting and braking, the average wind pressure complying with the dynamic wind pressure on the construction and the cargo 250 Pa. It is considered in calculation of endurance (fatigue strength) of the upper structure carried out by a method approved by the River Register for compliance with requirements of the Rules. The obtained value of safety factor shall be determined by the calculation given in 6.4.13.2;
.2 maximum loads in working condition.

Case I. The upper structure is motionless (the hoisting machinery alone is working); the hoisting machinery operates for lifting the load from the ground (deck) or for braking while lowering the load, drop of load.

The loads to be included in the calculations are: weight load of lifted load masses and cargo-gripping devices allowing for the maximum dynamic load factor; mass of components of cargo-handling appliance; inertia loads resulted from the drop of load and from ship's rolling in sea and in still water; wind
pressure on the crane structure and the load in the operating condition; load resulted from swinging of cargo on the flexible suspension with the maximum vertical tilt angle 16°.

The dynamic load factor shall be calculated with due account to the maximum speed of load handling, rigidity of the structure (the ropes included) and the structure and load masses both for hoisting (tearing off) and braking (when lowering) the load.

In determining the load, slewing component of the floating crane upper structure shall be considered when two movements are combined:

- lifting — lowering of cargo and crane slewing;
- crane slewing and luffing;
- hoisting — lowering of cargo and luffing.

Case 2. The upper structure when the load is in motion (traveling, luffing or slewing), one of the mechanisms operating in acceleration or deceleration duty.

The loads to be included in the calculations are: weight load of lifted load masses and cargo-gripping devices and mass of components of cargo-handling appliance with due allowance for the shock factor while moving along the track, inertia forces resulted from rolling; maximum horizontal inertia forces of masses of the upper structure and the load allowing for skidding of wheels, disconnection of limiting moment couplings or other design features; wind pressure on the upper structure and the load in the operating condition and load resulted from swinging of the cargo on flexible suspension.

The shock factor is determined depending on the travelling speed and availability of the rail joints;

- maximum load under non-working condition.

The loads to be included in the calculations are: the self-weight of construction components and wind pressure corresponding to the dynamic pressure on the construction in non-working condition.

In well-founded cases, owing to peculiarities of service or the upper structure the design loads may be required, which will differ from those stated above.

**6.5 ALLOWABLE STRESSES, SAFETY FACTORS AND STABILITY RESERVES**

6.5.1 The stresses in metal structures of the ship’s derricks and floating cranes when subject to the action of the design loads shall not exceed the allowable values as specified in Table 6.5.1 with regard to requirements of 6.5.2 to 6.5.5.

<table>
<thead>
<tr>
<th>Lifting capacity, t</th>
<th>Allowable stress expressed as a portion of yield stress of materials $\sigma / R_{th}$</th>
<th>Safety factor $R_{th} / \sigma$</th>
<th>Dynamic factor $\psi_l$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\leq$ 5</td>
<td>0.40</td>
<td>2.50</td>
<td>1.75</td>
</tr>
<tr>
<td>10</td>
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<td>2.08</td>
<td>1.46</td>
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<td>$\geq$ 75</td>
<td>0.60</td>
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<td>1.17</td>
</tr>
</tbody>
</table>

Note. Intermediate values of parameters are determined by linear interpolation.

For manually operated cargo-handling appliances the allowable stresses may be taken equal to 0.6 of the yield stress of the material $R_{th}$.

The safe working load (SWL) (see 1.2.1.17) of ropes (wire, natural fibre and synthetic) shall not exceed the design breaking load divided by the safety factor in accordance with Table 6.5.7-2 and Table 6.5.8.

6.5.2 The values of allowable stresses as specified in Table 6.5.1 include the dynamic load factors determined by the following formula:

$$\psi_l = 0.7 R_{th} / \sigma,$$  \hspace{1cm} (6.5.2-1)

where $\psi_l$ — standard dynamic factor obtained as the ratio of the maximum expected dynamic load to the static stress when subjected to design loads.

When the maximum cargo hoisting or lowering speed is more than $1.33(\psi_l - 1)$, m/s...
the dynamic load factor must be verified by calculation using the formula:

$$\psi = 1 + 0.318 \sqrt{f_a}$$, \hspace{1cm} (6.5.2-2)

where $\psi$ — dynamic factor obtained as the ratio of the dynamic load to its static value;

$v$ — maximum speed of load movement, m/s;

$f_a$ — calculated vertical shifting of the load suspension point (including variations in the rope length) under the action of static force induced by cargo weight equal to the lifting capacity, m.

If the calculated dynamic load factor $\psi$ exceeds $\psi_l$, the allowable stresses as specified in Table 6.5.1 shall be multiplied by $\psi_l/\psi$. If the calculated dynamic load factor is equal to or less than $\psi_N$, the allowable stresses are assumed to be equal to those given in Table 6.5.1.

6.5.3 In calculating the allowable stresses in metal structures, the design yield stress to be taken with regard to its value as established in national standard for material or technical documentation; in all cases, however, it shall be taken max. 0.70 of the minimum tensile strength (ultimate resistance) established in the technical documentation developed by the designer and approved by the River Register.

6.5.4 The requirements of 6.5.2 apply to tensile, compression and bending stresses as well as equivalent stresses. The values of transition coefficients to allowable stresses for other types of deformation, as well as for calculation of welded, riveted and bolt joints shall be taken according to Tables 6.5.4-1 to 6.5.4-3.

Transition coefficients are applicable if the holes for rivets and finished bolts after reaming are drilled in the joined items at one go or separately through jib plates. Allowable stresses for field rivets shall be reduced up to 10%. Allowable stresses for flat-top countersunk-head rivets and for raised-top countersunk-head rivets shall be reduced up to 20%. As initial values for calculating of allowable stresses for rivet and bolt joints, allowable stresses determined for tension and cut due to the yield stress of material for rivets and bolts, and for crumpling — due to the yield stress of material of metal structures shall be assumed.

<table>
<thead>
<tr>
<th>Type of deformation</th>
<th>Transition coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tension, compression, bending</td>
<td>1.00</td>
</tr>
<tr>
<td>Shear</td>
<td>0.60</td>
</tr>
<tr>
<td>Local crumpling at a dense contact</td>
<td>0.75</td>
</tr>
<tr>
<td>Butt end surface crumpling (with fitting)</td>
<td>1.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of weld</th>
<th>Type of deformation</th>
<th>Transition coefficient for welding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butt weld</td>
<td>Tension</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>Compression</td>
<td>0.85</td>
</tr>
<tr>
<td></td>
<td>Shear</td>
<td>0.60</td>
</tr>
<tr>
<td>Fillet weld</td>
<td>Shear</td>
<td>0.70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of joint</th>
<th>Transition coefficient to allowable stresses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rivets with the half-round head</td>
<td>0.60 (the head tearing off) 0.80 2.0</td>
</tr>
<tr>
<td>Bolts for reamed holes</td>
<td>0.70 0.70 2.0</td>
</tr>
<tr>
<td>Bolts for connections with a gap between a bolt and a hole</td>
<td>0.70 0.60 1.2</td>
</tr>
</tbody>
</table>

6.5.5 The design and scantlings of the loose gear shall be such as to exclude residual deformations and breaking when tested with an ultimate load. For items which are manufactured based on technical documentation approved by the River Register are considered as satisfying this requirement. The allowable stresses in the non-standard fixed gear shall not exceed the allowable stresses assumed for metal structures (see 6.5.1 to 6.5.4).

6.5.6 The safety factor of chains of cargo-gripping devices relative to breaking load shall be at least 4.
Crane operation mode

<table>
<thead>
<tr>
<th>The qualitative characteristic of a class of usage</th>
<th>Load factor K up to 0.125</th>
<th>Load factor K over 0.125 to 0.25</th>
<th>Load factor K over 0.25 to 0.50</th>
<th>Load factor K over 0.50 to 1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rare usage up to 800</td>
<td>M1</td>
<td>M1</td>
<td>M1</td>
<td>M1</td>
</tr>
<tr>
<td>Rare usage over 800 to 1600</td>
<td>M1</td>
<td>M1</td>
<td>M2</td>
<td>M3</td>
</tr>
<tr>
<td>Regular usage of low intensity 1200 to 3200</td>
<td>M2</td>
<td>M3</td>
<td>M4</td>
<td>M5</td>
</tr>
<tr>
<td>Regular usage of average intensity 3200 to 6300</td>
<td>M3</td>
<td>M4</td>
<td>M5</td>
<td>M6</td>
</tr>
<tr>
<td>Irregular intensive usage at work with two changes 6300 to 12500</td>
<td>M3</td>
<td>M4</td>
<td>M5</td>
<td>M6</td>
</tr>
<tr>
<td>Intensive usage at work with three changes 12500 to 25000</td>
<td>M4</td>
<td>M5</td>
<td>M6</td>
<td>—</td>
</tr>
<tr>
<td>Rather intensive usage at work with three changes 25000 to 50000</td>
<td>M5</td>
<td>M6</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

6.5.7 The safety factor of steel load and boom cables of a crane relative to breaking load of the rope as the whole shall depend on the operating mode (Table 6.5.7-1) and be not less than the values given in Table 6.5.7-2.

<table>
<thead>
<tr>
<th>Operating mode in accordance with Table 6.5.7-1</th>
<th>Safety factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>3.15</td>
</tr>
<tr>
<td>M2</td>
<td>3.35</td>
</tr>
<tr>
<td>M3</td>
<td>3.55</td>
</tr>
<tr>
<td>M4</td>
<td>4.00</td>
</tr>
<tr>
<td>M5</td>
<td>4.50</td>
</tr>
<tr>
<td>M6</td>
<td>5.60</td>
</tr>
</tbody>
</table>

Load factor $K$ used in Table 6.5.7-1 is determined by the formula:

$$K = \sum_{i=1}^{n} t_i \left( \frac{P_i}{P_{\text{max}}} \right)^3 \sum_{i=1}^{n} t_i$$  \hspace{1cm} (6.5.7)

where $t_i$ — average duration of use of the mechanism at partial load levels, h:

$$t_i = t_1, t_2, ..., t_n;$$

$$\sum_{i=1}^{n} t_i$$ — total duration of use of the mechanism with various load levels, h:

$$\sum_{i=1}^{n} t_i = t_1 + t_2 + ... + t_n;$$

$P_i$ — load levels with average duration $t_i$ at general application of the given mechanism, H:

$$P_i = P_1, P_2, ..., P_n;$$

$n$ — the total number of levels of loadings;

$P_{\text{max}}$ — value of the greatest load applied to the mechanism, N.

6.5.8 The safety factor of the natural fibre ropes relative to breaking load of the rope as a whole shall be not less than the values given in Table 6.5.8, and that of the synthetic fibre ropes not less than 10.

<table>
<thead>
<tr>
<th>Nominal rope diameter, mm</th>
<th>Safety factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>14 to 17</td>
<td>10</td>
</tr>
<tr>
<td>18 to 23</td>
<td>8</td>
</tr>
<tr>
<td>24 to 39</td>
<td>7</td>
</tr>
<tr>
<td>40 and over</td>
<td>6</td>
</tr>
</tbody>
</table>

6.5.9 The stability factor shall not be less than the safety factor (relative to yield point) for the compression of the same element.

6.5.10 The compressed beams shall be checked for overall stability and their thin-walled elements, for local stability.

Beams subject to transverse bending shall be checked for overall stability and their vertical walls and compressed belts for local-stability.

6.5.11 In calculating the buckling strength of beams compressed axially shall be taken of the initial eccentricity of the longitudinal forces and the initial bend; the total value of both shall not be less than 0.001 of the beam length.

6.5.12 Flexibility of each portion of the axially compressed fabricated beams, taken
between the connecting members (strips or lattices) shall be not more than 40.

6.5.13 Flexibility of compressed and expanded members of metallic structures shall not exceed the values given in Table 6.5.13.

**Table 6.5.13**

<table>
<thead>
<tr>
<th>Members of metallic structures</th>
<th>Flexibility of members</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Compressed</td>
</tr>
<tr>
<td>Chords of main trusses</td>
<td>120</td>
</tr>
<tr>
<td>Single-beam structures of jibs</td>
<td>150</td>
</tr>
<tr>
<td>Other beams of main trusses</td>
<td>150</td>
</tr>
<tr>
<td>Chords of auxiliary trusses</td>
<td>150</td>
</tr>
<tr>
<td>All other beams</td>
<td>250</td>
</tr>
</tbody>
</table>

In calculating flexibility the design length shall be included in the calculations with due allowance for the type of end fixing. The flexibility shall be calculated within the plane of main inertia moments.

6.5.14 The design loads in metallic constructions of the upper structures of floating cranes shall not exceed the allowable values given in Table 6.5.14 with due regard for requirements of 6.5.3 and 6.5.4.

**Table 6.5.14**

<table>
<thead>
<tr>
<th>Combination of maximum loads</th>
<th>Allowable stresses in portions of yield stress $\sigma/\sigma_y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under working conditions</td>
<td>0.70</td>
</tr>
<tr>
<td>Under non-working conditions</td>
<td>0.75</td>
</tr>
</tbody>
</table>

For the upper structures of simple construction the allowable stresses shall be taken in accordance with 6.5.1.

**6.6 STRENGTH CALCULATION OF CARGO-HANDLING MACHINERY**

6.6.1 In calculating, the following shall be taken into account:

1. Safety factors of machinery items shall be so that no after-effects or deformations (except manufacturing defects) remain after testing the machinery with a proof load in accordance with the present Rules;
2. In calculating the design loads on items of the machinery, the loads on cargo handling appliances and conditions for which stresses in the structural elements were determined (see 6.4 and 6.5) shall be included;
3. Safety factors of machinery items shall not be less than those obtained for the metal structures of cargo handling appliances according to 6.5.

**6.7 GENERAL REQUIREMENTS TO CRANES**

6.7.1 Cranes shall be designed and installed in such a way as to obviate the risk of jack-knifing (see also 6.10.1).

6.7.2 Cranes with derricks on rope suspension shall be designed in such a way as to obviate the risk of jack-knifing of the derrick to the side opposite to the outreach; due account shall be taken of heel and trim which are likely to be encountered in service including the use of limiting stops (see also 6.4.8).

6.7.3 The design of cranes must enable them to be securely attached to the ship’s hull. The hull framing shall be adequately stiffened in the place where a crane will be installed.

6.7.4 Provision shall be made to ensure efficient fastening of cranes, their booms when stowed for sea (see GOST 25938).

**6.8 SAFETY DEVICES OF CRANES**

6.8.1 The cranes shall be provided with limit switches that automatically come into action to stop the following machinery in the extreme positions:

1. Hoisting;
2. Jib luffing;
3. Travel of the crane and its crab;
4. Slewing of the crane (for cranes with the limited slewing angle);
5. Interlocking of the grab in the uppermost position if the whole rope of the closing winch is hauled.
The possibility of the reverse movement must be provided for the above items after the limit switches have operated.

Where closing switches are provided for shunting the limit switches (e.g. for lowering the jib when the crane is being stowed for sea), only the authorized persons from the ship’s staff shall be admitted to them.

On cranes where the jib, when lowering, superimposes on the cargo-gripping device, the hoisting machinery shall be switched off simultaneously with the topping machinery adjusted to jib lowering.

6.8.2 On cranes where the safe working load varies with jib radii, an automatic indicator of safe working load corresponding to the appropriate radii shall be provided. The indicator scale shall be visible for operator from his workplace.

6.8.3 The cranes stability of which depends upon the load position on the hook shall be provided with limit load switches automatically disconnecting the crane hoisting and jib luffing machinery when an attempt is made to lift the load exceeding the safe working load of the crane for a given outreach by more than 10%. The possibility of lowering of the load and jib decreasing shall be provided after the limit load switches have operated.

Limit load switches may be fitted on cranes of other types.

6.8.4 Cranes with varying jib radii and constant safe working load over the whole radius shall be provided with limit-load switches of hoisting machinery.

The limit load switch shall actuate to prevent lifting the load with weight exceeding safe working load by more than 10%. After limit load switch actuation the lowering of the load shall be provided.

Short-time overloading (up to 0.5 ±0.1 s) shall not cause the limit-load switch to actuate.

6.8.5 The cargo handling appliances with the stationary control station or radio and telecontrol shall be equipped with audible warning device which shall be put into operation by the operator at any time. The audible warning signal shall be clear and distinctive among other audible signals and operation noises.

6.9 MACHINERY OF THE CRANES

6.9.1 The safety factor of braking for the hoisting machinery shall not be less than 1.5. For topping (luffing) machinery the safety factor of braking shall not be less than 2; the static moment on the braking shaft due to the weight of the load, weight of the jib and the counterbalance, shall be determined for such a position of the jib in which the moment is maximum.

In case of two or more brakes at a drive, the safety factor of braking shall be set at an assumption that all the load is hold by one brake.

The safety factor of braking of each of these brakes shall not be less than 1.25 at simultaneous operation of all brakes. If operation of brakes is not simultaneous, the safety factors of braking shall be taken the same as for individual brakes.

6.9.2 Slewing and travelling motion brakes shall act automatically or be controlled; the open-type brake may be used subject to technical justification.

The safety factor of braking shall not be less than 1.0.

The safety factor of braking for the upper structures of the floating cranes and for the cranes intended for operation at rolling shall be not less than 1.5.

Hand-braked slewing and travelling motion machinery shall be provided with stops against uncontrolled slewing or movement of the cranes.

6.10 Travelling of Cranes

6.10.1 Stability of the travelling cranes shall be ensured under all conditions, whether in service or not. The stability shall be checked in accordance with procedures developed by the designer and approved by the River Register.

6.10.2 Travelling cranes shall be provided with permanent anchoring devices or reverse rollers.
Travelling cranes shall be provided with efficient anticreeping devices (detachable anchoring devices, etc.).

6.10.3 Fastening of cranes when stowed for sea shall be such to prevent any movement of the crane.

6.10.4 Running wheels of the crane travelling machinery shall be designed or fitted to prevent their derailment. Fastening of rails to the ship’s framing shall withstand the worst combination of service loads.

6.10.5 Frames of the travelling cranes shall be provided with bearing struts arranged at a distance of not more than 20 mm from the rails and may be used as supports in case of breaking of wheels or axles. These struts shall be designed for the maximum permissible load.

6.10.6 Power-driven travelling cranes shall be provided with buffers against possible contact with stops. The buffers may be fitted on stops.

6.10.7 The stops shall be provided at both ends of the railway designed to withstand the impact of crane moving with the maximum working load at the nominal speed.

6.10.8 If several cranes travel at one railway, they shall be provided with stops so as to prevent collision.

6.11 COUNTERBALANCES AND METAL STRUCTURES OF CRANES

6.11.1 The crane counterbalance shall be designed to prevent specified weight change in service. Separate cargoes in the counterbalance shall be fastened to exclude their displacement.

6.11.2 The adjustable counterbalances shall either move automatically when the jib radii are being changed or be provided with a counterbalance position indicator. In case of adjustable counterbalance moving, the possibility of its jamming shall be excluded. It is recommended to provide the interlocking of the jib radii in case of failure in the adjustable counterbalance.

6.11.3 The thickness of walls of stress-bearing elements of crane metal structures which are readily accessible for inspection and maintenance from all sides shall not be less than 4 mm; the thickness of walls of box-type or tubular metal structures inaccessible for inspection and maintenance from the inside shall be at least 6 mm.

The maximum structural camber of the crane boom shall not exceed $1/1500$ of its length, both in the plane of suspension and in the plane normal to it.

6.11.4 The construction liable to loads, especially to vibration load, dangerous for breaking away rivet heads shall be avoided. Tensile stresses in rivets with countersunk or half-countersunk heads shall not be allowed.

The holes for rivets and finished bolts shall be drilled in the joined items at one go or separately through jib plates.

The diameter of rivets and bolts used in the stress bearing items connections shall not be less than 12 mm.

The maximum thickness of riveted items shall not exceed five diameters of the rivet.

The number of rivets securing the item in the assembly or arranged on either side of the joint shall be at least two.

6.12 CRANE CABS

6.12.1 Stationary crane control stations shall be positioned in specially equipped cabs.

6.12.2 Crane cabs shall be positioned in a way as to provide the operator with the possibility to observe the gripping appliances and the cargo during the whole cycle of crane operation. The operator shall be provided with 230° horizontal area of view from his working place. It is recommended to increase the angle up to 270°.

6.12.3 The cab shall be positioned in such a way as to preclude the possibility of cab damage in case of abruption or other damages of constructions supporting the jib (cables, ties, etc.).

6.12.4 Crane cabs shall be closed from all sides. View area surfaces shall be glazed.
possibility of glass surfaces cleaning shall be provided, as well as their heating to prevent sweat or icing. Lower glass surfaces, where the operator can get on, shall be protected with gratings withstanding human weight. The cab shall be provided with ventilation and heating system in accordance with national standards\(^1\).

The requirements concerning cab closing from all sides are not applicable to ship’s der- ricks.

6.12.5 Crane cab dimensions shall provide free access to the equipment.

6.12.6 The door of the cab shall open outside and be provided with a fenced platform located in front of the door. Provision shall be also made for a cab locking device if the operator is absent.

6.12.7 Cab access and entry shall not be blocked up by machinery, cables and other appliances.

The leading of cargo and jib ropes through the crane cab, as well as the positioning of drums for ropes winding are not allowed.

6.12.8 The crane cab shall be equipped with the stationary adjustable seat in regard to the height and horizontal plane.

6.12.9 The cab of the floating crane shall be at least 1.9 m high; the height of cabs of ship’s derricks may be reduced down to 1.5 m where the sitting posture of the operator is implied.

In floating cranes cabs the possibility of presence of at least one person except the operator is to be implied.

6.13 UPPER STRUCTURES OF THE FLOATING CRANES.
CRANES MOUNTED ON FLOATING DOCKS

6.13.1 The upper structures of floating cranes and cranes installed on floating docks are subject to all the requirements of the present Section of the Rules applied to the cranes, as well as to additional requirements specified in 6.13.2 to 6.13.11.

6.13.2 In case of inclinations permissible for the floating crane in service, the counterbalance and slewing element of the crane, except the jib, shall not extend outboard.

The accommodation and service spaces shall be located away from the cargo transferring area and their entrances - away from the cargo transferring area at least 1000 mm from the maximum extending members of the slewing element. Moreover, if it is possible, the entrances shall be led to the area opposite to the slewing area of the crane.

6.13.3 The upper structures shall be provided with safety arrangements which comply with the requirements of 6.8.1 to 6.8.4.

6.13.4 Self-weight of the jib appliance shall be balanced by means of the counterbalance.

6.13.5 The wall thickness of the stress-bearing elements of metallic structures shall be at least, mm:
- for profiles painted from the inside and outside: 5.0
- for closed box sections: 6.0
- for hot-rolled or extruded tubes with hermetically closed ends: 5.0

6.13.6 The thickness of the profile plate in welded structures shall be not less than 30 mm and not less than 50 mm in riveted and bolted structures.

6.13.7 The ratio of the drum (block) and rope diameters shall be determined with regard to operation mode of the crane machinery (see Table 6.5.7-1). The least allowable values of this ratio in accordance to the mode are indicated in Table 6.13.7.

6.13.8 The metallic structures shall be so designed as to provide an access for their examination from inside. Enclosed cavities of metallic structures inaccessible for the examination shall be subjected to air pressure test with the excessive pressure of 0.03 MPa; foaming solution shall also be applied to the outside walls of structures. Technical condition of metallic structures forming enclosed cavities may be checked using non-destructive test methods. In such a case, tests are omitted.

\(^{1}\) GOST 5534, GOST 12.1.005.
### Table 6.13.7

<table>
<thead>
<tr>
<th>Load-handling device</th>
<th>Group of machinery mode</th>
<th>Ratio of the drum (block) diameter to the rope diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load-handling machines of all types, except for cranes and winches</td>
<td>M1; M2; M3</td>
<td>18</td>
</tr>
<tr>
<td>Load-handling machines of all types, except for cranes and winches</td>
<td>M4</td>
<td>20</td>
</tr>
<tr>
<td>Load-handling machines of all types, except for cranes and winches</td>
<td>M5</td>
<td>25</td>
</tr>
<tr>
<td>Load-handling machines of all types, except for cranes and winches</td>
<td>M6</td>
<td>30</td>
</tr>
<tr>
<td>Assembly mechanisms</td>
<td>M1</td>
<td>35</td>
</tr>
<tr>
<td>Electric tackles</td>
<td>M3</td>
<td>22</td>
</tr>
<tr>
<td>Grabbing winches</td>
<td>M6</td>
<td>30</td>
</tr>
<tr>
<td>Blocks of grabs</td>
<td>M6</td>
<td>18</td>
</tr>
</tbody>
</table>

6.13.9 The upper structure of the prototype floating crane intended for operation at rolling shall be subject to the full-scale tests in natural conditions with maximum values of rolling and wind pressure.

6.13.10 The upper structure of the serial floating crane intended for operation at rolling shall be additionally tested with the proof load equal to 1.4 of the safe working load with maximum radius of the jib along the ship. The proof load shall be applied statically. The time of keeping the upper structure under the load shall be at least 5 min.

6.13.11 Static and dynamic tests of cranes are performed in accordance with 7.2.9 and 7.2.11 RTSC.

### 6.14 GEARS OF THE CRANES

6.14.1 The mating of parts in movable joints shall ensure the correct adjoining of bearing surfaces with the minimum permissible radial and axial clearances in service.

6.14.2 The safe working load (SWL) of the loose gear other than blocks shall be defined as maximum load (weight) for which the gear is designed.

6.14.3 Fixed gear shall be so attached to the metal framework as to ensure required strength and uniform distribution of forces in the metal structure members.

6.14.4 The cargo hooks and shackles shall be forged. The hooks used in cargo handling operations shall be so designed as to exclude any possibility of slipping off slings or catching the projected structures while lifting the load. The cargo hooks, shackles and their fastening parts shall not have any protruding parts and sharp edges.

For cranes with safe working load of 10 t and more, ramshorn hooks may be used, which shall meet the requirements imposed to cargo hooks of standard design. Ramshorn hooks for floating cranes and cargo handling appliances installed on industrial ships may be designed without special arrangement for protection from slipping off slings or catching the projected structures.

6.14.5 Swivels of cargo hooks and blocks are to be forged. The nut of the swivel shall be efficiently secured against turning on the thread.

6.14.6 The shackles shall be forged straight with pins that are screwed into the eye plates or secured with nuts. Pins or nuts shall be locked.

Club shackles may be used as cargo shackles and also for the natural and synthetic fibre ropes.

The shackles for securing the components in cargo suspension system (hooks, counterweights, triangular bars and chains) shall have pins with half-countersunk heads without nuts.

The shackles shall be so arranged as to ensure the correct fitting of pins and to prevent twisting of the rope.

6.14.7 The block shall be made so that the rope will not be jammed between the block cheek plates and the sheave.

Axles of sheaves shall be locked against turning and axial displacement. The block sheaves supported by plain bearings shall be provided with bushes made of antifriction materials (e.g. bronze).

The eyes and lugs of the blocks shall be forged integral with the latter; the nuts of swivels shall be locked. Blocks with open hooks shall not be used in cargo handling appliances.
The diameter of sheaves for wire ropes measured in the bottom of the groove shall not be less than 14 times the rope diameter for ropes movable under load, and at least 9 times the rope diameter for ropes fixed under load.

The diameter of sheaves intended for use with natural or synthetic fibre ropes shall not be less than 5 times the diameter of the rope.

The groove shall be so shaped as to accept the rope tightly and without jamming.

The diameter of the sheave and the shape of the groove shall be assumed basing on the diameter of the rope with the minimum acceptable calculated tensile strength of wires.

The depth of the sheave grooves shall be more than 1.4 of the rope diameter depending on the purpose and place of installation of the sheave and in any case shall be at least one rope diameter.

The groove bottom shall have circular contour forming a segment with an angle of at least 120°. The radius of the groove shall exceed the rope radius by at least 10%.

6.14.8 The triangular and multiangular plates used for connection of ropes or chains shall be so thick as to suit the shackles secured to them and to leave a minimum clearance enabling shackles to move easily; symmetrically welded reinforcing pads may be used.

6.14.9 Forged eye ends and screwed forks shall be forged integral with the rigging screws; use of rigging screws with hooks is not allowed. The design of the rigging screws shall ensure locking of tightened screws.

The fork may be fastened on the thread and locked subject to technical justification.

6.14.10 Thimbles shall be made of steel by smith forging or punching. Cast-in thimbles may be used subject to technical justification.

6.14.11 Chains used in cargo handling appliances, where not covered by this Section of the Rules shall comply with the requirements of 3.7 and be electric-welded (contact welding) or forge-welded.

Short link chains with terminal links for attachment (calibrated chains, when used on sprocket wheels) are to be used as cargo chains.

6.14.12 Connecting links (of anchor chain links type) in cargo handling appliances may be used for fastening the ropes and chains to the metal structures and components.

Connecting links shall be forged. The joint shall be designed to provide reliable connection of the both halves of link and stopping to prevent their spontaneous disconnection.

The link installation shall provide their free movement in the holes of the components to be connected and prevent the link operation with cocking.

6.15 SHIP’S LIFTS

6.15.1 When designing cargo ship’s lifts, follow Guidelines P.005-2004 “Technical requirements to cargo ship’s lifts”.

6.16 CARGO BOOMS

6.16.1 When designing cargo booms, the requirements of 6.1 to 6.14 shall be observed.

6.17 DOCUMENTS AND MARKING

6.17.1 Cargo-handling appliances manufactured at technical supervision of the River Register shall be provided with the Cargo Handling Survey Report.

6.17.2 Each loose gear, except lifts, tested with a proof load and accepted shall be marked and stamped by the manufacturer’s technical control service. The marking shall contain the following data:

1. cargo weight, corresponding to safe working load (stated after the inscription “SWL”), t;
2. month and year of test;
3. individual identification symbol of the item;
4. stamp of the manufacturer;
5. steel quality grade mark in accordance with Table 6.17.3.5.

The stamps shall be positioned on items as follows:
blocks, on the strap or, if there is no strap, on the cheek plate between the eye and the sheave axle pin;

swivels, on the wide side of the bow-piece close to the eye Shank;

swivel of blocks, on the side surface close to the pin;

hooks, on any side close to the eye, on ramshorn hooks — on wide portion between the horns; rope sockets — on the tapered portion; cross-heads of blocks — in the middle of the side surface;

shackles, on any side of the shackle close to the eye;

connecting chains, on one side surface; identification number — on the centre insert of the lock;

rigging screws, on tubular body; identification number — on the eye or lug;

chains, on end link of each union end. Where small dimensions of items make stamping difficult, the date of test may be omitted.

6.17.3 Cranes, if the results of the examination are satisfactory, shall be marked with:

.1 safe working load, t;

.2 month and year of test;

.3 identification number;

.4 stamp of the River Register (if tested under the River Register supervision) and manufacturer’s stamp.

In addition to above mentioned data, marking shall be also applied in accordance with paragraph 14 of Technical Regulations1.

6.17.4 All cargo handling appliances tested with a proof load shall, if the results of the examination are satisfactory, be marked with:

.1 safe working load, t, the allowable maximum and minimum jib radii; where the safe working load varies with the jib radii - the maximum and the minimum jib radii for each appropriate safe working load (see Table 6.17.4.1);

6.17.5 The places of marking shall be distinctly painted.

The stamp shall have a rounded outline to avoid concentration of stresses and shall not be put at welded areas.

6.17.6 If it is found that marking according to 6.17.4.1 is unnecessary large, data on in-

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1Technical Regulations on Safety of Inland Marine Transport Facilities approved by Decree of the

Intermediate values of the safe working load of the crane may be reduced.

In such cases, the cranes where the safe working load varies with jib radii shall be provided with a metal plate containing jib radii for each appropriate safe working load.

The marks shall be made with paint, in Arabic figures at least 80 mm high.

On metal structures of cranes the marks shall be punched or welded on.
7 HOISTABLE WHEELHOUSES

7.1 GENERAL PROVISIONS

7.1.1 A hoistable wheelhouse and its hoisting and lowering arrangement shall be designed so that to prevent a risk of human injury due to unprovoked contact of wheelhouse with persons on board.

Provision shall be made for immediate unlocking of fixing devices for all service conditions as well as in case of emergency power cut-off to wheelhouse hoisting and lowering arrangement.

7.1.2 Hoisting and lowering of the wheelhouse shall not impede the operations performed from the wheelhouse.

7.1.3 The wheelhouse shall be lowered at all service conditions by one person from the deckhouse. Emergency lowering shall be performed both from deckhouse and from a separate control station located outside the deckhouse. The possibility of lowering a wheelhouse shall be excluded under rolling conditions.

7.2 TECHNICAL REQUIREMENTS TO DESIGN OF HOISTING AND LOWERING ARRANGEMENT

7.2.1 The drive gear of the arrangement shall be designed for lifted load equal at least 1.5 times the weight of fully equipped wheelhouse with watch personnel.

7.2.2 The hoisting and lowering arrangement shall be designed to stop and hold the wheelhouse in any specified position, provision shall be made for safe entrance and exit from the wheelhouse.

7.2.3 The hoisting gear of the wheelhouse shall operate without jamming at all possible cases of asymmetric load as well as at all heel and trim angles which may occur in normal operation of the ship.

7.2.4 The hoisting gear shall ensure transient slowing down of the wheelhouse when reaching the upper and lower utmost positions or buffer devices shall be provided.

7.3 TECHNICAL REQUIREMENTS TO HOISTING ARRANGEMENT DRIVE

7.3.1 The hoisting and lowering arrangement of the wheelhouse shall have a power drive capable of operating at all normal service conditions.

The wheelhouse shall be lowered by power drive or under action of its own weight.

7.3.2 The wheelhouse shall be equipped with emergency lowering arrangement which actuates independently of the main hoisting and lowering drive.

The emergency lowering arrangement shall be designed to provide for a smooth and controlled lowering of the wheelhouse under action of its own weight.

7.3.3 The hoisting and lowering arrangement of the wheelhouse shall ensure its emergency lowering at a speed at least equal to lowering speed under normal service conditions using main power-operated hoisting and lowering drive (see 7.3.1).

7.3.4 No self-braking hoisting gears are allowed.
8 LIFE-SAVING APPLIANCES

8.1 GENERAL REQUIREMENTS

8.1.1 The present Section of the Rules establishes standards for equipment of inland navigation ships with life-saving appliances as well as requirements for their stowage and arrangement on board a ship.

8.1.2 Standards of supply of ships with life-saving appliances are assigned on condition that a ship is intended to operate in basins of a category corresponding with her class.

8.1.3 For non-crewed non-self-propelled ships not intended for carrying people, life-saving appliances may be omitted.

8.1.4 In ships operating northwards 66°30' N. L. and in the Baikal lake and being equipped with free-fall liferafts not fitted with devices which provide boarding without getting into the water, an immersion suit shall be provided for each crew member engaged in rescue operations on such liferafts.

8.1.5 Life-saving appliances used on board ships shall have compliance certificates of the River Register.

8.1.6 Unless otherwise specified in this Section, collective and individual life-saving appliances shall:

.1 not be damaged in stowage at air temperature from –30 to +50 °C;
.2 be operable at water temperature from 0 °C to 30 °C;
.3 be rot-proof, corrosion-resistant and withstand water, oil, oil products or fungal exposure during service life;
.4 be resistant to deterioration (maintain its qualities) where exposed to sunlight during service life;
.5 be coloured orange which assists in detection;
.6 be fitted with retro-reflective material where it will assist in detection, with due regard of the requirements of the present Section;
.7 retain properties as required by the present Section when used at rolling (if designed for such a purpose);
.8 provide for safe launching by one person from its onboard location (for collective life-saving appliances).

8.1.7 The service life of life-saving appliances and outfit items which are subject to deterioration with age shall be determined. Such life-saving appliances and outfit items shall be marked with a means determining their age or the date by which they shall be replaced.

8.1.8 Materials used for manufacture of life-saving appliances and arrangements as well as welded structures shall comply with the requirements of Part X of the Rules.

8.1.9 Requirements of the present Section other than those stated in 8.1.6 to 8.1.8, 8.2.2.2, 8.2.16, 8.4.1, 8.4.15, 8.4.17, 8.4.19, 8.4.21, 8.4.24 to 8.4.27, 8.4.31, 8.4.35 to 8.4.51, 8.4.54 to 8.4.56, 8.5.5 to 8.5.7, 8.9.3, 8.9.5, 8.9.6, 8.10.4, 8.10.6, 8.10.8 and 8.10.17 apply also to ships in service.

8.1.10 If prior to approval of the Rules, the ship is not covered by requirements similar to those of this Section, when performing re-equipment, modernization or re-classification of such a ship life-saving appliances shall be brought in conformity with requirements of the present Section of the Rules.

8.1.11 Hull of a landing-stage, fire-watch craft or jetty pontoon throughout the periphery in the waterline area shall be guarded by a rescue handrail which is to be attached to the hull in the points located at a distance 0.5 – 1 m from each other.

8.1.12 Passenger ships, crew boats and special purpose ships shall be equipped with ar-
rangements for safe disembarkation in shallow water, on shore or on the other ship.

8.1.13 Inflatable life-saving appliances on board ships shall comply with the following requirements:

.1 comprise at least two separate pneumatic chambers;

.2 be automatically inflated when launched, manual pumping of chambers shall be provided;

.3 take and retain a stable trim regardless of the load even in case of half inflated pneumatic chambers.

8.1.14 The requirements of 8.2.13 to 8.2.20, 8.3.5, 8.4.22 to 8.4.25, 8.5.21 to 8.5.22, 8.6 are mandatory for ships engaged on coastal voyages. Ships engaged on international voyages as well as passenger ships of III-IV class regardless of the type of voyages (coastal or international) shall comply with the requirements of the International Convention for the Safety of Life at Sea, 1974, as amended (SOLAS), and the International Life-Saving Appliance Code (LSA Code), 1997.

Ships which navigate in areas of Northern Sea Route shall comply with requirements of navigation in the water area of the Northern Sea Route approved by the Order of the Ministry of Transport of Russia No.7 dated 17.01.2013.

8.1.15 On board the ships in service the life-saving appliances or means, after their replacement or additional introduction, shall comply with the requirements of 8.4 to 8.10.

8.2 STANDARDS FOR EQUIPPING WITH COLLECTIVE LIFE-SAVING APPLIANCES

8.2.1 Passenger ships, crew boats, special purpose ships, self-propelled and non-self-propelled ferries shall be equipped with collective life-saving appliances according to the standards specified in Table 8.2.1 with due regard of 8.2.12 and 8.3.6.

In these ships intended for operation in basins of P, O categories southwards 66°30' S.L. lifeboats may be replaced with liferafts provided that 8.2.3 is met.

<table>
<thead>
<tr>
<th>Navigation area category</th>
<th>Length of ship, m</th>
<th>Number of people provided with collective life-saving appliances, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lifeboats</td>
<td>liferafts</td>
</tr>
<tr>
<td>M-II, O-II, M</td>
<td>≤ 30</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>&gt; 30</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>≤ 30</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>&gt; 30</td>
<td>85</td>
</tr>
<tr>
<td>P</td>
<td>≤ 30</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>&gt; 30</td>
<td>10</td>
</tr>
<tr>
<td>J</td>
<td>≤ 30</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>&gt; 30</td>
<td>—</td>
</tr>
</tbody>
</table>

* For ships entering lakes and reservoirs of P category as well as in river estuaries of O category with sea navigation conditions.

8.2.2 Non-passenger ships of M-III class shall be fitted with collective life-saving appliances according to the standards specified in Table 8.2.2.

<table>
<thead>
<tr>
<th>Types of ships</th>
<th>Number of persons provided with life-saving appliances, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>lifeboats</td>
<td>liferafts</td>
</tr>
<tr>
<td>Dry cargo ships with ( L \geq 85 ) m and oil tankers</td>
<td>100*</td>
</tr>
<tr>
<td>Dry cargo ships with ( L &lt; 85 ) m</td>
<td>—</td>
</tr>
<tr>
<td>Tugboats, ice-breakers and industrial ships</td>
<td>100*</td>
</tr>
</tbody>
</table>

* Norm of supply on each side

When using the data in Table 8.2.2, the following shall be considered:

.1 Dry cargo ships (85 m long and longer) shall be fitted with semi-enclosed or enclosed lifeboats which comply with the requirements of LSA Code.

Instead of the above mentioned lifeboats, cargo ships may be fitted with one or more lifeboats being launched by a free fall from the after part, of appropriate design, with total capacity sufficient for the total number of
persons on board the ship. The ship shall be additionally provided with one or more liferafts of the same capacity on each side, on one side the liferafts shall be served by launching arrangements;

.2 oil tankers for oil cargoes with flash point of 60 °C and below shall be fitted with fire-protected lifeboats complying with requirements of 8.4.52 to 8.4.56;

.3 in tugboats, ice breakers and industrial ships less than 85 m in length lifeboats may be replaced with liferafts;

.4 in dry cargo ships less than 85 m in length as well as tugboats, ice breakers, industrial ships all liferafts shall be of the same capacity. Where the liferafts cannot be moved from side to side, the liferaft capacity on each side shall be at least 150%.

Note. The possibility of moving liferafts from side to side is considered ensures when liferafts are located as such to provide for their free movement from side to side at a single deck level, the total weight of one liferaft shall be less than 185 kg.

8.2.3 Passenger ships of M-ПП and M class and more than 30 m in length shall be equipped with engined lifeboat.

Passenger ships more than 30 m in length intended for operation in basins of M, O-ПП and O category or lakes, reservoirs and areas with sea navigation conditions of P category shall be equipped with at least one engined lifeboat or rescue boat for towing all liferafts. The rest lifeboats may be replaced with liferafts.

8.2.4 Equipment of hydrofoil craft, hovercraft and skimming ships with collective life-saving appliances shall comply with the standards specified in Table 8.2.4.

Table 8.2.4

<table>
<thead>
<tr>
<th>Navigation area category</th>
<th>Number of people provided with liferafts, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>100</td>
</tr>
<tr>
<td>O</td>
<td>20</td>
</tr>
<tr>
<td>P*</td>
<td>10</td>
</tr>
<tr>
<td>JI</td>
<td>—</td>
</tr>
</tbody>
</table>

* For ships entering lakes and reservoirs of P category as well as in river estuaries of O category with sea navigation conditions.

8.2.5 Equipment with collective life-saving appliances of self-propelled ships (other than those mentioned in 8.2.1 and 8.2.4), and crewed non-self-propelled oil tankers shall comply with the standards specified in Table 8.2.5, the requirements of 8.2.6 and 8.2.7 shall be fulfilled.

Table 8.2.5

<table>
<thead>
<tr>
<th>Navigation area category</th>
<th>Length of ship, m</th>
<th>Number of people provided with collective life-saving appliances, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>lifeboats</td>
</tr>
<tr>
<td>M</td>
<td>≤ 30</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>&gt; 30</td>
<td>—</td>
</tr>
<tr>
<td>O</td>
<td>≤ 30</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>&gt; 30</td>
<td>—</td>
</tr>
<tr>
<td>P</td>
<td>≤ 30</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>&gt; 30</td>
<td>—</td>
</tr>
<tr>
<td>JI</td>
<td>any</td>
<td>—</td>
</tr>
</tbody>
</table>

* For ships entering lakes and reservoirs of P category as well as in river estuaries of О category with sea navigation conditions.

In ships less than 30 m in length intended for operation in basins of M and O categories and ships over 30 m in length intended for operation in a basin of P category equipped with lifeboats for 100% of persons, liferafts may be omitted.

8.2.6 Non-passenger ships permitted for carriage of organized groups of people shall be equipped with collective life-saving appliances according to Table 8.2.5 with due regard of the total number of persons on board.

8.2.7 In ships mentioned in 8.2.5 which are intended for operation in basins of M and O categories other than oil tankers intended for oil transportation with flash point of 60°C and below, lifeboats may be replaced with liferafts.

8.2.8 Equipment of non-self-propelled other than oil tankers with collective life-saving appliances shall comply with the standards specified in Table 8.2.8, the requirements of 8.1.3 and 8.2.9 shall be fulfilled.

8.2.9 In non-self-propelled ships intended for operation in basins of P and JI categories other than those mentioned in 8.2.1, collective life-saving appliances may be omitted.
Table 8.2.8  Standards for equipping non-self-propelled other than oil tankers with collective life-saving appliances

<table>
<thead>
<tr>
<th>Navigation area category</th>
<th>Length of ship, m</th>
<th>Number of people provided with collective life-saving appliances, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>liferafts</td>
<td>life-saving buoyancy aids</td>
</tr>
<tr>
<td>M</td>
<td>any</td>
<td>100</td>
</tr>
<tr>
<td>O</td>
<td>≤ 30</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>&gt; 30</td>
<td>100</td>
</tr>
</tbody>
</table>

8.2.10 Passenger ships of M-ΠΠ, O-ΠΠ, M and O class over 30 m in length in which free-fall liferafts are applied, shall be provided with embarkation slides preventing people from getting into the water. This requirement does not apply to ships in which boarding on the liferafts is carried out from the deck located less than 1.5 m above the waterline corresponding to the minimum operational draught.

8.2.11 Ships intended for operation in the Baikal lake or permanent operation in the Onega and the Ladoga lakes, ships intended for operation in basins of M and O categories northwards 66°30’, passenger ships and crew boats intended for operation in basins of P category in the Ob river northwards 66°35’, and other areas northwards 66°30’ shall be equipped with lifeboats and liferafts for 100% of persons onboard.

8.2.12 Where capacity of lifeboats provided on board the ship exceeds the established standards, a number of liferafts or life-saving buoyancy aids may be reduced to the number corresponding to the total number of persons provided with collective life-saving appliances.

Where capacity of liferafts exceeds the established standards, a number of life-saving devices may be reduced to the total number corresponding to the total number of persons provided with collective life-saving appliances.

8.2.13 Ships of M-СП class shall be fitted with a rescue boat (see 8.6). One of lifeboats may be considered as a rescue boat if it complies with the requirements for rescue boats.

8.2.14 Equipment of passenger ships, crew boats and special purpose ships of М-ΠΠ and О-ΠΠ class with life-saving appliances shall be taken according to the standards specified for passenger ships operating in basins of Μ category.

8.2.15 Equipment of cargo vessels, tugboats, catcher boats and self-propelled industrial ships of M-ΠΠ and O-ΠΠ class with life-saving appliances shall comply with standards specified in Table 8.2.15.

Table 8.2.15  Standards for equipping cargo vessels, tugboats, catcher boats and self-propelled industrial ships of M-ΠΠ and O-ΠΠ class with life-saving appliances

<table>
<thead>
<tr>
<th>Length of ship, m</th>
<th>Number of people provided with collective life-saving appliances, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lifeboats</td>
</tr>
<tr>
<td>≤30</td>
<td>50*</td>
</tr>
<tr>
<td>&gt;30</td>
<td>100*</td>
</tr>
</tbody>
</table>

* Norm of supply on each side

Notes. 1. In ships less than 30 m in length lifeboats may be replaced with liferafts.
2. In ships with length from 30 to 85 m lifeboats may be replaced with liferafts (for 100% of persons on each side), all liferafts shall be of the same capacity.
3. In ships with length of 85 m and more 50% of lifeboats may be replaced with liferafts provided that at least one lifeboat is provided on each side.

8.2.16 Oil tankers intended for carriage of oil products with a flash point of 60°C and below shall be fitted with fire-protected lifeboats.

8.2.17 Crewed non-self-propelled ships shall be fitted with life-saving appliances as the following:
for ships of M-ΠΠ class as for self-propelled cargo vessels of M class;
for ships of O-ΠΠ class as for non-self-propelled cargo vessels of М class.

8.2.18 Hydrofoil craft of M-ΠΠ and O-ΠΠ class shall be fitted with life-saving appliances according to the standards specified for hovercraft of Μ class.

8.2.19 For ships of М-ΠΠ class intended for operation in the Laptev Sea and in the East Siberian Sea in the area from the estuary of the Jana River to the estuary of the Kolyma River, collective life-saving appliances shall meet the requirements for ships of М-СП class.
8.2.20 For cargo ships of М-СП, М-ПП and О-ПП class where the horizontal distance from the extreme end of the stem or stern of the ship to the nearest end of the closest collective life-saving means is more than 100 m shall carry, in addition to life-saving appliances required by 8.2.2 and 8.2.15, a liferaft for at least 4 persons stowed as far forward or aft as practicable, or one liferaft as far forward and another liferaft as far aft as practicable. This liferaft or liferafts shall be securely fastened so as to permit manual release.

8.3 STANDARDS FOR EQUIPPING WITH INDIVIDUAL LIFE-SAVING APPLIANCES

8.3.1 All ships shall be provided with lifejackets for 100% of persons on board.

In floating objects moored on shore provided with deck ladders ensuring safe evacuation of people on shore, lifejackets may be omitted.

8.3.2 Ships of М, О, Р and ІІ class as well as cargo ships, tugboats, catcher boats and self-propelled industrial ships of М-ПП and О-ПП class shall be provided with additional lifejackets for 2% of people on board.

Ships of М-СП, М-ПП, О-ПП, М and О class shall be provided with additional lifejackets in the wheelhouse and the machinery space for the attending personnel in a number equal to a number of the persons on duty.

Lifejackets shall be arranged in readily accessible areas. Stowage positions of lifejackets shall be clearly indicated with inscriptions.

8.3.3 Hydrofoil craft of М-СП, М-ПП and О-ПП class shall be provided with additional lifejackets for 5% of people onboard.

8.3.4 Provision shall be made for lifejackets suitable for children with weight from 15 to 35 kg inclusive, at least 10% of the number of passengers onboard. At least 100% children onboard shall be provided with children lifejackets.

8.3.5 Equipment of ships with lifebuoys shall comply with the standards specified in Table 8.3.5.

8.3.6 Self-propelled and non-self-propelled ferries intended for operation on crossroads on rivers and canals of Р and ІІ categories are allowed to be equipped with one lifebuoy per each 5 m of the overall length of the ferry; here, life-saving appliances provided by Table 8.2.1 are not required.

8.3.7 Floating objects of 30 m and less in length shall be equipped with two lifebuoys on each deck, and those over 30 m in length – with four lifebuoys on each deck. One of the lifebuoys located on the main deck shall be equipped with a lifeline.

8.3.8 In ships up to 30 m in length intended for navigation in basins of Р, Р and ІІ categories all life-saving buoyancy aids may be replaced with lifebuoys assuming that one lifebuoy may hold two persons; here, lifebuoys required by Table 8.3.5 may be considered.

8.3.9 An immersion suit shall be provided for each crew member of a rescue boat for ships of М-СП class.

8.3.10 Ships of М-СП class shall be fitted with immersion suits for each person being rescued on free-fall liferafts when embarkation facilities to liferafts without getting into water are not available on board the ship.

8.4 LIFEBOATS

General requirements

8.4.1 Strength of lifeboats and lifting hooks for ships of М, О, Р and ІІ class shall be sufficient to provide for their launching when loaded with full permitted complement of persons and equipment.

The strength of lifeboats and lifting hooks for ships of М-СП, М-ПП and О-ПП class shall be sufficient to withstand the load as specified in this paragraph without residual deformation after its removal:

1. For metallic lifeboats – 1.25 times the total weight of such a lifeboat with a full complement of people and equipment; or

2. For non-metallic lifeboards – 2 times the total weight of such a lifeboat with a full complement of people and equipment; or
### Standards for equipping ships with lifebuoys

<table>
<thead>
<tr>
<th>Types of ships</th>
<th>Length of a ship $L$, m</th>
<th>Number of lifebuoys</th>
<th>with self-igniting buoy</th>
<th>with rescue line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger ships, crew boats, special purpose ships, self-propelled ferries of M, O, P and J class</td>
<td>$15 &lt; L \leq 30$</td>
<td>4</td>
<td>1</td>
<td>$\geq 1^*$</td>
</tr>
<tr>
<td></td>
<td>$30 &lt; L \leq 60$</td>
<td>8</td>
<td>1</td>
<td>$\geq 1^*$</td>
</tr>
<tr>
<td></td>
<td>$&gt; 60$</td>
<td>12</td>
<td>1</td>
<td>$\geq 1^*$</td>
</tr>
<tr>
<td>Hydrofoil craft, hovercraft, skimmers of M, O, P and J class</td>
<td>$15 &lt; L \leq 30$</td>
<td>2</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$30 &lt; L \leq 60$</td>
<td>4</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$&gt; 60$</td>
<td>6</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>Cargo ships, tugboats, catcher boats and self-propelled industrial ships of M, O, P and J class</td>
<td>$\leq 30$</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$30 &lt; L \leq 60$</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$&gt; 60$</td>
<td>8</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Non-self-propelled except non-crewed non-self-propelled transport ships (barges) of M, O, P and J class</td>
<td>$\leq 30$</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$&gt; 30$</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dry cargo ships and oil tankers of M-СП class</td>
<td>$L \geq 85$</td>
<td>10</td>
<td>$5^1$</td>
<td>$2^2$</td>
</tr>
<tr>
<td>Dry cargo ships of M-СП class</td>
<td>$85 &gt; L \geq 31$</td>
<td>8</td>
<td>$4^1$</td>
<td>$2^2$</td>
</tr>
<tr>
<td></td>
<td>$L \leq 31$</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Tugboats, ice breakers, catcher boats and industrial ships of M-СП class</td>
<td>any</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Passenger ships, crew boats and special purpose ships of М-ПП and О-ПП class</td>
<td>$\leq 15$</td>
<td>2</td>
<td>1</td>
<td>$\geq 1^*$</td>
</tr>
<tr>
<td></td>
<td>$15 &lt; L \leq 30$</td>
<td>4</td>
<td>1</td>
<td>$\geq 1^*$</td>
</tr>
<tr>
<td></td>
<td>$30 &lt; L \leq 60$</td>
<td>8</td>
<td>2</td>
<td>$\geq 1^*$</td>
</tr>
<tr>
<td></td>
<td>$&gt; 60$</td>
<td>12</td>
<td>2</td>
<td>$\geq 1^*$</td>
</tr>
<tr>
<td>Cargo ships, tugboats, catcher boats and self-propelled industrial ships of М-ПП and О-ПП class</td>
<td>$\leq 30$</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>$&gt; 30$</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

* Standard of supply on each deck at each side.

1 At least two lifebuoys shall be fitted with self-activating smoke signals.

2 One on each side of a ship.

3 All exposed deck areas intended for passengers shall be provided with lifebuoys on both sides of the ship with maximum 20 m spacing between them. Passenger ships in service are to be equipped with lifebuoys as per the requirements of the present note by the time of ordinary survey of the ship but not later than 19.07.2021.

Each lifeboat for ships of М-СП, М-ПП and О-ПП class launched by means of falls shall have a sufficient strength to withstand an impact on the ship side when fully completed with people and equipment and fitted with skids or fender bars when moving in a direction normal to the ship side at a speed of at least 3.5 m/s as well as drop into water from height of at least 3 m. This requirement does not apply to freefall lifeboats.

Points for lifeboat hanging shall be located in such a way as to ensure lifeboat launching in fully loaded condition without loss of stability.

**8.4.2** The lifeboat filled with water up to the top edge of a gunwale with a full complement of persons and equipment shall keep buoyancy and stability. Here, the lifeboat shall not have a list and the freeboard shall be not less than 20 mm.

The lifeboat shall keep stability and stable trim when held by people being in water in a complement not exceeding that as indicated on its marking in accordance with 8.4.11.

**8.4.3** Stability of the lifeboat is considered sufficient when the residual freeboard is at least 100 mm when the lifeboat is loaded with 50% of the number of persons permitted to accommodate seated to one side of the centreline.
8.4.4 Buoyancy of the lifeboat filled with water with a specified complement of persons and equipment shall be ensured by buoyancy of the material of the lifeboat or by water-tight air boxes or buoyant material.

Material of the lifeboat and elements which ensure buoyancy (water-tight air boxes, benches, buoyant material) shall comply with requirements of 8.1.6.

The ships of М-СП, М-ПР and О-ПР class shall be additionally provided with buoyant material in a quantity ensuring the buoyancy force of 280 N per person out of complement allowed for accommodation in the lifeboat. The buoyant material shall not be fitted outside the lifeboat except the material provided in excess of the required above mentioned quantity.

8.4.5 Length of the water-tight air boxes shall not exceed 600 mm. Air boxes of up to 1200 mm in length may be fitted provided that transverse tight bulkheads and longitudinal stiffeners are arranged inside.

8.4.6 In order to ensure lifeboat damage stability (see 8.4.2) the air boxes or buoyant material shall be arranged along the sides. Where it is impracticable, they may be located in the bow, the stern and the midship under thwarts but not by the bottom.

8.4.7 Where detachable boxes are installed, the easy replacement, protection against damage shall be provided and their shifting shall be avoided.

8.4.8 Freeboard of the lifeboat in fully loaded condition shall be not less than 0.4 of its side depth.

8.4.9 The number of persons permitted to be accommodated in the lifeboat is preliminary defined by gross capacity taking at least 0.226 m³ per person. Finally, the number of persons shall be established at testing to determine the number of adults which may accommodate in the lifeboat so as not to obstruct rowing and conning.

8.4.10 Surface of the gunwale and the sheer strake at a width of 150 mm shall be painted with orange colour.

8.4.11 On the sheer strake at either sides in the bow of the lifeboat a water-proof marking shall be made indicating a ship’s name, a shipowner, main dimensions of the lifeboat, permissible number of people to be accommodated and date of testing.

8.4.12 Lifeboats shall be so designed or be fitted with special arrangements as to provide a possibility of boarding of helpless people out of water.

8.4.13 Lifeboat equipment shall be taken according to the standards specified in Table 8.4.13. Items of lifeboat equipment shall have an appropriate package and excepting boat-hooks be adequately secured on assigned places in the lifeboat and be stowed in boxes and compartments. The equipment shall be so secured as not to interfere with the abandonment procedures.

When using the data in Table 8.2.2, the following shall be considered:

1. strength of sea anchor, hawser and tripping line specified in 8 Table 8.4.13 shall be adequate for all sea conditions;

2. a painter specified in 9 Table 8.4.13 shall be of at least 14 mm in diameter with a breaking load not less than 0.35 of the lifeboat’s weight with full complement of persons, equipment and the engine and of length not less than twice the distance from the stowage position of the lifeboat on board the ship to the waterline of the ship in the lightest sea-going condition in sea water or 15 m, whichever is the greater. One painter attached to the release device shall be placed at the forward end of the lifeboat and the other shall be firmly secured at or near the stem of the lifeboat and be ready for use;

3. watertight electric torch specified in 19 Table 8.4.13 shall be suitable for Morse signalling and be available with one spare set of batteries and one spare bulb in watertight packaging;

4. illustrated table of the life-saving signals specified in 21 Table 8.4.13 shall be either in waterproof packaging or made of waterproof material;
### Standards for equipping lifeboats

<table>
<thead>
<tr>
<th>Description</th>
<th>Water basin category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Set of buoyant oars with pins or crutches attached to the boat by lanyards or chains</td>
<td>M-CTI</td>
</tr>
<tr>
<td>2. Standby oars with pins or crutches</td>
<td></td>
</tr>
<tr>
<td>3. Boat-hook of a length equal to oar length</td>
<td>2</td>
</tr>
<tr>
<td>4. Bailer</td>
<td>1</td>
</tr>
<tr>
<td>5. Bucket</td>
<td>2</td>
</tr>
<tr>
<td>6. Survival manual</td>
<td>1</td>
</tr>
<tr>
<td>7. Compass with luminous card or provided with suitable means of illumination of the diameter sufficient for normal reading of indications, with binnacle</td>
<td>1</td>
</tr>
<tr>
<td>8. Sea anchor with a hawser of at least three times the lifeboat’s length and a tripping line</td>
<td>1</td>
</tr>
<tr>
<td>9. Painter</td>
<td>2</td>
</tr>
<tr>
<td>10. Throwing line at least 15 m in length</td>
<td></td>
</tr>
<tr>
<td>11. Hatchet with lanyard</td>
<td>2</td>
</tr>
<tr>
<td>12. Potable water ration</td>
<td>1</td>
</tr>
<tr>
<td>13. Rustproof dipper with lanyard</td>
<td>1</td>
</tr>
<tr>
<td>14. Rustproof graduated drinking vessel of the approved type</td>
<td>1</td>
</tr>
<tr>
<td>15. Food ration</td>
<td>1</td>
</tr>
<tr>
<td>16. Rocket parachute flares</td>
<td>4</td>
</tr>
<tr>
<td>17. Red hand flare</td>
<td>6</td>
</tr>
<tr>
<td>18. Buoyant smoke signal</td>
<td>2</td>
</tr>
<tr>
<td>19. Watertight electric torch</td>
<td>1</td>
</tr>
<tr>
<td>20. Day signalling mirror (heliograph)</td>
<td>1</td>
</tr>
<tr>
<td>21. Illustrated table of the life-saving signals</td>
<td>1</td>
</tr>
<tr>
<td>22. Signal whistle or equivalent sound signal</td>
<td>1</td>
</tr>
<tr>
<td>23. First-aid kit (see 8.5.10.1)</td>
<td>1</td>
</tr>
<tr>
<td>24. Set of six doses of anti-seasickness medicine and one seasickness bag for each person</td>
<td>1</td>
</tr>
<tr>
<td>25. Jack-knife to be kept attached to the boat by a lanyard</td>
<td>1</td>
</tr>
<tr>
<td>26. Tin opener</td>
<td>3</td>
</tr>
<tr>
<td>27. Buoyant rescue ring attached to a buoyant line at least 30 m long</td>
<td>2</td>
</tr>
<tr>
<td>28. Manual drainage pump</td>
<td>1</td>
</tr>
<tr>
<td>29. Set of fishing tackle</td>
<td>1</td>
</tr>
<tr>
<td>30. Set of tools and spares for the engine</td>
<td>1</td>
</tr>
<tr>
<td>31. Portable fire extinguisher suitable for extinguishing oil fires</td>
<td>1</td>
</tr>
<tr>
<td>32. White circular lantern</td>
<td></td>
</tr>
<tr>
<td>33. Searchlight</td>
<td>1</td>
</tr>
<tr>
<td>34. Radar reflector</td>
<td>1</td>
</tr>
<tr>
<td>35. Individual thermal protective aids sufficient for 10% of the number of persons the lifeboat is permitted to accommodate, but at least two sets</td>
<td>1</td>
</tr>
</tbody>
</table>

1 Only for rowboats.  
2 For lifeboats of ships entering reservoirs of P category.  
3 One hatchet at each end of the lifeboat.  
4 Watertight receptacles containing a total of 3 L of fresh water for each person the lifeboat is permitted to accommodate, or only 2 L for each person, if there is a de-salting apparatus in the lifeboat capable of producing 1 L of fresh water for each person for 2 days.  
5 Food ration totalling not less than 10 MJ for each person the lifeboat is permitted to accommodate in air- and watertight packaging.  
6 Only for lifeboats with engine.
8.4.13 A searchlight specified in 33 Table 8.4.13 shall be capable of effectively illuminating a light-coloured object at night having a width of 18 m at a distance of 180 m for a period of 6 hours including continuous operation for at least 3 h. If the searchlight is fixed, it shall be installed to allow turning by 360° in horizontal plane and tilting in vertical plane by 90° upwards and 30° downwards from horizontal plane.

8.4.14 Equipment of lifeboats of ships of M-IIP class shall correspond to standards adopted for ships of M-CP class excepting items required in subparagraphs 15 and 20 Table 8.4.13 and equipment of liferafts of those ships shall be taken according to 8.5.20 in any area of navigation.

Equipment for lifeboats and liferafts of ships of O-IIP class shall be taken according to the standards for ships of M class.

8.4.15 The engine of the lifeboat shall be fitted with a reverse reduction gear or another device enabling to move astern and an arrangement disconnecting the propeller (shaft) and engine.

8.4.16 The engine of the lifeboat shall be started manually within 2 min in any conditions possible during the lifeboat operation. A force on the engine handle shall not exceed 160 N per person.

Additional devices and appliances are allowed to facilitate the engine start.

8.4.17 The engine output shall provide lifeboat ahead speed with full complement of persons and equipment on calm water of at least 11 km/h and not more than 15 km/h.

Fuel store shall be sufficient for the engine operation for at least 2 hours at running mode. Built-in or portable capacities depending on the engine type (built-in or hinged) shall be provided for the fuel storage.

8.4.18 The engine and relevant appliances shall be protected in such a way that faultless operation is provided at flooding of the lifeboat up to the crankshaft axis line.

8.4.19 The propeller shall be located and guarded so that to ensure safety of people in water and prevent its damage by floating objects.

8.4.20 The engine, reverse reduction gear and hinged technical facilities shall be protected with casing made of material with low flame-spread characteristics (see 2.1.3.1 Part III of the Rules) or of non-combustible material.

Provision shall be made to protect people against accidental contact with hot or moving parts and protect the engine against environmental exposure. Provision shall be made for means of reduction of engine noises.

Starter batteries shall be arranged in watertight boxes ventilated with regard to 10.12.19 Part IV of the Rules.

8.4.21 Pipelines of systems serving the engine (fuel, lubrication, cooling) shall be protected against mechanical damages. Fixed fuel tanks on lifeboats shall be equipped with stop valves fitted on the fuel tank or fuel pipeline directly at the fuel tank. These valves shall be readily accessible. The air intake duct (ducts) of the engine and its exhaust system shall be designed to prevent the ingress of foreign objects and sea water in the engine. Insulation of exhaust system elements shall comply with the requirements of 1.9.2 Part IV of the Rules.

8.4.22 The engine start manual made of water-proof material shall be provided in the engined lifeboat.

8.4.23 Cleats shall be installed at sides of the engined lifeboat near the stern to ensure the towing of liferafts.

8.4.24 Handrails and buoyant grabline with floats attached to be held by a person in water shall be provided on the outer surface around the lifeboat above its waterline except for area in way of rudder and propeller.

8.4.25 The lifeboat shall be equipped with at least one bleed valve in way of the lowest hull point which shall be capable of opening automatically for draining water from the lifeboat when not in water and closing automatically when the lifeboat is in water. The bleed valves shall be accessible from inside of the
lifeboat and their location shall be clearly marked.

Each valve shall be fitted with a cap or plug for its closing with lanyards or chains attached to the lifeboat. This requirement does not apply to freefall lifeboats.

8.4.26 The lifeboat shall be provided with rudder and tiller.

Where a lifeboat is equipped with a steering wheel or other rudder remote control arrangement, provision shall be made for steering the lifeboat by means of a tiller in case of their failure. The tiller shall be permanently installed on the rudder stock or connected to it. However, where a lifeboat is equipped with the rudder remote control arrangement, the tiller may be of removable type and be kept attached near the rudder stock. The rudder and tiller shall be designed so that to prevent their damage during operation of launch and recovery arrangement or propeller.

8.4.27 The lifeboats shall be provided with embarkation ladder allowing the people in water to board the lifeboat through any access hatch. The lower step of ladder shall be at least 0.4 m below the lifeboat in the light condition.

The lifeboat shall be designed so that to allow the helpless people to be boarded from water or on stretchers.

All surface of the lifeboat which may be used for walking shall have a non-slip coating.

8.4.28 Both sides of lifeboats of ships of М-СП, М-ПП and О-ПП class in the bow end shall be marked with the following:

1. inscriptions indicating actual main dimensions of the lifeboat and the number of persons the lifeboat is permitted to accommodate made with indelible paint;

2. the name and port of registry of the ship which the lifeboat belongs to in block Latin letters; The name of ship which the lifeboat belongs to and its number shall be made so as to be visible from above.

8.4.29 Outer plating of the lifeboat’s hull of ships of М-СП, М-ПП and О-ПП class, exterior of folding and rigid enclosures and interior of that part of the lifeboat covered by the canopy shall be coloured orange.

**Partially enclosed lifeboats**

8.4.30 Partially enclosed lifeboats shall comply with requirements of 8.4.1 to 8.4.29 and 8.4.31 to 8.4.33.

8.4.31 A partially enclosed lifeboat shall have rigid water-tight enclosures extending for not less than 20% of its length from stem and aft end. The lifeboat shall be provided with permanently attached folding canopy which covers the people in the lifeboat together with the rigid enclosures to protect them against bad weather and environmental exposure.

The lifeboat shall be provided with entrances in front and aft ends and from each side. Entrances in rigid enclosures shall be water-tight when closed.

The canopy shall:

1. be provided with appropriate rigid sections or supports for its installation;

2. be fitted by max. 2 persons for max. 2 min;

3. ensure insulation of undercanopy space by at least two layers of material separated with air gap or other means with similar heat-insulating properties. Provision shall be made for means preventing water accumulation in the air gap;

4. have an external surface of distinctive colour and the internal surface causing no irritation to people in the lifeboat;

5. be provided with entrances equipped with adjustable enclosures which are capable of being opened and closed from inside and outside to provide ventilation but preventing the ingress of water, wind and cold in the lifeboat. Provision shall be made for arrangements allowing the entrances to be kept in opened and closed positions;

6. permanently pass a sufficient air for people in the lifeboat when the entrances are closed;

7. be provided with arrangement for collecting rainwater;

8. be capable of being abandoned by people in case of capsizing.
8.4.32 The internal surface of the lifeboat shall be of the light colour causing no discomfort for people in the lifeboat.

8.4.33 Where a lifeboat is equipped with stationary two-way VHF radiotelephone apparatus, this apparatus shall be arranged in an adequately sized wheelhouse to accommodate radiotelephone apparatus and operator. No separate wheelhouse is required if the lifeboat is designed to provide for a protected area so that not to impede its performance when the lifeboat is flooded up to upper thwart level.

Totally enclosed lifeboats

8.4.34 Totally enclosed lifeboats shall comply with requirements of 8.4.1 to 8.4.29 and 8.4.35 to 8.4.41.

8.4.35 Each totally enclosed lifeboat shall be provided with rigid water-tight enclosure allowing it to be completely covered.

The enclosure shall:

1. protect people in the lifeboat against heat and cold;
2. provide access to the lifeboat through hatches capable of being tightly closed;
3. arrange the access hatches so that the launch and recovery operations are possible without disembarkation of people. This requirement does not apply to freefall lifeboats;
4. be capable of opening and closing of access hatch covers from outside and inside. Hatch covers shall be kept opened;
5. provide for rowing. This requirement does not apply to freefall lifeboats;
6. be able to support the capsized lifeboats when hatches are closed with a full complement of people, equipment and technical facilities without any water leakage;
7. be provided with portholes and window capable of transmitting daylight inside when hatches are closed;
8. have an orange external surface and light internal surface;
9. be provided with handrails for people moving outside the lifeboat and which may be used during embarkation and disembarkation;
10. provide for passage of people from entrance to their seats without climbing over transverse thwarts and other obstacles;
11. provide for air pressure inside the lifeboat at engine operation when the entrances are closed which is not more or less than atmospheric pressure by more than 20 GPa.

8.4.36 The safety belts shall be provided at each clearly indicated area of the seat. Each set of safety belts for a seat shall be of colour in contrast with those in adjacent seats. The safety belts shall be designed to keep the person with weight of 100 kg in place when the lifeboat is capsized. This requirement does not apply to freefall lifeboats.

8.4.37 The stability of a lifeboat shall be so that it is capable of righting when totally or partially completed with people and equipment, all its entries and openings are tightly closed and safety belts are fastened.

8.4.38 After damage in any area below the waterline, the lifeboat shall be capable of supporting the full complement of people and equipment and its stability shall be so that it shall be capable of automatically positioning so that to be abandoned from the escape above the water level in case of capsizing. When the lifeboat is in a stable flooded condition, water level inside the lifeboat shall be max. 500 mm above any seat.

8.4.39 All engine exhaust pipes, air channels and other openings shall be designed to prevent ingress of water in the engine in case of capsizing and righting of the lifeboat.

8.4.40 The engine and associated arrangements shall provide stable operation in any position during capsizing and after righting of the lifeboat or shall be capable of being stopped automatically at capsizing and then being restarted after righting of the lifeboat. The fuel system shall be designed to prevent fuel leakage from the engine, the lubrication system shall be designed to prevent leakage of more than 250 mL of lubrication oil in case of capsizing of the lifeboat.

8.4.41 The air-cooled engines shall be provided with air ductworks for intake of cooling
Freefall lifeboats

8.4.42 Freefall lifeboats shall comply with requirements of 8.4.34 to 8.4.41 and 8.4.43 to 8.4.50.

8.4.43 The capacity of a freefall lifeboat is determined with regard to number of persons with average weight of 75 kg (82.5 kg for lifeboats of passenger ships) for which seats may be provided arranged not to impede operation of lifeboat propulsion arrangements and any other equipment. The seats shall be provided with foot support. The seats shall be arranged and designed to prevent a risk of injuries during launching. Passage between seats shall have clear width of at least 430 mm and be provided with non-slip coating.

8.4.44 The angle between seat pan and seatback shall be at least 90°. The seat width shall be at least 430 mm. Clear opening forward of the seatback measured perpendicular to the seatback shall be at least 650 mm. The seat back height above the pan shall be at least 1.075 m. The seats shall provide height to shoulders measured along the seat back equal at least 760 mm. The foot support shall be oriented so that the angle of inclination of support plane shall be at least half the angle of inclination of seat pan. The support shall be at least 330 mm long.

8.4.45 Each seat of the freefall lifeboat shall be provided with safety belts of contrast colour capable of keeping a person with weight of 100 kg in place when launching the lifeboat by freefalling and when the lifeboat is capsized. The safety belts shall be provided with fasteners capable of being unbuckled when belts are tensioned.

8.4.46 Each freefall lifeboat with a full complement of equipment for any of the following loading conditions:

- with a full designed complement of people;
- with a complement of people located so that the centre of its gravity is as far forward as practicable;
- with a complement of people located so that the centre of its gravity is as far aft as practicable;
- with a complement of launching crew only shall be capable of immediately running away from the ship right after its dropping into water and shall not contact with the ship after launching by free falling at trim of up to 10° by bow and heel of up to 20° either side from the permissible height of installation.

8.4.47 Oil tankers, chemical tankers and gas carriers of M-CII class shall be capable of launching of the lifeboat at a final heel angle above 20° if this angle does not exceed the maximum permissible heel angle under dynamic effect of a heeling moment due to wind and waves.

8.4.48 Each freefall lifeboat shall be capable of withstanding a launch by free falling from height 1.3 times the permissible height of installation, with a full complement of equipment and people according to its capacity.

8.4.49 Each freefall lifeboat shall be designed so that to protect people and equipment against hazardous accelerations which occur at its launching from permissible height into calm water at adverse trim of up to 10° and heel of up to 20° either side, with a full complement according to 8.4.46.

8.4.50 Each freefall lifeboat shall be provided with release system which shall:

- be provided with two independent and capable of being controlled from inside of the lifeboat arrangements for actuation of the system painted with different colours other than that of the internal surface;
- be designed so that to provide release at any loading conditions - from light condition to loading at least 200% the standard load produced by the weight of fully completed lifeboat with a complement of people corresponding to its capacity;
- be adequately protected against accidental or early use;
4 be designed so that the release system may be tested without launching of the lifeboat;
5 be designed so that to provide a safety factor equal to 6 times tensile strength of the materials used.

**Lifeboats with self-contained air support system**

8.4.51 Lifeboats with self-contained air support system shall comply with requirements of 8.4.34 to 8.4.41 and shall be equipped with compressed air system. The volume of compressed air cylinders of this system shall be sufficient for safety of people and uninterruptible operation of engine for at least 10 min with all entrances and openings closed. Within this period, air pressure inside the lifeboat shall not drop below or exceed the ambient atmospheric pressure by more than 20 GPa. Air supply system shall be provided with indicators permanently indicating the supply air pressure.

**Fire-protected lifeboats**

8.4.52 A fire-protected lifeboat shall comply with requirements of 8.4.51 and in addition, protect the complement of people allowed to be accommodated being in water in the area of continuous oil fires all around the lifeboat within at least 8 min.

8.4.53 The lifeboat shall be equipped with performance manual during fire as well as set of medicines against burns and carbon dioxide intoxication (see GOST R 53451).

8.4.54 In conditions specified in 8.4.52, carbon monoxide concentration inside the lifeboat shall not exceed 0.2 mg/L, carbon dioxide concentration – 3% by volume.

8.4.55 The lifeboat equipped with the water sprinkling system for firefighting shall comply with the following requirements:

1 the system shall be supplied with seawater fed from self-priming pump. Provision shall be made for switch on and shut off of water supply for sprinkling of lifeboat external surface;

2 water intake arrangement of the water sprinkling system shall be designed to prevent ingress of combustible liquids from the water surface into the system;

3 the system shall be capable of being washed with fresh water and be fully drained.

8.4.56 Water sprinkling system or thermal insulation of the lifeboat shall provide air temperature inside the fire-protected lifeboat at the headlevel of a sitting person max. 60 °C in conditions mentioned in 8.4.52.

**8.5 LIFERAFTS**

8.5.1 A liferaft shall be so designed that neither the liferaft nor its equipment are damaged after dropping into the water from a height of at least 10 m.

8.5.2 The liferaft shall be capable of withstanding a jump of a person having a mass of 75 kg on it from a height of 4.5 m above the bottom both with and without the canopy erected.

The liferaft shall keep stable trim when held by people being in water in a complement not exceeding that as indicated on its marking in accordance with 8.5.19.

8.5.3 Design of the liferaft and its equipment shall enable it of being towed at a speed of 5.5 km/h on calm water with the design number of persons and equipment. Herewith, the liferaft shall keep stability.

8.5.4 Buoyancy chambers of inflatable liferaft shall be divided into at least two separate compartments, each inflated through a non-return inflation valve on each compartment. The buoyancy chambers shall be so arranged that, in the event of any one of the compartments being damaged or failing to inflate, the intact compartments shall be able to support, with positive freeboard, over the liferaft’s entire periphery, the design number of persons, each having a weight of 75 kg and seated in their normal position.

Buoyancy of a rigid liferaft shall be ensured by means of buoyant material located as close as possible to the liferaft edges. The buoyant material shall be low spreading flame or have
a relevant coating (see 1.2.1.16 Part III of the Rules).

8.5.5 The liferaft of free-fall type shall be so designed that the capsized floating inflated raft may be turned over by one person in water after that this raft may be capable of being used effectively as when it is floating in a right position.

8.5.6 Liferafts for ships of М-СШ, М-ПР, М and О-ПР class shall be equipped with a canopy which shall:

.1 protect people from drops, cold and wind;
.2 provide adequate ventilation;
.3 have a viewing port;
.4 have entrances fitted with simple and efficient closing arrangements;
.5 have sufficient headroom for sitting occupants.

8.5.7 The liferaft shall be fitted with lifelines securely becketed around the inside and outside periphery of the liferaft as well as with means of drawing it up to a ship side and holding during the embarkation.

8.5.8 If the float-free arrangements use a weak link, it shall:

.1 not be broken by the force required to pull the painter from the liferaft container;
.2 be of sufficient strength to permit the inflation of the liferaft;
.3 break under a strain equal to 0.105n, but of not more than 2.2±0.4 kN, where \( n \) is liferaft capacity, persons.

8.5.9 If the float-free arrangements use a hydrostatic release unit, it shall:

.1 be so designed to prevent its incorrect operation. Galvanizing or other forms of metallic coating on parts of the hydrostatic release unit not permitted;
.2 automatically release the liferaft from a ship at a depth of not more than 4 m;
.3 have drains to prevent the accumulation of water in the hydrostatic chamber when the unit is in its normal position;
.4 be designed to prevent release the liferaft from a ship when seas wash over the unit;
.5 be permanently marked on the unit or identification plate attached to the unit with the date of manufacture, type and serial number and whether the unit is suitable for use with liferafts designed for not less than 25 persons;
.6 be such that each part connected to the painter and associated arrangements has a strength of not less than that required for the painter.

8.5.10 Liferaft equipment shall comprise the following:

.1 a first-aid kit in a waterproof case capable of being closed tightly after use (see GOST R 53451);
.2 two buoyant oars (paddles);
.3 a bailer;
.4 rescue buoyancy aid attached to buoyant line 15 m long;
.5 repair tool set for patching up of punctures in the buoyant chamber (for inflatable liferafts);
.6 manual bellows for topping up (for inflatable liferafts);
.7 six hand flares for ships operating in basins of M category and three hand flares operating in basins of O category;
.8 one whistle or equivalent sound signal means;
.9 two sponges;
.10 knife with a handle made of buoyant material, attached and stored on the face side of the canopy close to the attaching point of the painter to the liferaft;
.11 individual thermal protection aids (see 1.2.1.20) sufficient for at least 10% of the number of persons the liferaft is permitted to accommodate but not less than two.

Note. The individual heat-reflecting means shall be included in the supply of liferafts for ships operating northwards 66°30’ and in the Baikal lake.

8.5.11 A number of persons admitted for accommodation in a liferaft shall be equal to the least of the following values:

.1 the greatest number obtained from division of volume of main buoyant elements in inflated condition, \( m^3 \), on inflatable liferafts
or a volume of buoyant material, m³, on rigid liferafts, by 0.096;

.2 the greatest integer obtained from division of internal horizontal area of the bottom section, m², (including transverse thwarts) by 0.315;

.3 number of persons each having weight of 75 kg wearing immersion suits (for ships operating northwards 66°30’ and in the Baikal lake) and lifejackets which may be seated in their normal position not obstructing the use of liferaft equipment.

In any case, capacity of liferafts shall be at least 4.

8.5.12 The liferaft shall be equipped with a device to facilitate boarding from the water.

In way of one entrance, provision shall be made for semi-rigid boarding ramp capable of withstanding a load of 980 N and allowing the people in water to climb the liferaft. The ramp shall be fitted so as to prevent gas leakage from liferaft in case of damage. On the davit-launched liferaft with several entrances, provision shall be made for a boarding ramp near entrance opposite to the side which is used for drawing the raft up to the ship's side and where arrangements for boarding from ship to the raft are available.

Entrances not equipped with boarding ramp shall be provided with embarkation ladder with the lower step at least 0.4 m below the waterline of the liferaft in light condition.

Inside the liferaft provision shall be made for arrangements allowing the people to board the liferaft from the ship.

8.5.13 The bottom of the liferaft shall be waterproof and shall be capable to provide sufficient insulation against cold.

8.5.14 Non-toxic gas shall be used for inflating a liferaft. The liferaft shall be inflated to the working condition within 1 min at an ambient temperature of +20 °C and within max. 3 min at an ambient temperature of minus 30 °C.

8.5.15 Any liferaft shall be designed to be used afloat for at least 3 days.

8.5.16 Inflatable liferafts shall be capable of topping up inflatable elements by manual bellows.

8.5.17 Each inflatable liferaft shall be surveyed and restowed (see Appendix 7, RSSS) at least every twelve months.

8.5.18 Inflatable liferaft shall be packed in a container or a water-tight case of weatherproof type. The container or case together with stowed liferaft shall keep positive buoyancy for at least 20 min.

The weight of stowed liferaft on board ships not equipped with liferaft launching arrangements shall not exceed 80 kg.

The liferaft shall be packed in a container so that after dropping into water and release from container it shall be capable of inflating while being in upright position.

8.5.19 Marking of the inflated liferaft, case or container shall be clearly legible throughout their specified life and contain data on number of accommodated persons, brand and type, serial number, date of manufacture, name and address of manufacturer or trademark, weight, inspection and test intervals, disposal method.

Marking of the case or container shall include brief manual for bringing the liferaft in service condition.

8.5.20 Items of liferaft equipment for ships of M-CII class shall be compact and small-size, be packed and adequately secured on regular places in the raft.

The liferaft equipment shall include the following items:

.1 buoyant rescue ring attached to a buoyant line at least 30 m long;

.2 knife of the non-folding type having a buoyant handle attached by a lanyard and stowed in a pocket on the exterior of the canopy near the point at which the painter is attached to the liferaft. The liferafts permitted to accommodate 13 persons or more shall be provided with a second knife which may be of folding type;

.3 buoyant bailer;

.4 two sponges;
a sea anchor with a shock-resistant hawser and a tripping line. The sea anchor shall be permanently attached to the liferaft so that when the liferaft inflates and is waterborne it will cause the liferaft to lie oriented to the wind in the most stable manner. The strength of the sea anchor, hawser and tripping line shall be adequate for all sea conditions. The sea anchor shall be fitted with swivels at each end of the line and preclude turning inside-out between its shroud lines;

.6 two buoyant oars (paddles);

.7 a first-aid kit in a waterproof case capable of being closed tightly after use;

.8 signal whistle or equivalent sound signal;

.9 six hand flares;

.10 watertight electric torch suitable for Morse signalling together with a spare set of batteries and a spare bulb in watertight packaging;

.11 instructions on how to survive in the liferaft;

.12 instructions for immediate actions;

.13 individual thermal protection aids (see 1.2.1.20) sufficient for at least 10% of the number of persons the liferaft is permitted to accommodate but not less than two.

8.5.21 The marking in liferafts for ships of M-CII class equipped in accordance with 8.5.20 shall be “C PACK” in block capitals.

8.5.22 For ships of M-CII class the equipment of each liferaft shall be stowed in a container secured inside the liferaft except the cases when the container is an integral part of the liferaft, is permanently attached to the latter and is capable of floating in water for at least 30 min without damage to its contents.

8.6 REQUIREMENTS FOR RESCUE BOATS

8.6.1 Rescue boats shall comply with the following requirements:

.1 have a document issued by the River Register on compliance with the Rules as well as marking in accordance with 8.4.28;

.2 in addition, marking of inflated rescue boats shall contain a serial number, the manufacturer’s name or trade mark and the date of manufacture;

.3 unless the rescue boat of rigid construction has adequate sheer, it shall be provided with a bow cover extending for not less than 15% of its length;

.4 totally enclosed rescue boat shall be of self-righting type and comply with the requirements of national standards. Partially enclosed rescue boat shall be of automatically self-bailing type or be provided with effective means of bailing;

.5 enclosure of the rescue boat shall have railings to provide a passage outside the enclosure. In addition, partially enclosed rescue boat shall have a handrail at least 600 mm high in its open part;

.6 the rescue boat shall have a control station providing free view in all directions for the helmsman;

.7 the rescue boat shall be capable of manoeuvring at speeds up to 6 knots and maintaining that speed for a period of at least 4 h;

.8 rescue boats shall have sufficient mobility and manoeuvrability in a seaway to enable persons to be retrieved from the water, marshal liferafts and tow the largest liferaft carried in the ship when loaded with its full complement of persons and equipment;

.9 the rescue boat shall be fitted with an inboard engine or outboard motor;

.10 rescue boats shall be fitted with fixed arrangements for towing which shall be sufficiently strong to marshal or tow liferafts as required by 8.6.1.8;

.11 the buoyancy of an inflated rescue boat shall be provided by either a single buoyancy tube subdivided into at least five separate compartments of approximately equal volume or two separate buoyancy tubes neither exceeding 60% of the total volume;

.12 the buoyancy tubes forming the boundary of the inflated rescue boat shall on inflation provide a volume of not less than 0.17 m³ for each person the rescue boat is permitted to accommodate;

1 GOST R 53451 and GOST 52638.
.13 Each buoyancy compartment of the inflated rescue boat shall be fitted with a non-return valve for manual inflation and means for deflation;

.14 Underneath the bottom and on vulnerable places on the outside of the inflated rescue boat rubbing strips shall be provided;

.15 Where a transom is fitted, it shall not be inset by more than 20% of the overall length of the inflated rescue boat;

.16 Suitable patches shall be provided for securing the painters fore and aft and the becketed lifelines inside and outside the boat;

.17 The inflated rescue boat shall be maintained at all times in a fully inflated condition;

.18 Preparation and launching of the rescue boats shall be performed within max. 5 min.

8.6.2 Items of rescue boat equipment shall be packed and be secured on regular places in the rescue boat.

The equipment of each rescue boat shall include:

.1 At least two buoyant oars and one steering oar with pins or crutches provided for each oar;

.2 A boat-hook;

.3 A buoyant bailer and a bucket;

.4 A knife (of a safe type for inflated rescue boats);

.5 Two buoyant heaving lines 30 m in length with lifebuoys;

.6 A binnacle containing an efficient compass with luminous card or provided with suitable means of illumination of the diameter sufficient for normal reading the indications;

.7 A sea anchor and tripping line with a hawser of adequate strength not less than 10 m in length;

.8 A painter of sufficient length and strength so attached at the forward end of the rescue boat that to be released quickly for releasing when the rescue boat is in motion;

.9 Buoyant line, not less than 50 m in length, of sufficient strength to tow a liferaft;

.10 Electric torch of water-proof type suitable for Morze signalling together with a spare set of batteries and a spare bulb;

.11 Signal whistle or equivalent sound signal;

.12 A first-aid kit in a waterproof case;

.13 Searchlight capable of illuminating a light-coloured object at night having a width of 18 m at a distance of 180 m for a period of 6 hours including continuous working for at least 3 h;

.14 Individual thermal protection aids sufficient for at least 10% of the number of persons the rescue boat is permitted to accommodate but not less than two, whichever is the greater;

.15 Radar reflector;

.16 Additionally for inflated rescue boats: two sponges, manually operated bellows or pump, a repair kit for repairing punctures in a suitable container, a safety boat-hook.

8.7 LIFE-SAVING BUOYANCY AIDS

8.7.1 Carrying capacity of a life-saving buoyancy aid shall be sufficient for supporting of the design number of persons being in the water and grabbing it.

8.7.2 The number of persons \( n \), supported by the buoyancy aid shall be taken as the least of the values calculated by the formulas:

\[
 n = \frac{P_{\text{aid}}}{P_1}; \quad (8.7.2-1)
\]

\[
 n = \frac{Q}{q_1}, \quad (8.7.2-2)
\]

where \( P_{\text{aid}} \) — aid periphery, m;

\( P_1 \) — permissible periphery length per one person, \( P_1 = 0.3 \) m;

\( Q \) — carrying capacity, N;

\( q_1 \) — carrying capacity per one person, \( q_1 = 142 \) N.

8.7.3 Strength of the buoyancy aid shall be such as no damages may occur after dropping it into the water from a height of at least 10 m which may affect its performance characteristics.

8.7.4 The life-saving buoyancy aid shall maintain stability regardless of the side being above when afloat.

8.7.5 Floodability (buoyancy) of the aid shall be provided by air boxes or other equivalent floating means. The life-saving buoyancy
aid shall support a metallic weight of 7.5 kg in fresh water for 24 h.

8.7.6 The life-saving buoyancy aid shall be fitted with a lifeline, buoyant or fitted with floats becketed around the periphery of the aid with sags, the number of which shall correspond to the number of supported persons.

8.7.7 The life-saving buoyancy aid shall be coloured orange. An inscription “Life-saving buoyancy aid” shall be made on a visible place of the aid and the design number of persons and the name of a ship shall be indicated.

8.7.8 Each life-saving buoyancy aid shall be fitted with a towing line at least 18 m in length and diameter of at least 8 mm. The towing line shall be becketed to the aids in such a way that it may be towed. The life-saving buoyancy aid shall be fitted with a device to secure towing line of another life-saving buoyancy aid.

8.8 LIFEBOYS, LIFEJACKETS AND IMMERSION SUITS

8.8.1 Construction of lifebuoys, lifejackets, immersion suits and individual heat-reflecting means shall meet national standards¹ as well as requirements of 8.8.2 to 8.8.25.

8.8.2 The materials for lifejackets, lifebuoys, immersion suits and individual heat-reflecting means shall comply with requirements of 8.1.6.

Lifejackets, lifebuoys, immersion suits and individual heat-reflecting means shall not sustain burning or continue melting after being totally enveloped in a fire for a period of 2 s.

8.8.3 Lifebuoys shall:

.1 have an inner diameter of not less than 400 mm;
.2 be made of buoyant material; the life-buoy buoyancy shall not depend upon any loose materials or inflatable air chambers;
.3 be capable of supporting not less than 14.5 kg of steel or cast iron in fresh water for a period of 24 h;
.4 have a weight of at least 2.5 kg;
.5 be designed so as to withstand a drop into the water from the height of 10 m without impairing its performance characteristics and damaging of the outfit attached;
.6 be fitted with a grabline not less than 9.5 mm in diameter and not less than 4 times the outside diameter of the body of the buoy in length secured at four equidistant points;
.7 strips of retro-reflecting material at least 100×50 mm shall be fitted at both sides of the lifebuoy at four equidistant points.

8.8.4 Lifebuoy shall bear an inscription with the name of the ship, port of registry and testing stamp.

8.8.5 Grabline becketed to the lifebuoy shall be:

.1 of diameter at least 8 mm and not less than 27.5 m in length;
.2 non-twisting;
.3 have a breaking strength of at least 5 kN.

8.8.6 Self-igniting buoys shall be becketed to the lifebuoy with a line of 1.5 m in length. The burning period of automatically igniting light shall be not less than 45 min with luminous intensity of 2 cd. The buoys shall be coloured orange and automatically igniting light shall be white coloured and shall burn continuously at all directions of the upper hemisphere or provide flashes with frequency of at least 50 and max. 70 flashes per minute with effective luminous intensity of 2 cd.

8.8.7 Construction of a lifejacket for adult shall be such as:

.1 persons, completely unfamiliar with the lifejacket, can correctly use it without any assistance, guidance or prior demonstration;
.2 it is comfortable to wear;
.3 it allows the wearer to jump from the height of at least 4.5 m without injury and without dislodging or damaging the lifejacket;
.4 it allows the wearer to swim for a short distance and board a lifeboat or a liferaft.

8.8.8 The lifejacket shall have sufficient buoyancy and stability in calm fresh water to:

¹ GOST 22336, GOST 19815, GOST 54596.
support above the water surface the head of an exhausted or unconscious person in order to lift the mouth not less than 120 mm clear of the water with the body inclined backwards at an angle of not less than 20° from the vertical position;

turn the body of an unconscious person in the water from any position to one where the mouth is clear of the water in not more than 5 s.

8.8.9 The lifejacket shall have buoyancy which is not reduced by more than 5% after 24 h submersion.

8.8.10 Lifejackets and lifebuoys shall be orange in colour and be fitted with retro-reflecting material in those places where it assists in detection.

Each side of the lifejacket that may be the outer one shall be provided with at least three strips of retro-reflecting material of 50×100 mm in dimension; two of those strips shall be located on outer part and one of them on a collar.

8.8.11 Each lifejacket shall be fitted with a whistle fastened to it with a lace.

Each lifejacket shall be fitted with an electric search light of white colour which shall meet the following requirements:

luminous intensity shall be at least 0.75 cd in all directions of the upper hemisphere;
energy source shall be capable of providing the required luminous intensity for at least 8 h of continuous operation;
electric light shall be readily visible when attached to the lifejacket in the largest part of the upper hemisphere segment.

Where the electric search light is of flashing type, in addition to requirements mentioned in this paragraph, it shall meet the following requirements:
be equipped with manual switch;
flash frequency shall be at least 50 and max. 70 flashes per minute;
effective luminous intensity shall be at least 0.75 cd.

8.8.12 The lifejacket shall bear the name of the ship and a testing stamp.

8.8.13 A child lifejacket shall have the same design and characteristics as an adult lifejacket. In addition to afore-mentioned requirements it shall:

have such construction as it can be adjusted for the child body;

lift the mouth of an exhausted or unconscious child clear of the water;

assist a child to board a collective life-saving appliance.

8.8.14 A child lifejacket shall bear an indelible inscription “Child” and marking indicating the limits of child’s height or weight.

8.8.15 The immersion suit shall be made of waterproof materials and comply with the following requirements:

it shall be capable of being unpacked and donned without assistance within max. 2 min taking into account donning of any associated clothing, donning of a lifejacket if the immersion suit shall be worn in conjunction with a lifejacket;

it shall cover the whole body with the exception of the face. Hands shall also be covered unless permanently attached gloves are provided;

it shall be provided with arrangements to minimize or reduce free air in the legs of the suit;

following the jump from a height of not less than 4.5 m, the ingress of water into the suit shall not exceed 500 g.

8.8.16 An immersion suit which also complies with the requirements of 8.8.7 to 8.8.9 may be classified as a lifejacket.

8.8.17 An immersion suit which shall permit the person wearing it or a lifejacket, if the immersion suit shall be worn in conjunction with a lifejacket, to:

climb up and down a vertical ladder of at least 5 m in length;

perform normal duties during abandonment;

jump from a height of not less than 4.5 m into water without damaging or dislodging the immersion suit or being injured;
4. Swim a distance through the water from the ship to survival craft and board a survival craft.

8.8.18 An immersion suit which has buoyancy and is designed to be worn without a lifejacket shall be fitted with a whistle and electric search light complying with requirements of 8.8.11.

8.8.19 If the immersion suit shall be worn in conjunction with a lifejacket, the lifejacket shall be worn over the immersion suit. The immersion suit shall be so designed to allow a person wearing such an immersion suit to don a lifejacket without any assistance.

8.8.20 An immersion suit with or without a lifejacket if the immersion suit shall be worn in conjunction with a lifejacket, shall provide sufficient thermal protection following one jump by the wearer into the water from a height of 4.5 m to ensure that when it is worn for a period of 6 h in calm circulating water at a temperature of 0 to 2°C the wearer's body core temperature does not fall by more than 2°C.

8.8.21 The design of immersion suit or immersion suit with a lifejacket shall allow a person to turn in fresh water from a face-down to a face-up position in not more than 5 s.

8.8.22 An immersion suit made of material which has no inherent insulation with warm clothing may be used as an immersion suit. Such an immersion suit shall be:

1. Marked with instructions that it shall be worn in conjunction with warm clothing;

2. So constructed that when worn in conjunction with warm clothing and with a lifejacket if required, if the immersion suit continues to provide sufficient thermal protection, following one jump by the wearer into the water from a height of 4.5 m, to ensure that when it is worn for a period of 1 h in calm circulating water at a temperature of 5°C the wearer’s body core temperature does not fall by more than 2°C.

8.8.23 An individual thermal protective aid shall be made of waterproof material and be so constructed to reduce a heat loss from the wearer’s body when put on.

8.8.24 The individual thermal protective aid shall:

1. Cover the whole body with the exception of the face. Hands shall also be covered unless permanently attached gloves are provided;

2. Be capable of being unpacked and easily donned without assistance in the lifeboat or liferaft;

3. Permit the wearer to remove it in the water in not more than 2 min if it impairs ability to swim.

8.8.25 The individual thermal protective aid shall function properly at air temperature of minus 30°C to +20°C.

8.9 LAUNCHING APPLIANCES

8.9.1 Each launching appliance shall be capable of safe launching of life-saving appliances with full complement and design number of persons at static trim of up 5° and heel of 15° either way.

8.9.2 Each launching appliance shall be fitted with brakes being capable of stopping launching of the life-saving appliance and of holding it when loaded with the design number of persons and equipment.

8.9.3 The launching appliance and its related attachments shall be of sufficient strength to withstand a static test with a proof load not less than 1.5 times the maximum working load.

8.9.4 In ships of all classes lifeboats shall be installed under the boat davits. Where it is impossible, other equipment may be installed instead of davits subject to technical justification.

8.9.5 An arm of boat davits shall be so that at lifeboat launching from ships of M and O class without a heel a clearance of 0.3 ± 0.05 m is provided between a ship side or protruding parts (rubbing strip, extended deck etc.) and the lifeboat, and at least 0.15 m when launching lifeboats from ships of P class.
8.9.6 Strength of boat davits, falls, sheaves and other elements of the boat appliance shall be sufficient for safe boat launching and hoisting of a load of the weight kg,

\[ G = 1.25(Q + qn), \]

(8.9.6)

where \( Q \) — weight of the lifeboat with equipment, kg;
\( q \) — weight of one person (75 kg);
\( n \) — number of persons in the lifeboat for which the boat equal to:

at dumping, launching and recovery — a design number of persons on board;
at recovery — a number of persons on board for its maintenance purposes.

At strength calculations of elements of the boat appliances on board ships of M and O class a list of ship on either side of at least 15° and trim of at least 5° shall be considered.

Length of falls of tackles shall be sufficient for boat launching to the water at a list of a light ship on either side of 15° and trim of 5°. Herewith, at least three wraps of a rope shall remain on the boat winch drum.

8.9.7 Boat launching period shall not exceed 5 min including preparation for the launching and dumping over board.

The standard time does not consider the time required for embarkation.

8.9.8 The electrically-driven boat appliance shall be capable of recovering the lifeboat with equipment and persons for its maintenance purposes also by means of a manual drive.

8.9.9 Ships shall be equipped with appliances for dropping of inflatable liferafts. These appliances may be omitted when a weight of each liferaft does not exceed 80 kg.

8.9.10 Where the liferafts are stowed in hardly accessible places and no passages are provided to them on board ships less than 30 m in length, special effective remote-controlled dropping appliances shall be provided.

8.9.11 Steel wire ropes, natural and synthetic fibre ropes shall meet the requirements of 6.15 and buckles, swivels, screw turnbuckles and other loose components — the requirements of Section 5. Non-rotating and corrosion-resistant steel wire ropes shall be used as falls.

8.9.12 Embarkation ladders shall have free from sharp edges hard treads with a non-slip surface of a length not less than 450 mm and equally spaced in the horizontal position not less than 380 mm apart.

8.10 STOWAGE OF LIFE-SAVING APPLIANCES ON BOARD

8.10.1 Collective life-saving appliances shall be stowed as close as practicable to the water surface so as not to be damaged by wave hammering.

8.10.2 Collective life-saving appliances shall be stowed as close as practicable to the accommodation and service spaces in the safest places with regard to explosions, fires, touch by other ships, etc.

8.10.3 Collective life-saving appliances shall be so stowed that to avoid obstacles for mustering of people at embarkation stations, simultaneous boarding on launched life-saving appliances, dumping and launch of the life-saving appliances.

8.10.4 Collective life-saving appliances shall be stowed in way of wall-sided section of a ship’s side. They may be stowed also in the area where an angle between the vertical and tangent to outer shell plating laid in a framing plane at a level of waterline of light or ballasted ship does not exceed 45°.

When stowing side-launched lifeboats the following requirements are to be met:

1. bow extremity of the lifeboat shall not extend over the plane of the fore peak bulkhead;
2. after extremity of the lifeboat shall be located at a distance equal to at least its length forward of the propeller plane on ships with open propellers, and at least a half of its length on board ships with propellers in nozzles.

8.10.5 The lifeboat may be installed on the stern of a ship in the centre line plane, if provision is made to prevent the lifeboat against
damage by protruding parts of the propeller and the rudder or after structures during launching.

8.10.6 The lifeboat shall be installed on the keel-blocks, the shape of which shall correspond to its hull lines.

Keel-blocks shall be so designed as to provide launching of the lifeboat without preliminary hoisting.

8.10.7 For securing boats for navigation which are installed on the keel-blocks, lashes shall be provided.

8.10.8 Boarding of people to the lifeboats shall be provided directly from its stowage place; no dumping or launching of the lifeboat shall be required before launching.

8.10.9 Passenger ships shall have embarkation stations for boarding launched lifeboats and liferafts from the main deck, fitted with embarkation ladders.

Inflatable stairways may be used.

8.10.10 Liferafts and life-saving buoyancy aids shall be easily secured; life-saving appliances shall be so stowed as to be easily released and float free when a ship is immersed into the water.

8.10.11 Life-saving buoyancy aids and liferafts are recommended to be stowed so as they may be carried from one side to the other.

8.10.12 Life-saving buoyancy aids may be stored with one put over the other, with linings provided between the aids and measures are taken to prevent the aids from shifting at rolling or pitching.

8.10.13 Places of stowage of collective life-saving appliances, approaches to them and the water surface in the launching area shall be illuminated.

8.10.14 Lifebuoys shall be uniformly distributed along the port and starboard at visible and easily accessible places. Dead securing of lifebuoys which does not enable its free-floating when the ship is being flooded, is not permitted.

One lifebuoy shall be located in the immediate vicinity of wheelhouse.

8.10.15 Where ship’s outfit comprises two lifebuoys with lifelines or self-igniting buoys, such lifebuoys shall be stowed at the opposite sides.

8.10.16 Lifejackets for cabin passengers shall be stowed in cabins in easily accessible places.

8.10.17 Lifejackets for non-cabin passengers shall be distributed in easily accessible places. Not more than 20 lifejackets shall be stowed at the same place. An inscription “Lifejackets” shall be provided near lifejacket stowage places.

Child lifejackets shall be stowed separately, an inscription “Child lifejackets” shall be provided near lifejacket stowage places.

Stowage places of lifejackets shall be illuminated.

8.10.18 For all persons on board passenger ships with a length of 65 m and over or with three or more decks, mustering stations shall be provided which shall meet the following requirements:

1 be in the vicinity of, and permit ready access for all passengers to the embarkation stations of collective life-saving appliances unless in the same location;

2 the total area of mustering stations \( A \) shall be not less than the value calculated by the following formulas, m\(^2\):

for ships engaged on day voyages \[ A = 0.35 N_{\text{max}} \]

for cabin ships \[ A = 0.45 N_{\text{max}} \],

where \( N_{\text{max}} \) — maximum number of persons onboard;

3 the area of each single mustering station shall be at least 10 m\(^2\);

4 mustering stations shall be located on decks above emergency waterline;

5 mustering stations and evacuation areas shall provide ready access to life-saving appliances on any ship’s side;

6 mustering stations and evacuation areas shall be displayed in safety plan and prominently displayed on board the ship;
.7 if movable furniture is provided in the room where mustering stations are located, it shall be properly secured against slippage;

.8 if stationary seats or benches are provided in the room where mustering stations are located, when calculating the total area of mustering stations in accordance with 8.10.18.2, the corresponding number of persons may be neglected. However, a number of persons for which stationary seats or benches are considered shall not exceed a design number of persons for mustering stations in this room;

.9 requirements of 8.10.18.7 and 8.10.18.8 shall be complied with also for exposed areas of decks where mustering stations are located;

.10 where the ship is fitted with collective life-saving appliances, the design number of persons may be neglected when calculating the total area of mustering stations in accordance with 8.10.18.2;

.11 if the requirements of 8.10.18.8 to 8.10.18.10 are not met, the total area of mustering stations shall be adequate for accommodation of at least 50% passengers.
9 SIGNAL MEANS

9.1 GENERAL PROVISIONS

9.1.1 Requirements of the present Section apply to ships under design and construction as well as to ships in service.

9.1.2 The nomenclature and the location of navigation lights and daytime signal means for ships operating on inland waterways of Russia are defined by the Rules for Navigation on Inland Waterways of the Russian Federation and rules for navigation and berthing of ships in individual basins of inland waterways of the Russian Federation.

9.1.3 Inland navigation ships operating in areas with sea navigation conditions shall be equipped with navigation lights and sound signal means according to requirements for river-sea navigation ships.

9.1.4 Length, breadth and depth of a ship are length overall and maximum breadth and depth accordingly.

9.1.5 River-sea navigation ships shall be fitted with both signal means required for navigation in inland waterways and signal means required for navigation in sea areas in accordance with provisions of International Regulations for Preventing Collision at Sea (1972) regardless of the voyage type (coastal or international).

9.2 STANDARDS FOR EQUIPPING WITH NAVIGATION LIGHTS AND DAYTIME SIGNAL MEANS

9.2.1 Ships operating on inland waterways shall be equipped with navigation lights and daytime signal means according to the standards specified in Table 9.2.1-1, and ships operating in sea areas – to the standards specified in Table 9.2.1-2.

9.2.2 Navigation lights used in ships shall be electric ones.

9.2.3 Cargo motorships equipped for pushing shall be equipped with navigation lights provided in Table 9.2.1-1 for pushboats.

Table 9.2.1-1

Standards for equipping ships operating in inland waterways with navigation lights and daytime signal means

<table>
<thead>
<tr>
<th>Types of ships</th>
<th>Navigation lights</th>
<th>Daytime signal means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>masthead sidelight</td>
<td>all-round</td>
</tr>
<tr>
<td></td>
<td>white red green</td>
<td>red green</td>
</tr>
<tr>
<td>1. Self-propelled ships excepting tugboats and pushboats</td>
<td>1 1</td>
<td>1 1</td>
</tr>
<tr>
<td>2. Tugboats and pushboats</td>
<td>3 3</td>
<td>1 1</td>
</tr>
<tr>
<td>3. Non-self-propelled ships</td>
<td>1 1</td>
<td>1 1</td>
</tr>
</tbody>
</table>

1 Self-propelled trailing suction hopper dredgers (TSHD) are fitted with three vertically located signs: two black balls with black cone in-between.
2 Ships belonging to the transport supervision service are fitted with a blue all-round flashlight.
3 Ships with length of 50 m and over are fitted with two white masthead lights.
4 Required for ships carrying dangerous goods.
5 Ships with a breadth of 5 m and less are fitted with one sternlight only.
6 Electrical flashing lights with incandescent lamps may be additionally fitted.
7 Fire-watch vessels, floating workshops and landing stages are fitted with one all-round white light on the mast and one all-round white light on the superstructure wall visible from the side of the navigational pass (for landing stages – one all-round white light on each side). One all-round white light is fitted on oil processing stations, pumping stations, industrial ships, berths and pontoons less than 50 m in length as well as on cable ferries.

8 Required for ships carrying dangerous goods and for oil processing stations. Dredgers shall be fitted with two all-round red lights (on the awning deck).

9 Required for dredgers, mud dredgers and ships engaged in underwater operations, sweeping the navigation pass, operation at the floating signs of navigational aids. In addition, mud dredges shall be fitted with two green all-round lights (on the awning deck). Ships engaged in diving operations and self-propelled trailing suction hopper dredger (TSHD) shall be fitted with two green all-round lights.

10 Required for water-displacement passenger vessels intended for permanent operation within the harbourage and at the crossings, self-propelled ferries as well as tugboats and pushboats servicing non-propelled ships at the crossings. Cable ferries shall be equipped with one yellow all-round light.

11 Required for self-propelled ships with a breadth over 5 m.

12 Required for mud dredgers and ships engaged in underwater operations, sweeping the navigation pass, operation at the floating signs of navigational aids. Ships engaged in diving operations shall be fitted with two flags “À” (shields).

13 Required for fishing vessels.

14 Required for pushed vessels.

15 Ships with length of up to 50 m may be fitted with one white all-round light.

---

### Table 9.2.1-2 Standards for equipping ships operating in sea areas with signal means

<table>
<thead>
<tr>
<th>Types of ships</th>
<th>Navigation lights</th>
<th>Sound signals</th>
<th>Signal shapes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>masthead</td>
<td>sidelight</td>
<td>all-round</td>
</tr>
<tr>
<td>Self-propelled vessels excepting tugboats, pushboats and fishing vessels</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Tugboats and pushboats</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Fishing vessels</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Non-self-propelled vessels</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Ships not under command and restricted in their ability to manoeuvre</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Additional means for ships at anchorage and aground</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

1 Ships of 50 m in length and over shall be fitted with two masthead lights.
2 Only for hovercraft
3 For passenger ships and other types of ships with gross tonnage over 150
4 For ships with length of 100 m and over.
5 If the length of towing rope is over 200 m — three masthead lights and a diamond
6 Not required for ships pushing ahead or towing alongside.
7 Not required for ships being pushed.
9.2.4 All ships shall be fitted with the following spare parts for navigation lights:
   .1 light filters, one for each coloured light unless coloured lens is applied in the light;
   .2 electric lamps, one for each electric light.

9.2.5 In self-propelled ships less than 7 m in length masthead lights and light impulsive (light) lamps are not required.

9.2.6 Tugboats and pushboats intended for work with non-self-propelled ships carrying oil products, explosives and dangerous substances are additionally fitted with a red masthead light and red all-round light.

9.2.7 Self-propelled ships of M-СП and M-ПП class shall be fitted with a set of spare electrical lanterns comprising masthead, side, stern, all-round lights for vessels not under command (see Table 9.2.1-2), all-round lights for ships at anchorage and aground, towing light.

9.2.8 All ships shall be provided with lights being placed at aground at the level of a floating sign:
   from side/sides where navigation pass is free – white all-round light on the part of the ship protruding into navigation pass.
   from the side where passage is impossible at night – three red all-round lights, at daytime – three readily visible black balls located vertically.

9.3 STANDARDS FOR EQUIPPING WITH PYROTECHNICAL SIGNAL MEANS

9.3.1 Pyrotechnical signal means include distress signal parachute rocket and a hand flare.

9.3.2 Navigational and technical requirements to pyrotechnic means shall comply with 9.6.

9.3.3 Self-propelled, non-self-propelled ships with a crew (except for floating objects) shall be equipped with pyrotechnic means according to the standards specified in Table 9.3.3.

<table>
<thead>
<tr>
<th>Name of signal means</th>
<th>Number¹ for ships of class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship parachute rocket</td>
<td>12</td>
</tr>
<tr>
<td>Distress signal hand flare, red</td>
<td>6</td>
</tr>
<tr>
<td>One-star rocket, red</td>
<td>6²</td>
</tr>
<tr>
<td>One-star rocket, green</td>
<td>6²</td>
</tr>
<tr>
<td>Hand flare, white (not required when daytime visual or audible alarm is available)</td>
<td>6²</td>
</tr>
</tbody>
</table>

¹ Pyrotechnical means are not required in non-crewed non-self-propelled ships.
² Recommended

9.3.4 Ships of P class entering water reservoirs of P category shall be equipped with the same pyrotechnic means as ships operating in basins of О category.

9.3.5 Equipment of lifeboats with pyrotechnic means shall be taken according to Section 8.

9.3.6 For launching distress rockets on port and starboard of a ship a special slotted cup inclined at an angle of 60 to 70° from the horizon to the outside shall be fitted on railing of the navigation bridge wings or a bulwark.
9.3.7 Hand flares shall not be used in oil tankers or other ships intended for carriage of oil products as well as in pushboats and tugboats towing and pushing non-self-propelled oil tankers. Instead of hand flares, these ships may be provided with parachute rockets in a quantity exceeding the standards specified in Table 9.3.3 by 50%.

9.3.8 Distress signal parachute rockets may be replaced with ship red six-star rockets.

9.4 STANDARDS FOR EQUIPPING WITH SOUND SIGNAL MEANS

9.4.1 All self-propelled ships shall be fitted with air typhons or steam whistles and bells for giving sound signals.

9.4.2 In ships less than 25 m in length and in ships of O, P and J class not fitted with air receivers or steam boilers electric horns may be used as the main sound signal instead of typhons or whistles. Bells in ships of 10 m in length or less may be omitted.

9.4.3 In ships of М-СІ, М-ПР, М class, electric horn may be used as auxiliary signal means.

9.4.4 In ships less than 20 m in length electric car horns may be used as the main sound signal.

9.4.5 In non-self-propelled ships a signal bell or a metal plate shall be provided. In non-self-propelled oil tankers a bell or a plate shall be made of non-ferrous metals.

In non-crewed ships sound signal is not required.

9.5 NAVIGATION AND TECHNICAL REQUIREMENTS TO NAVIGATION LIGHTS AND DAYTIME SIGNALS

9.5.1 Navigation lights designed for inland and river-sea navigation ships shall be manufactured in compliance with the technical documentation approved by the River Register.

9.5.2 Navigation lights of ships operating on inland waterways shall have light angles and range of visibility as specified in Table 9.5.2-1 with regard to the following:

.1 the range of visibility of masthead lights of self-propelled ships less than 20 m in length shall be at least, km:

<table>
<thead>
<tr>
<th>Type of navigation light and light colour</th>
<th>Range of visibility, km</th>
<th>Arc of visibility in horizontal plane</th>
<th>Light angle</th>
<th>Visibility angles</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Masthead light: white red</td>
<td>8 5.5</td>
<td>225° 112.5° from centreline from right ahead on either side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Green sidelight</td>
<td>3.7</td>
<td>112.5° From right ahead up to 22.5° abaft the beam on starboard side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Red sidelight</td>
<td>3.7</td>
<td>112.5° From right ahead up to 22.5° abaft the beam on port side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. White sternlight</td>
<td>3.7</td>
<td>135° 67.5° from right aft on either side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Yellow towing light</td>
<td>3.7</td>
<td>135° ditto</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. All-round: white red, green, yellow, blue</td>
<td>1.85</td>
<td>360° All round the horizon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Combined two-colour green and red light</td>
<td>1.85</td>
<td>225° 112.5° from centreline from right ahead on either side: starboard – green sector, portside – red sector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. White anchorage sidelight</td>
<td>3.7</td>
<td>180° 90° forward of and abaft the beam on either side, on European inland waterways – 360° all round the horizon</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Light-impulsive flashing lamp:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>by day</td>
<td>2</td>
<td>112.5° Forward of the beam with overlap of the centreline by 22.5° and abaft the beam with overlap of the centreline by 22.5°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>by night</td>
<td>4</td>
<td>112.5° ditto</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Light lamp</td>
<td>4</td>
<td>112.5° ditto</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 9.5.2-2

<table>
<thead>
<tr>
<th>Lights</th>
<th>Light colour</th>
<th>Minimum range of visibility, nautical miles for ships with $L$, m</th>
<th>Arc of visibility in horizontal plane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$L &gt; 50$</td>
<td>$12 \leq L \leq 50$</td>
</tr>
<tr>
<td>1. Masthead</td>
<td>white</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>2. Sidelight, starboard</td>
<td>green</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3. Sidelight, port</td>
<td>red</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>4. Combined two-colour</td>
<td>Green, red</td>
<td>—</td>
<td>2</td>
</tr>
<tr>
<td>5. Combined three-colour</td>
<td>Green, red, white</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>6. Sternlight</td>
<td>white</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>7. Towing</td>
<td>Yellow</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>8. All-round</td>
<td>White, red, green</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>9. All-round flashing</td>
<td>Yellow</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>10. Additional all-round lights for fishing vessels engaged in trawling and fishing with purse seine gear in close proximity to other vessels</td>
<td>White, red, yellow</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>11. All-round for towed, slightly conspicuous, partly submerged vessels and objects</td>
<td>White</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

1. In vessels less than 20 m in length the minimum range of visibility is three nautical miles.
2. The minimum range of visibility of white sector is two nautical miles.
3. The range of visibility shall be at least one nautical mile but less than that of other all-round lights.

Signal lights required for navigation in sea areas as well as lights with double function (lights used at navigation both on inland waterways and in sea areas) shall comply with requirements established in Tables 9.5.2-2 and 9.5.2-3.

9.5.3 Horizontal luminous intensity $I_n$ of one flash of signal flashing lights specified in Tables 9.5.2-2 and 9.5.2-3 shall be at least, cd:

$$I_n = (0.2 + t_n)I_n$$  \(9.5.3\)

where $t_n$ — flash duration, s;
Table 9.5.2-3
Signal flashing lights for M-CL, M-HIP and O-HIP class ships

<table>
<thead>
<tr>
<th>Light</th>
<th>Range of visibility, nautical miles</th>
<th>Arc of visibility in horizontal plane total angle of sector</th>
<th>sector position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daytime signalling lamp</td>
<td>≥2 Directed beam (the lantern showing its light in proper direction)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manoeuvring light(^1)</td>
<td>5 360° All round the horizon</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Recommended for accompanying sound signals with light signals

Note: Lights are white coloured.

1 — luminous intensity determined in accordance with 9.5.15.

9.5.4 Visibility angles of lights specified in Table 9.5.2-1 in the vertical plane shall be at least 10° either side from a horizontal plane crossing the centre of a light source.

9.5.5 Navigation lights shall be designed for operation in conditions stated in 2.2 Part VI of the Rules.

9.5.6 Navigation lights shall be made of corrosion-resistant materials or be protected with anti-corrosive coatings.

9.5.7 The lanterns shall be of such design as to ensure drainage of condensate. Electric lanterns shall be of protected design in accordance with requirements of 2.3.6 Part VI of the Rules.

9.5.8 The navigation lights shall be so designed as to allow opening and closing of the lantern case as well as rapid change of electric lamps without using tools.

9.5.9 The lamps in the lanterns shall be located vertically and be in the lens focus. Measures shall be taken to prevent from self-unscrewing.

Two-filament lamps shall not be used in the navigation lights.

9.5.10 Inner surfaces of navigation lanterns shall be covered with a protective coating resistant to temperature and moisture which does not impair the colour and light characteristics of the lanterns.

9.5.11 The navigation lanterns may be fitted with lenses and plain glasses provided the minimum range of visibility meets the requirements of Tables 9.5.2-1 and 9.5.2-2 and the curve of vertical light distribution of the lantern – requirements of the present paragraph.

The inner and outer surfaces of the lenses and plain glasses shall be smooth, and the glass shall be free from foreign inclusions, blisters and chippings impairing the lantern characteristics.

The lenses of the navigation lanterns shall be so designed that the curve of vertical light distribution of the lantern shall ensure:

1. luminous intensity not less than specified in Table 9.5.15 within the range of visibility in the vertical plane up to 5° from the horizontal plane of symmetry of the lens;

2. not less than 60% of the luminous intensity specified in Table 9.5.15 within the range of visibility up to 7.5° on either side from the horizontal plane of symmetry of the lens.

The curve of horizontal light distribution of the side lights shall be such that lanterns fitted in the ship have the luminous intensity from right ahead, as prescribed in Table 9.5.15, which shall decrease and disappear between 1° and 3° outside the limit sectors.

For sternlights and masthead lights as well as arcs of 22.5° abaft the beam for sidelights the specified luminous intensity shall be maintained up to 5° within sectors prescribed in Tables 9.5.2-1 and 9.5.2-2. From 5° within the prescribed sectors the intensity may decrease by 50% up to the sector limit; then it shall gradually decrease to reach practical cut-off within not more than 5° outside the prescribed limits as specified in Tables 9.5.2-1 and 9.5.2-2.

9.5.12 The coloured light filters and lenses shall comply with the following requirements:

1. the colouring of the navigation lights may be obtained using appropriate light filters or coloured lenses. Plain coloured glasses may be used provided that the chromaticity of the filter is ensured over their whole surface.
Coloured lenses may be used subject to technical justification;
.2 the coloured light filters used in the navigation lights may be manufactured of glass coloured throughout its entire thickness or over the surface only.

The light filters may be manufactured of plastics provided all their characteristics are in all cases are at least equal to those of glass light filters;
.3 corner coordinates \( \alpha \) and \( \beta \) of the allowable zones for each colour are given in Table 9.5.12.3.

<table>
<thead>
<tr>
<th>Light colour</th>
<th>Corner coordinates</th>
<th>Corner points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( x )</td>
<td>( y )</td>
</tr>
<tr>
<td>Red</td>
<td>0.680</td>
<td>0.320</td>
</tr>
<tr>
<td>Green</td>
<td>0.028</td>
<td>0.723</td>
</tr>
<tr>
<td>White</td>
<td>0.525</td>
<td>0.440</td>
</tr>
<tr>
<td>Yellow</td>
<td>0.612</td>
<td>0.382</td>
</tr>
</tbody>
</table>

Here the colour of light is considered as a result obtained in the light filter – source of light optical system.

The luminous transmission factors of the coloured light filters shall have such values as to ensure the specified range of visibility of the lights according to the requirements of Tables 9.5.2-1, 9.5.2-2 and requirements of 9.5.11;
.4 the height and the length of the arc of a coloured light filter shall be such as to cover the whole inside surface of the lens;
.5 the inner and the outer surfaces of the light filters shall be free from notches and indentations, and the filter glass shall be free from blisters, foreign inclusions and drops degrading the characteristics of the lanterns;
.6 the light filters shall be fixed in the lanterns in such a way as to prevent their spontaneous shifting in course of their use on board.

9.5.13 Removable light filters shall be fitted with metal reinforcement throughout their periphery or other equivalent protection against chipping or mechanical damages which may occur during their use and storage.

9.5.14 The light filters of sidelights and their fittings shall be so designed as to avoid placing the red filter to the starboard lantern, and the green filter – to the port lantern.

9.5.15 The permissible luminous intensity \( I, \) cd, in the lanterns to ensure the range of visibility required in Table 9.5.2-1 shall be not less than that determined by the formula:

\[
I = 3.43 \cdot 10^6 T d^2 k^{-d}, \tag{9.5.15}
\]

where \( T \) — threshold factor, lux;
\( T = 2 \cdot 10^7 \) lux;
\( d \) — range of visibility of the light, nautical miles;
\( k \) — atmospheric transmission factor corresponding to meteorological visibility of approximately 13 nautical miles; \( k \) shall be taken equal to 0.8.

Luminous intensity values calculated by formula (9.5.15) are given in Table 9.5.15.

<table>
<thead>
<tr>
<th>Range of visibility of the light, ( d )</th>
<th>Luminous intensity of the light, ( I ), at ( k = 0.8 ), cd</th>
</tr>
</thead>
<tbody>
<tr>
<td>nautical miles</td>
<td>km</td>
</tr>
<tr>
<td>1</td>
<td>1.85</td>
</tr>
<tr>
<td>2</td>
<td>3.7</td>
</tr>
<tr>
<td>3</td>
<td>5.55</td>
</tr>
<tr>
<td>4</td>
<td>7.4</td>
</tr>
<tr>
<td>5</td>
<td>9.26</td>
</tr>
<tr>
<td>6</td>
<td>11.1</td>
</tr>
</tbody>
</table>

The maximum permissible luminous intensity of lanterns may be increased by more than 1.7 times as compared to values given in Table 9.5.15, but it shall not exceed 150 cd.

Reflectors in the navigation lanterns are not allowed.

9.5.16 A daytime signalling lamp (see GOST R ISO 25861) to be stowed in the wheelhouse or charthouse and be always ready for use shall meet the following requirements:
.1 daytime signalling lamp shall be so designed to remain operable under conditions specified in 2.2 Part VI of the Rules;
.2 At daytime, at atmospheric transmission factor of 0.8, range of visibility of light signals emitted by daytime signalling lamps shall be at least equal to that in Table 9.5.2-3 or correspond to luminous intensity of 60000 cd;

.3 Luminous intensity along the axis of the light beam of the daytime signalling lamps shall be at least 90% of maximum luminous intensity;

.4 Luminous intensity of the daytime signalling lamp shall be maximum at the centre of luminous intensity distribution and uniformly decrease from this centre to the distribution periphery;

.5 The half of the angle of deviation shall not exceed 9°, the tenth of the angle of deviation shall not exceed 14°;

.6 Colour characteristic of the white signal light shall be within angular coordinates specified in Table 9.5.12.3;

.7 The effective light area of the daytime signalling lamp shall be circular in shape. The total time of activation and deactivation shall not exceed 500 ms;

.8 The daytime signalling lamp shall be marked with its operating specifications;

.9 The daytime signalling lamp and storage battery required for its operation shall ensure safe operation and easy use by one person. Provision shall be made to use the daytime signalling lamp wearing gloves;

.10 The daytime signalling lamp shall be designed so as:

- to provide for safe installation of a light source (avoid threaded lampholders);
- to be able to replace a light source in the dark;
- to prevent condensate in the lamp;
- to ensure protection at least IP 56;

.11 Sighting device shall be fixed in parallel to optical axis of the lamp;

.12 All parts of the daytime signalling lamp shall be made of non-magnetic materials;

.13 The materials used in the lamp shall be suitable for temperature which may occur during its operation. Outer parts of the daytime signalling lamp shall be heated during operation up to the temperature which may result in injury of the operator when used manually;

.14 Each daytime signalling lamp shall be equipped with at least three spare light sources;

.15 The daytime signalling lamp shall be protected against short-circuit currents;

.16 Provision shall be made for powering of the daytime signalling lamp not only from ship’s main and standby electric power sources but also from other sources;

.17 The daytime signalling lamp shall be equipped with portable storage battery with the weight of max. 7.5 kg in total;

.18 Capacity of the portable storage battery shall be sufficient for operation of the daytime signalling lamp with at least 2 h;

.19 Provision shall be made for arrangements to protect against overcurrent, overvoltage and short-term accidental power source reverse polarity;

.20 When powered from different sources, provision shall be made for arrangements to switch from one power source to another. The daytime signalling lamp may not include such arrangements;

.21 The light source shall be marked with the name of the manufacturer, voltage and power consumption.

9.5.17 The manoeuvring lantern specified in Table 9.5.2-3 shall send flashing light signals within the whole manoeuvring period of the ship. The duration of each flash and the interval between flashes shall be about 1 s and the interval between successive signals – at least 10 s.

9.5.18 Signal shapes (daytime signals) shall be of black colour; the ball shall have a diameter of at least 0.6 m and the diamond shall consist of two cones with a common base with dimensions of each cone at least \( dh = 0.6 \times 0.6 \text{ m} \), where \( d \) is the diameter of the cone base and \( h \) the cone height.

9.5.19 The signal flags shall be made of special woolen cloth (bunting) or synthetic materials.
9.5.20 The signal flags shall be of square shape. The square side shall be at least 1000 mm, and for hand flags — at least 700 mm. In ships less than 25 m in length the flag side shall be at least 500 mm.

9.6 REQUIREMENTS TO PYROTECHNIC SIGNAL MEANS

9.6.1 The distress signal pyrotechnic means shall be safe in handling and during storage for the whole warranty period.

9.6.2 Pyrotechnic signal means shall be protected against moisture and mechanical damage. Storage cases for pyrotechnic signal means shall be capable of opening without using any tools.

9.6.3 Each pyrotechnic signal means shall bear the following made with indelible paint: stamp of the manufacturer, the date of manufacture, storage period, purpose and operating manual. On signal rockets the launching direction shall be indicated with an arrow.

9.6.4 Signal rockets shall be so designed as to ensure its launching both by hand (without using special arrangement) and using special arrangement.

9.6.5 All pyrotechnic signal means shall be vibration-resistant, moisture-resistant and non-extinguishable at a wind speed up to 30 m/s. They shall keep their properties at air temperature from –45 to +45 °C and be capable of operating at rain.

9.6.6 Characteristics of ship pyrotechnic signal means shall comply with the requirements of Table 9.6.6.

9.6.7 The parachute rocket shall have integral means of ignition and be so designed as not to cause discomfort to the operator when using it in accordance with the manufacturer’s instructions.

9.6.8 The hand flare shall:

.1 have integral means of ignition;

.2 be so designed as not to endanger the ship or collective life-saving appliance by burning or glowing residues when used in accordance with the manufacturer’s instructions;

.3 continue burning after having been immersed for 10 s under 0.1 m of water.

9.7 REQUIREMENTS TO SOUND SIGNAL MEANS

9.7.1 Whistles and typhons shall produce sound signals without sound level oscillations, hissing or other distortions. The beginning and the end of a signal shall be clearly audible.

9.7.2 The design and material of sound signal means for ships operating on inland waterways shall provide the range of audibility not less than that specified in Table 9.7.2.

9.7.3 Basic specifications of whistles for ships operating on sea areas shall comply with requirements of Table 9.7.3. The range of audibility shall be determined by such frequencies which may include the main and (or) one or several higher frequencies within 180 to 700 Hz ±1% which provide the required sound pressure levels.

9.7.4 A bell or gong of ships operating on sea areas or other facility with similar sound characteristics shall produce a sound pressure level of at least 110 dB at 1 m.
Table 9.7.3

<table>
<thead>
<tr>
<th>Length of a ship $L$, m</th>
<th>Range of fundamental frequencies, Hz</th>
<th>$1/3$rd-octave sound pressure level at 1 m, dB, referred to $2 \times 10^{-4}$ N/m²</th>
<th>Audibility range, nautical miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L \geq 200$</td>
<td>70–200</td>
<td>143</td>
<td>2</td>
</tr>
<tr>
<td>200 &gt; $L \geq 75$</td>
<td>130–350</td>
<td>138</td>
<td>1.5</td>
</tr>
<tr>
<td>75 &gt; $L \geq 20$</td>
<td>250–700</td>
<td>130</td>
<td>1</td>
</tr>
<tr>
<td>$L &lt; 20$</td>
<td>250–700</td>
<td>120</td>
<td>0.5</td>
</tr>
</tbody>
</table>

9.7.5 Bells and gongs of ships operating on sea areas shall be made of corrosion-resistant material and shall produce the sound of even tone.

No painting of the bell or gong is permitted. An outer diameter at the bell mouth shall be not less than 300 mm for ships with a length over 20 m and not less than 200 mm for ships with a length of 12 to 20 m. The total weight of movable (suspended) part of the bell (rod with striker) shall be at least 3% of the whole bell weight.

9.8 GENERAL REQUIREMENTS TO FITTING OF SIGNAL MEANS ON BOARD

9.8.1 The navigation lights shall be so located that during the whole lighting period no other lights or external illumination which may be taken for signal or navigation lights are visible.

9.8.2 Lights of all-round visibility (360°) in horizontal plane, excepting anchor lights, shall be so located as not to be obscured by masts, topmasts or superstructures within sectors of more than 6°. In this case, the lantern shall be considered as an all-round source of light with the diameter equal to the outside diameter of the source of light (filament of the lamp).

9.8.3 When the requirement of 9.8.2 cannot be met, it is permitted to install a system of lanterns for each light. Each of the systems shall be placed in the same horizontal plane. In this case measures shall be taken to prevent the lights of these lanterns from being seen separately in any direction.

9.8.4 All regular places of location of the navigation lights shall be provided with arrangements for their replacement and installation.

9.8.5 The accuracy of installation of the sector lights shall be controlled by their position as regards the centreline plane of a ship. The horizontality of installation of the lights shall be checked for ship’s fully loaded condition.

9.8.6 When several lights to be switched on simultaneously are placed on a mast one over the other on board ships operating in inland waterways, they shall be spaced not less than 1 m apart.

When lights are fitted in a vertical line one over the other on mast of the ships operating on inland waterways, the lights shall be spaced not less than 2 m apart and the lowest of these lights shall, except where a towing light is required, be not less than 4 m above the hull.

9.9 FITTING OF MASTHEAD AND MANOEUVRING LIGHTS

9.9.1 The masthead lights excepting lower ones on pushboats shall be located in the centreline plane of a ship. The vertical distance between the masthead light (lower masthead lights in tugboats and pushboats) and sidelights shall be at least 1 m.

9.9.2 The masthead lights in pushboats shall be located as an equilateral triangle with a side of 1 to 3 m with the base located downwards and the top in the centreline plane. The red masthead light shall be placed directly above the upper white masthead light regardless of requirements of 9.8.6.

9.9.3 The masthead lights on tugboats shall be placed on a mast vertically with due regard of 9.8.6.

9.9.4 On self-propelled ships of a length 50 m and over masthead lights shall be placed in the fore and aft at least 20 m apart. The vertical distance between them shall be such as under all normal conditions of trim the forward light is not less than 1 m lower than the after light; here, the forward masthead light may be located lower than the sidelights.
and the after light — abaft and not less than 1 m above them.

9.9.5 The forward masthead light on board ships operating in sea areas shall be placed on the foremost in the centreline of a ship at a height of at least 6 m above the main deck. When the breadth of a ship exceeds 6 m, then this light shall be placed at a height not less than the ship's breadth but no more than 12 m above the main deck.

9.9.6 The after masthead light of ships operating on sea areas shall be fitted in the centreline of the ship. The vertical distance between the forward and the after masthead lights shall be at least 4.5 m. The horizontal distance between these lights shall be at least 0.5 of the ship's length; the forward masthead light shall be fitted not be more 0.25 of the ship's length from the stem.

Where only one masthead light is prescribed for the self-propelled ship, this light shall be located ahead of the midship.

9.9.7 A ship which requires masts to be hinged in order to pass under bridges may be fitted with a reserve masthead light in the fore part; it may be placed below the sidelights. In a ship of 50 m and over in length this light may be permanently used as a forward masthead light provided the requirements of 9.9.4 are met.

9.9.8 All masthead lights shall be fitted with horizontal screens below to prevent persons in the wheelhouse and the deck from dazzling.

9.9.9 In ships operating in sea areas, the manoeuvring light shall be placed in the centreline and, as far as practicable, at a height of not less than 2 m from the forward masthead light; it shall be also placed at least 2 m higher or lower than the after masthead light.

In a ship fitted with only one masthead light the manoeuvring light shall be placed in a position where it can best be seen at a distance of at least 2 m in the vertical above the masthead light.

Where simultaneous actuation of light and sound signals is provided, separate actuation of light signals shall be also foreseen.

9.10 FITTING OF SIDELIGHTS

9.10.1 Sidelights (the red sidelight on the port and the green sidelight on the starboard) shall be clearly visible to the ships coming from the opposite direction and overtaken ships within the ranges of visibility defined in 9.5.2. The lanterns and their enclosures shall not extend beyond the overall breadth of a ship.

9.10.2 Sidelights shall be located in a horizontal line symmetrically to the centreline of a ship and placed in the following way:

.1 in open vessels — at least 0.5 m above the gunwale (in particular well-grounded cases the lantern may be placed at the gunwale level);

.2 in ships with a single-tier superstructure (deckhouse) — in its upper part;

.3 in ships with a double-tier or multi-tier superstructure — not lower than the wheelhouse deck.

9.10.3 Each sidelight shall be enclosed from the side by special lantern shield with two fore and aft transverse screens.

The distance between the outer edge of the protective glass or lens of the lanterns fitted in ships of 25 m in length and over and the after edge of the fore transverse screen shall be not less than 915 mm. The shield length for these lanterns shall be not less than 1 m.

The fore transverse screen shall be of such breadth that a line joining its outer edge and the centre of the light source is parallel to the centreline of the ship. The aft transverse screen shall be of such breadth as to mask completely the lantern from being seen across the stern, but not hinder showing its light to 22.5° abaft the beam.

9.10.4 The sidelights in self-propelled ships operating on sea areas shall be placed abaft the forward masthead light and above the hull at a height not greater than 0.75 of the height of the forward masthead light.

The sidelights in non-self-propelled ships operating on sea areas shall be placed in the fore part of the hull.

9.10.5 The side lanterns may be placed in recesses of the superstructures or deckhouses.
The dimensions of the recesses shall comply with the dimensions of the lantern shields; the recesses shall be fitted with the same screens as those of the lantern shield.

9.10.6 The inner surfaces of the lantern shield and recesses shall be painted matt black.

9.10.7 In ships less than 25 m in length and in hydrofoil craft and hovercraft the shield dimensions may be reduced or the shields may be omitted if the ranges of visibility of the lights defined by 9.5.2 are ensured.

9.11 FITTING OF STERNLIGHTS AND TOWING LIGHTS

9.11.1 In ships carrying one sternlight this lantern shall be located abaft the chimney or superstructure in the centreline of a ship and, as far as practicable, at the same height with sidelights but not above them.

9.11.2 In ships carrying three sternlights the upper one shall be placed as per 9.11.1 and the two lower ones — on the bulwark or after end walls of a bulkhead close as far as practicable to the sides in one horizontal line symmetrically to the centreline of the ship.

9.11.3 In ships operating in sea areas, the sternlight shall be placed in the centreline of a ship on the bulwark gunwale, after handrail or on the after wall of the poop deckhouse.

In tugboats operating on sea areas the sternlight may be placed on a chimney (false chimney, wall of the deckhouse) above the towing arrangement. In all cases the sternlight shall be placed lower than the side lights.

9.11.4 Towing light shall be placed in the centreline above the sternlight. The vertical distance between those lanterns shall be at least 0.5 m.

9.11.5 The towing lights in ships operating on sea areas shall be placed upper and/or lower the forward or after masthead lights with regard to 9.8.6.

9.11.6 Towing light in ships operating on sea areas shall be fitted above the sternlight with regard to 9.8.6.

9.12 FITTING OF ALL-ROUND AND ANCHORAGE SIDE LANTERNS

9.12.1 All-round lantern with white light for self-propelled ships operating on inland waterways used during anchorage shall be located in the ship's fore part. This lantern may be fitted on a mast, flagstaff or be hoisted on a stay.

9.12.2 All-round white lights (anchor lights) for ships operating on sea areas shall be placed in the fore and after parts of the vessel, the forward all-round white light shall be carried at a height of not less than 6 m above the hull. The stern all-round white light shall be placed not less than 4.5 m lower than the same forward light.

Where only one all-round lantern is required in accordance with Tables 9.5.2-1 and 9.5.2-2, it shall be placed in a position where it can best be seen.

All-round lanterns with white light may be installed either in fixed position on special uprights or by means of a special hoisting gear.

9.12.3 An all-round red light shall be placed higher than all-round white lights. This lantern shall not be located in one vertical line with anchorage lights.

9.12.4 In ships operating on sea areas two all-round red lights (“Vessel not under command”) shall be placed on a visible place in a vertical line one over the other with due regard of the requirements of 9.8.2, 9.8.3 and 9.8.6 either in fixed position or by means of a hoisting gear.

9.12.5 Yellow flashing all-round lantern shall be placed in a place where it can best be seen; it may be located in one vertical line with the masthead light above.

9.12.6 Side anchorage lanterns shall be placed at sides on the edges of the pilot bridge wings. In coastal vessels one anchorage side-light is fitted at the running side.
9.13 FITTING OF LIGHT IMPULSIVE (LIGHT) LAMPS

9.13.1 Light impulsive (light) lamps shall be fixed pairwise (fore and aft) at each side of a ship above the sidelights at the height not less than 0.5 m and in ships up to 12 m in length — at the height not less than 0.25 m from them.

9.13.2 The lamps shall be switched on separately of each other.

9.14 FITTING OF ALL-ROUND LANTERNS IN FISHING VESSELS

9.14.1 All-round lanterns in fishing vessels shall be placed vertically on the mast at mid-ship with the white lantern being located below red and green lanterns.

9.14.2 One white lantern and one red lantern shall be able to be switched on separately of each other.

9.15 FITTING OF NAVIGATION LIGHTS IN NON-SELF-PROPELLED SHIPS AND INDUSTRIAL SHIPS

9.15.1 Non-self-propelled ships shall be fitted with two fore and aft flagstaffs for installation of the masthead and white all-round lanterns. These lanterns shall be located in the centreline of a ship in the following way:

1. the masthead light — in the fore part, generally, 2 m above the deck;
2. white all-round lanterns — in the fore and after parts at least 2 m above the highest deck or 1 m above the deck cargo.

9.15.2 In oil tankers and ships carrying dangerous goods besides fore and after flagstaffs a mast for carrying red all-round light shall be fitted as per 9.12.2. This mast shall be equipped for hoisting the daytime signals.

9.15.3 White all-round lantern in landing stages, floating workshops, firewatch vessels shall be placed on a mast in the midship at least 2 m above the superstructure roof.

In oil processing stations over 50 m in length the lanterns shall be placed in the fore and aft parts. The red all-round lantern shall be located as per 9.12.2.

9.15.4 All-round lanterns in mud dredgers and ships engaged in underwater or diving operations shall be placed vertically on the mast. One white and one red all-round lanterns shall be able to be switched on separately of each other.

In mud dredgers one green all-round light shall be placed on the mast. In the fore and aft parts on each side 2 all-round lanterns, green and red, shall be located at the awning level.

9.16 FITTING OF SOUND SIGNAL MEANS

9.16.1 Steam whistles and air typhons shall be located at least 2.5 m above the uppermost deck and be raised over the surrounding objects located on the uppermost deck excepting masts and smoke funnels.

9.16.2 In ships less than 25 m in length sound signal means shall be located not lower than the wheelhouse roof (or directly on it).

9.16.3 The signal bell shall be located as far as practicable at fully clear parts in the fore part of the ship. The bell shall be freely hung up in such a manner as not to touch the surrounding objects in list conditions.

9.16.4 The gong shall be placed as near the after end of the ship as practicable in such a place where nothing will intercept the propagation of sound, and shall be hung up freely so as to avoid contact with nearby items in list conditions.

The gong beetle shall be kept in a special pocket to be fitted close to the gong.

9.17 STORAGE OF SPARE AND PORTABLE SIGNAL MEANS ON BOARD

9.17.1 For storage of non-fixed signal means and spare lanterns ships shall be fitted with special easily accessible store rooms, lockers or boxes which are recommended to be arranged in way of the wheelhouse.

9.17.2 Signal lantern rooms shall be fitted with metal shelves with arrangements for reliable securing of the lanterns to prevent their shifting at rolling.
9.17.3 For storage of signal flags special shelves shall be provided with separate clearly designated cells for each flag. The shelves shall be arranged in the wheelhouse or on the pilot bridge wings at a place protected against precipitation and direct sunlight.

9.17.4 For storage of signal pyrotechnical means gas-tight metal lockers shall be provided in way of the pilot bridge wings or in the wheelhouse. The lockers shall be fitted with tight doors opening outwards to the wheelhouse deck.

In ships less than 25 m in length a gas-tight metal locker for storage of pyrotechnical means may be arranged in the wheelhouse.
10 NAVIGATION OUTFIT

10.1 GENERAL PROVISIONS

10.1.1 The present Section of the Rules establishes standards of navigation outfit for ships.

10.1.2 Requirements of the present Section for navigation outfit completeness apply to ships under design and construction as well as to ships in service.

10.2 NAVIGATION OUTFIT STANDARDS

10.2.1 To determine navigation outfit standards ships are divided into three categories:

I — self-propelled ships with an overall length over 25 m;

II — self-propelled ships with an overall length of 25 m and less;

III — non-self-propelled ships.

10.2.2 Navigation outfit of ships shall be assigned according to the standards specified in Table 10.2.2 according to the navigation basin and ship categories.

10.2.3 Navigation outfit may be omitted:

in ships of 10 m and less in overall length navigating in basins of P and І класс categories;

in non-crewed ships of category III.

10.2.4 Inclinometer may be omitted in hydrofoil craft, hovercraft and skimming vessels.

10.2.5 Non-self-propelled ships of І класс, ІІ класс and ІІІ класс class carrying people on board shall be fitted with binoculars, manual sounding lead and an inclinometer.

Table 10.2.2

<table>
<thead>
<tr>
<th>Description</th>
<th>Standards for navigation outfit for navigation basin category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>І</td>
</tr>
<tr>
<td>1. Ship’s chronometer</td>
<td>1</td>
</tr>
<tr>
<td>2. Aneroid barometer</td>
<td>1</td>
</tr>
<tr>
<td>3. Stopwatch</td>
<td>1</td>
</tr>
<tr>
<td>4. Anemometer</td>
<td>1</td>
</tr>
<tr>
<td>5. Prismatic binocular</td>
<td>2</td>
</tr>
<tr>
<td>6. Sounding lead with a leadline</td>
<td>1</td>
</tr>
<tr>
<td>7. Sounding rods (depth gauges)</td>
<td>1</td>
</tr>
<tr>
<td>8. Inclinometer</td>
<td>1</td>
</tr>
<tr>
<td>9. Thermometer for measuring ambient air temperature</td>
<td>1</td>
</tr>
</tbody>
</table>

* Only ships navigating in lakes and reservoirs of P category.
11 EMERGENCY OUTFIT

11.1 GENERAL PROVISIONS

11.1.1 Requirements of the present Section apply to ships under design and construction as well as to ships in service. For the purposes of this Section, the length shall mean an overall length.

11.1.2 Emergency outfit is not required in ships of the following types:

- .1 non-crewed non-self-propelled ships;
- .2 non-self-propelled ships with a single-compartment floodability;
- .3 crewed non-self-propelled ships of P and І class less than 30 m in length;
- .4 non-self-propelled tankers regardless of the length;
- .5 passenger ships and ferries with one-hour trip or less;
- .6 coastal vessels;
- .7 self-propelled ships of О, І class with a number of crew members not more than three per trip;
- .8 self-propelled ships of P and І class with a length less than 25 m;
- .9 hydrofoil craft, hovercraft and skimming vessels.

Emergency outfit is not required for floating objects.

11.1.3 Tugboats and pushboats operating with non-self-propelled ships listed in 11.1.2, shall be fitted with emergency outfit as for ships having a group one position higher than the group of the given tugboat or pushboats (see 11.2.1). Tugboats and pushboats over 15 m in length regardless of 11.1.2.7 and 11.1.2.8 shall be fitted according to the standards for ships of Group V.

11.1.4 For non-self-propelled ships of М-СІ, М-ПІ and О-ПІ class emergency outfit shall be taken according to the standards specified in Table 11.2.2 for ships of Group VI. These ships are additionally fitted with a set of rigging tools according to the standards specified in Table 11.2.4.

11.1.5 Outfit items listed in Tables 11.2.2, 11.2.3 and 11.2.4 and available on board but intended for other purposes may be considered as emergency outfit items.

11.2 EMERGENCY OUTFIT STANDARDS FOR SHIPS

11.2.1 In order to determine the emergency outfit standards ships are divided into 10 groups:

I — self-propelled ships of М and О class with a length over 90 m;
II — self-propelled ships of М and О class with a length of 40 to 90 m inclusive;
III — self-propelled ships of М and О class with a length of 25 to 40 m inclusive and ships of P and І class over 70 m in length;
IV — self-propelled ships of P and І class with a length of 40 to 70 m inclusive;
V — self-propelled ships of P and І class with a length of 25 to 40 m inclusive and ships of М and О class with a length up to 25 m;
VI — non-self-propelled ships of М-СІ, М-ПІ, О-ПІ, M and О class;
VII — non-self-propelled ships of P and І class with a length of 30 m and over;
VIII — self-propelled ships of М-СІ and М-ПІ class with a length of 70 to 140 m;
IX — self-propelled ships of М-СІ and М-ПІ class with a length of 30 to 70 m inclusive and self-propelled ships of О-ПІ class with a length of 30 to 140 m;
X — self-propelled ships of М-СІ, М-ПІ and О-ПІ class with a length of less than 30 m.

11.2.2 In all ships other than listed in 11.1.2 the emergency outfit shall be available
according to the standards specified in Table 11.2.2.

**11.2.3** Set of fitter's tools specified in Table 11.2.2 shall be completed as per Table 11.2.3.

**Table 11.2.2**

<table>
<thead>
<tr>
<th>Description</th>
<th>Number of outfit items for the ship groups</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lightened collision mat, 3.0×3.0 m</td>
<td>I 1 II III IV V VI VII VIII IX X Note</td>
<td>For ships without double bottom and double sides with a number of crew members over 10 persons ditto</td>
</tr>
<tr>
<td>2. Thrummed mat, 2.0×2.0 m</td>
<td>I 1 II III IV V VI VII VIII IX X Note</td>
<td>ditto All training and industrial vessels shall be also fitted with a mat ditto</td>
</tr>
<tr>
<td>3. Tarpaulin or training mat</td>
<td>I 1 II III IV V VI VII VIII IX X Note</td>
<td>According to the standards of Table 11.3.2</td>
</tr>
<tr>
<td>4. Tarpaulin or training mat, 2.0×2.0 m</td>
<td>I 1 II III IV V VI VII VIII IX X Note</td>
<td>ditto</td>
</tr>
<tr>
<td>5. Collision mat equipment, set</td>
<td>I 1 II III IV V VI VII VIII IX X Note</td>
<td>According to the standards of Table 11.2.3</td>
</tr>
<tr>
<td>6. Thrummed mat, 0.4×0.5 m</td>
<td>I 1 II III IV V VI VII VIII IX X Note</td>
<td>See 11.2.4</td>
</tr>
<tr>
<td>7. Semi-linen tarpaulin СКПБ, m²</td>
<td>I 1 II III IV V VI VII VIII IX X Note</td>
<td>See 11.2.4</td>
</tr>
<tr>
<td>8. Set of rigging tools in a bag</td>
<td>I 1 II III IV V VI VII VIII IX X Note</td>
<td>According to the standards of Table 11.2.3</td>
</tr>
<tr>
<td>9. Set of fitter's tools in a bag</td>
<td>I 1 II III IV V VI VII VIII IX X Note</td>
<td>See 11.2.4</td>
</tr>
<tr>
<td>10. Quick-setting cement of at least grade 400, kg</td>
<td>I 10 II 75 III 50 IV 50 V 75 VI 50 VII 200 VIII 50 IX X 100</td>
<td>50</td>
</tr>
<tr>
<td>11. Sand, natural, kg</td>
<td>I 100 II 75 III 50 IV 50 V 75 VI 50 VII 200 VIII 50 IX X 100</td>
<td>50</td>
</tr>
<tr>
<td>12. Liquid glass (accelerator for concrete setting), kg</td>
<td>I 5 II 4.0 III 2.5 IV 2.5 V 2.5 VI 4.0 VII 2.5 VIII 2.5 IX X 10</td>
<td>2.5</td>
</tr>
<tr>
<td>13. Pine bar 100×100×2000 mm</td>
<td>I 2 II 2 III 2 IV 1 V 2 VI 1 VII 1 VIII 4 IX X 2</td>
<td>1</td>
</tr>
<tr>
<td>14. Pine plank 50×200×4000 mm</td>
<td>I 1 II 1 III 1 IV 1 V 1 VI 1 VII 1 VIII 1 IX X 2</td>
<td>2</td>
</tr>
<tr>
<td>15. Pine plank 50×200×2000 mm</td>
<td>I 1 II 1 III 1 IV 1 V 1 VI 1 VII 1 VIII 1 IX X 2</td>
<td>2</td>
</tr>
<tr>
<td>16. Pine plank 20×150×2000 mm</td>
<td>I 1 II 1 III 1 IV 1 V 1 VI 1 VII 1 VIII 1 IX X 2</td>
<td>2</td>
</tr>
<tr>
<td>17. Birch wedge 60×200×400 mm</td>
<td>I 2 II 2 III 2 IV 2 V 2 VI 2 VII 2 VIII 2 IX X 2</td>
<td>2</td>
</tr>
<tr>
<td>18. Pine wedge 30×200×200 mm</td>
<td>I 2 II 2 III 2 IV 2 V 2 VI 2 VII 2 VIII 2 IX X 2</td>
<td>2</td>
</tr>
<tr>
<td>19. Pine wedge 50×150×200 mm</td>
<td>I 2 II 2 III 2 IV 2 V 2 VI 2 VII 2 VIII 2 IX X 2</td>
<td>2</td>
</tr>
<tr>
<td>20. Pine plug for ships with side scuttles (along the side scuttle diameter, 400 mm in length)</td>
<td>I 2 II 2 III 2 IV 1 V 1 VI 1 VII 1 VIII 2 IX X 2</td>
<td>Not required for ships fitted with storm covers</td>
</tr>
<tr>
<td>21. Pine plug 10×30×150 mm</td>
<td>I 2 II 1 III 1 IV 1 V 1 VI 1 VII 1 VIII 4 IX X 2</td>
<td>2</td>
</tr>
<tr>
<td>22. Coarse felt, industrial 10 mm thick, m²</td>
<td>I 1.0 II 1.0 III 0.5 IV 0.5 V 0.5 VI 0.5 VII 1.5 VIII 1.5 IX X 1.0</td>
<td>0</td>
</tr>
<tr>
<td>23. Rubber plate 5 mm thick, m²</td>
<td>I 0.5 II 0.5 III 0.25 IV 0.25 V 0.25 VI 0.25 VII 0.5 VIII 0.5 IX X 0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>24. Semi-linen tarpaulin СКПБ, m²</td>
<td>I 4 II 2 III 1 IV 1 V 1 VI 1 VII 1 VIII 1 IX X 4</td>
<td>2</td>
</tr>
<tr>
<td>25. Bend tarred tow, kg</td>
<td>I 10 II 10 III 5 IV 5 V 2.5 VI 2.5 VII 10 VIII 20 IX X 15</td>
<td>10</td>
</tr>
<tr>
<td>26. Low-carbon steel wire with a diameter of 3 mm, coil</td>
<td>I 0.5 II 0.5 III 0.25 IV 0.25 V 0.25 VI 0.25 VII 0.5 VIII 1.0 IX X 0.5</td>
<td>Each coil containing 50 m</td>
</tr>
</tbody>
</table>
**End of Table 11.2.2**

<table>
<thead>
<tr>
<th>Description</th>
<th>Number of outfit items for the ship groups</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>27. Construction shackle with a diameter of 12 mm, 300 mm in length</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>28. Construction nails 3×70 mm, kg</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>29. Construction nails 6×150 mm, kg</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>30. Hexagon-head bolts M16×400</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>31. Hexagon-head bolt M16×260</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>32. Hexagonal nut M16</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>33. Washer for nut M16</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>34. Paste iron minimum, kg</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>35. Technical fat, kg</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>36. Wood saw, cross-cut, two-handled, 1200 mm in length</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>37. Hacksaw, wood, cross-cut, 615 mm in length</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>38. Carpenter's axe</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>39. Axe helve (spare)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>40. Sledge hammer, blunt-nosed 5 kg</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>41. Shovel LII</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>42. Scoop for sand</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>43. Galvanized cone bucket with lanyard 12 L</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>44. Metal stop of telescopic type</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>45. Emergency clamp</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>46. Portable accumulator lantern of explosion-proof type</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>47. Claw-ended lever (only for ships with wooden superstructures)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>48. Submersible pump of type ECH-16 with hoses of flow capacity 30 to 40 t/h (recommended)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>49. Tight packing of 50 kg for cement</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>50. Jars for storage of minimum, liquid glass and technical fat with capacity of 5 kg</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>51. Bow for stowing tools and outfit, pc</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>52. Log book for emergency outfit</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

11.2.5 Outfit items marked with asterisk in Tables 11.2.2, 11.2.3 and 11.2.4 shall be provided in oil tankers carrying inflammable liquids with a flash point of 60°C and below in spark-proof type.
### Table 11.2.3

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity per set</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bench hammer* 0.5 kg with a handle</td>
<td>1</td>
</tr>
<tr>
<td>2. Sledge hammer*, blunt-nosed 3.0 kg</td>
<td>1</td>
</tr>
<tr>
<td>3. Forged chisel* 20 mm wide</td>
<td>1</td>
</tr>
<tr>
<td>4. Fid 200 mm long</td>
<td>1</td>
</tr>
<tr>
<td>5. Pincers (pliers) multi-purpose 200 mm long</td>
<td>1</td>
</tr>
<tr>
<td>6. Punch 18 mm in diameter</td>
<td>1</td>
</tr>
<tr>
<td>7. Punch 25 mm in diameter</td>
<td>1</td>
</tr>
<tr>
<td>8. Triangle file 300 mm long</td>
<td>1</td>
</tr>
<tr>
<td>9. Half-round file 300 mm long</td>
<td>1</td>
</tr>
<tr>
<td>10. Screwdriver* 10 mm wide, 150 mm long</td>
<td>1</td>
</tr>
<tr>
<td>11. Screwdriver for cross-head screws and wood screws</td>
<td>1</td>
</tr>
<tr>
<td>12. Adjustable wrench* with a spanner up to 36 mm wide</td>
<td>1</td>
</tr>
<tr>
<td>13. Wrench* with open spanner 22x24 mm</td>
<td>1</td>
</tr>
<tr>
<td>14. Hack-sawing machine</td>
<td>1</td>
</tr>
<tr>
<td>15. Hack-saw blade</td>
<td>8</td>
</tr>
<tr>
<td>16. Cutting nippers (cutting pliers)</td>
<td>1</td>
</tr>
</tbody>
</table>

* See 11.2.5

### Table 11.2.4

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity per set</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bench hammer* 0.5 kg with a handle</td>
<td>1</td>
</tr>
<tr>
<td>2. Forged chisel* 20 mm wide</td>
<td>1</td>
</tr>
<tr>
<td>3. Fid 200 mm long</td>
<td>1</td>
</tr>
<tr>
<td>4. Socket chisel 300 mm long, 200 mm wide</td>
<td>1</td>
</tr>
<tr>
<td>5. Pincers* 200 mm long</td>
<td>1</td>
</tr>
<tr>
<td>6. Tape-measure 2000 mm long</td>
<td>1</td>
</tr>
<tr>
<td>7. Chisel 20 mm wide</td>
<td>1</td>
</tr>
<tr>
<td>8. Piercer 4 mm in diameter</td>
<td>1</td>
</tr>
</tbody>
</table>

* See 11.2.5

#### 11.3 MATS

**11.3.1** Mats shall be made of tarpaulin with waterproof impregnation or other equivalent cloth. They shall be edged with four embedded thimbles at the corners. Cringles shall be also provided in quantity equal to the number of ropes specified in Table 11.3.2.

**11.3.2** Technical parameters and outfit of the mats shall be assigned as per standards stated in Table 11.3.2.

#### 11.3.3

The length of each sheet \( L_{sh} \), m, shall be determined by the following formula:

\[
L_{sh} = 1.6 \left( D + 0.5B \right),
\]

where \( D \) — side depth from the keel to the upper edge of the bulwark, m;

\( B \) — overall breadth of a ship, m.

The length of guy shall be at least \( 2L_{sh} \).

The length of control lanyard shall be equal to the sheet length.

The length of each keel hauling line \( L_{k,h,l} \), m, shall be determined by the following formula:

\[
L_{k,h,l} = 1.6 \left( 2D + 0.5B \right),
\]

The length of sheets, keel hauling lines, guys and lanyards for mats which shall be provided in ships as per 11.1.3, shall be calculated according to the dimensions of the biggest ship in a convoy.

#### 11.3.4

Mats shall be made of natural fibre strands and thrummed with natural spun line. A tarpaulin shall be sewed from the bottom side of the mat.

### 11.4 ARRANGEMENT OF EMERGENCY OUTFIT

**11.4.1** An emergency station shall be provided for arrangement of the emergency outfit located not lower than the main deck.

In ships less than 40 m in length the emergency station may be located lower than the main deck provided it is easily accessible.

As the emergency station a special space, box or assigned place on the deck or in the ship’s spaces may be used.

In ships less than 20 m in length the emergency outfit may be located in several spaces.

**11.4.2** Width of free passage before the emergency station shall be at least 0.8 m and in ships less than 30 m in length — at least 0.6 m.

### 11.5 MARKING

**11.5.1** Emergency outfit items or pack for their storage excepting mats shall be painted blue, totally or with a stripe.
Table 11.3.2

Technical parameters and standards for equipping with mats

<table>
<thead>
<tr>
<th>Name of items</th>
<th>Quantity of items per mat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lightened 3.0×3.0 m</td>
</tr>
<tr>
<td>1. Tarpaulin sheet</td>
<td>2</td>
</tr>
<tr>
<td>2. Lining</td>
<td>1 made of felt 1 mat</td>
</tr>
<tr>
<td>3. Rigid fastening</td>
<td>2</td>
</tr>
<tr>
<td>4. Snatch-block for steel rope (permissible load per suspension is 9.8 kN)</td>
<td>2</td>
</tr>
<tr>
<td>5. Snatch-block for hemp rope 75 mm in diameter (permissible load per suspension is 8 kN)</td>
<td>—</td>
</tr>
<tr>
<td>6. Tackle with swivel hook (permissible load per suspension is 9.8 kN)</td>
<td>2</td>
</tr>
<tr>
<td>7. Joining shackle of type CA-2,5</td>
<td>9</td>
</tr>
<tr>
<td>8. Joining shackle of type P-0,5</td>
<td>—</td>
</tr>
<tr>
<td>9. Sheet of galvanized steel rope 13.5 mm in diameter</td>
<td>2</td>
</tr>
<tr>
<td>10. Sheet of hemp rope 75 mm in circle</td>
<td>—</td>
</tr>
<tr>
<td>11. Keel hauling line of galvanized steel rope 13.5 mm in diameter</td>
<td>2</td>
</tr>
<tr>
<td>12. Guy of galvanized steel rope 13.5 mm in diameter</td>
<td>2</td>
</tr>
<tr>
<td>13. Control lanyard of kapron halyard 8 mm in diameter with marking</td>
<td>1</td>
</tr>
<tr>
<td>14. Mat case</td>
<td>1</td>
</tr>
</tbody>
</table>

The storage pack for emergency outfit shall bear clear inscription indicating the material, weight and permissible storage period of the outfit.

11.5.2 In the vicinity of the emergency station there shall be clearly visible inscription “Emergency station”. In addition, in the passages and on the decks the position indicators of the emergency station shall be provided.

Provision shall be made for lightning from emergency power source in the vicinity of the emergency station.

When the emergency outfit is stored in several spaces, the diagram of its location on board shall be placed in the wheelhouse.
12 WHEELHOUSE EQUIPMENT

12.1 GENERAL REQUIREMENTS

12.1.1 Control consoles fitted in the wheelhouse shall be provided with ship, engine, appliance, systems and equipment controls (levers, handles, wheels, button and key-operated switches, switches) as well as display and alarm devices and the requirements of 11.12 Part IV of the Rules shall be met.

12.1.2 Steering gear remote control system elements shall be arranged in the wheelhouse so that to the selected heading is visible to the navigator from the control station. If the mentioned remote control system is designed as disconnectable, provision shall be made for ON or OFF position indicators/indicator. The remote controls shall be arranged and manipulated in such a way to be easy to use by the navigator. Non-fixed equipment for remote control of such auxiliary (in terms of steering gear) arrangement as active bow rudders shall be used provided that control of these auxiliary arrangements may be any time transferred to the wheelhouse.

12.1.3 The wheelhouse shall be equipped with adjustable heating and ventilation system complying with requirements of 10.12 Part IV of the Rules. The arrangement for darkening of the wheelhouse shall not prevent its ventilation.
13 ADDITIONAL SHIP’S OUTFIT

13.1 GENERAL REQUIREMENTS

13.1.1 All crewed ships shall be equipped with loudhailer, boat hook and gangway 400 mm wide with a guardrail with the length according to the type and design features of the ship.

13.1.2 Ships of M-CP class shall be fitted with a line-throwing appliance with four projectiles and four lines.

14 EMBARKATION LADDERS FOR SHIPS OF M-CP, M-IP AND O-IP CLASSES

14.1 GENERAL REQUIREMENTS

14.1.1 Embarkation ladder shall be provided in every self-propelled ship near the muster station of the collective life-saving appliances being launched along the ship’s side.

This requirement does not apply to cargo and passenger ships with gross tonnage less than 500, in which boarding on the liferafts is carried out from the deck located less than 2 m (less than 1.5 m in passenger ships) above the waterline corresponding to the minimum operational draught.

14.1.2 Every self-propelled ship shall be fitted with a pilot embarkation ladder as well as arrangements for its installation on any side of a ship. The boarding place of the pilot shall be clearly marked.

14.1.3 In each place of installation of the pilot embarkation ladder there shall be a life-buoy with self-igniting buoy as well as throwing line.

14.1.4 The pilot embarkation ladder and the area outside the ship in the boarding place of the pilot shall be adequately illuminated.

14.1.5 Embarkation ladders shall be located outside the drainage outlet areas and, as far as practicable, outside the sharp lines of the ship; each ladder rung of the ladder shall be reliably set against the ship’s side.

When this requirement cannot be met due to design features of a ship (i.e., fender bars), measures shall be taken to ensure safe boarding.

14.1.6 Handrails shall be provided to ensure a safe passage from the deck to the embarkation ladder and vice versa.

14.1.7 Embarkation and pilot ladders shall comply with requirements of national standards, the ladder structure shall be continuous (not consist of separate sections) and have such length that to reach the water level at the place of installation at any operational draughts and trims of a ship as well as in conditions of list of 15° to the opposite side.

1 GOST R ISO 799, GOST R ISO 5489.
CALCULATION METHOD FOR HYDRODYNAMIC LOADS, BENDING MOMENTS, SHEAR FORCES AND SUPPORT REACTION FORCES ACTING IN THE STOCK-RUDDER SYSTEM

1 This Appendix establishes the method for accounting for a non-uniform nature of hydrodynamic load distribution over the height of ship's rudders and calculation methods for bending moments, shear forces and support reaction forces acting in the stock-rudder system.

2 Hydrodynamic loads (resultant of hydrodynamic forces and torque) acting on the rudder shall be determined based on experimental or calculation results for all possible range of rudder angles.

3 When calculating hydrodynamic forces acting on the rudder within the propeller jet or steerable nozzle, the effects of the ship's hull and propeller jet shall be taken into account.

4 When determining hydrodynamic forces acting on the rudder within the propeller jet or steerable nozzle experimentally, the compliance between load factors for model and full-scale propeller shall be ensured:

\[ C_T = \frac{8T_p}{\rho V_A^2 \pi D^2}, \]  
(A1.4)

where:
- \( T_p \) — propeller thrust, kN;
- \( \rho \) — water density, t/m³;
- \( V_A \) — propulsion and steering system inflow velocity, m/s;
- \( V \) — design speed of a ship in loaded condition (for pushboats — together with the convoy), m/s;
- \( W_f \) — wake factor for straight motion of the ship by calculation of propulsion ability;
- \( D \) — propeller diameter, m.

5 Bending moments, shear forces and support reaction forces acting in the stock-rudder system shall be calculated according to methods shown in Fig.A1.5-1 to A1.5-3.

Calculation shall be performed for such combination of hydrodynamic loads when the stock is subject to maximum equivalent stresses defined in accordance with 1.2.2 of this Part of the Rules.

Maximum unit load intensity \( q \), kN/m shall be calculated by the following formula:

\[ q = R \left[ l_{10} \left( \frac{0.45D}{l_{10}} - 0.975 \right) f + 0.95 \right], \]
(II1.5-1)

where:
- \( D \) — propeller diameter, m;
- \( l_{10} \), \( l_{10} \) — lengths of steering gear elements (see Fig. A1.5-1 to A1.5-3), m;
- \( R \) — resultant force on a rudder, kN;
- \( f \) — coefficient considering non-uniformity of load distribution for suspended rudders and rudders with support on sternframe heel determined by Table A1.5 depending on load factor \( C_T \) and relative height of the part of the rudder protruding from the jet \( \left( \frac{l_{10} - D}{l_{10}} \right) \).

For semi-suspended rudders, totally or partially falling into the propeller jet when the ship is moving ahead at \( \left( \frac{l_{10} - D}{l_{10}} \right) \leq 0.4 \), coefficient considering non-uniformity of load distribution shall be taken...
Fig. A1.5-1. Calculation method for moments, forces and reaction forces acting in the stock-suspended rudder system

Fig. A1.5-2 Calculation method for moments, forces and reaction forces acting in the system of stock and rudder with lower support on sternframe heel

Table A1.5
Coefficient considering non-uniformity of load distribution $f$

<table>
<thead>
<tr>
<th>$(l_{10} - D)/l_{10}$</th>
<th>0</th>
<th>2</th>
<th>6</th>
<th>12</th>
<th>≥25</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>0.000</td>
<td>0.133</td>
<td>0.196</td>
<td>0.226</td>
<td>0.256</td>
</tr>
<tr>
<td>0.1</td>
<td>0.000</td>
<td>0.226</td>
<td>0.326</td>
<td>0.373</td>
<td>0.418</td>
</tr>
<tr>
<td>0.2</td>
<td>0.000</td>
<td>0.315</td>
<td>0.447</td>
<td>0.506</td>
<td>0.561</td>
</tr>
<tr>
<td>0.3</td>
<td>0.000</td>
<td>0.435</td>
<td>0.597</td>
<td>0.664</td>
<td>0.722</td>
</tr>
<tr>
<td>0.4</td>
<td>0.000</td>
<td>0.540</td>
<td>0.715</td>
<td>0.779</td>
<td>0.827</td>
</tr>
<tr>
<td>0.5</td>
<td>0.000</td>
<td>0.631</td>
<td>0.801</td>
<td>0.850</td>
<td>0.876</td>
</tr>
<tr>
<td>0.6</td>
<td>0.000</td>
<td>0.707</td>
<td>0.856</td>
<td>0.879</td>
<td>0.880</td>
</tr>
</tbody>
</table>

\[ f = -1.625 \left[ \left( \frac{l_{10} - D}{l_{10}} \right)^2 \right] + 1.75 \left( \frac{l_{10} - D}{l_{10}} \right) + 0.65. \]  
\[ (A1.5-2) \]

For rudders totally beyond the propeller jet, $f$ is taken equal to 0.

Jet diameter is taken to be equal to propeller diameter.

For rudders downstream of the propeller, for the astern motion of the ship, $f$ is taken equal to 0.

Support rigidity factor $Z$, kN/m shall be determined as follows:

For support on sternframe heel

\[ Z = \frac{1}{u_b}; \]  
\[ (A1.5-3) \]

For support in the rudder horn

\[ Z = \frac{1}{(u_b + u_5 + u_6)}; \]  
\[ (A1.5-4) \]
Fig. A1.5-3. Calculation method for moments, forces and reaction forces acting in the system of stock and rudder with pins on sternframe hinges

where \( u_b \) — displacement of the support due to bending when the force of 1 kN is applied to the support centre:

\[
u_b = l_{50} \cdot 10^3 / (3EJ_{50})
\]

where \( u_s \) — displacement of the support due to shear when the force of 1 kN is applied to the support centre:

\[
u_s = l_{50} \cdot 10^3 / (GF)
\]

where \( u_t \) — displacement of the support due to horn torsion when the force of 1 kN is applied to the support centre:

\[
u_t = l_{50}l_{60} \cdot 10^3 / (Gl_t)
\]

\( E \) — Young’s modulus of the horn and sternframe heel material, MPa;

\( G \) — shear modulus of horn material, MPa;

\( F \) — average cross-sectional area of the rudder horn, m²;

\( J \) — average polar moment of inertia of cross-sectional area of the rudder horn, m⁴;

\( J_{10} - J_{60} \) — moments of inertia of appropriate sections of steering gear elements, m⁴.

Where a bending moment applied to the rudder stock is determined experimentally, the idealized law of load distribution over height as shown in Fig. A1.5-1 to A1.5-3 may be neglected.

6 When the lateral force from the steering drive is transmitted to the rudder stock, this force and corresponding bending moments shall be taken into account when stock strength is calculated.

7 When calculating the height of the plain bearing sleeve, assumed design reaction from the rudder stock being side \( b_h \) kN, for suspended rudder and rudder with lower support on sternframe heel shall be not less than determined by the formula:

\[
B_{sw} = \left[ R(\eta l_{10} + l_{30} + l_{40}) - B_{at}(l_{10} + l_{20} + l_{30} + l_{40}) \right] / l_{40},
\]

where \( \eta \) — nondimensional arm of bending moment (Table A1.7).

<table>
<thead>
<tr>
<th>( (l_{10} - D)/l_{10} )</th>
<th>0</th>
<th>2</th>
<th>6</th>
<th>12</th>
<th>≥25</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \eta ) at ( C_2 )</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>0.0</td>
<td>0.50</td>
<td>0.52</td>
<td>0.53</td>
<td>0.54</td>
<td>0.54</td>
</tr>
<tr>
<td>0.1</td>
<td>0.50</td>
<td>0.54</td>
<td>0.55</td>
<td>0.56</td>
<td>0.57</td>
</tr>
<tr>
<td>0.2</td>
<td>0.50</td>
<td>0.55</td>
<td>0.58</td>
<td>0.59</td>
<td>0.60</td>
</tr>
<tr>
<td>0.3</td>
<td>0.50</td>
<td>0.57</td>
<td>0.61</td>
<td>0.63</td>
<td>0.65</td>
</tr>
<tr>
<td>0.4</td>
<td>0.50</td>
<td>0.60</td>
<td>0.64</td>
<td>0.67</td>
<td>0.69</td>
</tr>
<tr>
<td>0.5</td>
<td>0.50</td>
<td>0.62</td>
<td>0.68</td>
<td>0.71</td>
<td>0.74</td>
</tr>
<tr>
<td>0.6</td>
<td>0.50</td>
<td>0.64</td>
<td>0.71</td>
<td>0.75</td>
<td>0.78</td>
</tr>
</tbody>
</table>

\( B_{at} \) shall be taken in accordance with 8, for suspended rudders, \( B_{at} = 0 \).

Element lengths \( l_{10}, l_{30}, l_{40} \) shall be determined in accordance with Fig. A1.5-1 and A1.5-2.

For the rudders with lower support on sternframe heel, calculation for \( \eta = 0.5 \) shall be additionally performed.
Reaction force in the sternframe heel, \( R \) — yield point of the stock material, kN, shall be determined by formula (A1.8), MPa.

\[
B_{str} = R \left( \eta l_{10} + l_{30} \right)^3 \left\{ 1 + 1.5 \left( l_{10} - \eta l_{10} + l_{20} \right) / \left( \eta l_{10} + l_{30} \right) + 
+ J_{10} J_{40} \left[ 1 + \left( l_{10} - \eta l_{10} + l_{20} \right) / \left( \eta l_{10} + l_{30} \right) \right] / \left[ J_{40} \left( \eta l_{10} + l_{30} \right) \right] \right\} / \left[ J_{10} J_{50} / J_{50} + \left( l_{10} + l_{30} + l_{20} \right)^3 + J_{10} J_{10} \left( l_{10} + l_{30} + l_{20} \right)^2 / J_{40} \right].
\]

(A1.8)
TESTS OF CHAINS AND ACCESSORIES

1 All finished chain cables shall undergo the tests specified in this Appendix in the presence of a Surveyor. Chain cables are allowed for testing if they are free from paint and anti-corrosive coating.

2 All chain links shall undergo visual examination.

All chain links and accessories shall have a clean surface consistent with the method of manufacture and be free from cracks, notches, foreign impurities and other defects impairing the use of the product as intended. The overflows or burrs on forgings shall be ground. The surface defects within the limits of admissible diameter tolerances established in the manufacturer's technical documentation shall be ground to ensure smooth transition of the surface. Hollows may be removed by means of local grinding up to 5% of the nominal link diameter or the item thickness.

The welds shall be free from defects which impair the use of the chain cable as intended. Undercuts, end craters and similar defects shall be ground off.

Allowable tolerances of chain links

3 Diameter tolerances in the elbow outside the link contact area shall not exceed values specified in Table A2.3.

4 Cross-sectional area of the chain link at elbow shall have no negative tolerances.

This area shall be calculated using a diameter determined as an arithmetic mean of four diameter values measured in the same cross section at different points of its outer contour.

<table>
<thead>
<tr>
<th>Nominal link diameter, mm</th>
<th>Allowable tolerances(^1), mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 40</td>
<td>−1</td>
</tr>
<tr>
<td>Over 40 to 84</td>
<td>−2</td>
</tr>
<tr>
<td>84 to 122</td>
<td>−3</td>
</tr>
<tr>
<td>Over 122</td>
<td>−4</td>
</tr>
</tbody>
</table>

\(^1\) Positive diameter tolerances shall not exceed 5% of the nominal diameter.

5 Allowable tolerances of a shot length measured over a length of any 5 links shall not exceed +2.5 % of the nominal length. Measurements shall be performed on the chain under tension after proof load testing.

6 The following tolerances are allowed for chain accessories: for diameter +5 %, — 0 %; for other dimensions ±2.5 %.

Weldability tests

7 During type approval of the chain, in-process welding tests for the welding of chain studs shall be performed in accordance with Section 4 Appendix 10 Part X of the Rules.

Proof load test

8 Each length of chain cable (27.5 m) shall be subject to proof load test at the proof load specified in Tables A2.8-1 and A2.8-2.

Testing load for studless link chain cables

<table>
<thead>
<tr>
<th>Grade</th>
<th>Testing load, kN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proof load</td>
</tr>
<tr>
<td>1</td>
<td>0.185d(^2)</td>
</tr>
<tr>
<td>2</td>
<td>0.260d(^2)</td>
</tr>
</tbody>
</table>

\(*\) Minimum permissible criteria are specified in the Table.

Note. \(d\) — nominal chain diameter, mm.
### Table A2.8-2

<table>
<thead>
<tr>
<th>Chain cable diameter, mm</th>
<th>Testing load, kN, chain grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proof load</td>
</tr>
<tr>
<td>11</td>
<td>36</td>
</tr>
<tr>
<td>12.5</td>
<td>46</td>
</tr>
<tr>
<td>14</td>
<td>58</td>
</tr>
<tr>
<td>16</td>
<td>76</td>
</tr>
<tr>
<td>17.5</td>
<td>89</td>
</tr>
<tr>
<td>19</td>
<td>105</td>
</tr>
<tr>
<td>20.5</td>
<td>123</td>
</tr>
<tr>
<td>22</td>
<td>140</td>
</tr>
<tr>
<td>24</td>
<td>167</td>
</tr>
<tr>
<td>26</td>
<td>194</td>
</tr>
<tr>
<td>28</td>
<td>225</td>
</tr>
<tr>
<td>30</td>
<td>257</td>
</tr>
<tr>
<td>32</td>
<td>291</td>
</tr>
<tr>
<td>34</td>
<td>328</td>
</tr>
<tr>
<td>36</td>
<td>366</td>
</tr>
<tr>
<td>38</td>
<td>406</td>
</tr>
<tr>
<td>40</td>
<td>448</td>
</tr>
<tr>
<td>42</td>
<td>492</td>
</tr>
<tr>
<td>44</td>
<td>538</td>
</tr>
<tr>
<td>46</td>
<td>585</td>
</tr>
<tr>
<td>48</td>
<td>635</td>
</tr>
<tr>
<td>50</td>
<td>686</td>
</tr>
<tr>
<td>52</td>
<td>739</td>
</tr>
<tr>
<td>54</td>
<td>794</td>
</tr>
<tr>
<td>56</td>
<td>851</td>
</tr>
<tr>
<td>58</td>
<td>909</td>
</tr>
<tr>
<td>60</td>
<td>969</td>
</tr>
<tr>
<td>62</td>
<td>1030</td>
</tr>
<tr>
<td>64</td>
<td>1100</td>
</tr>
<tr>
<td>66</td>
<td>1160</td>
</tr>
<tr>
<td>68</td>
<td>1230</td>
</tr>
<tr>
<td>70</td>
<td>1290</td>
</tr>
<tr>
<td>72</td>
<td>1390</td>
</tr>
<tr>
<td>74</td>
<td>1500</td>
</tr>
<tr>
<td>76</td>
<td>1580</td>
</tr>
<tr>
<td>78</td>
<td>1690</td>
</tr>
<tr>
<td>80</td>
<td>1800</td>
</tr>
<tr>
<td>82</td>
<td>1920</td>
</tr>
<tr>
<td>84</td>
<td>2050</td>
</tr>
<tr>
<td>86</td>
<td>2130</td>
</tr>
<tr>
<td>88</td>
<td>2260</td>
</tr>
<tr>
<td>90</td>
<td>2340</td>
</tr>
<tr>
<td>92</td>
<td>2470</td>
</tr>
<tr>
<td>94</td>
<td>2560</td>
</tr>
<tr>
<td>96</td>
<td>2700</td>
</tr>
<tr>
<td>98</td>
<td>2790</td>
</tr>
<tr>
<td>100</td>
<td>2970</td>
</tr>
<tr>
<td>102</td>
<td>3110</td>
</tr>
<tr>
<td>104</td>
<td>3260</td>
</tr>
</tbody>
</table>

**Note.** Minimum permissible criteria are specified in the Table.

---

### Table A2.9

<table>
<thead>
<tr>
<th>Grade</th>
<th>Manufacturing method</th>
<th>Heat treatment</th>
<th>Number of samples' from each 4th chain length or each 100 m for tensile test</th>
<th>impact test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>base metal</td>
<td>welded joint</td>
</tr>
<tr>
<td>1</td>
<td>Welding</td>
<td>Not required</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>Welding</td>
<td>Normalizing</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>ditto</td>
<td>Not required</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Welding</td>
<td>Normalizing, quenching and tempering</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

---

### Breaking, tensile, impact tests

9 For breaking load testing in accordance with Tables A2.8-1 and A2.8-2 samples are taken from the chain cables in conformity with Table A2.9 which comprise at least three stud links or five studless links. The links concerned shall be made according to the same procedure and shall be welded and heat treated together with the chain cable. Samples are separated from the chain cable in the presence of a Surveyor.
In any case, from each fourth length or 100 m one specimen shall be taken for tensile test. Specimens are taken from each fourth length of the non-heat treated chain. The specimens shall be cut out as in Fig. A11.2.4.2 Appendix 11 Part X of the Rules on that side of the link which is opposite to the weld. Testing of the weld-cut specimens may be additionally performed: tensile testing across the weld and impact testing of a specimen with a notch through the weld.

If the adequate breaking load cannot be obtained due to insufficient capacity of the testing machine or large diameter of the chain cable, tensile and impact tests and investigation of microstructure of specimens made of chain links may be performed (see GOST 228).

If the results of the breaking load tensile do not comply with the requirements of Table A2.8-1, A2.8-2, the other specimen shall be taken from the same length. The tests are considered successful if the load corresponding to the required one specified in Table A2.8-1, A2.8-2 has been obtained.

If the results of repeated tests do not comply with requirements of Tables A2.8-1, A2.8-2, the length is rejected. At the manufacturer's discretion sample lengths may be taken from the remaining three lengths of the batch and subject the breaking load testing. If test results for at least one chain length do not comply with requirements of Tables A2.8-1, A2.8-2, the whole batch is rejected.

If the proof load test fails, the defective links/link shall be replaced, a new link/links shall undergo a local heat treatment and the proof load testing shall be repeated. The cause of link/links damage shall be determined.

For sampling an extra link shall be provided in a chain length (or some links for small-diameter chain). The extra link shall be manufactured similarly to the breaking load test specimen (see 9).

Test results shall comply with requirements of Table 3.7.8 of the Rules as well as requirements of this Appendix and shall be specified in the manufacturer's quality control document.

Tests of chain accessories

15 Chain accessories shall be tested in the presence of a Surveyor. Accessories are allowed for testing if they are free from paint and anti-corrosive coating.

16 All accessories shall undergo proof load tests according to Table A2.8-1.

17 For proof load testing according to Table A2.8-1, items shall be presented in batches. A batch of shackles, swivels, swivel shackles, enlarged and end links shall comprise of not more than 25 items, a batch of connecting links — of 50 items of the same grade and dimensions, made of metal of the same heat and heat treated in the same furnace charge.

One item out of each batch shall undergo tests; the use of tested items according to its purpose is not permitted.

18 Breaking load tests may be omitted, if: breaking load is confirmed by satisfactory results of initial tests at the manufacturer during survey of the organization in order to obtain the Recognition Certificate; results of mechanical tests of each batch performed in accordance with 19 comply with requirements of Table 3.7.8 of the Rules and items are subjected to non-destructive testing by organization with the Recognition Certificate issued by the River Register.

19 One tensile test specimen and one set of three impact test (KV) specimens (see Appendix 10 Part X of the Rules) cut out of specific sample or item as in Fig. A11.2.4.2 Appendix 11 Part X of the Rules shall be tested from each batch of items.

20 The results of mechanical tests shall comply with requirements of Table 3.7.8 of the Rules and shall be specified in the manufacturer’s quality control document.

1 GOST 18353, GOST R 51751
Part VI

ELECTRICAL EQUIPMENT
1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION

1.1.1 The present Part of the Rules applies to the electrical equipment of all classes of the ships, if otherwise is stated in the text of particular requirements.

1.1.2 The present Part of the Rules does not apply to electrical equipment intended for household, domestic and manufacturing purposes excepting:

.1 connected cables;
.2 protection, insulation, earthing, electromagnetic compatibility (only for the equipment installed in the spaces where the ship's radio communication and navigation means as well as the control systems of technical facilities having electronic components are operated) and equipment mounting means.

1.2 DOCUMENTATION

1.2.1 The following operational documents for electrical equipment shall be available onboard the ship:

.1 specifications;
.2 technical description and operating guidelines for shipboard electric drives (with diagrams);
.3 electric schematic diagram of generation and distribution of electric energy;
.4 electric schematic diagram of electric propulsion (for ships with electric propulsion);
.5 electric diagrams of main distribution devices (main switchboard, emergency switchboard, propulsion plant control panel etc.);
.6 electric schematic diagrams of charging line;
.7 calculations of the ship's electric power plant required power, generators quantity and power selection, as well as calculation of power of the emergency power supply sources;
.8 album of the switchboard front sides;
.9 electric schematic diagrams of power line, primary lighting line, secondary lighting line, minor emergency lighting (battery), signal and identification lights, starter circuits, special systems;
.10 technical description and operating guidelines for telephony, ship controls and other communication and signaling within the ship (with diagrams);
.11 electric diagrams of telephony connections, ship controls and other signaling within the ship;
.12 technical description and operating guidelines for navigation sets and instrumentation systems.

The following document approved by the River Register shall be available on board of bulk oil-carrying ships and other ships equivalent to them in addition to the documents specified in 1.2.1.1 – 1.2.1.12: “The layout of fire and explosion hazardous areas and spaces, list of electric installations in such areas”.

The availability of the documents specified in 1.2.1.1 – 1.2.1.12 is not required on board of the ships which do not have a crew, but the ship owner is to submit them on demand.
2 GENERAL REQUIREMENTS

2.1 DEFINITIONS AND EXPLANATIONS

2.1.1 In the present Part of the Rules the following terms and definitions are used:

1. **Emergency lighting** — lighting of ship's spaces and areas by means of lighting fixtures fed from the emergency or momentary emergency source of electric power.

2. **Emergency source of electric power** — electric power source intended for the necessary ship consumer's supply in the event of voltage break-off on the main distribution switchboard.

3. **Momentary emergency source of electric power** — electric power source intended for the necessary ship consumer's supply from the moment of voltage break-off in the main power source until the emergency diesel generator starts running.

4. **Antistatic earthing (bonding)** — electrostatic sparking safety device — electric connection which ensures potential equalization (bonding) of static electricity in structural parts of ship's equipment and hull by means of their direct electric contact or contact via earth wires.

5. **Shaft generator** — ship's generator of electric current driven from the ship's shaft line or from the main propulsion engine.

6. **Explosion hazardous area** — volume where explosive mixtures of air and gas or air and dust are present or may be generated. Explosion hazardous areas are subdivided into areas 0, 1 and 2.

7. **Galvanic spark safety** — condition of ship's equipment and systems when the probability of fire or explosion initiation caused by electric sparking during galvanic contact of the ship with onshore facilities or other ship is excluded. The galvanic contact in its turn may be caused by electro-chemical phenomena and vagabond currents water or ground.

8. **Ship's length** — ship's length at the design waterline.

9. **Protective earthing** — electrical connection of the equipment to the Earth. Onboard a ship such connection is attached to the hull.

10. **Ship's hull** — all metal parts of the ship, which are reliably connected with the outer metal plating. For the ships with non-conducting hull — a special copper sheet of at least 0.5 m² in area and at least 2 mm in thickness or a carbon steel sheet of at least 1.5 m² in area and at least 6 mm in thickness attached to the submerged part of the outer plating at light draught and used for earthing of all shipborne facilities.

11. **Small voltage** — a voltage which is not hazardous to the personnel. The safety condition is considered as satisfied, if the windings of the transformers, converters and other voltage-lowering devices are electrically separated and the value of the stepped-down voltage across these devices or electric power sources does not exceed:

   - 50 V between poles at direct current;
   - 50 V between phases or 30 V between phases and the hull at alternating current.

12. **Lightning divertor** — the upper part of lightning arrester intended for direct perception of atmospheric discharges.

13. **Essential facilities** — facilities, the normal operation of which provides the ship navigation safety, safety of people
and cargo onboard. Such facilities include those listed in 5.3.1.

14 Isolating transformer — a transformer intended to separate the electrical receiver feeding circuit from the primary electrical network.

15 Special electrical spaces — spaces or places intended for electrical equipment only and accessible only for attending personnel.

2.2 OPERATING CONDITIONS

2.2.1 The design of electrical equipment shall provide its operability at deviations of voltage and frequency from their nominal values specified in Table 2.2.1, unless otherwise specified in the present Part of the Rules.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Deviation from nominal values, %</th>
<th>Duration of short deviation, seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC voltage</td>
<td>+6</td>
<td>+15</td>
</tr>
<tr>
<td></td>
<td>–10</td>
<td>–30</td>
</tr>
<tr>
<td>Frequency</td>
<td>±5</td>
<td>±10</td>
</tr>
<tr>
<td>DC voltage</td>
<td>±10</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: When powered by accumulator battery which is operating into load in parallel with a charger, the long deviation is to be within the following limits: from +30 to –25 %.

When powered by accumulator battery for the equipment which is not connected to the battery during the charging process, the long deviation is to be within the following limits: from +20 to –25 %.

2.2.2 The values specified in Table 2.2.2 shall be taken as nominal operating temperatures of ambient air and cooling water for electrical equipment.

<table>
<thead>
<tr>
<th>Equipment location</th>
<th>Temperature, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery spaces, galleys and special electrical spaces</td>
<td>From +55 to –10</td>
</tr>
<tr>
<td>Open decks</td>
<td>From +55 to –30</td>
</tr>
<tr>
<td>Other spaces and areas</td>
<td>From +40 to –10</td>
</tr>
</tbody>
</table>

2.2.3 Electrical equipment is to operate reliably at relative air humidity (80±3) % and temperature (40±2) °C, as well as at relative air humidity (95±1) % and temperature (25±2) °C.

2.2.4 Electrical equipment of ships of all classes, except for "P" class ships not operated at water storage basins and "J" class ships, is to operate reliably at a permanent list up to 15° and trim up to 5°, as well as at rolling motion up to 22.5° with the period of 7 – 9 seconds and pitching up to 10° from the horizontal line.

Emergency sources of electric power and electrical equipment fed from the emergency sources are to operate reliably at a permanent list up to 22.5° and trim up to 10°, as well as at simultaneous list and trim within the specified limits.

2.2.5 Electrical equipment is to operate reliably at vibrations with frequency of 2 – 80 Hz, amplitude of 0.1 – 1.0 mm and at impacts with acceleration of 5g with frequency of 40 – 80 impacts per minute.

2.2.6 (shall be considered to have lost force.)

2.3 STRUCTURAL REQUIREMENTS

2.3.1 The components of electrical equipment to be replaced while in operation shall provide easy dismantling and disassembly.

2.3.2 When using screw fastenings the screws and nuts shall be prevented from self-unscrewing and loss in places subject to frequent dismantling and opening.

2.3.3 Tightening gaskets of parts of the electrical equipment (detachable, opening, stuffing boxes etc.) are to correspond to the protective type of the equipment casing. Sealings are to be fastened to covers or housings.

2.3.4 Electrical equipment, where water may be condensed inside, is to be fitted with appropriate water drainage device. Drainage channels shall be provided inside the equip-
ment to drain water condensate out of all parts of the equipment.

Alive windings and parts of the equipment are to be so located or protected as to being prevented from the affection of water condensate inside the equipment.

2.3.5 Electrical equipment with forced ventilation intended for installation in the lower parts of wet spaces is to be fitted with a ventilation system which would prevent sucking of moisture and oil vapours inside the equipment.

2.3.6 Protection type of electrical equipment, depending on its location, is to be at least as specified in the Table 2.3.6.

2.4 MATERIALS

2.4.1 Structural parts of electrical equipment are to be made of strong fire retardant materials stable to affection of high humidity and oil vapours or be appropriately protected against it. Screws, nuts, hinges and other parts intended for fastening closings of electrical equipment located on the open deck and in spaces with high humidity are to be made of corrosion resistant materials or be fitted with reliable corrosion-proof covering.

2.4.2 All the alive parts of electrical devices are to be made of copper, copper alloys or other materials with the same physical characteristics with the exception of:

<table>
<thead>
<tr>
<th>Location of electrical equipment</th>
<th>Name of electrical equipment</th>
<th>Distribution devices</th>
<th>Double-side-operated main and emergency distribution switchboards</th>
<th>Communication and alarm equipment, accessories</th>
<th>Heating equipment</th>
<th>Lighting fixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry spaces</td>
<td></td>
<td>IP20</td>
<td>IP20</td>
<td>IP20</td>
<td>IP20</td>
<td>IP20</td>
</tr>
<tr>
<td>Accommodation spaces except for lazarets and washrooms</td>
<td></td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
</tr>
<tr>
<td>Wheelhouse</td>
<td>Total volume</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
</tr>
<tr>
<td></td>
<td>Near the fore wall</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
</tr>
<tr>
<td>Service spaces, refrigerator rooms (excepting ammonia refrigerating plants), emergency generator rooms, general purpose storerooms, pantries, provision stores</td>
<td></td>
<td>IP22</td>
<td>IP22</td>
<td>IP44</td>
<td>IP44</td>
<td>IP44</td>
</tr>
<tr>
<td>Engine and boiler rooms</td>
<td>Above plating</td>
<td>IP22</td>
<td>IP22</td>
<td>IP44</td>
<td>IP44</td>
<td>IP44</td>
</tr>
<tr>
<td></td>
<td>Below plating</td>
<td>IP44</td>
<td>IP44</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
</tr>
<tr>
<td></td>
<td>Control stations (dry)</td>
<td>IP44</td>
<td>IP44</td>
<td>IP22</td>
<td>IP22</td>
<td>IP22</td>
</tr>
<tr>
<td>Steering rooms</td>
<td></td>
<td>IP44</td>
<td>IP22</td>
<td>IP55</td>
<td>IP55</td>
<td>IP55</td>
</tr>
<tr>
<td>Lazarets and washrooms</td>
<td></td>
<td>IP44</td>
<td>IP22</td>
<td>IP55</td>
<td>IP55</td>
<td>IP55</td>
</tr>
<tr>
<td>Cooled spaces, galleys, laundries, bathrooms, shower rooms</td>
<td></td>
<td>IP44</td>
<td>IP22</td>
<td>IP55</td>
<td>IP55</td>
<td>IP55</td>
</tr>
<tr>
<td>Cargo holds</td>
<td></td>
<td>IP55</td>
<td>IP55</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Open decks prevented from water overflow</td>
<td></td>
<td>IP55</td>
<td>IP54</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Open decks subject to water overflow</td>
<td></td>
<td>IP56</td>
<td>IP56</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Spaces and areas where the equipment may operate in underwater conditions</td>
<td></td>
<td>IP68</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Notes: 1. For explosive spaces and areas the requirements for electrical equipment are given in 2.10, 16.2.4 – 16.2.6, 16.2.10, 16.3.4, 16.3.7.
2. If the protection level of electrical equipment is lower than the protection level required by the present Table, protective components (shields, screens, casings) shall be applied to ensure the safety of such equipment operation in its installation location.
3. In spaces and areas with explosive dust and similar spaces the equipment used shall be of IP66 protection level or equivalent explosion-proof equipment.
4. Designation of protection levels is specified in Appendix 1.
.1 resistor components which shall be made of materials with high mechanical strength, high resistivity and high temperature resistance;

.2 short-circuit windings of armatures of asynchronous motors made of aluminium or its alloys;

.3 coal brushes, metal-ceramics contacts, technical coal for slip rings and other similar parts when it is stipulated by the required properties of such devices;

.4 electrical equipment components directly attached to the hull used as a return wire in a single-wire system.

2.4.3 Insulation materials of parts being under voltage are to have appropriate dielectric strength, be able to withstand appearing of leakage current along its surface, be moisture-proof, oil-proof and have sufficient strength or be adequately protected.

2.4.4 To provide insulation of windings of machinery, apparatus and other essential facilities the insulation materials of B, F and H classes are to be used.

2.5 CONNECTIONS OF CURRENT-CARRYING PARTS

2.5.1 The minimal permissible cross-sectional area of wiring for inner mounting of distribution facilities including control and alarm measuring circuits shall be at least 0.75 mm². Cross-sectional area less than 0.75 mm² is allowed only for control, intercommunication, alarm and protection circuits, as well as electrical equipment.

The wire sections from busbars to protection devices not protected against short circuit shall be as short as possible.

2.5.2 Current-carrying parts shall be so attached that to avoid any additional mechanical loading; they shall not be attached by means of screws screwed directly into the insulation material.

2.5.3 The endings of stranded cores of cables and wires are to be treated properly depending on the type of the terminal used or to be fitted with cable tips. When soldering the tips no acids or other corrosion-active substances shall be used.

2.5.4 Insulated wires are to be laid and fastened so as not to decrease their insulation resistance and prevent them from damages caused by electrodynamic loads, vibrations and shocks. The cables are to be laid in straight lines without any crossings in their routes. The crossings are allowed only in: cable tails from the routes, paths through the bulkheads, spreading to electrical equipment.

2.5.5 Measures shall be taken to prevent the inadmissible temperature rise of insulated wire in normal operating conditions or during the period of cutting-off short-circuit current.

2.5.6 Insulated wires are to be connected to the terminals or busbars so as to prevent affection of inadmissible temperature on cables' insulation in normal operating conditions.

2.6 PROTECTIVE EARTHING

2.6.1 All non-alive metal parts of the electrical equipment, which are likely to be touched by attending personnel under service conditions, excepting those listed in 2.6.2, are to be earthed.

2.6.2 Protective earthing is not required for:

.1 electrical equipment with double or reinforced insulation;

.2 electrical equipment fed by low voltage current;

.3 metal parts of electrical equipment fastened in non-conducting material or passing therethrough and separated from the earthed and alive parts in such manner that under normal operating conditions these parts cannot become alive or contact with the earthed parts;

.4 housings of specially insulated bearings;

.5 lamp caps and fasteners for luminescent lamps, lamp shades, reflectors and guards attached to lamp holders or lighting fixtures made of or screwed into non-conducting material;

.6 cable clips;
small individual consumers fed from separating transformers.

2.6.3 Fixed electrical equipment, cable outer sheathes (armour) protecting from mechanical damage, cable outer sheathes (armour) and conductor shields used for shielding are to be earthed. Earthing is to be made by means of external wiring, earth core in the feeding cable or using direct electrical contact between the equipment casing and metal hull.

Earthing of electrical equipment and cable sheathes is considered adequately effective when the parameters specified in Table 2.6.3-1 are met.

<table>
<thead>
<tr>
<th>Earthing type</th>
<th>Earthing method</th>
<th>Resistance, Ohm, not more than</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>by separate conductor</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>by cable core</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>by direct contact</td>
<td>0.1</td>
</tr>
<tr>
<td>Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shielding</td>
<td></td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.02</td>
</tr>
</tbody>
</table>

When external earth conductor is used for earthing, corrosion-resistant materials shall be used. The cross-sectional area of earth copper conductor is to be at least as specified in Table 2.6.3-2.

<table>
<thead>
<tr>
<th>Cross-sectional area of earth conductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-sectional area of cable core connected to consumer, mm²</td>
</tr>
<tr>
<td>up to 2.5</td>
</tr>
<tr>
<td>from 2.5 to 120</td>
</tr>
</tbody>
</table>

When a cable core is used for earthing, its cross-sectional area is to be equal to: for cables with cross-sectional area up to 16 mm² inclusive – the nominal cross-sectional area of the main cable cores, and for cables with cross-sectional area over 16 mm² – equal at least to half cross-sectional area of the main cable core but not less than 16 mm². When feeding cable core is used for earthing, the resistance of earth circuit shall not exceed 0.4 Ohm.

2.6.4 Earth circuits of fixed equipment shall have no circuit-breakers.

2.6.5 Earthing of shields and metal armour of the cables is to be carried out in one of the following ways:

- 1 using a copper earth wire with cross-sectional area not less than 2.5 mm² for cables with core cross-sectional area up to 25 mm² and not less than 4 mm² for cables with core cross-sectional area over 25 mm²;
- 2 attaching the armour or metal sheath to the hull by means of firm, reliably adjoining clamp with good conductivity;
- 3 by means of cable gland rings provided that they are made of corrosion-resistant material and possess good conductivity.

Both cable ends are to be earthed. Cable sheathing of branched end circuits may be earthed at the feeding side solely.

2.6.6 Secondary windings of current- and voltage-measuring transformers are to be earthed.

2.6.7 External earth wires are to be accessible for monitoring and protected against mechanical damage.

2.6.8 Earth wires are to be connected to the metal hull or to earthing busbar by means of screws and bolts with at least 6 mm diameter.

Contact surfaces on the electrical equipment and the hull in places of adjoining of earth conductors are to be cleaned up to metal glitter and reliably protected against corrosion.

2.6.9 Superstructures from aluminium alloys insulated from the hull are to be earthed by means of at least two special wires with each cross-sectional area of not less than 16 mm², non-bringing to electrolytic corrosion in places of its connection with superstructure and hull. Such earthing connections are to be made in several places on the superstructure's perimeter, be accessible for observation and protected against damage.

2.6.10 Earthing of mobile or portable electrical equipment is to be made using a special core in flexible feeding cable by contact connection in the plug unit.
2.6.11 Earthing of electrical equipment on pipelines, compressed gas reservoirs and oil tanks is prohibited.

2.6.12 Casing of movable wheelhouse is to be earthed at least in two places by flexible copper wire laid separately from other wires going to the wheelhouse. This protective earthing may be at the same time a part of lightning arrestor, if the lightning divertor is installed on the wheelhouse.

2.6.13 Earthing shall be provided for static electricity discharging.

2.6.14 In ships with non-metal hull a special copper sheet with area not less than 0.5 m² and thickness not less than 2 mm or a carbon steel plate with area not less than 1.5 m² and thickness not less than 6 mm shall be used for earthing. Such sheet is to be attached to the submerged part of the outer plating at light draught and used for earthing of all shipborne facilities.

A metal stem or other metal structures of the ship immersed in water under any navigation condition may be used for earthing.

2.6.15 In the case when the ship’s technical facilities, assemblies or electrical equipment, which require earthing, are installed using shock absorbers or shock-absorbing mounts the earthing strip shall be connected without tension.

2.7 ELECTROMAGNETIC COMPATIBILITY

General requirements

2.7.1 The present requirements are applicable to electrical equipment, automation equipment, radio- and navigation equipment to ensure electromagnetic compatibility on board.

2.7.2 Failure-free performance of the equipment shall be ensured under conditions of interference having the following parameters:

1. static and variable (50 Hz) magnetic field in accordance with Table 2.7.2.1. The magnetic field resistance test shall be carried out using test generator and inductance coil generating the required magnetic field intensity;

<table>
<thead>
<tr>
<th>Distance from the field source at which the installation of equipment is permitted, m.</th>
<th>Intensity, A/m, of static and variable magnetic field (50 Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 and more from a powerful field source (bus bar, group transformer)</td>
<td>100</td>
</tr>
<tr>
<td>1 and more from a powerful field source</td>
<td>400</td>
</tr>
<tr>
<td>Without limitation</td>
<td>1000</td>
</tr>
</tbody>
</table>

2. harmonics of voltage in supply circuits in accordance with the higher harmonics diagram for ship mains to be found in Fig. 2.7.2.2 on logarithmic scale.

![Fig. 2.7.2.2. Diagram of higher harmonic components for ship mains: $U_c$ — actual circuit voltage; $U_n$ — voltage of n-order harmonic component](image)

2.7.3 The levels of electromagnetic interference and resistance to it shall not exceed the values specified in Tables 2.7.3-1 and 2.7.3-2.

2.7.4 On ships, for which the level of interference from power semiconductor converters cannot be limited in conformity with 2.7.3, the mains of automation radio and navigational equipment shall be galvanically isolated from the mains of those converters so that at least 40 dB are damped within the frequency range 0.01–30 MHz.

The power supply cables of equipment having the radio interference levels in excess of those stipulated by 2.7.3 shall be laid at least 0.2 m away from the cables of other equipment groups where the common cable run is longer than 1 m (see 2.7.11).
Table 2.7.3-1

<table>
<thead>
<tr>
<th>Interference</th>
<th>Frequency band</th>
<th>Limitations$^{*1, *2}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduction</td>
<td>For equipment installed on open deck and navigation bridge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10–150 kHz</td>
<td>96–50 dBμV$^{*3}$</td>
</tr>
<tr>
<td></td>
<td>150–350 kHz</td>
<td>60–50 dBμV</td>
</tr>
<tr>
<td></td>
<td>350 kHz – 30 MHz</td>
<td>50 dBμV</td>
</tr>
<tr>
<td></td>
<td>150–300 kHz</td>
<td>80–52 dBμV/m$^{*4}$</td>
</tr>
<tr>
<td></td>
<td>300 kHz – 30 MHz</td>
<td>52–34 dBμV/m</td>
</tr>
<tr>
<td></td>
<td>30–2000 MHz except for</td>
<td>54 dBμV/m</td>
</tr>
<tr>
<td></td>
<td>156–165 MHz</td>
<td>24 dBμV/m (30 dBμV/m — for peak measuring receiver)</td>
</tr>
<tr>
<td>Inductive</td>
<td>For equipment installed below bulkhead deck</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10–150 kHz</td>
<td>120–69 dBμV$^{*3}$</td>
</tr>
<tr>
<td></td>
<td>150–500 kHz</td>
<td>79 dBμV</td>
</tr>
<tr>
<td></td>
<td>0.5–30 MHz</td>
<td>73 dBμV</td>
</tr>
<tr>
<td></td>
<td>0.15–30 MHz</td>
<td>80–50 dBμV/m$^{*4}$</td>
</tr>
<tr>
<td></td>
<td>30–400 MHz except for</td>
<td>60–54 dBμV/m</td>
</tr>
<tr>
<td></td>
<td>156–165 MHz</td>
<td>24 dBμV/m (30 dBμV/m — for peak measuring receiver)</td>
</tr>
<tr>
<td></td>
<td>400–1000 MHz</td>
<td>54 dBμV/m</td>
</tr>
</tbody>
</table>

$^{*1}$ The values are given for quasi-peak measuring receiver.
$^{*2}$ at the limit frequency the lesser value is considered as standard.
$^{*3}$ dBμV — value of radio interference voltage in decibels to 1 μV.
$^{*4}$ dBμV/m — value of radio interference field intensity to 1 μV/m.

Measures to ensure electromagnetic compatibility

2.7.5 To ensure protection of radioequipment against electromagnetic interference the requirements specified in Part VII of the Rules shall be taken into account.

2.7.6 For the purpose of dividing the power supply of the ship, rotary converters, transformers and filters shall be used.

2.7.7 Continuous screening shall be ensured, for this purpose cable screens shall be connected to the equipment casings, and it shall also be ensured in cable branch boxes, cable distribution boxes and in way of cable penetrations through the bulkheads.

2.7.8 The earthing installed for the purpose of interference protection shall have an electric resistance not greater than 0.02 Ohm, minimum length possible, shall be resistant to vibration and corrosion, and readily accessible for inspection.

2.7.9 Cable screens shall not be used as return conductors.

2.7.10 By the type of signals conveyed, the ship cables are subdivided in groups as follows:

.1 coaxial cables of radio receivers and conveying video signals with the level of signals 0.1 μV – 500 mV;

.2 screened or coaxial cables conveying analogue and digital signals with the level 0.1–115 V;

.3 screened cables of telephone and radio broadcasting apparatus, control and signaling with the level of signals 0.1–115 V;

.4 unscreened and located below the deck or screened and located above the deck cables of power and lighting network with the level of signals 10 – 1000 V;

.5 coaxial or screened cables of transmitting aerials of radio transmitters, radar installations, echo sounders and power semiconductor converters with the level of signals 10 – 1000 V.

2.7.11 Cables of the same group may be laid in the same cable run provided that interference-sensitive equipment is not influenced by the difference in the levels of signals conveyed. Where the cable lengths laid in parallel are in excess of 1 m, the cables (cable runs) of different groups shall be laid at least 0.1 m apart and their intersections shall be effected at right angles. Coaxial or screened cables of transmitting aerials of radio transmitters, radar installations, echo sounders and power semiconductor converters with the level of signals 10 – 1000 V shall be double-screened or laid inside a metal pipe, if they are coaxial. The outer screen shall be earthed as well as the principal cable screen.
### Electromagnetic interference resistance standards

<table>
<thead>
<tr>
<th>Interference, test types</th>
<th>Equipment</th>
<th>Portable</th>
<th>Protected</th>
<th>Unprotected</th>
<th>Submerged</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conducted low-frequency interference</td>
<td>Test not applicable</td>
<td>Level of applicable effective value of sinusoidal voltage depending on frequency as per Fig. 2.7.2.2. At the input AC/DC power ports. &quot;A&quot; performance criteria.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conducted radio frequency interference</td>
<td>3 V — root-mean-square value. 150 kHz – 80 MHz; 10 V — root-mean-square value for particular specified frequencies. Amplitude modulation frequency is to be 400 Hz or 1 kHz at 80% of modulation depth. At the input/output AC/DC power ports and at the signal and control ports. &quot;A&quot; performance criteria.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiated radio frequency interference</td>
<td>10 V/m, 80 MHz – 2 GHz, 80% modulation depth, frequency 400 Hz or 1 kHz. Hull port. &quot;A&quot; performance criteria. Test not applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nanosecond pulse interference due to high-speed transients</td>
<td>2 kV — &quot;wire to earth&quot; scheme at the AC power inputs 1 kV — &quot;wire to earth&quot; scheme at the inputs of signal and control circuits, &quot;B&quot; performance criteria.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microsecond pulse interference, slow transients</td>
<td>1 kV — &quot;wire to earth&quot; scheme, 0.5 kV — &quot;wire to wire&quot; scheme at the AC power inputs. At the AC power source inputs. &quot;B&quot; performance criteria.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-period parametric variations in power supply network</td>
<td>Voltage ±20% during 1.5 s, frequency ±10% during 5 s. At the AC power source inputs. &quot;B&quot; performance criteria.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power source faults</td>
<td>Power interruption during 60 s. At the AC/DC power source inputs. &quot;C&quot; performance criteria.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrostatic discharge</td>
<td>6 kV — at contact discharge. 8 kV — at air discharge. &quot;B&quot; performance criteria. Test not applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cables laid close to magnetic compasses shall not affect them and cause distortion of their readings.

2.7.12 When installing electrical equipment and laying cables the requirements of Part VIII of the Rules shall be taken into account to protect the navigational equipment from interference.

2.7.13 On board the ships built from the materials, which do not carry current, and where the installation of radio equipment is required, all cables shall be screened or otherwise protected from interference, and all the electrical equipment shall have specific devices for radio interference suppression.

2.7.14 In spaces where radio communication and navigation equipment is installed, as well as on the open decks and superstructures, which are not separated from antennae by a metal deck or bulkhead, all cables and wirings shall have continuous screening braid. All the telephone and other cables of the intercom (except for the end circuits of exclusive telephones) shall be screened.

### 2.8 ARRANGEMENT OF ELECTRICAL EQUIPMENT

2.8.1 Electrical equipment shall be installed in such a manner as to provide convenient
access to controls and to all components that require maintenance, inspection and replacement.

2.8.2 Electrical equipment under hatches, trunks, fittings or connecting devices of water, steam, oil, fuel and hydraulic systems, as well as in places subject to adverse conditions (temperature, oil, gas, salt water, hot steam). Arrangement of electrical equipment in such conditions is allowed if corresponding protection of electrical equipment and cable runs is provided. Electrical equipment shall be installed at a distance of not less than 100 mm from heat sources, which may heat up the components of electrical equipment above the permissible temperature.

2.8.3 The air-cooled electrical equipment shall be so located that the cooling air is not taken from bilges or other spaces wherein the air may be contaminated with substances having a harmful effect on insulation.

2.8.4 Electrical equipment installed in locations subject to vibration and shocks, which are heavier than those specified in 2.2.5, shall be so designed as to ensure its normal operation under these conditions or to be mounted on shock absorbers.

2.8.5 Electrical equipment shall be fixed in position in such a manner that the strength and impermeability of decks, bulkheads and skin are not impaired as a result of this.

2.8.6 Exposed parts of electrical equipment, which are under voltage, shall be located at a distance of not less than 300 mm in horizontal direction and 1200 mm in vertical direction from unprotected flammable materials.

2.8.7 Electrical equipment designed for operation under voltage above 500 V shall be installed in special electrical spaces.

Electrical equipment designed for operation under voltage above 500 V may be installed outside the special electrical spaces if the access to the current carrying parts is available only using special tools and after the voltage is removed. The doors of electric spaces and the covers of such electrical equipment shall have inscriptions specifying the voltage value.

2.8.8 It is strictly prohibited to mount the electrical equipment directly on the walls of tanks containing flammable liquids. The electrical equipment shall be installed at a distance of at least 75 mm from the tank walls.

The signaling and automation (level, pressure etc.) sensors may be mounted directly on the tank.

2.8.9 Electric engines designed for actuation of submersible pumps may be installed on open deck if their arrangement and construction comply with the requirements specified in the present chapter and in 2.3.6, 7.2.4, 7.8.2 and 16.2.

2.9 SPECIAL ELECTRIC SPACES

2.9.1 The doors of special electrical spaces shall be locked and open outwards or be sliding. From within the special electrical spaces the doors shall be open without a key, and from outside a warning inscription shall be provided.

2.9.2 Special electrical spaces shall not be adjacent to the tanks filled with flammable liquids.

2.9.3 No exits, side scuttles of the opening type or other openings are permissible from special electrical spaces into dangerous spaces.

2.9.4 Handrails of non-conducting material shall be installed in servicing areas of special electrical spaces when the open-type electrical equipment is used.

2.10 EXPLOSION-PROOF ELECTRICAL EQUIPMENT

2.10.1 The requirements of the present chapter are applicable to the electrical equipment installed onboard the ships in closed and semi-closed spaces where explosive mixtures of vapours, gases or dust with air may be formed. Semi-closed spaces — partially closed spaces located in a dangerous area at a distance up to 3 meters from tanks (compartments) or where cargo pumps and its systems, as well as pump hoses are located.
Semi-closed spaces have no forced air supply, and their natural ventilation is limited with partial bulkheads, sheds etc. Such spaces include paint stores, lamp rooms (for oil lamps), accumulator rooms and spaces containing tanks, pumps and piping for flammable liquids with a flash point below 60°C, holds of ships carrying dangerous goods and spaces of ammonia refrigerating plants.

Supplementary installation requirements for electrical equipment in oil tankers are specified in 16.2, and installation requirements for electrical equipment in the ships with holds and other spaces for carriage of transport means with filled fuel tanks, tank wagons and trunk tanks for flammable liquids are specified in 16.3.

2.10.2 In dangerous spaces and areas specified in 2.10.1 only the explosion-proof electrical equipment with explosion protection type complying with the category and group of mixture with the highest risk of explosion may be located, except for that specified in 2.10.3. electrical equipment in accumulator rooms shall be installed according to the requirements specified in 8.7.

Cables to tightly closed echo sounder oscillators shall be laid within the cofferdams in appropriately sealed steel watertight tubes at the required distance above the main deck.

Electrical engines of exhaust ventilators in refrigerating plant rooms and the lighting fixtures of stand-by lighting (see 15.2) shall have explosion-tight casing for explosive mixtures of categories and groups not lower than IIBT3 (see Appendix 2).

2.10.3 Electrical equipment to be installed in spaces where dust or fibres may generate an explosive mixture with air shall have the protection type not lower than IP65.

In cases when explosive fibre-air or dust-air mixture may be generated occasionally as a result of damage or leakage of operating technological devices or ventilation stop, electrical equipment of IP55 protection type may be installed.

Electrical equipment installed in such spaces shall have such casing that the temperature of its upper elements, vertical or inclined up to 60° from the horizontal, at prolonged operation is lower for at least 75°C than the smouldering temperature of dust present in those spaces (the smouldering temperature shall be determined for a dust layer of 5 mm thickness).

2.10.4 Explosion-proof lighting fixtures shall be installed in such a manner that to provide clear space of at least 100 mm around them except the place of their attachment.

2.10.5 Any electrical equipment located in explosive spaces and areas, except fire alarm detectors, is to be fitted with a switch to cut off the current carrying cores which is located in a safe place outside explosive spaces and areas.

2.10.6 In closed and semi-closed spaces, where no vapour or gas explosive mixtures can be generated, but having openings leading to explosive spaces the electrical equipment shall be of explosive-proof type.

2.10.7 In the holds intended for transportation of explosive cargoes in containers no electrical equipment or cabling may be located. If necessary, the electrical equipment located in such holds shall be of the following explosive-proof type:

1. spark-proof electrical circuit (Exi),
2. pressurized enclosure (Exp);
3. explosion-tight casing (Exd);
4. improved explosion-proof (Exe).

2.10.8 Cabling in explosive spaces and areas is allowed only for the electrical equipment located in those spaces and areas. Transit cables across such spaces and areas may be laid only when the requirements specified in 2.10.9 – 2.10.11 are met.

2.10.9 All the cables laid in explosive zones shall be covered with tight non-metal sheath with armour or other metal covering for mechanical protection and monitoring of cable core insulation.

The following wires and cables may be used in explosive zones:

1. wires with rubber or polyvinylchloride insulation;
2. wires with rubber or polyvinylchloride insulation in rubber, polyvinylchloride or metal sheath.

No cables with aluminium sheath or wires and cables with polyethylene insulation or sheath may be used.

2.10.10 Cables laid in explosive spaces and areas shall be protected against mechanical damage. Local cables led to accumulators may be laid open.

2.10.11 All metal sheathes of the cables laid across explosive spaces and areas or led to the equipment located therein shall be earthed on both ends.

2.10.12 Cables connected to the electrical equipment of "spark-proof electrical circuit" type are to comply with the following requirements:

1. spark-proof circuits shall be separated from other circuits;
2. the same cable shall not be used for spark-proof and spark-hazardous circuits;
3. cable core insulation of spark-proof circuits shall be of distinctive blue colour. It is allowed to mark with blue colour only the core ends;
4. cable cores of spark-proof circuits shall be protected against the effect of other cables on its spark-proof properties;
5. cables led to the electrical equipment of Exi protection type may be laid open and covered with a non-tight casing if protection from mechanical damage is required.

2.10.13 Cables laid in explosive spaces and areas shall have:

metal armour or braid covered with non-metallic sheath;
or lead sheath with additional mechanic protection;
or copper sheath or stainless steel sheath (for cables with mineral insulation only).

2.11 ADDITIONAL REQUIREMENTS FOR INSTALLATION OF ELECTRICAL EQUIPMENT IN PAINT STORES

2.11.1 Paint stores and ventilation ducts of these stores may be fitted only with the electrical equipment which is necessary for maintenance of these spaces.

This electrical equipment is to be explosion-proof and of the type specified in 2.10.7.

2.11.2 Minimal requirements to this equipment with regard to the explosion protection type are to correspond to the gas mixture category IIB and gas mixture group T3 (see Appendix 2).

2.11.3 Cables (transit or local) laid across the paint stores and spaces specified in 2.10 are to comply with 2.10.10.

2.11.4 Electrical equipment located in the open deck spaces within 1 m from the openings of forced and exhaust natural ventilation or within 3 m apart from the outer opening of exhaust artificial ventilation is to be of explosion-proof type according to 2.11.1.

2.11.5 Cables (transit or local) laid across the paint stores and spaces specified in 2.11.4 are to have metal armour or to be laid in metal pipes.
3.1 NUMBER AND CAPACITY OF MAIN SOURCES OF ELECTRICAL POWER

3.1.1 The number and capacity of the main sources of electric power are to be determined with due regard of the following operating conditions of the ship:

- 1 rate of speed;
- 2 maneuvering;
- 3 in the event of fire, hole in the hull or other conditions which impose the safety of navigation;
- 4 anchorage;
- 5 other operating conditions according to ship's purpose.

3.1.2 Every self-propelled ship shall be fitted with at least two main power sources. If these sources are generators, at least one of them shall have its own independent drive.

3.1.3 Capacity of the main electric power sources is to provide the power supply of essential facilities in the ship's operating conditions specified in 3.1.1.1; 3.1.1.2; 3.1.1.3 in the event of failure of one of the main power sources by the rest of them.

This requirement is not applied to the tugboats and pushers intended for service of the ships carrying flammable substances and liquids during the fire-extinguishing mode on the serviced ship (see 3.1.1.3).

3.1.4 Under normal operating conditions the capacity of electric power sources is to be sufficient to provide the start-up of the most powerful electric motor without spontaneous disengaging of other electric motors being in operation.

3.2 ACCUMULATOR BATTERY AS THE MAIN SOURCE OF ELECTRIC POWER

3.2.1 The accumulator battery may be considered as the main source of electric power solely when it can be charged from shipborne electric power source.

3.2.2 If the accumulator battery is operating in parallel with a charging set, then the ship is considered as fitted with two main electric power sources.

In that case every power source is to be supplied by its own feeder for the consumers supply and have its own protection.

3.2.3 If the accumulator battery is operating in parallel with a charging set, then its capacity is to be sufficient to supply the electric circuit in the event of generator failure, as well as to provide operation of essential facilities within 6 hours for "M" and "O" class ships and within 3 hours for "P" and "L" class ships. This requirement is not applied for the ships of "M-СП", "M-ПР" and "O-ПР".

3.2.4 On the ships where the accumulator battery is the sole main electric power source, its capacity is to be sufficient to provide the fulfillment of the requirements specified in 3.1.1 without recharging and within the following periods of time:

- 8 h — ships of "M-СП", "M-ПР", "O-ПР" classes;
- 6 h — ships of "M" и "O" classes;
- 3 h — ships of "P" и "L" classes.

3.2.5 When the accumulator battery and generator are operating in parallel, the latter shall be fitted with automatic voltage regulator preventing the rise of the accumulator battery charging current over the permitted value.
3.2.6 The generator (rectifier) operating in parallel with the accumulator battery is to have a capacity sufficient for the supply of all shipborne essential consumers and charging of the accumulator battery under normal operating conditions.

3.3 DRIVE OF GENERATORS
3.3.1 Engines intended for the generator drive are to comply with Section 2, Part IV of the Rules, as well as with the requirements specified in the present Chapter.
3.3.2 Diesel generators shall be designed for continuous operation.
3.3.3 Generator drive from the main non-reversible engines operating with variable frequency is allowed provided that the voltage is regulated within 85 – 100 % of the rating and the frequency – within 45 – 52.5 % Hz range.

If the frequency (voltage) of the shaft generators is decreasing after the minimal specified limits have been reached, the consumers which provide the running conditions safety (see Table 4.5.1) are to be switched to the accumulator battery designed for their supply within 15 minutes. Simultaneously one of the diesel generators is to be started automatically and to be connected to the busbars of the electric power plant and assume the load.

Shaft generators onboard the ships with the consumers which do not allow power interruption in operation (e.g. gyrocompass), as well as voltage and frequency oscillations within the limits stated above may be used only when the shaft generator and the diesel generator are operating in parallel.

3.4 AC GENERATOR VOLTAGE REGULATION
3.4.1 Every AC generator is to have a separate independent system for automatic voltage regulation.
3.4.2 AC sets are to be equipped with the voltage regulation systems which comply with the regulation curves of prime movers in such a manner that to maintain the voltage rating with 2.5% accuracy (up to 3.5% for emergency sets) when the load varies from idling up to the nominal with the nominal power ratio.

3.4.3 AC generators are to have the excitation margin sufficient to maintain the voltage rating within 2 minutes with 10% accuracy in the event of generator overload by current equal to 150% of the rated current and power ration equal to 0.6.

3.4.4 A sudden change in the balanced load of the generator running at the nominal revolution frequency and voltage shall not bring the rated voltage drop lower than 85% or rise above 120%. Afterwards the generator voltage shall be restored to the rating with a deviation not exceeding ± 3 % within the time period not longer than 1.5 s. For emergency sets the specified parameters may be increased up to 5 s and up to ± 4 % of voltage deviation.

When no exact data on the maximal values of sudden load, which may be connected additionally to the existing generator load, are available, the load, which is connected at idle speed and then disconnected, may be taken equal to 60% of the current rating with the power ratio of 0.4 or less.

3.5 DC GENERATOR VOLTAGE REGULATION
3.5.1 Shunt-wound DC generators are to have automatic voltage regulators.
3.5.2 Compound-wound generators are to have independent voltage regulating devices with the accuracy up to 1 % for generators with capacity up to 100 kW and up to 0.5% for those with capacity over 100 kW. The above indicated regulation limits are to be maintained both in cold and heated condition, as well as at any load within the generator working load range.

3.5.3 Voltage regulators of compound-wound generators are to enable reduction of the idling voltage for at least 10% below the rated generator voltage in cold condition with due regard of increase of the revolution frequency of the prime mover at idling.

3.5.4 Manual voltage regulators are to be so designed that the clockwise turn of its controls leads to the voltage increase.
3.5.5 Voltage regulators of shunt-wound generators are to be so designed that the exciting winding is shorted after the excitation has disappeared.

3.5.6 DC sets with compound-wound generators are to have such external characteristics that the voltage of the heated generator set for the rated value with the accuracy up to 1% at 20% load does not vary for more than 1.5% for generators with capacity of 50 kW and over and for 2.5% for those with lower capacity.

Voltage variation within 20 – 100% of the rated load of compound-wound generator shall not exceed the following values:
- 3% — for generators with capacity of 50 kW and over;
- 4% — for generators with capacity of more than 15 kW, but less than 50 kW;
- 5% — for generators with capacity of 15 kW and lower.

3.5.7 DC sets with shunt-wound generators are to have such external generator characteristics and automatic voltage regulators that the voltage is maintained with the accuracy of 2.5% when varying the load from idle to full loading.

3.6 LOAD DISTRIBUTION AT THE PARALLEL OPERATION OF THE GENERATORS

3.6.1 When the electric power sources are not designed for prolonged parallel operation on common busbars, provision shall be made for switching them to parallel operation for the period of load transfer from one generator to another.

3.6.2 When AC generators operate in parallel, the synchronization device is to be provided on the main distribution switchboard. When automatic synchronization is used, the reserve manual synchronization device is to be provided.

3.6.3 When several DC generators are installed, a magnetizing device is to be arranged in the main distribution switchboard.

3.6.4 The regulators of the driving motors of AC generators, designed for operation in parallel, are to have such characteristics that the generator active loads vary from the proportional capacity values of single generators for not more than 10% of the rated resistance load of the maximal generator operating in parallel within the range of 20 – 100% of the rating.

3.6.5 AC sets designed for operation in parallel are to be fitted with such reactive voltage drop compensation system that the distribution of reactive load among the generators varies from the values proportional to their capacities for not more than 10% of the rated reactive load of the maximal generator while the sets are operating in parallel.

3.6.6 The revolution frequency regulators of the driving motors of DC generators are to have such characteristics that the load of single generators when operating in parallel is distributed proportionally to the capacity of each generator so far as possible.

For the loads within 20 to 100% of the rated load, the load of single generators shall not differ from the value proportional to the capacity of the given generator for more than 10% of the rating of the maximal generator or on 20% of the rating of the minimal one of those operating in parallel.

For generators of the same capacity the load of any generator shall not differ from the value proportional to their capacity for more than 10% of the rating.

3.7 AUTOMATION OF ELECTRIC POWER STATIONS

3.7.1 The requirements of the present Chapter apply to ships with "A" character in the class formula.

3.7.2 The control systems of generator sets are to provide the following:
- automatic synchronization, acceptance and distribution of load;
- automatic switch-off of non-essential power consumers in the event of the generator overload or when one of the generators oper-
ating in parallel is overloaded due to emergency switching-off of other generator.

3.7.3 When the electric power is supplied by shaft generator, the latter shall be switched off automatically regardless of the voltage (frequency) during the remote start-up of diesel generator.

3.7.4 In the event of voltage cut-off in the ship network the essential consumers required for the ship control, which were in operation, are to be remotely switched on automatically after the voltage has been restored. Automatic start of these consumers shall be performed according to the preset programme preventing the running generators from overload.

3.7.5 When the generator sets are switched off at load decrease, measures shall be taken to prevent it at short-term load variations as per Table 2.2.1 or the forced operating mode of the generator is to be provided to prevent it from going to standby operation at load decrease.

3.7.6 When the standby generator sets are switched on automatically at overloading of the running sets, it shall be possible to determine the sequence of start of those sets.
4 EMERGENCY ELECTRICAL INSTALLATIONS

4.1 GENERAL REQUIREMENTS

4.1.1 The requirements of the present Section are applied to the emergency electrical installations onboard the inland navigation ships and the ships of combined (river – sea) navigation performing domestic voyages. The ships performing international voyages are subject to the requirements of international conventions.

4.2 EMERGENCY SOURCES OF ELECTRIC POWER

4.2.1 All ships are to be equipped with emergency source of electric power.

When the accumulator batteries are used as the main sources of electric power onboard the ship, one or a group of the accumulator batteries may be used as emergency source of electric power provided that its arrangement and capacity meet the requirements for emergency sources of electric power.

The capacity of the emergency source shall be sufficient for provision of power supply to all consumers, simultaneous operation of which is required for the safety of navigation when the main sources of electric power failed to supply voltage.

The emergency source shall provide electric power for emergency consumers listed in Table 4.5.1:

- on self-propelled ships of "M", "O", "P" and "JI" class within the time period specified in Table 4.2.1;
- on the ships of "M-СП" class with a gross tonnage of 300 and more, on the ships of "M-ПР" class designed for operation in the Laptev Sea and the East Siberian Sea from the estuary of the river Yana up to the estuary of the river Kolyma, on the ships of "M-ПР" and "O-ПР" class, where the emergency source supplies power to the navigational and radio equipment, during 12 hours;
- on the ships of "M-СП" class with a gross tonnage of less than 300 during 6 hours;
- on the ships of "M-ПР" and "O-ПР" class within the time period specified in Table 4.2.1 as for the ships of "M" and "O" class accordingly.

4.2.2 On the non-self-propelled ships and floating objects with shore power supply source as main source of electric power

<table>
<thead>
<tr>
<th>Ship type</th>
<th>Ship class</th>
<th>Operation time, h, at least</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. passenger ships</td>
<td>&quot;M&quot;, &quot;O&quot;, &quot;P&quot;, &quot;JI&quot;</td>
<td>6</td>
</tr>
<tr>
<td>2. dry cargo ships, oil tankers, tugboats, pushboats, industrial ships (except for ships specified in p. 4), fishing ships</td>
<td>&quot;M&quot;, &quot;O&quot;, &quot;P&quot;, &quot;JI&quot;</td>
<td>3</td>
</tr>
<tr>
<td>3. Auxiliary industrial ships (i.e. multcats, scows, sounding vessels), non-self-propelled ships</td>
<td>&quot;M&quot;</td>
<td>3</td>
</tr>
<tr>
<td>4. Auxiliary industrial ships specified in p. 3, oil pumping and refinery stations, living quarter barges</td>
<td>&quot;O&quot;, &quot;P&quot;, &quot;JI&quot;</td>
<td>1</td>
</tr>
<tr>
<td>5. Berth-connected ships with shore power supply source as main source of electric power</td>
<td>&quot;M&quot;, &quot;O&quot;, &quot;P&quot;, &quot;JI&quot;</td>
<td>1</td>
</tr>
</tbody>
</table>
the emergency source of electric power shall supply the electric power to:

.1 upon availability of the crew — emergency lighting network (it is allowed to use portable electric torches instead of it) and signal side lights;

.2 if now crew is available — signal side lights.

The time of emergency source operation shall be as specified in 4.2.1.

4.2.3 Emergency consumers are to be supplied from the busbars of emergency distribution switchboards via separate feeders directly or via distribution switchboards or via electric power converter.

4.2.4 Emergency diesel generator is to have a system of automatic engine start and switching to the emergency distribution switchboard busbars in the event of voltage loss on the busbars of main distribution switchboard.

The time from the start signal activation to the moment of readiness to receive 100% load shall not exceed 30 seconds.

The emergency diesel generator starter onboard the ships of "M-СИП" class shall have two independent power sources. Each source is to ensure at least three starts.

4.2.5 No devices having effect on the start, operation and stop of the emergency diesel generator shall be present in the main distribution switchboard and central control station.

4.2.6 Onboard the ships equipped with a generator attached to the main engine and an accumulator battery operating in parallel with this generator, the abovementioned accumulator battery is considered as emergency source of electric power.

4.2.7 Onboard the ships equipped with emergency diesel generator an accumulator battery shall be present to be used as the emergency transitional (short-term) source of electric power.

4.2.8 Accumulator battery used as emergency or emergency transitional (short-term) source of electric power is to provide power supply to all consumers specified in Table 4.5.1 without recharging and voltage drop on its terminals lower than 0.9 of the rated one for the period of time not less than that specified in 4.2.1 as emergency source and for at least 30 minutes — as emergency transitional (short-term) source of electric power.

4.2.9 Accumulator batteries used as emergency or emergency transitional source of electric power are to be equipped with automatic connector to the emergency consumers' network in the event of voltage loss on the busbars of main distribution switchboard — for emergency source, and on the busbars of emergency distribution switchboard — for emergency transitional source. An automatic connection of accumulator batteries to the network when charging shall be provided also.

4.2.10 Emergency and emergency transitional sources of electric power are to have protection from short-circuit only.

When the diesel generator is used as the emergency source of electric power, it is required to use the warning system signaling the generator's overload. The warning devices are to be located at ship's control station or at central control station.

4.3 SPACES FOR EMERGENCY SOURCES OF ELECTRIC POWER

4.3.1 Emergency diesel generator, emergency distribution switchboard, accumulator battery for feeding the starter and the emergency set automation system, as well as emergency fuel storage tank are to be located in the same space.

Accumulator batteries of emergency source and emergency transitional (short-term) source of electric power shall not be located in one space with emergency distribution switchboard.

4.3.2 Onboard the ships of "М-СИП", "М-ПИП", "О-ПИП", "М" and "O" classes and onboard of all passenger ships the spaces for emergency sources and emergency transitional sources of electric power, as well as emergency distribution switchboard are to be lo-
cated above the watertight bulkhead deck, outside the trunks of machinery and boiler rooms and abaft the collision bulkhead. Exits from these spaces are to lead directly to the open deck.

Onboard the ships of "P" and "J" classes the emergency sources of electric power may be located in the machinery space.

4.3.3 Emergency diesel generator room is to be equipped with a heating system sufficient for the faultless start of emergency diesel generator.

Emergency accumulator battery room shall meet the requirements specified in 8.5 and 8.6.

4.4 DISTRIBUTION OF ELECTRIC POWER FROM EMERGENCY SOURCES

4.4.1 Failure of single emergency consumers of electric power in emergency situation (flooding, fire etc.) shall not affect the power supply of other consumers being in operation.

4.4.2 No switches are to be arranged in the circuits of the distribution switchboard of single emergency lighting fixtures except for the cases when the emergency distribution switchboard and emergency circuit are used for the main lighting.

Emergency electrical lighting in the wheelhouse is to be equipped with a switch-off device.

4.4.3 In normal operation the emergency distribution switchboard shall be fed from the main distribution switchboard, and the power supply line shall be protected from short-circuit current and overload. When the ship is moored at the quay the emergency generator may be used to supply power for the non-emergency consumers, in this case the connecting line shall be likewise protected in the emergency distribution switchboard.

4.5 EMERGENCY CONSUMERS OF ELECTRIC POWER

4.5.1 In emergency mode the consumers specified in Table 4.5.1 shall be fed from emergency or emergency transitional source of electric power.

4.5.2 Every lighting fixture and lamp holder of combined lighting fixture of the emergency lighting are to be marked red.

4.5.3 An indicator, displaying the charge level of accumulator battery used as emergency source of electric power, shall be arranged in the central control station or wheelhouse.
<table>
<thead>
<tr>
<th>Emergency consumers of electric power</th>
<th>Electric power source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Emergency</td>
</tr>
<tr>
<td>1.1 Navigation lights</td>
<td>+</td>
</tr>
<tr>
<td>1.2 Daytime signaling lantern, sound signaling means (typhon, ship's whistle, syren)</td>
<td>+</td>
</tr>
<tr>
<td>1.3 Projectors controlled from the wheel house</td>
<td>+</td>
</tr>
<tr>
<td><strong>2 Emergency lights of areas and spaces</strong></td>
<td></td>
</tr>
<tr>
<td>2.1 Places of embarkation into life-saving appliances and areas by the board where the life-saving appliances are lowered, places of location, usage and lowering of collective life-saving appliances</td>
<td>+</td>
</tr>
<tr>
<td>2.2 Spaces for passengers and crew for more than 20 berths and their exits</td>
<td>+</td>
</tr>
<tr>
<td>2.3 Passages and ladders of accommodation and service spaces, as well as exits to open deck</td>
<td>+</td>
</tr>
<tr>
<td>2.4 Machinery spaces and electric generator set spaces together with their local control stations</td>
<td>+</td>
</tr>
<tr>
<td>2.5 Main distributors and emergency switchboard</td>
<td>+</td>
</tr>
<tr>
<td>2.6 Emergency diesel generator space</td>
<td>+</td>
</tr>
<tr>
<td>2.7 Wheel house</td>
<td>+</td>
</tr>
<tr>
<td>2.8 Navigation and radio room</td>
<td>+</td>
</tr>
<tr>
<td>2.9 Storage areas for emergency and fire fighting equipment and kits, as well as locations of manual fire alarms</td>
<td>+</td>
</tr>
<tr>
<td>2.10 Steering room</td>
<td>+</td>
</tr>
<tr>
<td>2.11 Galley</td>
<td>+</td>
</tr>
<tr>
<td>2.12 Gyrocompass room</td>
<td>+</td>
</tr>
<tr>
<td>2.13 Spaces for crew mustering in case of emergency</td>
<td>+</td>
</tr>
<tr>
<td>2.14 Medical locations</td>
<td>+</td>
</tr>
<tr>
<td>2.15 Boilers’ water meters</td>
<td>+</td>
</tr>
<tr>
<td>2.16 “Exit” and “Emergency Exit” illuminated indicating boards in accordance with 10.4.7 of Part I of the Rules</td>
<td>+</td>
</tr>
<tr>
<td>2.17 At fire water pump and spray pump, as well as at emergency bilge pump and locations whereof their engines are activated (for ships with &quot;M-CTII&quot; class only)</td>
<td>+</td>
</tr>
<tr>
<td><strong>Onboard of the passenger ships</strong></td>
<td></td>
</tr>
<tr>
<td>2.18 Exit signs to the boat deck and information plates at life-saving appliances</td>
<td>+</td>
</tr>
<tr>
<td>2.19 Elevators and lifting facilities for passengers including persons with reduced mobility (only when emergency diesel generator is installed)</td>
<td>+</td>
</tr>
<tr>
<td>3 Controls, intercommunication and alarm systems</td>
<td></td>
</tr>
<tr>
<td>3.1 Electrified system of main engines remote control</td>
<td>+</td>
</tr>
<tr>
<td>3.2 Ship controls</td>
<td>+</td>
</tr>
<tr>
<td>3.3 Remote controls of fire-smothering means and their alarm</td>
<td>+</td>
</tr>
<tr>
<td>3.4 General alarm system (operating time not less than 15 minutes)</td>
<td>+</td>
</tr>
<tr>
<td>3.5 Fire detection alarm system, fire-smothering means activation warning system</td>
<td>+</td>
</tr>
<tr>
<td>3.6 Magnetic compasses scales lighting</td>
<td>+</td>
</tr>
<tr>
<td>3.7 Alarm warning system of cargo vapours detection in spaces and areas (for gas carriers and oil tankers)</td>
<td>+</td>
</tr>
<tr>
<td>3.8 Intercommunication and announcing means</td>
<td>+</td>
</tr>
<tr>
<td>3.9 Remote controlled doors closing devices, alarm system of doors position and closing warning</td>
<td>+</td>
</tr>
<tr>
<td>3.10 Ship security alert system, equipment of ship identification and long-range tracking system (for ships with &quot;M-CTII&quot; class only)</td>
<td>+</td>
</tr>
</tbody>
</table>
### Emergency consumers of electric power

| 3.11 Equipment of Automatic Identification System (onboard the ships built before 2002 the emergency accumulator battery shall provide 1 hour operation; onboard the ships built after 2002 – 6 hours operation) | + | + |

#### 4 Power consumers

4.1 Electric and electro-hydraulic rudder drive and its remote control system, as well as rudder indicators (operating time – 15 minutes)

4.2 Electric drives of watertight and fireproof doors together with their indicators and closing warning system

4.3 Electric drive of stationary emergency fire pump in accordance with 3.3.17 of Part III of the Rules (only when emergency diesel generator is installed)

4.4 Automatic pump of spray system (only for passenger ships of "M-CII" class, when emergency diesel generator is installed)

4.5 Emergency bilge pump and the equipment required for operation of the valves of bilge pumping system with electric remote control (only for passenger ships of "M-CII" class, when emergency diesel generator is installed)

4.6 Emergency means for leveling the elevator cabins with the deck during evacuation (only for passenger ships of "M-CII" class, when emergency diesel generator is installed)

#### 5 Means of communication and navigational equipment

5.1 Radio communication facilities specified in p. 3 of Part III of the Rules

5.2 Navigational equipment (only when emergency diesel generator is installed) except for magnetic compass (see p. 3.6 of the Table)

5.3 Navigational equipment of combined navigation (river – sea) ships
5 DISTRIBUTION OF ELECTRIC POWER

5.1 DISTRIBUTION SYSTEMS

5.1.1 The following systems of electric power distribution are allowed onboard the ships:

1. for three-phase alternating current:
   - three-wire insulated system;
   - four-wire insulated system.
   Application of three-phase four-wire distribution system with earthed neutral wire is allowed only for ships with shore power supply system as main source of electric power;
2. for single-phase alternating current:
   - two-wire systems insulated from the hull;
   - two-wire systems with one earthed wire — up to 30 V only;
3. for direct current:
   - two-wire systems insulated from the hull;
   - single-wire systems where the hull is used as return line — up to 30 V only.

5.1.2 In the three-wire insulated distribution systems the generator’s neutral may be earthed. The earthing shall be made via compensating unit near the generator or on the main distribution switchboard.

5.1.3 When using the single-wire distribution system the following conditions are to be met:

1. electric equipment within accumulator rooms, lamp rooms, store rooms and cargo holds is to be fed via two-wire system. Connection of negative wire with the hull is to be arranged outside the abovementioned spaces;
2. lighting fixtures of accommodation spaces (cabins, messes etc.), as well as signal lights, radio and navigational equipment are to be fed via two-wire system. The negative wire of these consumers is to be connected with the hull by means of earthing busbar of the feeding switchboard;
3. common terminals or a busbar for connection of negative connecting wiring of the group of electric power consumers are to be connected to the hull using separate wire with cross-sectional area chosen according to the total current of electric power consumers;
4. wire connection points to the metal hull are to be located in the areas and places with free access and monitoring of contact joints on framing parts or other massive parts of the hull.

It is prohibited to locate the connection points on the outer plating of the ship.

5.1.4 Three-phase alternating current consumers shall be connected in such a manner that phase current of different phases differs for not more than 15% under normal operating conditions.

5.1.5 In direct current systems where the hull is used as return line all the cables arranged in the area of magnetic compass are to have bipolar location (on two poles).

Leading and return wires are to be laid in the same cable or in the proximity to each other.

5.2 PERMISSIBLE VOLTAGE AND FREQUENCY

5.2.1 Voltage rating on the terminals of electric power sources designed for feeding the ship’s power mains shall not exceed the following values:

400 V — three-phase alternating current;
230 V — single-phase alternating current;
230 B — direct current.
Table 5.2.2

<table>
<thead>
<tr>
<th>Consumers</th>
<th>Voltage, V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Machinery electric drives, fixed cooking and heating appliances and their control circuits</td>
<td>220</td>
</tr>
<tr>
<td>2 Heating devices in cabins and public spaces</td>
<td>220</td>
</tr>
<tr>
<td>3 Lighting, alarm and communication on all types of ships including liquid cargo ships carrying oil products with vapor flash point above 60 °C</td>
<td>220</td>
</tr>
<tr>
<td>4 Lighting, alarm and communication on liquid cargo ships carrying oil products with vapor flash point 60 °C and below, as well as on their pushboats</td>
<td>110</td>
</tr>
<tr>
<td>5 Plug sockets for portable hand lamps (excluding cargo chandeliers)</td>
<td>24</td>
</tr>
<tr>
<td>6 Plug sockets for domestic electrical equipment in cabins and public spaces</td>
<td>220</td>
</tr>
<tr>
<td>7 Portable tools and portable control panels</td>
<td>24</td>
</tr>
<tr>
<td>8 Plug sockets for feeding the movable power consumers fixed during operation</td>
<td>220</td>
</tr>
</tbody>
</table>

1 380 V voltage is allowed when the parts being under voltage are not accessible without special tools.
2 220 V voltage is allowed provided that continuous automatic checking device for insulation of electric circuits is installed, which actuates a signal in the event of insulation decrease in permanently attended spaces (wheelhouse, machinery space, main distribution switchboard room etc.).
3 It is allowed to use portable tools with double insulation, which operates on 220 V power.

In the docks, as well as on the dredgers and other industrial ships it is allowed to use three-phase current of 10,000 V inclusive for special electrical high-power drives. In this case the electrical installation is to meet the requirements of Sections 14 and 17 of the present Part of the Rules.

AC frequency rating is to be taken for 50 Hz.

5.2.2 Voltage rating on consumers’ terminals shall not exceed the values specified in Table 5.2.2. Intersystem voltage is not regulated.

5.3 POWER SUPPLY OF ESSENTIAL FACILITIES

5.3.1 The following consumers are to be fed from the bushbars of the main distribution switchboard by separate feeders:
1. Electric drives of the steering gear;
2. Electric drives of the anchor gear;
3. Electric drives of fire pumps;
4. Electric drives of bilge pumps;
5. Electric drives of compressors;
6. Gyrocompass;
7. Cargo holds refrigerator panel;
8. Actuation system devices of electric propulsion plant;
9. Main lighting panels;
10. Radio station panel;
11. Navigation aids panel;
12. Navigation lights panel;
13. Sectional panels and supply distribution devices for other essential consumers grouped according to the principle of similarity of their functions;
14. Distribution devices built into the general ship control panels;
15. Fire-detecting automatic alarm station panel;
16. Electric drives of machinery providing operation of main power plant;
17. Panels of electric drives of cargo, mooring, boat and other arrangements, as well as ventilation and heating devices;
18. Charging device for starting and emergency accumulator batteries, as well as batteries supplying essential facilities;
19. Power supply panels of electric drives intended for closing of watertight doors and for the devices maintaining the fireproof doors in open position, as well as the panels of signaling devices which indicate the position and closing of watertight and fireproof doors.

Consumers specified in 5.3.1.6, 5.3.1.10, 5.3.1.12, 5.3.1.15, 5.3.1.16 and 5.3.1.19 may be fed from the distribution devices specified in 5.3.1.13 and 5.3.1.14 via separate feeders fitted with commutation devices (onboard the
5.3.2 If a ship is equipped with two or more mechanisms of the same purpose having electric drives specified in 5.3.1, then one of those electric drives is to be fed via a separate feeder from the main distribution switchboard. The electric drives of the rest of the mechanisms may be fed from the section boards or special distribution devices intended for feeding the essential consumers.

If the collecting busbars on the main distribution switchboard divided into sections having intersection disconnecting devices, then the electric drives of the mechanisms duplicating each other, special distribution devices having equal names, control panels or the same objects fed via two feeding lines shall be connected to the different sections of the main distribution switchboard.

5.3.3 Feeding circuits for smaller groups of consumers and their safety devices and switches shall be rated for the current not exceeding 16 A. These feeding circuits shall not feed lighting and heating devices simultaneously.

5.4 POWER SUPPLY OF ELECTRIC CONSUMERS OF PUSHED BARGES

5.4.1 Electric consumers of pushed barges are to be supplied as follows: from the pusher by means of a cable fixed on the pushed barge; between neighboring barges and the pusher – by means of flexible cable bridge sagging freely and being connected to the fixed circuit by means of a plug connection.

Multipolar plug connections and stranded cables may be used to supply several consumers. In this case single consumers are to be fed from stationary distribution devices.

5.4.2 A possibility to switch off the power supply onboard of the pushed barge is to be provided.

5.4.3 On pushed convoys the area of plug connections and the coupling gear shall be fitted with plates with warnings that the feeding cables shall be disconnected prior to disconnecting.

5.5 POWER SUPPLY FROM EXTERNAL SOURCE OF ELECTRIC POWER

5.5.1 If the ship network may be fed from external source of electric power, then the ship shall be equipped with external feeder switchboard.

5.5.2 The following facilities are to be provided in the external feeder switchboard:

1. terminals for external portable cable including neutral wire;
2. commutation and protection devices in the cable circuit to the main distribution switchboard (if the external feeder switchboard and the main distribution switchboard are less than 10 m apart from each other, the protection device is not obligatory);
3. signal lamps or voltmeter;
4. a device or a possibility to connect a device for checking polarity and phase sequence;
5. a plate indicating voltage, current type and frequency.

5.5.3 External feeder switchboard shall be connected with the main distribution switchboard by means of stationary laid cables.

5.5.4 Devices for mechanical fixation of the flexible cable tip laid to the switchboard, as well as cable suspensions are to be arranged in the proximity of the external feeder switchboard. Connecting cables shall not be tensioned.

5.5.5 The following facilities are to be provided in the main distribution switchboard in the feeding circuit from external source of electric power:

1. commutation and protection devices;
2. signal lamp and voltmeter;
3. antisingle-phasing device.

5.5.6 The requirements specified in 5.5.2.3 and 5.5.2.4 are not applicable for a ship supplied from external power source with current rating not exceeding 16 A.

5.5.7 If several ships are supplied from the common source of electric power, then each
ship is to be equipped with a device for disconnection from such power source.

**5.6 POWER SUPPLY TO OTHER SHIPS**

**5.6.1** Power supply to other ships shall be performed via separate lines protected with automatic switches or breakers through feeder switch boards of guarded construction according to their location onboard the ship. If the plug connections for 16 A of rated current are used for power supply of other ships, then it is required to provide connection/disconnection in no-voltage condition only (e. g. using switches or lockout devices).
6 DISTRIBUTION DEVICES, ELECTRICAL APPARATUS, TRANSFORMERS

6.1 DESIGN OF DISTRIBUTION SWITCHBOARDS

6.1.1 Frameworks, front panels and casings of main, emergency, sectional and group distributions switchboards shall be made of metal or other non-combustible material with fire retardant and self-extinguishing characteristics.

The generator section of the main distribution device is to be separated from the adjacent sections with divisions made of non-combustible material which prevent spark and flame spreading.

6.1.2 Detachable or opening parts of distribution switchboards intended for installation in locations accessible for unauthorized persons are to be locked with a special key which is the same for all distribution switchboards onboard the ship. The doors shall have a possibility to be fixed in open position.

6.1.3 The main and emergency distribution switchboards as well as the control panels are to be equipped with handrails on their front sides. The distribution switchboards accessible from the back side are to be additionally equipped with horizontal handrails located behind the switchboard.

Handrails shall be made of insulation materials. Firm sorts of wood are allowed for such application.

6.1.4 The panels of generator sections of main and emergency distribution switchboards are to be lightened with lighting fixtures fed from the corresponding generator's side in front of the generator switch.

The panels of distribution sections are to be lightened with lighting fixtures fed from the busbars.

No commutation devices are allowed in the lighting circuits.

6.1.5 The front side of the distribution switchboard panels is to be lightened in such a manner as not to interfere with monitoring the devices and not to dazzle.

6.1.6 Equipment, devices and facilities which require monitoring and maintenance shall be located on the switchboard not higher than 2 m.

6.1.7 Distribution devices designed for rated voltage higher than the low voltage, which are fitted with commutation and protection equipment and do not have a voltmeter installed, are to be equipped with a signaling lamp showing availability of voltage on the busbars.

6.1.8 The opening panels and doors, which have electric control equipment and measuring devices, are to be earthed at least with a flexible crosspiece.

Distribution device shall be equipped with at least one external earthing node. When the distribution device is sectional, then each section or casing shall have an independent earthing node.

6.1.9 Busbars and non-insulated wires in the distribution switchboards shall have dynamic and thermal stability when short-circuit currents occur in corresponding points of the circuit.

Electrical loads occurring in the busbars and in non-insulated wires at short circuit
shall be specified according to national standards.

6.1.10 Busbars and non-insulated wires of different polarity shall be painted with the following distinctive colours:

.1 red — for positive pole;
.2 dark blue — for negative pole;
.3 black or yellow-green — for earthing wire;
.4 light blue — for middle wire.

The equalizing wire shall be painted with the colour of the pole of its location with additional white transverse bands.

6.1.11 Busbars and non-insulated wires of different phases are to be marked with the following distinctive colours:

.1 yellow — for phase 1;
.2 green — for phase 2;
.3 purple — for phase 3;
.4 light blue — for neutral wire;
.5 yellow-green (transverse bands) — for earthing wire.

6.1.12 Busbars and non-insulated wires of separate phases or poles within the switchboard are to be located in the same way relatively to each other.

6.1.13 Equalizing busbars are to ensure for at least one half of the current rating of the major generator connected to the main distribution switchboard.

6.1.14 The maximal permissible load of busbars and non-insulated wires is specified in the Table 6.1.14.

The permissible temperature for busbars and non-insulated wires shall not exceed 90 °C.

The data specified in Table 6.1.14 are defined for the ambient temperature 40 °C under the following conditions:

.1 relative distance between the busbars is equal to their thickness;
.2 only the outer surface of the bunch is coloured.

If the ambient pressure differs from 40 °C or the busbars have a cross-section not specified in the Table 6.1.14, then the maximum permissible load shall be recalculated accordingly.

6.1.15 The busbars shall be connected in such a manner as to prevent corrosion in the places of their junction.

6.1.16 For light alarm indicating the status of shipborne facilities in the distribution switchboards or panels the signaling fixtures are to be used with the colour of lamps or lenses as specified in the Table 6.1.16.

6.1.17 If both alternative and direct current are used onboard the ship, then the electrical equipment shall be fed from separate distribution switchboards or from a distribution switchboard with a division or a distribution section where the voltage values are marked. The wiring diagrams of each switchboard shall be available in the distribution switchboards.

6.1.18 The design of the distribution switchboards shall provide space for mounting of external cable cores to the terminal clamps, block of terminal clamps and electrical connectors.

6.1.19 Signal lamps shall be fitted with signs and inscriptions specifying the signals' designation.

6.2 ELECTRICAL APPARATUS. GENERAL REQUIREMENTS

6.2.1 The switches with replaceable contacts are to be so designed that their replacement could be carried out using common tools without dismantling the switch or its main components.

6.2.2 All switches and disconnectors are to be fitted with mechanical or electrical indicators of "ON" position of the contacts being located in place where the apparatus is put in operation by the operator.

6.2.3 The location of the controller and bracket drums are to be clearly fixed; the neutral position is to be fixed more distinctly than other positions.

1 GOST R 51321.1
### Table 6.1.14

<table>
<thead>
<tr>
<th>Dimension of the busbar cross-section, mm</th>
<th>Maximal permissible load, A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AC from 40 to 60 Hz for the number of separate busbars</td>
</tr>
<tr>
<td></td>
<td>coloured</td>
</tr>
<tr>
<td>12×2</td>
<td>163</td>
</tr>
<tr>
<td>15×2</td>
<td>203</td>
</tr>
<tr>
<td>19×3</td>
<td>242</td>
</tr>
<tr>
<td>20×2</td>
<td>268</td>
</tr>
<tr>
<td>20×3</td>
<td>298</td>
</tr>
<tr>
<td>20×5</td>
<td>423</td>
</tr>
<tr>
<td>25×3</td>
<td>392</td>
</tr>
<tr>
<td>25×5</td>
<td>502</td>
</tr>
<tr>
<td>30×3</td>
<td>456</td>
</tr>
<tr>
<td>30×5</td>
<td>587</td>
</tr>
<tr>
<td>40×3</td>
<td>787</td>
</tr>
<tr>
<td>40×10</td>
<td>1088</td>
</tr>
<tr>
<td>50×5</td>
<td>901</td>
</tr>
<tr>
<td>50×10</td>
<td>1335</td>
</tr>
<tr>
<td>60×5</td>
<td>1075</td>
</tr>
<tr>
<td>60×10</td>
<td>1560</td>
</tr>
<tr>
<td>80×10</td>
<td>2010</td>
</tr>
<tr>
<td>100×10</td>
<td>2450</td>
</tr>
</tbody>
</table>

### Table 6.1.16

<table>
<thead>
<tr>
<th>Colour</th>
<th>Meaning</th>
<th>Signal type</th>
<th>Status of the device</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Danger</td>
<td>Blinking</td>
<td>Dangerous conditions requiring immediate actions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permanent</td>
<td>Dangerous conditions (general signal), as well as dangerous conditions already detected but not eliminated yet</td>
</tr>
<tr>
<td>Yellow</td>
<td>Attention</td>
<td>Blinking</td>
<td>Abnormal conditions not requiring immediate elimination</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permanent</td>
<td>Intermediate condition between abnormal and safe condition.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Abnormal condition already detected but not eliminated yet</td>
</tr>
<tr>
<td>Green</td>
<td>Safety</td>
<td>Blinking</td>
<td>Indicating that the objects put into operation from standby condition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permanent</td>
<td>Normal operating conditions</td>
</tr>
<tr>
<td>Blue</td>
<td>Instructions and information</td>
<td>Blinking</td>
<td>Technical facilities and devices are ready for start. Everything is OK</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permanent</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>General information</td>
<td>Blinking</td>
<td>Signals to be decoded if necessary. Inscriptions related to automatic actions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permanent</td>
<td>Other additional signals</td>
</tr>
</tbody>
</table>

The controller and bracket drums are to have a scale and an indicator or a device indicating the "ON" position.

6.2.4 The direction of the motion of manual controls of the commutation or start-control devices is to be such that the clockwise rotation of the fly-wheel handle or upward or forward movement of the handle (lever) corresponds to the apparatus activation, start of electric motor, increase of the rotation speed, voltage rise etc.

For the control of lifting or lowering arrangements the clockwise rotation of the fly-wheel handle or movement of the handle (fly-wheel) towards the operator is to correspond
to lifting operation and counter-clockwise rotation of the fly-wheel handle or movement of the handle (lever) against the operator is to correspond to lowering operation.

6.2.5 The resistors are to be located and cooled in such a manner as to prevent other devices from heating above permissible temperatures caused by the resistors.

6.2.6 Tell-tale lamps as well as monitoring and recording instruments are to be protected against short-circuit current or fitted with the short-circuit current limiting devices.

It is allowed not to equip the tell-tale lamps with their own short-circuit current protection or short-circuit current limiting devices, if:

.1 the lamps are located in the common casing of the device;
.2 lamps are fed from the circuits laid inside the device casing;
.3 damage of the lamp circuit does not cause interruption of operation of essential facilities;
.4 the device circuit protection is designed for current not exceeding 25 A.

6.2.7 The voltage coils of the apparatus and controls are to be fitted with short-circuit current protective devices; however, they may have no protection if:

.1 the coils are installed in common casing of the device, have common protection and belong to the control system of the same device;
.2 the coils are fed from the device circuit, the protection of which is designed for current not exceeding 25 A.

6.2.8 Fastening of the wire or its tip to the coil block of electrical apparatus is to be made in such a manner that no forces from the connected wire could be transferred to the coil turns. The voltage coil taps are to be made of stranded flexible wire, except for the cases when the lead terminals are fastened directly on the coil shell.

6.2.9 Coils are to have name plates with their technical data.

6.2.10 The radio interference suppression capacitors installed in the circuits of the main and emergency distribution switchboards, generator circuits, as well as in the circuits of essential electric facilities shall be protected against short-circuit current.

6.3 MACHINE-DRIVEN ELECTRICAL APPARATUS

6.3.1 The drive gear of the current breakers shall be so designed that its contacts would be fixed in “ON” or “OFF” positions when the energy feeding the drive gear disappears.

6.3.2 The electrical drive is to provide correct activation of the circuit breaker under all load conditions at control voltage within 85 – 100 % of the rated current, and in case of alternating current — at frequency deviation from the nominal value a per 2.2.1 in addition to the above conditions.

6.3.3 The drive is to provide correct activation of the circuit breaker at the rated making current, ambient temperature +40 °C and hot winding of the drive when the control voltage is not lower than 85 % of the rated value.

6.3.4 Voltage drop down to 70% of the rated control voltage shall not cause the shutdown or reduction of pressure of the movable contacts below the minimal required one at ambient temperature of +40 °C and hot winding of the drive.

6.3.5 The design of the machine-driven circuit breaker shall provide manual control.

6.4 SELECTION OF ELECTRICAL APPARATUS

6.4.1 Electrical apparatus shall be selected in such a way that their rated voltage, load and permissible temperature would not be exceeded under normal operating conditions. Such apparatus shall withstand the rated overloads in transient modes without any damage or temperature rise up to dangerous values.

6.4.2 Rated breaking capacity of electrical apparatus designed for breaking the short-circuit-current is to be not less than the ex-
pected short-circuit current in the place of their installation in the event of shut-off.

6.4.3 Rated making capacity of automatic circuit breakers as well as switches that can be incorporated into a shorted circuit shall be not less than the expected maximal making current in the place of their installation in the event of short circuit.

6.4.4 Rated dynamic stability of electrical apparatus not designed for breaking the short-circuit-current shall be not less than the expected maximal short-circuit current in the place of its installation.

6.4.5 Thermal stability of electrical apparatus shall comply with the expected short-circuit current in the place of its installation as well as with the duration of the short circuit caused by the selective operation of the protection.

6.4.6 Automatic circuit breakers in the circuits of compound generators intended for operation in parallel are to have a pole in equalizing wire which is mechanically connected to other poles of the circuit breaker in such a way that it would switch on prior to connection of other poles to the busbars and would switch off after their disconnection.

6.4.7 The calculation of short-circuit currents shall be performed on the basis of national standard\(^1\) or according to the procedures approved by the River Register.

6.5 ELECTRICITY MEASUREMENT DEVICES

6.5.1 One voltmeter and one ammeter shall be fitted on the main and emergency distribution switchboards for each DC generator.

6.5.2 For each AC generator the following devices shall be fitted on the main and emergency distribution switchboards:

- .1 ammeter with a switch for current measuring in each phase;
- .2 voltmeter with a switch for measurement of phase and linear voltages;
- .3 frequency meter or double frequency meter for generators operating in parallel;
- .4 wattmeter — for capacity exceeding 50 kVA.

6.5.3 In the circuits of essential consumers with rated current of 20 A and more the ammeters are to be provided, which should be installed in close proximity to the consumer or at the remote control stations or in the main distribution switchboard.

It is allowed to use an ammeter with a switch but not more than for six consumers.

6.5.4 In the main and emergency distribution switchboards for each circuit of insulated systems an individual device for insulation measuring is to be installed. For all circuits of insulated systems it is allowed to use one displaying device which can be activated using a switch.

The insulation control devices are to check the circuit insulation permanently and send a light and sound signal (which can be switched off) to the engine room, central control station or the wheelhouse, when the insulation of the circuit increases up to 0.06 M at 100 V, and 0.2 M at 500 V.

The enclosure leakage current caused by the operation of the measuring device shall not exceed 30 mA in all conditions.

6.5.5 Measuring devices with at least the following scale limits are to be used:

- .1 voltmeters — 120 % of rated voltage;
- .2 ammeters for generators not operating in parallel and for consumers — 130 % of rated current;
- .3 ammeters for generators operating in parallel:
  - scale limit for load current — 130 % of rated current;
  - scale limit of reverse current — 15 % of rated current;
- .4 wattmeters for generators not operating in parallel — 130 % or rated power;
- .5 wattmeters for generators operating in parallel:
  - scale limit of load capacity — 130 %;
  - scale limit of reverse capacity — 15 %;

\(^1\) GOST R 51321.1
6. frequency meters — +10 % of rated frequency.

6.5.6 The rated values of voltage, current and power on the scales of measuring devices fitted in the circuits of electric power sources and essential consumers shall be marked with distinguishable marks or signals.

6.6 INSTALLATION OF APPARATUS AND MEASURING DEVICES

6.6.1 The switches shall be installed and connected to the power source in such a way that the movable contacts and all protecting and monitoring apparatus connected to the switch are not alive in off position.

6.6.2 The fuses in distribution switchboards shall be installed in such a way that to provide access and safety for service personnel when replacing fuse strips.

The fuses in distribution switchboards mounted on a foundation at the plating level shall be located not lower than 150 mm and not higher than 1800 mm from the plating.

If the circuit breakers are available in the distribution switchboard circuits, then the fuses shall be located between the busbars and the circuit breaker.

6.6.3 The feeding wire of screwing fuses shall be connected to the central terminal.

6.6.4 The fuses protecting poles or phases of the same circuit shall be installed close to each other either horizontally or vertically according to the design of the fuse.

The relative position of the fuses in AC circuit shall correspond to the sequence of phases either from left to right or downwards.

In the DC circuit the fuse of the positive pole shall be located to the right, from above or closer to the service personnel.

6.6.5 The manual drives of voltage regulators installed on the main or emergency distribution switchboards are to be located close to the measuring devices of corresponding generators.

6.6.6 Apparatus controls, devices, panels and coming-out circuits in distribution switchboards shall have corresponding inscriptions. The positions of commutation apparatus shall be indicated.

Irrespective of the availability of manufacturer's plate the fusing current and the release current setting shall be indicated near the fuses and current-limiting automatic circuit breakers.

6.6.7 Every feeder coming out of the distribution switchboard shall be fitted with protection and commutation devices.

It is allowed not to install the commutation apparatus in the secondary distribution boxes of lighting circuits which have common switch, as well as in the circuits of interlocking and alarm devices, switchboards local lighting which are protected with fuses.

6.6.8 Ammeters of compound generators intended for operation in parallel shall be installed in the circuit of the pole not connected to the equalizing wire.

6.6.9 The controls of generator apparatus shall be located not lower than 800 mm from the plating. The controls of other apparatus shall be located not lower than 300 mm from the plating.

6.7 PROTECTION DEVICES

6.7.1 The circuits outgoing from the distribution switchboards shall be protected against short-circuit currents and overloads by means of appropriate devices installed at the inception of each circuit as close as practicable to the feeding terminals. The overload protection of the circuit is not required when the consumers fed from the switchboard are fitted with individual overload protection devices, and the cable of the switchboard feeding circuit is rated on the maximal working current.

6.7.2 Protection devices are to comply with the characteristics of protected equipment in such a way that to be activated at prohibitive overloads.

6.7.3 Protection system is to be selective both on overload currents and short-circuit currents.

6.7.4 The protection against short-circuit current shall be installed in each insulated...
pole of DC system and in each phase of AC system. The short-circuit release current settings shall be chosen in accordance with calculations but not less than for 200% of consumers' rated current.

It is allowed to use the same protection devices to protect the electric circuits (cables) and consumers against the short circuit.

6.7.5 If the cross-sectional area of the cable is reduced at some sections of the feeding circuit, then additional protection shall be provided for each cable with reduced cross-sectional area in case the preceding protection device does not protect the cable with reduced cross-sectional area.

6.7.6 In the feeding circuits from the main distribution switchboard to the emergency distribution switchboard it is not allowed to use the protection devices which are not capable of immediate reactivation after protection operation.

6.7.7 It is not allowed to install the protection apparatus in the equalizing wire of DC generators.

6.7.8 Overload protection is to be installed in:
  .1 at least one pole or phase in two-wire system;
  .2 all phases in insulated four-wire system of three-phase current;
  .3 at least two phases in insulated three-wire system of three-phase current.

6.7.9 The casings of the fuses are to be of entirely closed type and not to allow the outside emission of arc, sparking or any other harmful effect on the adjacent structural elements when fusion occurs.

6.7.10 The casings of the fuses should provide the possibility to visually detect the fusion of the fuse.

6.7.11 The design of protection devices with screw caps shall prevent them from self-unscrewing.

6.8 LOCATION OF DISTRIBUTION SWITCHBOARDS

6.8.1 When a distribution switchboard of IP10 protection or lower is located in a special room, locker or recess, then such spaces are to be made of non-combustible material or have coating made of such material.

6.8.2 Location of pipelines and tanks close to the distribution devices is to comply with the requirements specified in 1.9.7 and 10.5.17, 10.5.18 of Part IV of the Rules.

6.8.3 The main distribution switchboard is to be located in the same vertical fire protection zone with the generators (see 1.2.1.8 of Part III of the Rules).

6.8.4 Distribution devices shall be protected against or removed from the sources of vibration and high temperature.

6.8.5 At the front and back sides of free-standing distribution switchboards (except for leaning-type switchboards) a passage shall be provided of at least 600 mm width for the switchboards of 3 m long and at least 800 mm for the longer switchboards.

6.8.6 As a rule, the distribution switchboards longer than 1.2 m shall be of free-standing type.

When using the leaning-type switchboards, the access to the parts which require maintenance shall be provided.

6.8.7 The space behind the free-standing distribution switchboards with open alive parts shall be enclosed and fitted with doors. The doors shall be opened from the inside without a key and from the outside using a key. The doors are to bear plates with warnings. A device holding the door in open position shall be provided.

6.8.8 Distribution switchboards longer than 3 m specified in 6.8.7 are to be provided with at least two doors for entering the space behind the switchboard from the space of its location. One of the doors may lead into the adjacent space.
6.9 STATIC POWER CONVERTERS

6.9.1 The requirements of the present chapter are applicable to the shipborne static power converters and other semiconductor power units as an addition to the requirements of other chapters of the present Part of the Rules.

6.9.2 The distortion factor $K_{\text{dist}}$ of the ship network is subject to the operation of the semiconductor power units and shall not exceed 10%.

The distortion factor is determined using the following formula, %

$$K_{\text{dist}} = 10^2 \sum_{n=2}^{\infty} \left( \frac{U_n}{U_1} \right)^2$$

(6.9.2)

where $U_n$ — active value of $n^{th}$ harmonic of distorted voltage;

$U_1$ — active value of 1$^{st}$ harmonic.

6.9.3 Electromagnetic interference generated by the semiconductor units including their feeders shall not exceed the values specified in 2.7.

6.9.4 The semiconducting converters shall have the air cooling (natural or forced) or the liquid cooling.

In the converters with the liquid cooling where the latter is in direct contact with unit’s parts a continuous monitoring of insulation resistance is to be ensured. A light and sound alarm shall be available in engine room to warn the watchkeeping of impermissible reduction of insulation resistance. Onboard the ships with unmanned engine room such alarm shall be available at the central station or the wheelhouse.

6.9.5 The semiconductor converters with forced cooling shall be fitted with a protection which reduces or shuts down the load in case of failure of cooling system or overheat of the latter.

A sound and light alarm is to be provided before activation of the protection. This alarm shall indicate that the temperature of the semiconductor converters exceeds the maximum permissible value and the cooling agent flow at the output of the cooling system disappears.

6.9.6 The semiconductor power units are to be protected against inner and outer overvoltage.

6.9.7 The blocks of semiconductor units shall be protected against short-circuit current. The protection of diodes and thyristors is to be separated from protection load circuit.

6.9.8 Where only one consumer is allowed, the load and the blocks of diodes and thyristors may have a common protection.

6.9.9 The semiconductor converters are to have a light alarm indicating the on/off condition of power and control circuits.

6.9.10 The power part of the semiconductor converters shall be electrically isolated from the control system.

6.10 TRANSFORMERS

6.10.1 Onboard the ships where the transformers are used for feeding the lighting circuits and essential facilities, at least two transformers are to be installed with such a capacity that in the event of failure of the highest capacity transformer the others would be capable to provide the ship’s total need in electric power under all operating conditions.

When using sectioned system of collecting busbars, the transformers are to be connected to different sections.

Onboard the ships of less than 25 m in length and on board the floating objects (except for passenger ships) it is allowed to install only one transformer.

6.10.2 Dry-type transformers are to be used on board the ships.

6.10.3 Short-circuit voltages of transformers operating in parallel are to be such as to limit the load deviation of every transformer from the value of appropriate capacity proportion for not more than 10% of the current rating of the given transformer.

6.10.4 Ratio of power ratings of transformers operating in parallel shall not exceed 3:1.
6.10.5 Transformer windings for primary and secondary voltages are to be electrically separated. This requirement is not applied to starting and excitation transformers.

6.10.6 In the single-phase and three-phase transformers intended for the ship network supply the voltage fluctuations at the active load within the limits from idling to rated load shall not exceed 5% per phase for transformers with capacity up to 5 kVA and 2.5% per phase for those with greater capacity.

6.10.7 The design of air-cooled and dry dielectric-cooled transformers shall ensure their capability to withstand 10% overload within 1 hour and 50% overload within 5 minutes.

6.10.8 Feeding circuits of transformers' primary windings are to be fitted with short-circuit current protective devices. Overload protection is to be provided only for transformers with capacity exceeding 6.3 kVA. Overload protective devices may be replaced with alarm devices.

6.10.9 If the transformers are intended for operation in parallel, the switches are to be installed which disconnect their primary and secondary windings (simultaneous disconnection is not obligatory).

When such transformers are fed from different sections of the main distribution switchboard which may be disconnected during operation, an interlocking is to be provided to prevent their parallel operation when disconnecting the sections of the main distribution switchboard.

6.10.10 The switching-over of current-measuring transformers is to be made in such a way that to prevent their secondary windings from being in an open circuit condition.

6.11 UNINTERRUPTIBLE POWER SOURCES

6.11.1 The uninterruptible power sources (UPS) complying with the requirements specified in 6.11.2 – 6.11.9 may be used as emergency or transitional sources of electrical power.

6.11.2 UPS type selection shall be appropriate to power supply requirements of the connected load.

6.11.3 UPS shall be provided with a bypass, which ensures power supply to connected load from the ship network if the inverter fails.

6.11.4 Each UPS shall be provided with light and sound alarm to be given in normally manned location for:

1. power supply failure to the connected load;
2. earth fault;
3. activation of battery protective device;
4. when the battery is being discharged;
5. when the bypass is in operation for online UPS.

6.11.5 The requirements for location of the UPS are similar to the requirements for the location of the emergency or transitional source of electrical power.

6.11.6 UPS with sealed batteries may be located in any space other than the accommodation space, provided that the ventilation of such space ensures at least three-time air circulation per hour.

6.11.7 UPS shall maintain rated voltage and frequency on the load side throughout the whole time necessary to supply the connected consumers.

6.11.8 On voltage recovery in the power supply circuit, the capacity of the UPS rectifier shall be sufficient to maintain rated voltage and frequency on the load side with simultaneous recharging the battery by the maximum possible charging current.

6.11.9 The accelerated (boost) charging of the UPS batteries by the maximum possible charging current shall be interlocked with the ventilation of the space where the UPS batteries are installed.
7 ELECTRICAL MACHINERY AND DRIVES

7.1 GENERAL REQUIREMENTS

7.1.1 Electrically driven machinery with remote or automatic control from combined stations are to have light alarm on the stations indicating the switching on of the drive.

7.1.2 When the devices and machinery have automatic, remote and local control, the automatic and remote control are to be switched off when the local control is activated. Local control is to be independent from the automatic and remote control.

7.2 ELECTRICAL MACHINERY

7.2.1 Ventilation doors for cooling air input to the electric machinery shall not be located below the flooring level.

7.2.2 Current drainage from the brush is to be carried out by means of flexible copper wire.

No brush-holder springs are allowed for current drainage.

7.2.3 The generators are to be so designed as to withstand the overcurrent specified in Table 7.2.3 after being heated up to the steady-state temperature corresponding to the power rating.

<table>
<thead>
<tr>
<th>Generator</th>
<th>Overcurrent, %</th>
<th>Duration of overcurrent, s</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>50</td>
<td>120</td>
</tr>
<tr>
<td>DC</td>
<td>50</td>
<td>15</td>
</tr>
</tbody>
</table>

7.2.4 The electric motors are to be so designed as to develop increased torques specified in 7.2.4 without stop or sudden change of the rotation speed.

7.2.5 The generators not intended for parallel operation shall have a protection against overcurrents and short circuits. Circuit breakers shall be used to protect every generator of more than 4 kW capacity.

7.2.6 Every generator intended for operation in parallel shall be protected against the following:

1. overload;
2. short circuit;
3. reverse current or power;
4. undervoltage.

<table>
<thead>
<tr>
<th>Motor type</th>
<th>Torque excess, %</th>
<th>Overload duration, s</th>
<th>Test conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Polyphase synchronous electric motors and shorted electrical motors with starting current less than 4.5-fold rated current</td>
<td>50</td>
<td>15</td>
<td>Frequency, voltage and excitation are to be maintained at the rating level</td>
</tr>
<tr>
<td>2 Polyphase asynchronous electric motors with shorted or phase-wound rotor intended for continuous and repeated intermittent operation</td>
<td>60</td>
<td>15</td>
<td>Frequency and voltage are to be maintained at the rating level</td>
</tr>
<tr>
<td>3 Electric motors specified in p. 2 but intended for short-time operation and for continuous operation with variable load</td>
<td>100</td>
<td>15</td>
<td>Frequency and voltage are to be maintained at the rating level</td>
</tr>
<tr>
<td>4 DC electric motors</td>
<td>50</td>
<td>15</td>
<td>Voltage are to be maintained at the rating level</td>
</tr>
</tbody>
</table>
It is recommended to use such devices for the generator overload protection which are fitted with overload alarm operating with time delay up to 15 minutes for the load from 100 to 110 % of current rating, and with the shut down of the generators with time delay corresponding to the thermal time constant of protected generator for the load from 100 to 150% of the current rating.

When setting the protection on 150% of the generator current rating, it is recommended for the time delay not to exceed 2 minutes for AC generator and 15 seconds for DC generator. At the load exceeding 150% of the current rating the generator should be shut down without any time delay.

Overload protection settings and time delays are to be selected in accordance with the overload characteristics of the generator prime mover in such a manner that the prime mover would be capable to develop the required output within the specified time delay. No protective devices which prevent from immediate restart of the generator are to be used for the generator overload protection.

7.2.7 Devices are to be provided which shut down automatically and selectively the consumers of less importance in the event of generators' overload. The consumers may be switched off in one or several steps depending on the generator's overload capacity.

7.2.8 The short-circuit protection of the generators for the systems with insulated zero point is to be provided in all phases or poles.

7.2.9 Protection of the generators intended for operation in parallel against reverse power or current is to correspond to the characteristics of the prime mover. The applicability range of protection against reverse current or power is to be in accordance with Table 7.2.9.

<table>
<thead>
<tr>
<th>Table 7.2.9</th>
<th>Applicability range of protection against reverse current or power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current type</td>
<td>Applicability range of protection against reverse current or power for internal combustion engine</td>
</tr>
<tr>
<td>AC</td>
<td>8–15 % of generator power rating, kW</td>
</tr>
<tr>
<td>DC</td>
<td>2–15 % of generator current rating, A</td>
</tr>
</tbody>
</table>

7.2.10 The undervoltage protection shall prevent the generators connection to the busbars prior to the moment when the generators' voltage stabilizes and reaches at least 80% of the voltage rating, as well as shut down the generators when the voltage across their terminals is reduced.

The undervoltage protection is to be activated with time delay for disconnecting the generators from the busbars when the voltage is reduced, and to be activated instantly in the event when the generator is connecting to the busbars prior to the moment when the abovementioned minimum voltage is reached.

7.2.11 The outgoing feeders of the distribution switchboards supplying electric motors of more than 0.5 kW power are to be fitted with protection devices against short-circuit current and overload, a well as the zero protection device if no automatic restart of motor is required.

The overload and zero protection devices are to be installed on the current collector or its starter.

Electric motors of less than 0.5 kW power shall be protected against short-circuit current.

7.2.12 AC motors are to be protected against overload in two phases.

DC motors are to be protected against overload in two poles.

7.2.13 Overload protection devices of electric motors are to be set so as to shut down the motor to be protected within 105–125 % of the current rating with time delay corresponding to the heat resistance characteristics of the protected electric motor.

7.2.14 For electric clutches the maximum torque in the field forcing mode shall not exceed the value equal to the double rated torque of the clutches.

7.3 INTERLOCKING OF ELECTRICAL DRIVES. SWITCHGEAR

7.3.1 Electrically and manually driven ship's facilities are to be fitted with interlocking device to prevent the drives from simultaneous operation.
7.3.2 If the technical facilities are required to operate in a specified sequence, then appropriate interlocking devices are to be used.

An interlocking switch-off device may be used provided that it is protected from spontaneous interlocking switching-off. An inscription indicating its purpose and forbidding its use by unauthorized personnel is to be located nearby.

7.3.3 Starting of the technical facilities, the electric motors or equipment of which require additional ventilation under normal operating conditions, is to be possible only when such ventilation is in operation.

7.3.4 The applied start-control equipment is to provide the start of electric motor only from the zero position.

7.3.5 The start-control equipment which shuts down the shunt excitation winding is to be fitted with field suppression devices.

7.3.6 Every electric motor with power of 0.5 kW and over as well as its start-control equipment are to be fitted with a power-off device. If the start-control equipment is mounted in the main distribution switchboard or in other distribution switchboard but in the same space and are visible from the place of electric motor location, then a switch mounted on a switchboard may be used for this purpose.

If the above requirements for the location of the start-control equipment are not practicable, the following is to be provided:

1. a device interlocking the switch on the distribution switchboard in off position, or
2. additional switch near the electric motor, or
3. protection devices in each pole or phase of start-control equipment which are located in such a manner as to be easily replaced.

7.4 SHUTDOWN SAFETY DEVICES

7.4.1 The control systems of technical facilities, the operation of which may create danger to the safety of people under certain conditions, shall be fitted with shutdown safety devices which ensure the power-off of electric drive.

7.4.2 The shutdown safety device is to be painted red and protected against occasional activation. An inscription indicating its purpose is to be located nearby.

7.4.3 The shutdown safety devices are to be located at the control stations or in other places ensuring safety of operation.

7.4.4 The electrical drives of technical facilities and devices, which require restriction of motion in order to prevent injuries or emergency situations, are to be fitted with terminal switches.

7.5 ELECTRIC DRIVE OF STEERING GEAR

7.5.1 The main and standby electrically driven steering gear are to be fed by separate lines from the main distribution switchboard of the electric power plant directly or via the switchboard of emergency diesel generator.

7.5.2 Every line is to be rated for supply of all electric motors that are connected to it and may operate simultaneously.

7.5.3 When the emergency and main power sources provide the same current type and voltage, then one of the lines specified in 7.5.1 is to be led across the emergency distribution switchboard.

7.5.4 When more than one power-generating sets of the steering gear are used, at least two steering gear control systems (independent from each other) are to be provided in the wheelhouse. Separate cables are to be led for such control systems.

Circuits used for both electrical drives are not to be combined in one device.

7.5.5 Protection apparatus of control circuits are to be connected behind the protection apparatus of the steering gear power set.

7.5.6 An alarm indicating the loss of voltage in the control circuit is to be provided.

7.5.7 Electric motors of electric or electrohydraulic steering gear are to be protected
against short circuit only. No undervoltage and overload protection are allowed. An alarm indicating the overload of electric motors is to be provided.

7.5.8 Automatic circuit breakers protecting electric motors of the steering gear against short-circuit current are to be set for instantaneous release: at current not less than 300% and not more than 400% of the current rating of electric motor under protection; for AC motors – at current exceeding 125% of the maximum starting current of the protected electric motor.

7.5.9 Starting devices are to provide repeated automatic start of electric motors after voltage restoration caused by interruption of power supply.

7.5.10 In the vicinity of main engine control stations, if any, or in the central control station, where available, as well as in the wheelhouse near the rudder control panel there shall be provided the devices indicating the voltage presence in the steering gear supply circuit, the steering gear overload and shutdown as well as when reaching the minimal oil level in the daily service tank of hydraulic system. The overload and shutdown alarm signals are to be both visible and audible.

7.5.11 Direction of the handwheel rotation and movement of the control device handle are to coincide with the selected direction of ship's movement.

When a push-button control is used, key-stroke of the button located on the right side makes the ship to move to the right and key-stroke of the button on the left side makes the ship to move to the left.

7.5.12 Electrical drive of the steering gear is to provide:

.1 a period from hard over to hard over within the time and angle specified in 2.4.11, 2.4.12, 2.4.31 of Part V of the Rules;

.2 continuous period from hard over to hard over within 30 minutes for every set at maximal ship's speed ahead and the draught corresponding to the load waterline;

.3 possibility of the electric motor stalling in energized condition within one minute after operation in a steady temperature conditions (only for steering gear with direct electrical drive).

7.5.13 The initial starting moment of the steering gear motor with direct electrical drive is to be not less than 200% of the rated one.

7.5.14 The end switches to limit the movement of the rudder or steering nozzle from hard over to hard over are to be provided in the control circuit of the electrical steering drive. It shall be possible to move the rudder in backward direction when one of them is activated.

7.5.15 When there are a number of control stations for electrical steering drive, a switch is to be provided for selecting only one station for operation.

7.5.16 The wheelhouse and all the control stations are to be fitted with rudder position indicators. For electrically or hydraulically driven steering gear the rudder position indicator sensor shall be driven either directly from the rudder stock or from a component being rigidly connected to the latter. The sensor is to be fed independently from the control system. The rudder position indicating system is to be fed by a separate feeder and be permanently in operation. Additional transmitters for automatic pilot facilities are to be fed by separate feeders and be electrically separated from that system.

7.6 ELECTRICAL DRIVE OF ANCHOR AND MOORING MACHINERY

7.6.1 When AC squirrel-cage electric motors are used, the electrical drives of the anchor and mooring machinery are to ensure the possibility of stalling of electric motor in energized condition at the rated voltage after 30 minutes of operation at the rated load for at least 30 s for anchor machinery and 15 s for mooring machinery. For the pole-changing motors this requirement is applicable for operation of the motors with the windings generating the maximal starting moment.
DC electric motors and AC wound-rotor electric motors are to withstand the above-mentioned stalling conditions but at the moment equal to 200% of the rated value, in this case the voltage may be lower than the rated one.

After stalling the temperature is not to rise by 30% above the permissible value under normal operating conditions.

7.6.2 Anchor and mooring capstans and mooring winches at the velocity stages intended for mooring operations only and not for anchor lifting are to be adequately protected against the overload protection of the electric motor.

**7.7 ELECTRICAL DRIVE OF BOAT WINCHES**

7.7.1 The controls of the boat winch electric drive are to be fitted with a self-return device to "Stop" position.

7.7.2 The electrical drive of the boat winch is to be prevented from being switched on when using the manual drive handle.

7.7.3 The power circuit switch of the electric motor is to be arranged in the vicinity of the boat winch control station.

7.7.4 The boat winch control station is to be located in such a way that the operator could observe the boat when it is being lifted from water to the place of arrangement.

**7.8 ELECTRIC PUMPS OF DRIVES AND VENTILATORS**

7.8.1 The feeding circuits of electrical drives of the fire pumps shall not contain the thermo-switch protection devices. The overload protection devices may be replaces with an alarm.

7.8.2 The electric motors of fuel and oil transfer pumps and separators are to be fitted with remote disconnecting switches located outside the spaces containing them and outside the trunks of machinery spaces but in close vicinity of exits from those spaces, as well as in the wheelhouse; onboard the ships with length less than 25 m the latter shall be fitted in the wheelhouse.

7.8.3 The remotely controlled fire pumps are to be fitted also with local control station.

7.8.4 Electric drives of ventilators in the machinery spaces, cargo holds, galleys and general shipboard ventilation are to be fitted with remote disconnecting device located in the wheelhouse.

Irrespective of the number of the disconnecting devices the electric motors of the galley stoves' exhaust ventilation are to be fitted with a disconnecting device located in the galley.

7.8.5 The supply and exhaust ventilation system for spaces protected by fire smothering system is to be automatically switched off after activation of the system.

7.8.6 The remote switching-off devices for the ventilators are to be fitted with visual alarm indicating that the electrical drive is stopped.

7.8.7 Activation of the ventilator electrical drive is to be accompanied with a visual alarm when remotely controlled.

**7.9 ELECTRICAL DRIVE AND ELECTRICAL EQUIPMENT OF CARGO HANDLING GEAR**

7.9.1 When the cargo handling gear has two independent electrically driven winches intended for joint lifting of a cargo, the electrical drive of these winches is to ensure simultaneous stop and braking of both winches in the event of deenergizing of one of them.

7.9.2 For power supply and control of movable cargo handling gear the automatically installed flexible hose cables shall be used. The use of bare (trolley) wires is not allowed.

7.9.3 The elevator is to be fitted with electromagnetic brake, end switches, limiters and grabs which automatically stop the cabin in the event of the rope rupture or excessive lowering speed.
When the cabin starts moving, it shall be prevented from being controlled by any buttons except the "Stop" button. An alarm indicating that the elevator is busy shall be provided at the control station.

7.9.4 The electrical drive of the elevator shall prevent its moving when the cabin doors are open, the rope is slack or the cabin is caught by the grabs.

7.10 ELECTRICAL DRIVE OF WHEELHOUSE HOISTING DEVICE

7.10.1 The electrical drive of the wheelhouse hoisting device shall have at least two shutdown devices, one in the wheelhouse, another – at the drive control station.

7.10.2 A light alarm is to be provided in the wheelhouse indicating the upper and lower end positions of the wheelhouse, as well as light and sound alarm indicating the movement of the wheelhouse.

An automatic shutdown of the hoisting device is to be provided in the end positions of the wheelhouse.

7.11 ELECTROMAGNETIC BRAKES

7.11.1 The brake is to be activated (braking) in the event of loss of voltage on the brake's coil.

7.11.2 Voltage drop down by 30% below the rated one shall not cause the actuation of the brake when it is in heated condition.

7.11.3 It shall be possible to unbrake the electromagnetic brakes manually.

7.11.4 The electromagnetic brakes are to have at least two pressure springs.

7.11.5 Shunt excitation windings of the compound excitation brakes are to maintain the brake in unbraked condition even when the current does not flow along the series winding.

7.11.6 Shunt excitation windings of the brake are to be made or protected in such a manner as to prevent their damage due to overvoltages generated when switching off the windings (see also 7.3.5).

7.12 ELECTRICAL DRIVE OF WATERTIGHT AND FIRE DOORS

7.12.1 Power supply of electrical drives and indicators of position and closure of watertight doors shall be taken from the main and emergency sources of electrical power in accordance with the requirements specified in 4.5.1 and 5.3.1.

7.12.2 Electrical equipment of watertight doors having no IP level shall be located above the bulkhead deck.

Electrical equipment of the door drives located below the bulkhead deck shall have the following IP levels:

- Electric motors and controls related thereto — IPX7;
- Door position indicator sensors and circuit elements related thereto — IPX8;
- Door movement sound alarm elements — IPX6.

7.12.3 Electric power, control, indication and alarm circuits shall be protected against fault in such a way that a failure in one door circuit will not cause a failure in any other door circuit. Short circuits or other faults in the alarm or indicator circuits of a door shall not result in a damage in the electric power and control circuits. The door design shall be such that the leakage of water into the electrical equipment located below the bulkhead deck will not cause the door to open.

7.12.4 A failure in the power operating or control circuits of a sliding watertight door shall not result in a closed door opening. Availability of power supply shall be continuously monitored. Loss of power supply in the power operating and control circuits shall activate a sound and light alarm in the central control room and the wheelhouse.

7.12.5 The electric drives of devices for holding the fire doors in open position (see 2.6.3 of Part III of the Rules) shall:

- be supplied from the main and emergency sources of electric power;
.2 be remotely controlled from the wheelhouse for closing the doors individually, in groups or all doors simultaneously;

.3 close automatically all the doors simultaneously in case of supply voltage loss;

.4 be so designed that any damage in the mechanism of closing any door could not render inoperative the systems of supply and operation of other doors.
8 ACCUMULATORS

8.1 DESIGN OF ACCUMULATORS

8.1.1 The storage-cell jars and opening closings are to be so designed that to prevent spilling and splashing of the electrolyte when the jar is inclined in any direction at an angle up to 40°.

The closings are to be made of strong and electrolyte-resistant material. The design of the closings is to prevent the increase of gas pressure in the accumulator.

8.1.2 Materials used for manufacturing of containers intended for accumulators are to be electrolyte-resistant. The accumulators are to be fixed inside the containers in such a way as to prevent their relative displacement.

8.1.3 The mastics used shall withstand the ambient temperature changes from –30 to +60 °C.

8.1.4 For the fully charged accumulators after 28 days storage in unloaded condition at the temperature (20±5) °C the capacity loss due to self-discharge shall not exceed 30% of the rated one for acid accumulators and 15% for alkaline accumulators.

8.2 PROTECTION OF ACCUMULATORS

8.2.1 The accumulator batteries, except for those intended for starting the internal combustion engines, are to be fitted with protection devices against short-circuit current.

8.2.2 Every accumulator charging system shall have an appropriate protection against batteries' discharge due to drop or loss of voltage feeding the charging device.

8.3 CHARGING DEVICES OF ACCUMULATOR BATTERIES

8.3.1 A charging device is to be provided for charging the accumulator batteries. This device is to charge the battery within 8 hours.

8.3.2 Charging device is to provide the possibility of measuring the charging current and voltage, as well as the possibility to indicate the charging rate at the battery outlet.

8.3.3 Onboard the ships with portable consumers fitted with accumulators it shall be possible to charge that accumulators.

8.3.4 It shall be possible to charge the starter battery of emergency diesel generator from the ship power network.

8.4 CAPACITY OF STARTER BATTERIES

8.4.1 The capacity of the starter accumulator battery is to provide at least 10 consecutive starts of each main engine starting from cold condition without recharging.

8.4.2 The starter accumulator batteries of main and auxiliary engines are to provide the power supply of controls, alarm devices and standard consumers of those engines' electricity.

Signal lights, lighting fixtures of main lighting, rudder indicators and low-capacity non-essential consumers may be connected to the starter battery.

The battery is to be of such capacity as to supply the required number of starts of every engine and connected consumers within at least 8 hours without recharging.
8.4.3 The starter battery of an auxiliary engine is to have such capacity as to provide not less than 6 consecutive starts of the engine starting from cold condition without recharging.

8.4.4 When calculating the capacity of the batteries the duration of every start is to be taken for at least 5 seconds.

8.4.5 The starter accumulator battery for internal combustion engines' start is to be fitted with a disconnecting switch in the beginning of the circuit from the accumulator side in order to disconnect the battery from consumers; such switch fitted in one pole is sufficient.

8.5 LOCATION OF ACCUMULATOR BATTERIES

8.5.1 The batteries for voltage over 50 V as well as those with charging capacity over 2 kW rated for the maximal charging current and the nominal voltage of accumulator with due regard of the charge characteristic of the charging device are to be located in accumulator rooms, recesses, containers accessible from the main deck.

The batteries that require capacity from 0.2 to 2 kW for charging may be located below the main deck in a locker or container.

The batteries with capacity lower than 0.2 kW may be located in any space onboard the ship, except for the wheelhouse, accommodation and service spaces, provided that they are protected against water and mechanical damages and do not adversely affect the nearby equipment.

8.5.2 Acid and alkaline accumulators are not to be located in the same space or container. The jars and devices intended for batteries with different electrolytes are to be located separately from each other.

8.5.3 The inner part of the accumulator room or container as well as all structural parts that can be adversely affected by electrolyte or gas are to have appropriate protection.

8.5.4 The accumulator batteries are to be fastened securely. When installing the single accumulators with jars made of conductive materials, the linings and spacers are to be made of non-hygroscopic insulation materials.

8.5.5 When installing the accumulator batteries or single accumulators, the linings and spacers between them are to be provided in order to ensure a clearance of at least 15 mm on all sides for air circulation.

8.5.6 The accumulator batteries are to be installed in such a way as to provide easy maintenance for replacement, control, tests, installing additional elements and cleaning the accumulators, and to be located in such a way as to provide a distance between the deck and the plugs of the upper tier not more than 1500 mm.

If the accumulators are installed on two or more shelves located one above the other, at least 50 mm clearance for air circulation is to be provided at the front and back sides of the shelves.

8.6 HEATING AND VENTILATION OF ACCUMULATOR ROOMS

8.6.1 The accumulator rooms where the temperature may be lower than +5 °C during operation shall be heated either with water or steam radiators or using heat supply from adjacent spaces.

8.6.2 The valves of the heating system are to be located outside the accumulator room.

8.6.3 The shipborne air conditioning system shall not be used for heating the accumulator rooms.

8.6.4 The accumulator rooms, lockers and containers are to be adequately ventilated thus preventing accumulation of explosive mixtures inside them. The ventilation system shall meet the requirements specified in 10.12 of Part IV of the Rules.

The ceiling in the accumulator room shall be even and with cavity-free structures, otherwise each cavity shall be individually ventilated to avoid dead zones.

8.6.5 The artificially ventilated accumulator rooms are to be fitted with devices preventing from activation of accumulator charging prior
to the activation of the ventilation. The charging is to be automatically shutdown after the shutdown of the ventilators.

8.7 PROTECTION AGAINST EXPLOSION

8.7.1 The explosion danger inscriptions are to be placed on the entrance doors to the accumulator rooms as well as on the accumulator containers and lockers.

8.7.2 The accumulator rooms may be fitted only with lighting fixtures with explosion-proof cover (Exd), which are to comply with the gas mixture category IIC and the gas mixture group T1 (see Appendix 2), as well as local cabling to accumulators and lighting fixtures.

Local cabling to accumulators may be laid without sheathing.
9 ELECTRICAL HEATING AND COOKING APPLIANCES

9.1 GENERAL REQUIREMENTS

9.1.1 The requirements of the present Section apply to galley electrical ovens, water heaters, heating pads, radiators and other heating and cooking appliances. The stationary type electrical heating appliances are allowed only.

9.1.2 The loaded structural parts of electrical heating appliances as well as the inner surfaces of their enclosures are to be made of non-combustible materials.

9.1.3 The electrical heating appliances are to be designed in such a way that the temperature of their handles or other components, which are used or likely to be touched by the attending personnel, does not exceed the values specified in Table 9.1.3.

9.1.4 The electrical heating devices and the water heaters are to be fitted with a device for automatic adjustment of temperature. The water heaters are to operate safely when being inclined in any direction at an angle up to 30° from the vertical.

9.1.5 The commutation facilities and switches of the heating appliances are to have clearly distinguishable indications of "on" / "off" positions as well as all other possible positions of the controller.

9.1.6 When the electrical heating appliances are not fitted with built-in switching-off devices, the spaces where such appliances are located are to have the corresponding switching-off devices.

9.1.7 The electric flowing liquid heaters are to have a thermal protection. Two thermo-regulators are to be provided in the heaters: one of them – a safety device, another – for adjustment.

9.1.8 The electrical heaters in oil and fuel tanks shall comply with the requirements specified in 16.2.32 – 16.2.34.

9.1.9 The stationary electrical heating appliances operating in automatic mode are to have a temperature protection.

A red light signal is to be provided near each appliance or on the appliance itself. This signal shall be activated simultaneously with the switching-on of the heating appliance. This signal shall not hinder the shipdriver.

9.2 HEATING APPLIANCES

9.2.1 The casings of heating appliances are to be so designed that no objects may be located on them.

<table>
<thead>
<tr>
<th>Name</th>
<th>Permissible temperature, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control handles and other components used by the personnel for a long period of time:</td>
<td></td>
</tr>
<tr>
<td>metal</td>
<td>55</td>
</tr>
<tr>
<td>non-metal</td>
<td>65</td>
</tr>
<tr>
<td>Control handles and other components used by the personnel which are subject to short-time touch:</td>
<td></td>
</tr>
<tr>
<td>metal</td>
<td>60</td>
</tr>
<tr>
<td>non-metal</td>
<td>70</td>
</tr>
<tr>
<td>Casings of electrical heating appliances, used for ship's spaces heating, at ambient temperature 20 °C</td>
<td>80</td>
</tr>
<tr>
<td>Air coming from electrical heating appliances to the heated spaces</td>
<td>110</td>
</tr>
</tbody>
</table>
9.2.2 The heating appliances intended for ship's spaces heating are to be of stationary type. The appliances are to be fitted with appropriate facilities that shutdown the power supply when the temperature of particular components exceeds the permissible values.

9.2.3 The galley heating appliances are to be so designed that to exclude the contact of cooking utensils with alive parts of the appliances, and the leakage of any liquid could not cause a short circuit or insulation damage.

9.2.4 The stationary heating appliances intended for 380 V voltage are to be of protected type in order to prevent any access to alive parts not using special tools. The casings are to have inscriptions indicating the voltage according to Table 5.2.2.

9.2.5 The electric water heaters are to be automatically shutdown when the water level is lower than the permissible one.

9.2.6 The electric radiant heaters for saunas shall be equipped with:
1. heat regulator – built-in or installed separately from the electric radiant heater – which switches off the heating elements when reaching the temperature of 120 °C;
2. red lights shall be installed on the control panel of the electric radiant heater and in the nearest ship's corridor or in the room of administrator on duty. These red lights shall be activated simultaneously with the power supply to the electric radiant heater.

9.2.7 The ironing rooms shall be fitted with a non-detachable connection of the iron via a packet switch with a signal lamp to be activated when the later is switched on and located near the entrance into the room.

9.3 SYSTEMS WITH HEATING CABLES

9.3.1 The systems using heating cables for removing ice and avoiding icing shall be provided for shipborne arrangements, equipment and spaces intended for:
- performing by ship of its main purpose;
- maintaining maneuverability and stability;
- crew safety (rafts, boats, ladders, guard rails etc.).

9.3.2 The heating capacity of such systems shall not be less than:
- 300 W/m² — for the spaces of open decks, helidecks, ladders and gangways,
- 200 W/m² — for superstructures,
- 50 W/m² — for guard rails with internal heating.

9.3.3 The switchboard for the said systems shall be equipped with:
- Wattmeter or ampermeter to indicate the total load;
- Name plate indicating the rated load of each circuit and the switchboard as a whole;
- Residual current device;
- Load signal lamps for each circuit.

9.3.4 The heating cables shall be protected against overload exceeding 125% of the rated current of the circuit. For the self-regulating cables the overload protection may be omitted.

9.3.5 The cables and the controls of the electric heating systems of the pipelines carrying combustible media, as well as of the pipelines located in dangerous spaces are to be of explosion-proof design.
10 LIGHTING AND NAVIGATION LIGHTS

10.1 GENERAL REQUIREMENTS

10.1.1 In all ship's spaces, places and areas where lighting is required for navigation safety, control of machinery and technical facilities, as well as appropriate habitability of passengers and crew the main stationary lighting fixtures are to be provided.

The list of spaces, places and areas where the emergency lighting fixtures are to be arranged in addition to the main ones is given in Table 4.5.1.

The lighting fixtures installed in those spaces and areas where their glass hoods may be exposed to mechanical damage are to be fitted with protective gratings.

10.1.2 The external lighting fixtures shall be installed in such a way as to avoid the unwanted light interference to the ship's navigation.

10.1.3 The accumulator rooms are to be illuminated with lighting fixtures located in the adjacent explosion-proof spaces through glazed gas-tight portholes or with the explosion-proof lighting fixtures located inside the space.

10.1.4 Where the spaces or places illuminated with luminescent lamps contain machinery with visible rotating parts, appropriate measures to avoid stroboscopic effect shall be taken.

10.1.5 The stationary lighting fixtures of the cargo holds are to be fed from a special distribution switchboard. This switchboard is to be fitted with control light alarm for individual lighting circuits in addition to the safety devices and switches.

10.1.6 The casings of devices are to be made of corrosion-resistant low flame-spreading materials having the adequate mechanical strength in accordance with 2.4.1. The casings of devices intended for installation on the open deck, in cooled spaces and other moist spaces are to be made of brass, bronze or equivalent alloys or fire-resistant plastics. When using steel or aluminium alloys for the casings, then a protection against corrosion is to be provided.

10.1.7 The insulation components which the current-carrying parts are fastened to are to be made of materials not emitting gasses igniting from electric sparks at the up to 500 °C.

10.1.8 The lighting fixtures installed on the combustible materials or in immediate vicinity to them shall be designed in such a way that the temperature on their surface does not exceed 90 °C.

10.1.9 Each lighting fixture is to have a marking indicating the maximum permissible power of the lamp.

10.1.10 All the work stations in the wheelhouse shall be fitted with lighting which allows adjustment of illumination and light direction. The brightness of light is to be sufficient for safe navigation. The adjustment of illumination density to the minimal level is to be provided.

10.1.11 The illumination required for continuous work in darkness and near the entrances into the wheelhouse is to be red and have adjustable brightness.
10.1.12 The illumination of spaces and working surfaces is subject to the sanitary regulations\(^1\).

10.2 SUPPLY OF MAIN LIGHTING CIRCUITS

10.2.1 The main lighting distribution switchboards are to be fed via separate feeders. Non-essential electric drives with capacity up to 0.25 kW and the single cabin electric heating pads with current rating up to 10 A may be fed from the said switchboards.

10.2.2 The protection devices of terminal branches of the lighting circuits are to be designed for the rated current not exceeding 16 A, the total load current of connected consumers shall not exceed 80% of the protected device rated current.

10.2.3 The terminal branch of the lighting circuit for accommodation and public spaces is to feed not more than:
- 10 lighting points at voltage up to 55 V;
- 14 lighting points at voltage up to 127 V;
- 24 lighting points at voltage up to 220 V.

A larger number of lighting points may be arranged provided that 10.2.2 is met and calculation sheets of voltage drop and cable cross-sections for all sections of the branched circuit are submitted to the River Register.

Cabin ventilators and other small consumers may be fed from lighting circuits.

For a daisy chain or ramp lighting schemes where lamp holders are located close to each other and are connected to the circuit without using flexible wires a larger (than specified above) number of lighting points may be connected to one circuit provided that the maximal working current in each circuit does not exceed 10 A.

10.2.4 The main lighting fixtures for corridors, machinery spaces, as well as lamps for messes, ladders and passages leading to boat deck on the passenger ships are to be fed via two independent feeders from different switchboards. The lighting fixtures are to be located in such a way as to provide the maximal possible evenness of illumination in the event of failure of one of the feeders.

10.2.5 The local lighting lamps in accommodation spaces and the sockets shall be fed from the lighting switchboard via separate feeder independent from the feeder of the common lighting lamps.

This requirement is not applied to individual plug transformers.

10.2.6 When the ship is divided into fire zones (see also 6.8.3), the lighting circuits of each zone are to be fed via separate feeder independent from those feeding the lighting circuits of other fire zones.

The lighting circuit cables shall be laid in such a way that the fire in one zone could not damage the cables feeding the circuits of other zones.

10.3 LIGHTING CIRCUIT BREAKERS

10.3.1 Two-pole circuit breakers shall be used in all lighting circuits.

Single-pole circuit breakers may be used in lighting circuits only at low voltage and for individual lighting fixtures in accommodation and service spaces.

10.3.2 The wheelhouse or other permanent watchkeeping station on the upper deck shall be fitted with centralized means of switching-off all the stationary external lighting fixtures.

10.3.3 The switches for lighting behind the free-standing switchboards are to be located in front of the passage to the backside the switchboard.

10.3.4 The lighting switches of refrigerator spaces, baths, shower rooms, saunas and other wet spaces are to be located outside those spaces.

10.3.5 The stationary lighting circuits in the cargo spaces are to be shutdown by means of multi-pole circuit breakers located outside the cargo area. The indicators of voltage presence in the circuits shall be provided.

\(^1\) Sanitary Regulations and Standards SanPin 2.5.2-703-98. «Inland and Combined (river – sea) Navigation Ships». 
10.4 PLUG-AND-SOCKET CONNECTIONS

10.4.1 The design of connector sockets of the socket outlets is to provide permanent pressure when being in contact with the plug pins.

10.4.2 Sockets for portable lamps and low-power household devices may be connected in groups as specified in 10.2.3.

10.4.3 Sockets intended for systems with voltage over 250 V are to be rated for current at least 16 A.

10.4.4 Plugs with slotted pins are not allowed for use. The pins of the plugs intended for current exceeding 10 A are to be cylindrical solid and hollow.

10.4.5 Sockets or plugs intended for connection of the consumers that require earthing are to have contacts for connection of earthing cores of the consumer cable. When inserting the plug into the socket outlet, the plug earthing part is to engage the socket earthing part up to the connection of current-carrying pins.

10.4.6 The socket outlets with housings of at least IP55 protection level are to be designed in such a way as to provide the required protection irrespective of whether the plug is in the socket or not.

10.4.7 The socket outlets intended for rated current over 16 A are to be fitted with switches which are to be assembled with the plug in such a way that the latter could be withdrawn from the socket only when the switch is in “off” position.

10.4.8 In the socket outlets without interlocking the clearances between contacts by air or via the insulation material are to be such that no short circuit could occur due to arcing over when withdrawing the plug loaded with current exceeding by 25% the rated one at the rated voltage.

10.4.9 The socket outlets and plugs are to be so designed as to prevent the possibility to insert only one current-carrying contact pin into the socket outlet or insert into the earthing jack. The socket outlets intended for connecting the motors (gears), the direction of rotation (operation) of which depends on the change of the phase or pole sequence, are to be designed in such a way as to prevent the possibility of sequence changing.

10.4.10 No safety devices shall be located in the socket outlets and plugs. This requirement is not applied to plug transformers.

10.4.11 The socket outlets fed by different voltages are to be designed in such a way as to prevent the insertion of plugs into the outlets for higher voltage.

10.4.12 The socket outlets on open decks are to be arranged in such a way as to prevent water penetration inside the outlets.

10.4.13 The purpose and feeding voltage of the socket outlets are to be indicated in the places of their location.

10.5 PORTABLE LIGHTING NETWORK

10.5.1 The socket outlets for portable lighting fixtures are to be located:

1. in the room of radio installation converters;
2. in the emergency generator set room;
3. in the steering and thruster rooms;
4. in the machinery spaces;
5. behind the main distribution switchboard;
6. in special electrical spaces;
7. in the wheelhouse;
8. in the radio room;
9. near the log and echo-sounder enclosures;
10. in the gyro compass room.

10.5.2 The socket outlets shall not be arranged lower than the plating in the machinery spaces.

10.6 GLOW DISCHARGE LAMPS

10.6.1 The throttles and capacitors shall be protected with earthed metal coatings.

10.6.2 The capacitors of 0.5 mcF and more are to be fitted with a discharge device which is to be designed in such a way that the ca-
Lighting and Navigation Lights

10.6.3 the throttles and transformers with high inductive impedance are to be installed as close as possible to the lamp which they are intended for.

10.6.4 The glow discharge lamps fed by the voltage exceeding 250 V are to have corresponding inscriptions indicating the voltage applied. All the alive components of such lamps are to be protected.

10.7 NAVIGATION LIGHTS

10.7.1 The navigation light panel shall be fed via two lines (intended solely for this purpose) directly or through a transformer: first line — from main distribution switchboard (see 5.3.1) or via emergency distribution switchboard (if available), second line — from the nearest group lighting panel or control panel.

Onboard the ships less than 25 m in length the navigation light panel may be fed via one line including the line from the ship's control panel.

10.7.2 The navigation lights controls may be installed on the panel located in the wheelhouse.

These devices may be fed from the panel if the latter is fed from the main distribution switchboard via two feeding lines.

The navigation lights shall be connected to the power supply network via flexible cable with plug-and-socket connector.

10.7.3 The following lanterns are to be fed from the navigation lights panel via separate feeding lines:

1. top lanterns (including the top light "triangle" on pushers);
2. side lanterns;
3. poop lantern in longitudinal central plane;
4. poop lanterns on boards;
5. towing lanterns.

The poop lanterns located on ship's sides, as well as the top light "triangle" on pushers may be combines and connected to the separate groups of the switchboard. In this case the checking alarm is to be activated when both single lantern and all the lanterns are extinct.

10.7.4 The lanterns not specified in 10.7.3 may be fed from separate distribution boxes or from the nearest lighting distribution switchboard or control panel.

The lanterns being risen temporarily may be fed from lighting sockets.

10.7.5 Onboard the ships, where the lanterns are connected to the accumulator battery operating in parallel with the charging set when the ship is moving, the standby power supply of the navigation lights panel is non-obligatory.

10.7.6 The navigation lights switchboard is to be located in the wheelhouse; the power supply switch is to be arranged in the vicinity of the switchboard unless it is arranged on the switchboard itself.

10.7.7 Every circuit of the navigation lights is to be protected on both wires (including ships with single-wire power distribution system); the circuits of the lanterns specified in 10.7.3 are to have an automatic light indicator of navigation lights operation.

The light indicator is to be designed and arranged in such a way that its damage would not cause the shutdown of the navigation light.

Regardless of the light alarm an audible alarm shall be provided, which is activated automatically when a navigation light fails and the switch is in "on" position.

The audible alarm may be omitted onboard the ships where control of the navigation lights operation is available directly in the wheelhouse.

10.7.8 The navigation lights network is to be designed in such a way as to provide operation of the lantern lamp when the pilot lamps on the switchboard of the navigation lights are damaged or unscrewed.

10.7.9 The voltage drop through the indicator element connected to the navigation lantern circuit shall not exceed 3% of the rated voltage.
10.8 PROJECTORS

10.8.1 The projector’s structure shall provide the following:

.1 installation of incandescent device or the illuminating device of the lamp in the focus of projector’s optics. The position of lampholder for different lamp types is to be indicated, and the extreme positions of the lampholder are to be limited;

.2 allowable horizontal turning, as well as up and down turning in relation to projector’s normal position. A possibility to fix the projector in any position is to be provided. The allowable turning of the projector is to be specified in the technical documentation for particular types or groups of projectors.

10.8.2 The projectors may be fitted with:

searching device for homing the projector onto the object;
remote control.

10.8.3 The internal wiring of projectors is to be made using high-temperature wires with cross section at least 0.75 mm².

10.8.4 The protective glass, diffusers and light filters of projectors are to be thermal-resistant.

10.8.5 The projector’s protection level is to be at least IP56.
11 INTERNAL COMMUNICATION AND ALARM

11.1 ELECTRIC TELEGRAPHS

11.1.1 Electric telegraphs are to be fitted with visual and audible alarm being fed from the emergency power source and indicating that the voltage disappears in the feeding circuit.

11.1.2 The scales of the telegraphs arranged in the wheelhouse are to have illumination with adjustable brightness.

11.1.3 The telegraphs are to be fed from the main distribution switchboard, navigation equipment switchboard or from ship's control station.

11.1.4 The control handle of command transmitter is to be arranged in such a way as to move in the same direction as the ship moves. As a rule, the vertical position of the handle shall correspond to "Stop" command.

11.1.5 When the electric telegraphs and remote control means are installed on the inclined control panels, the handle in "Stop" position may be inclined from the vertical.

11.1.6 When two or more columns with transceivers are located in the immediate vicinity to each other (on the same deck within the visibility limits), they are to ensure the command transmission from any of them and the acknowledgement of command by all of them simultaneously without any additional switching-over. The switching to control by the column not visible from the wheelhouse is to be performed using the switches located in the wheelhouse.

11.1.7 Every electric telegraph is to be fitted with audible alarm device sending the sound signal to the wheelhouse and the machinery space when transmitting a command and receiving acknowledgment. In the event of false command acknowledgment the sound signal shall not stop.

11.2 SERVICE INTERCOMMUNICATION

11.2.1 A two-way intercommunication is to be provided onboard the ship for conversation under normal and emergency conditions of ship operation.

11.2.2 Intercommunication shall provide the following:

1. communication between the wheelhouse and central control station, local control station of main engines, control stations of bow and stern anchor gear, local control station of the steering gear drive, local control station of electric propulsion motor, emergency distribution switchboard room, gyro room, smothering fire extinguishing station, captain's room;

2. communication between central or local control station of main engines and the accommodation spaces of engine room staff.

The separate two-way voice communication is not required if the communication device ensures the priority of call and conversation from the wheelhouse at any time.

11.2.3 An automatic power supply change-over to the emergency source is to be ensured in the event of loss of voltage from the main source of power supply.

11.2.4 Communications stations in the spaces with high noise level are to have additional light signalization indicating incoming call.
11.2.5 Damage or shutdown of one communications station shall not interrupt the operation of communication system.

11.2.6 The requirements specified in the present Chapter are not applied to the ships less than 25 m in length.

11.3 GENERAL ALARM

11.3.1 The ships, onboard of which the general alarm given by voice cannot be heard in all locations where people may be present, are to be fitted with electrical general alarm which ensures sufficient audibility of signals in all such spaces and areas.

11.3.2 The sound alarm is to be arranged:
   .1 in machinery spaces;
   .2 in public spaces of total area exceeding 100 m²;
   .3 on open decks;
   .4 in corridors of accommodation, service and public spaces.

The radio room is to be fitted with the general alarm red lamp located within the field of view of the operator instead of main sound alarm.

11.3.3 The general alarm is to be fed directly from the emergency accumulator battery or a single battery. The general alarm may be fed from the ship network provided that it is under voltage for 24-hour period under any operating conditions of the ship.

11.3.4 The sound devices of general alarm shall be located in such a way as to provide clear audibility of the signal in the given space. The sound devices installed in the spaces with high level of noise shall be fitted with light alarm. The sound of general alarm devices shall differ from the sound of other types of alarm.

11.3.5 The general alarm is to be activated by means of self-return contactor from both the wheel-house and the space intended for watchkeeping when mooring in a port, if any. The interlocking of the contactor in "on" position is to be provided.

The contactors shall have inscriptions specifying their purpose and indicating their positions – "on" or "off".

If the general alarm signal is not heard from the wheelhouse or central station, then a lamp for monitoring voltage supply to the general alarm circuit is to be installed in the contactor’s circuit.

11.3.6 No commutation facilities are allowed in the general alarm circuits except for the contactor specified in 11.3.5. It is allowed to use electromagnetic equipment activated by the contactor, but not more than one contactor may be arranged in each section.

11.3.7 The sound devices, switches and distribution devices of general alarm shall have identifying designations.

11.3.8 The feeding circuits of the general alarm are to be protected against short-circuit current only. The protection devices are to be fitted in both poles of the feeder, as well as in the circuits of each sound device.

11.4 FIRE ALARM

Fire detection alarm

11.4.1 Depending on the ship's type and design features the ships spaces are to be equipped with the following systems:
   .1 manual fire indicating alarm (passenger ships, ships carrying dangerous goods, ships with two or more decks);
   .2 automatic light and sound fire detection alarm (passenger ships, ships carrying dangerous goods, other self-propelled ships with a gross tonnage of 500 gross tons and more);
   .3 automatic light and sound alarm warning of activation of the smothering fire extinguishing system. This alarm is to be activated at least 30 seconds before the release of the extinguishing medium (spaces of the ships with crew consisting of more than two persons, where the people may be present permanently or periodically under normal operating conditions);
   .4 automatic light alarm in the wheelhouse and at the central control station which
indicates the presence of water pressure in the fire main.

11.4.2 The sensors of the automatic fire detection alarm are to be installed in the following spaces:
- in accommodation spaces of passenger ships;
- in pump rooms of oil tankers;
- in cargo spaces;
- in storage spaces for inflammable materials;
- in galleys and saunas;
- in machinery spaces if no continuous watch is available.

The sensors are to be installed above the main and emergency distribution switchboards, near the fuel pumps and boilers, above the main engines and diesel generators as well as in other spaces with the risk of fire.

The sensors installed in the passenger rooms shall activate also a sound signal in the location of their installation.

When installing the sensors the locations, where the air flow may affect their operation, should be avoided, as well as the locations where the sensor may be damaged. The sensors installed in the deckhead shall be located at a distance of at least 0.5 m from the bulkheads. If this requirement cannot be met due to the design of the cargo space, then it is possible to implement another solution on sensors installation. The installation of the sensors in the cargo space is to meet the requirements specified in Table 11.4.2.

**Table 11.4.2**

**Requirements for installation of sensors in cargo space**

<table>
<thead>
<tr>
<th>Sensor type</th>
<th>Max. deck area covered by one sensor, m²</th>
<th>Max. distance between sensors, m</th>
<th>Max. distance to bulkheads, m</th>
</tr>
</thead>
<tbody>
<tr>
<td>thermal</td>
<td>37</td>
<td>9</td>
<td>4.5</td>
</tr>
<tr>
<td>smoke</td>
<td>74</td>
<td>11</td>
<td>5.5</td>
</tr>
</tbody>
</table>

11.4.3 Onboard the passenger ships the smoke detectors are to be installed in all the between-deck interconnections, corridors and exit paths within the accommodation spaces.

11.4.4 The manual fire detectors of fire detection alarm are to be installed in the machinery spaces, corridors, lobbies, elevators, dining cabins and saloons with an area exceeding 50 m² and at least one detector per each deck.

11.4.5 The manual fire detectors are to be located in the vicinity of exits from the spaces in easily accessible and clearly visible places and not more than 20 m apart from each other.

Onboard the passenger ships the manual detectors are to be installed within each vertical fire zone, at least one at each ship’s side on each deck.

11.4.6 The manual fire detectors are to be painted red. The sensor’s button is to be under glass cap.

11.4.7 The reception devices of fire detection alarm and the activation devices of fire indicating alarm are to be installed in the wheelhouse or in the location of permanent watch (if any).

11.4.8 The automatic fire detection alarm system shall use sensors which are activated under the effect of heat or smoke and comply with the following requirements:
- .1 sensors, responding to the temperature rise at the rate of its increase not more than 1 °C per minute and depending on the place of their installation, are to be activated within the following temperature range:
  - Installation place | Temperature range, °C
  - spaces, where normal temperature does not exceed 45 °C | from 57 to 74
  - spaces with high temperature (galleys, drying areas etc.) | < 80 x 100
  - saunas | < 120 x 140
- .2 smoke detectors are to be activated before the smoke density value reaches the level when the light extinction exceeds 12.5 % per 1 m, but not less than 2 % per 1 m. Smoke detectors installed in the machinery space are to be activated at such smoke density when the light extinction reaches not more than 50% per 1 m;
- .3 after activation test the sensors shall return to their operation condition without replacement of any components.
11.4.9 An automatic switching of the power supply of the fire detection alarm system to the emergency power source in the event of voltage loss in the main ship network is to be provided (see p. 3.5 of Table 4.5.1).

11.4.10 The fire detection alarm sensors installed in the spaces, where explosive vapors may be accumulated, and the sensors exposed to the airflow evacuated from such spaces shall be used in accordance with 16.2.6 – 16.2.10.

11.4.11 The reception device of the fire detection alarm system shall provide the following:

1. any signal or damage of a circuit do not affect the normal operation of other circuits;
2. fire detection signal has priority over other signals received by the device and allows to determine the location of the space from which it has been sent. The signal is to be both light and sound;
3. device operation monitoring;
4. the circuits of the contact-type detectors of the automatic fire detection alarm operate for interruption;
5. a possibility to switch off the sound signals. In the event of subsequent signal receipt the previously switched off sound source shall be re-activated.

11.4.12 A failure in the fire detection alarm system shall initiate the activation of light and sound alarm.

11.4.13 The central control station is to be fitted with alarm of fire detection in the machinery spaces as well as with alarm indicating the release of fire extinguishing medium to the protected spaces.

11.4.14 The fire detection alarm systems, capable of remote determination of the location of the space wherefrom the fire detection signal has been sent, shall be designed in such a way as to:

1. the loop can not be damaged by fire in more than one point;
2. corresponding means are provided which maintain the loop in operating condition in the event of any damage (break, short circuit, earthing);
3. in the event of failure of electric components of the system or data corruption the system shall quickly restore its operability;
4. activation of the fire detector does not prevent the activation of any other detector and subsequent alarm signals.

11.4.15 It is allowed to use the automatic smoke detection air sampling system instead of the automatic fire detection alarm system. The requirements for the smoke detection system are specified in 5 of Part III of the Rules.

11.4.16 Each section with detectors shall be used by not more than one fire zone and cover not more than two decks located one above the other.

Warning alarm

11.4.17 The stationary fire extinguishing systems shall be fitted with systems (devices) indicating activation of every system by means of light and sound signals.

11.4.18 The warning signals shall be clearly visible and audible in the protected spaces and in the entrances into such spaces, as well as in the adjacent spaces when the doors are closed in the noisiest locations during at least 30 seconds. The warning signals shall differ from all other light and sound signals in the protected space.

11.4.19 A warning plate shall be arranged prominently at the entrance to the space where the extinguishing medium may penetrate. The following inscription is to be made on the plate with red colour on white background:
«ОСТОРОЖНО, СИСТЕМА ПОЖАРУШЕНИЯ! НЕЗАМЕДЛИТЕЛЬНО ПОКИНУТЬ ЭТО ПОМЕЩЕНИЕ ПРИ СИГНАЛЕ...(ОПИСАНИЕ СИГНАЛА)!»
Warning! Fire extinguishing system activated!
Leave the space immediately when [signal description] signal is activated!
11.5 PORThOLES OPENING ALARM

11.5.1 Onboard the passenger ships of all classes except for «І» class all the portholes, including the life saving portholes, installed in the hull shall be fitted with automatic alarm indicating their open position. This alarm is to be output to the wheelhouse.

11.6 MECHANICIANS CALL ALARM

11.6.1 Onboard the passenger ships of «О-ПР», «М-ПР» and «М-СП» classes in the mechanics’ accommodation spaces a sound alarm of mechanics’ emergency call is to be provided. This alarm shall be activated as follows:

- manually from the main engines control station in machinery space or from the central control station (if any);
- automatically when the signal of the warning alarm for the propulsion system is not answered.
12 CABLE NETWORK

12.1 GENERAL REQUIREMENTS

12.1.1 The cables used are to be flame retardant and have standard copper cores and be manufactured in accordance with the requirements of the present part of the Rules or according to the national standards\(^1\). The flame retardance tests of the cables are to be carried out in accordance with the requirements specified in Appendix 3.

12.1.2 The cross-sectional area of cable and wire cores used for alarm and communication circuits is to be at least 0.5 mm\(^2\). For portable electrical equipment flexible cables and cords with cross-sectional area of at least 0.75 mm\(^2\) shall be used. In all other cases the cables and wires shall have a cross-sectional area of at least 1 mm\(^2\).

12.1.3 The requirements on the minimum number of strands in the core of the cables used onboard the ships are specified in Table 12.1.3-1.

Connections of separate strands of the core shall be displaced from one another by not less than 500 mm along the length of the core.

Such connections shall not impair the mechanical and electrical properties of the strand nor change the cross-sectional area of the strand or the core.

The insulation of cable and wire cores is to be made of the insulating materials specified in Table 12.1.3-2.

12.1.4 The maximal permissible temperature for cable or wire core insulation is to be higher than the assumed ambient temperature by at least 10 °C.

12.1.5 In the places exposed to oil products or other aggressive media the cables to be used are to have a sheathing resistant to such media. The cables without such properties shall be either laid in pipes or be otherwise protected.

12.1.6 In the places, where the cables may be subject to mechanical damage, the cables with appropriate protective sheathing are to be used. The cables of other types used in such places are to be protected with special shrouds or to be laid in pipes.

12.1.7 The cables of telephone communication, alarm circuits indicating activation of fire smothering system, general alarm system and closing of watertight doors shall not be laid across the machinery or boiler spaces and other enclosed spaces with higher risk of fire except for the cases when the single devices of the above systems are located in such spaces.

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\(^1\) GOST 22483, GOST R 53315, GOST R IEC 60227-1.

### Table 12.1.3-1

<table>
<thead>
<tr>
<th>Nominal cross-sectional area of the core, mm(^2)</th>
<th>Minimal number of strands per core for conductors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Circular non-tightened</td>
</tr>
<tr>
<td>0.5–1</td>
<td>7</td>
</tr>
<tr>
<td>1.5–16</td>
<td>7</td>
</tr>
<tr>
<td>25–35</td>
<td>7</td>
</tr>
<tr>
<td>50</td>
<td>19</td>
</tr>
<tr>
<td>70</td>
<td>19</td>
</tr>
<tr>
<td>95</td>
<td>19</td>
</tr>
<tr>
<td>120–150</td>
<td>37</td>
</tr>
<tr>
<td>185</td>
<td>37</td>
</tr>
<tr>
<td>240</td>
<td>61</td>
</tr>
</tbody>
</table>
Table 12.1.3-2

Insulating materials used for insulation of cable and wire cores

<table>
<thead>
<tr>
<th>Type of insulating materials (and core limit temperature)</th>
<th>Insulation designation</th>
<th>Permissible operating temperature, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermoplastic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polyvinyl chloride or copolymer of vinyl chloride and vinyl acetate</td>
<td>PVC</td>
<td>70</td>
</tr>
<tr>
<td>Elastomeric compound or thermoplastic</td>
<td>EPR</td>
<td>90</td>
</tr>
<tr>
<td>Ethylene-propylene rubber or equivalent (EPM or EPDM)</td>
<td>HEPR</td>
<td>90</td>
</tr>
<tr>
<td>Ruggedized ethylene-propylene rubber</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-linked polyethylene</td>
<td>XLPE</td>
<td>90</td>
</tr>
<tr>
<td>Silicon rubber</td>
<td>S 95</td>
<td>95</td>
</tr>
<tr>
<td>Ethylene-propylene rubber or equivalent (EPM or EPDM)</td>
<td>HF EPR</td>
<td>90</td>
</tr>
<tr>
<td>Halogen-free</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ruggedized halogen-free ethylene-propylene rubber</td>
<td>HF HEPR</td>
<td>90</td>
</tr>
<tr>
<td>Cross-linked halogen-free polyethylene</td>
<td>HF XLPE</td>
<td>90</td>
</tr>
<tr>
<td>Halogen-free silicon rubber</td>
<td>HF S 95</td>
<td>95</td>
</tr>
<tr>
<td>Cross-linked halogen-free polyolefin</td>
<td>HF 90</td>
<td>90</td>
</tr>
</tbody>
</table>

*Wire temperature for calculation of permissible continuous load of the cable.

If this requirement can not be met due to the structure of the ship's spaces, then appropriate measures shall be taken to protect the cable network laid across the spaces with higher risk of fire.

12.1.8 The cores of standard cables shall not be used for power supply of the controls of essential facilities not connected with each other.

The simultaneous application of low voltage and operational voltages interrupting the low one is not allowed in the standard cable.

12.1.9 Non-insulated wires and busbars may be used for inner mounting of electrical equipment; non-insulated busways may be used for the electric power run provided that they are shielded reliably.

12.1.10 When the electric power source and the electrically-driven fire pump, including the emergency one, are located in different spaces separated by a tight or fire-resistant bulkhead, then the cable feeding the electric motor shall be noncombustible or adequately protected against fire.

12.2 SELECTION OF CABLES AND WIRES BY LOAD

12.2.1 If the permissible current load values for used types of cables and wires are not specified, then the permissible continuous loads are to comply with the values specified in Tables 12.2.1-1 – 12.2.1-4.

Table 12.2.1-1

Continuous loads of cables and wires with core limit temperature of 60 °C at ambient temperature of 40 °C

<table>
<thead>
<tr>
<th>Core cross-sectional area, mm²</th>
<th>Continuous load of cables and wires, A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single-core</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>1.5</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
</tr>
<tr>
<td>10</td>
<td>47</td>
</tr>
<tr>
<td>16</td>
<td>62</td>
</tr>
<tr>
<td>25</td>
<td>82</td>
</tr>
<tr>
<td>35</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>125</td>
</tr>
<tr>
<td>70</td>
<td>150</td>
</tr>
<tr>
<td>95</td>
<td>185</td>
</tr>
<tr>
<td>120</td>
<td>215</td>
</tr>
<tr>
<td>150</td>
<td>240</td>
</tr>
<tr>
<td>185</td>
<td>275</td>
</tr>
<tr>
<td>240</td>
<td>330</td>
</tr>
</tbody>
</table>

The load values given in columns 2, 4 and 6 of the above Tables are applicable to the following cases of cable laying:

1. not more than 6 cables belonging to the same circuit or equally loaded by current close to the rated one and laid in one or two layers;

2. in two layers but between each group of 6 cables belonging to the same circuit or equally loaded by current close to the rated one there are free gaps which provide free circulation of cooling air.
### Table 12.2.1-2
Continuous loads of cables and wires
with core limit temperature of 75 °C
at ambient temperature of 40 °C

<table>
<thead>
<tr>
<th>Core cross-sectional area, mm²</th>
<th>Single-core</th>
<th>Double-core</th>
<th>Three- and four-core</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>1.5</td>
<td>21</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>2.5</td>
<td>29</td>
<td>24</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>39</td>
<td>33</td>
<td>28</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
<td>43</td>
<td>37</td>
</tr>
<tr>
<td>10</td>
<td>67</td>
<td>58</td>
<td>49</td>
</tr>
<tr>
<td>16</td>
<td>90</td>
<td>76</td>
<td>65</td>
</tr>
<tr>
<td>25</td>
<td>120</td>
<td>107</td>
<td>87</td>
</tr>
<tr>
<td>35</td>
<td>145</td>
<td>120</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>180</td>
<td>150</td>
<td>125</td>
</tr>
<tr>
<td>70</td>
<td>220</td>
<td>185</td>
<td>155</td>
</tr>
<tr>
<td>95</td>
<td>270</td>
<td>230</td>
<td>195</td>
</tr>
<tr>
<td>120</td>
<td>310</td>
<td>265</td>
<td>225</td>
</tr>
<tr>
<td>150</td>
<td>355</td>
<td>305</td>
<td>260</td>
</tr>
<tr>
<td>185</td>
<td>405</td>
<td>345</td>
<td>295</td>
</tr>
<tr>
<td>240</td>
<td>485</td>
<td>415</td>
<td>350</td>
</tr>
</tbody>
</table>

The load values given in columns 3, 5 and 7 of the Tables are applicable to more than 6 cables belonging to the same circuit or equally loaded by current close to the rated one and laid in the same bunch so that there is no cooling air circulation around the cables.

12.2.2 Permissible loads for cables and wires installed in the circuits with intermittent short-term and short-term load are to be defined by multiplying the continuous loads of these cables by the correction factors specified in Table 12.2.2.

12.2.3 Permissible loads for cables and wires laid in places where the ambient temperature exceeds 40 °C shall be decreased taking into account the correction factors specified in Table 12.2.3.

12.2.4 The cables used in the circuits protected with circuit breakers operating with time delay in the event of short circuit shall be checked by calculation for short-circuit current.

12.2.5 All the cables laid in parallel for every single phase or pole are to have the same cross-sectional area and length.

12.2.6 When selecting the cables for terminal branches of lighting circuits and heating...
Table 12.2.2
Correction factors for circuits with intermittent short-term and short-term load

<table>
<thead>
<tr>
<th>Cross-section of core, mm²</th>
<th>Intermittent short-term service, 40%</th>
<th>Short-term operation during, minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>1</td>
<td>1.24</td>
<td>1.09</td>
</tr>
<tr>
<td>1.5</td>
<td>1.26</td>
<td>1.09</td>
</tr>
<tr>
<td>2.5</td>
<td>1.27</td>
<td>1.10</td>
</tr>
<tr>
<td>4</td>
<td>1.30</td>
<td>1.14</td>
</tr>
<tr>
<td>6</td>
<td>1.33</td>
<td>1.17</td>
</tr>
<tr>
<td>10</td>
<td>1.36</td>
<td>1.21</td>
</tr>
<tr>
<td>16</td>
<td>1.40</td>
<td>1.26</td>
</tr>
<tr>
<td>25</td>
<td>1.42</td>
<td>1.30</td>
</tr>
<tr>
<td>35</td>
<td>1.44</td>
<td>1.33</td>
</tr>
<tr>
<td>50</td>
<td>1.46</td>
<td>1.37</td>
</tr>
<tr>
<td>70</td>
<td>1.47</td>
<td>1.40</td>
</tr>
<tr>
<td>95</td>
<td>1.49</td>
<td>1.42</td>
</tr>
<tr>
<td>120</td>
<td>1.50</td>
<td>1.44</td>
</tr>
<tr>
<td>150</td>
<td>1.51</td>
<td>1.45</td>
</tr>
<tr>
<td>185</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>240</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 12.2.3
Correction factors at ambient temperature exceeding 40 °C

<table>
<thead>
<tr>
<th>Insulating material for cable and wire</th>
<th>Ambient temperature correction factors, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max permitted temperature, °C</td>
<td>45</td>
</tr>
<tr>
<td>1. Rubber or polyvinyl chloride of normal quality</td>
<td>60</td>
</tr>
<tr>
<td>2. Heat-resistant rubber or polyvinyl chloride</td>
<td>75</td>
</tr>
<tr>
<td>3. Varnished cloth or butyl rubber</td>
<td>80</td>
</tr>
<tr>
<td>4. Varnished glass or silicone rubber</td>
<td>85</td>
</tr>
<tr>
<td>5. Mineral insulation or silicone rubber</td>
<td>95</td>
</tr>
</tbody>
</table>

appliances neither the simultaneity factors nor correction factors shall be used.

12.3 CHECKING OF CABLES BY VOLTAGE DROP

12.3.1 The voltage drop along the cable connecting generators with the main or emergency distribution switchboard shall not exceed 1 %.

12.3.2 The voltage drop between the main distribution switchboard and the consumer at the rated load shall not exceed:

- 5 % — for lighting and alarm consumers at voltage exceeding 50 V;
- 10 % — for lighting and alarm consumers at voltage 50 V and less;
- 7 % — for power consumers, heating and cooking appliances, as well as for navigation lights irrespective of the voltage;
- 10 % — for power consumers with short-term and intermittent short-term operation irrespective of the voltage.

At the short-term loads, e. g. When starting the electric motors, large voltage drops are allowed provided that it does not adversely affect the operation of the shipborne power plant.

12.3.3 The cables feeding the directly-started AC electric motors shall be so designed that the voltage drop on the motor terminals does not exceed 25% of the rated voltage when starting the motor.

12.3.4 The voltage drop along the cable feeding the panel of the radio station and the radio electronic navigation means, as well as the voltage drop along the cable intended for charging the accumulator batteries shall not exceed 5%.

12.4 LAYING AND FASTENING OF CABLES

12.4.1 The cables shall be laid, as far as possible, on strait and accessible routes in the places free from condensate or moisture effect.

The cable route is to be located at least 100 mm apart from the heat sources.

12.4.2 The pipes with cables shall be laid at least 50 mm apart from the inner bottom plating, fuel and oil tanks, and at least 20 mm apart from tight bulkheads, outer plating and decks.

For cables laid on shackle-bridges, panels or in cassettes the above distance is to be at least 75 mm.
12.4.3 Cables and wires shall not be laid through oil and fuel tanks except for cases specified in 16.2.7.

12.4.4 The cables with outer metal sheathing may be laid using structures made of light alloys or be fastened by shackles made of such metal only when a reliable anti-corrosion protection is provided.

12.4.5 Inside the cargo holds the cables shall be located in the upper part and laid in pipes or closed with strong coatings.

12.4.6 In the spaces specified in 2.10.3 the cables may be laid in extremely urgent cases in a sealed pipeline fitted with automatic control and alarm device which activates when the circuit insulation resistance decreases.

12.4.7 It is not recommended to lay the cables under the flooring of machinery spaces. If such laying cannot be avoided, then the cables shall be laid in metal pipes or in closed trunks (see 12.6).

12.4.8 The cables laid across the expansion joints in the hull structure are to be provided with expansion bends of a radius sufficient for such joint. The inner diameter of the bend is to be equal to at least 12 cable diameters.

When mounting the heating cable in the places of dismountable joints of the pipelines fitted with electric heating, the bends with a radius sufficient for dismounting the pipeline without damaging the heating cable are to be provided.

12.4.9 The cables with insulation of different heat resistance when arranged in common cable routes shall be laid in such a manner as to provide the insulation temperature of any cable in the route to be within the permissible limits.

12.4.10 The cables with protective sheathings having different properties shall not be laid in a common pipe, if those being less protected under these conditions may be exposed to damage. When laid in a common trunk such cables shall be separated from each other and fastened.

12.4.11 The main current cables of the electric propulsion machinery shall be laid at least 0.5 m apart from the lower voltage cables and cables of other purpose.

12.4.12 The cables from any of two power sources for essential consumers, e.g. steering gear, and all the control and alarm cables connected with each source are to be laid via different routes as far apart from each other in the vertical or horizontal as possible.

12.4.13 When laying the cables in pipes or trunks made of inflammable materials, the latter shall be protected against ignition by means of appropriate fire-protecting means (facing, covering or impregnation).

12.4.14 Neither cables nor wires shall be laid in thermal or acoustic insulation. Cables may be laid in the insulation layer provided that special trunks faced with non-combustible material are used. The cables shall be designed with due regard of corresponding load decrease and be accessible for examination or be located at least 20 mm apart from the trunk sides.

12.4.15 The cables laid in cooled spaces shall have protective sheathing made of material resistant to the cooling agent effect. If the cables are armoured, the armour shall be adequately protected against corrosion.

12.4.16 The cables laid in cooled spaces shall not be located under the heat insulation. They are to be fastened on perforated panels, made of zinc-coated steel for example, or on similar braces, which are to be installed in such a manner as to provide clearance between the panel back side and the cooled space plating. The cables sheathed with thermoplastic or elastomer are allowed for laying directly on the cooled space plating. When the space is faced with aluminium, the cables are to be protected against electrolytic processes.

When cables are introduced into spaces through the heat insulation, they are to be laid in pipes fitted with glands made of material protected against oxidation. The pipes are to be located at a right angle to the bulkhead.
12.4.17 When laying the cables the minimal bending radii of cables shall be met according to Table 12.4.17.

<table>
<thead>
<tr>
<th>Cable insulating material</th>
<th>Type of cable protective sheathing</th>
<th>Cable's outer diameter, ( d ), mm</th>
<th>Minimal bending radius of cable, ( m ), mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rubber or polyvinyl chloride</td>
<td>Metal strip or wire armour</td>
<td>Any</td>
<td>( 10d )</td>
</tr>
<tr>
<td></td>
<td>Metal braiding Other sheathings</td>
<td>Up to 9.5</td>
<td>( 6d )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 9.5</td>
<td>( 3d )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Over 25.4</td>
<td>( 4d )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Any</td>
<td>( 6d )</td>
</tr>
<tr>
<td>2. Varnished cloth</td>
<td>Any</td>
<td>Up to 7</td>
<td>( 2d )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>From 7 to</td>
<td>( 3d )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12.7</td>
<td></td>
</tr>
<tr>
<td>3. Mineral insulation</td>
<td>Metal</td>
<td>Over 12.7</td>
<td>( 4d )</td>
</tr>
<tr>
<td></td>
<td>Semiconductive or metal</td>
<td>25 and over</td>
<td>( 10d )</td>
</tr>
</tbody>
</table>

12.4.18 The cables are to be fastened by means of shackles, clamps, collars or other fastening means made of steel or other non-combustible or flame retardant material. The fastenings shall not cause damage of the cable sheathings.

12.4.19 When the cables are laid horizontally, the distance between their fastenings shall not exceed the values specified in Table 12.4.19. In case of vertical laying the distance may be increased by 25%.

<table>
<thead>
<tr>
<th>Cable outer diameter, mm</th>
<th>Distance between cable fastenings, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 8</td>
<td>Non-armoured 200 250 300 370</td>
</tr>
<tr>
<td>Over 13</td>
<td>Armoured 300 350 450</td>
</tr>
<tr>
<td>Over 20</td>
<td>Mineral 400 450</td>
</tr>
</tbody>
</table>

12.4.20 The cables are to be fastened in such a manner as to prevent transmission of mechanical strains occurring in the cables to their inlets and connections.

12.4.21 The cable runs and the cables laid in parallel to the hull plating shall be fastened to the hull framing. On tight bulkheads and masts the cables are to be fastened using casettes, bridges etc.

12.4.22 The cables laid in parallel to the bulkheads subject to sweating are to be arranged on bridges or perforated panels in such a way as to provide clearance between the cables and the bulkheads.

12.4.23 The cable runs are to be laid with minimal number of crossings. Bridges are to be used in the places of cable crossings. A clearance of at least 5 mm is to be provided between the crossing runs.

12.4.24 The cable runs and the cables of essential consumers laid under the ceiling and bulkheads lining are to be closed with easily removable or opening panels or shields along the whole length. Other cables and the local ones may be laid under the lining without providing access to them.

12.4.25 The cables laid to the electrical equipment installed on shock absorbers shall not affect or restrict the operation of the latter. No load is to be applied to the cable at the maximal stroke of shock absorbers.

12.4.26 The cables on the surfaces of internal combustion engines, boilers or other equipment, which may cause overheat of the cable, shall be laid in such a way as to provide protection against external overheat, otherwise the cables suitable for the maximum possible ambient air temperature shall be used on such surfaces.

12.4.27 The cables laid on opened parts of the ship are to be protected against direct effect of solar radiation.

12.4.28 Laying of cables in the bulwarks or in the guard rail elements is not allowed.
12.5 CABLE PENETRATIONS THROUGH DECKS AND BULKHEADS AND THEIR SEALINGS

12.5.1 The cable penetrations via watertight, gastight and fire bulkheads as well as through the decks are to be sealed. Such sealings shall not decrease the tightness of the above bulkheads and decks. Strains occurring from the hull resilience shall not be transmitted to the cables.

12.5.2 When laying the cables through the non-watertight bulkheads or framing less than 6 mm thick, the holes for cables are to be bushed with facing or bushes protecting the cable against damage. If the bulkhead or framing is at least 6 mm thick, the bushes or facing are not required, however the edges of the penetration hole are to be rounded.

12.5.3 The cables shall be laid through the decks in the following ways:
1. in steel pipes raised above the deck for at least 900 mm in places where mechanical damage of the cable may occur, and to a height not less than that of the door coaming for the given space in other places;
2. in metal sockets or boxes additionally protected with cable jackets of a height not less then that specified in 12.5.3.1.

Sockets and boxes are to be filled with appropriate stuffing compounds, and the pipes are to have glands or be stuffed with cable compound.

12.5.4 The cable boxes in the watertight bulkheads and decks are to be filled with packing compounds having good adhesion with the inner surfaces of the boxes and cable sheathings, resistant to water and oil products, not shrinkable and not imposing tightness during long-term operation.

12.5.5 The sealings of cable penetrations through the fire-resistant bulkheads shall satisfy the fire-resistance test specified for the given type of bulkhead.

12.6 LAYING OF CABLES IN PIPES AND CONDUITS

12.6.1 Metal pipes or conduits with cables laid are to be protected against corrosion both from the inner and outer sides. The ends of pipes and conduits shall not cause the damage of cables when pulling in.

12.6.2 The radius of pipe's bend shall be not less than that permitted for the cable with the largest cross-section laid in it (see 12.4.17).

12.6.3 The total cross-sectional area of all cables defined using their outer diameters shall not exceed 40% of the inner cross-sectional area of the pipe.

12.6.4 The pipes are to be laid in such a way as to prevent water accumulation in them. The pipes are to be fitted with ventilation holes on the highest and lowest points, if possible, so that the air circulation is provided and vapour condensation is prevented. The sealed pipes are to be fitted bleeder plugs for condensate drainage in the lowest points.

12.6.5 The pipes are to be mechanically and electrically integral and earthed.

12.6.6 The cable pipes laid along the hull are to have compensation devices preventing their damage caused by hull deformation.

12.6.7 The cables laid in pipes vertically are to be fastened in such a way as to prevent cable damage by gravity.

12.6.8 It is allowed to use cable shrouds/trays made of flame-retardant plastic.

12.6.9 The cable shrouds/trays made of plastic shall be additionally fitted metal fastenings and clamps in order to prevent the falling of such shrouds and trays, together with the cables fastened, in the event of fire. The cable shrouds/trays made of plastic and laid on open decks shall be protected against UV emission.
12.7 CONNECTION AND JOINING OF THE CABLES

12.7.1 The ends of rubber-insulated cables to be inserted into machinery, apparatus, distribution devices and other equipment are to have appropriate contact, protection and sealing terminals which ensure reliable electrical contact, prevent the ingress of moisture inside the cable and protect the cable core insulation against mechanical damage and affection of air and oil vapours.

The cable cores connected to lighting fixtures, as well as to heating and cooking appliances shall have protected heat-proof terminals in order to avoid overheating of the cable.

12.7.2 Joining of cables in the places of their branching or connection is to be carried out inside the junction boxes using clamps.

12.7.3 The cable sheathings without protective terminals shall be inserted into a device for 3–5 mm, if the protective and sealing terminals are available – at least 10–15 mm.

12.7.4 In the places of cables and wires insertion, especially in the points of joining to the mobile elements and devices, means of cable slacking and kinking prevention are to be provided.

12.8 CABLE MARKING

12.8.1 The cables onboard the ship are to be marked in accordance with design documentation.

12.8.2 The marking method is to provide the safe keeping of the marking for the whole operation period of the cables.

12.8.3 Trunk cables shall be marked.
13 LIGHTNING PROTECTION DEVICES

13.1 GENERAL REQUIREMENTS

13.1.1 The ships are to be fitted with lightning conductors covering the protected zone (ship's open spaces where explosive gas-air mixtures may be present, explosive or inflammable cargoes, materials and equipment may be located or people may be present). The ships, where consequential effects of lightning strokes may cause fire or explosion, are to be fitted with lightning protection earthing devices.

Aerials shall not be used as lightning protection devices. Aerial facilities shall be installed lower than the lightning conductor.

13.1.2 The lightning conductor is to consist of lightning diverter, diverting wire and earth termination.

The lightning conductor may be omitted on metal masts if a reliable electrical contact with the metal hull or with the point of earthing is provided.

13.2 LIGHTNING DIVERTER

13.2.1 Onboard the metal hull ships the ship's vertically oriented structures (e.g. masts, half-masts, superstructure components etc.) shall be used as lightning diverters provided that reliable electrical contact between these structures and the metal hull is ensured.

Additional diverters shall be used only when the ship's structural elements do not ensure protection against lightning.

13.2.2 When electrical equipment is installed on top of the meal mast, an earthed lightning diverter is to be provided.

13.2.3 Every mast or topmast made of non-conducting material shall be fitted with earthed lightning diverter.

13.2.4 The lightning diverter is to be made of a rod with at least 12 mm in diameter. The rod may be made of copper, copper alloys or corrosion-protected steel. For aluminium masts the aluminium diverter is to be used. It is not allowed to mount aerials or other devices on the lightning diverters.

13.2.5 The lightning diverter is to be secured to the mast in such a way as to be raised above the mast top, or a device located over the top, for at least 300 mm.

13.3 DIVERTING WIRE

13.3.1 The diverting wire is to be made of a rod, strip or stranded wire with at least 70 mm² cross-sectional area when using copper or copper alloys, and at least 100 mm² when using steel; the steel wire is to be protected against corrosion.

13.3.2 The diverting wires are to be laid on the outer side of masts and superstructures as straight as possible and with the minimum number of bends which are to be smooth and have as large radius as possible.

13.3.3 The diverting wire shall not be laid through explosion-hazardous spaces and areas.

13.3.4 Onboard the non-metal hull ships the diverting wire is to be laid separately throughout its length (including its earthing connection) and shall not be connected to the busbars of protective and working earthing.
13.4 EARTHING

13.4.1 The diverting wire is to be attached to the hull (see 2.1.1.10).

13.4.2 Devices are to be provided for connection of the lightning conductor earthing or the metal hull with the shore earthing when the ship is in the dock or on the slipway.

13.4.3 Onboard the composite ships a metal stem or other metal structures submerged into water under all navigation conditions may be used for earthing.

13.5 LIGHTNING CONDUCTOR INTERNAL CONNECTIONS

13.5.1 Connections between lightning diverter, diverting wire and earthing are to be welded or bolted with clamps.

13.5.2 The contact surface area between the diverting wire and the diverter or earthing is to be at least 1000 mm². Connecting clamps and bolts are to be made of copper, copper alloys or corrosion-protected steel.

13.5.3 The resistance between the lightning conductor and the hull shall not exceed 0.03 Ohm.

13.6 LIGHTNING PROTECTION EARTHING DEVICES

13.6.1 The lightning protection earthing is to be provided for isolated metal structures, movable connections, pipelines, shields of power and communication lines, joints leading to explosion-hazardous spaces.

13.6.2 All the pipelines for oil products, as well as all other pipelines connected with explosion-hazardous spaces and located on the open deck areas or in the spaces without electromagnetic shielding shall be earthed to the hull at least each 10 m throughout their length.

All the pipelines located on the upper deck, where explosive gases may be present, and not connected with explosion-hazardous spaces shall be earthed to the hull at least each 30 m throughout their length.

13.6.3 Metal parts located near the diverting wires are to be earthed if none of them is located on earthed structure or connected otherwise with the hull. The devices or metal parts located up to 200 mm apart from diverting wires are to be connected with the diverting wire in such a way as to avoid sparking.

13.6.4 The connections of elements are to be accessible for monitoring and located in places where they are not subject to mechanical impacts.
14 ELECTRICAL EQUIPMENT WITH VOLTAGE OVER 1000 V

14.1 GENERAL REQUIREMENTS

14.1.1 The requirements of the present Section are applicable to the electrical equipment with voltage over 1000 V but less than 11000 V AC and are supplementary to the requirements specified in other Sections of the present Part of the Rules.

14.1.2 The insulating materials used for electrical equipment are to ensure 1500 Ohm insulation per 1 V of nominal voltage during ship's operation but not less than 2 M.

14.1.3 Warning inscriptions indicating voltage value are to be located in the vicinity of the entrance to the special electrical space. The casings of electrical equipment located outside special electrical spaces are to have warning inscriptions indicating voltage value.

14.2 DISTRIBUTION OF ELECTRIC POWER

14.2.1 The following electric power distribution systems are to be used:
- neutral earthed system;
- system with neutral connected to the hull via high-ohm resistor (reactor) provided that any possible current does not flow directly through any explosion-hazardous space or area.

14.2.2 The total earthing resistance of neutral point is to be selected in such a way that the short-circuit to hull current does not exceed the nominal current of the major generator in the given system but is at least three times greater than the current required for activation of each of applied protections against short circuit to the hull.

14.2.3 When the electric power is distributed from separate sections capable to operate autonomously, each of them is to have a separate earthing reactor.

14.2.4 The neutral points of generators intended for parallel operation may be connected together before the earthing resistor (reactor).

14.2.5 The neutral point of generator is to be earthed via resistor (reactor) on the distribution switchboard or directly near the generator.

14.2.6 The neutral wire of each generator is to be fitted with a disconnector by means of which the earthing of the generator's neutral point may be disconnected.

14.2.7 The nominal voltages of the electric power distribution systems are to comply with the requirements specified in Table 14.2.7.

<table>
<thead>
<tr>
<th>Inter-phase nominal voltages, kW</th>
<th>Nominal frequency, Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/3.3</td>
<td>50/60</td>
</tr>
<tr>
<td>6/6.6</td>
<td>50/60</td>
</tr>
<tr>
<td>10/11</td>
<td>50/60</td>
</tr>
</tbody>
</table>

14.2.8 The power supply of the ship network from external power source shall be provided only for ships operated at anchorage, such as floating docks etc.
14.3 PROTECTION DEVICES

14.3.1 When different voltages are applied in the equipment, measures shall be taken to prevent lower voltage circuits from being supplied by a higher voltage.

14.3.2 All phases of AC systems are to be protected against overload.

14.3.3 The circuits with insulated neutral point are to be fitted with light and sound alarm indicating the earth fault.

14.3.4 The electrical machinery is to be fitted with temperature detectors in the stator windings. These detectors shall indicate when the temperature of windings exceeds the permissible limits.

14.3.5 Generators are to be protected against earth fault.

14.3.6 Generators are to be de-excited automatically after activation of the generator protection of any type.

14.3.7 Generators are to be protected against inner damages and short-circuit current in the cable connecting generators and the switchboard.

14.3.8 The transformers at high voltage side are to be protected with automatic circuit breakers against the short-circuit current.

14.3.9 The transformers at low voltage side are to be protected against overload.

14.3.10 The voltage measuring transformers are to be protected against the short-circuit current.

14.4 PROTECTIVE EARTHING

14.4.1 Metal casings of electrical equipment are to be earthed using external flexible wires with a cross-section designed for the single-phase short-circuit current but not less than 16 mm². Earthing wires are to be marked.

14.4.2 The earthing conductors may be joined by means of welding or bolts of at least 10 mm in diameter.

14.5 ARRANGEMENT AND PROTECTION LEVEL OF ELECTRICAL EQUIPMENT

14.5.1 The electrical equipment shall be arranged in special electrical spaces and have a protection level not less than IP23 (see also 14.6).

The terminal boxes of electrical machinery shall have at least IP44 protection level.

The electrical equipment may be arranged outside the electrical spaces provided that its protection level is at least IP44 and its live parts are accessible only in the absence of voltage or using special tools.

14.5.2 The special electrical space shall have a diagram specifying arrangement and connections of electrical equipment.

14.6 DISTRIBUTION DEVICES

14.6.1 The high-voltage distribution switchboards are to be locked with a special key different from the keys of the low-voltage distribution switchboards and devices.

The opening of doors or pulling out of single elements is to be possible only when the switchboard or the given element are disconnected from the power network.

14.6.2 The automatic circuit breakers used in the distribution switchboards are to be of pullout type.

The circuit breakers are to be fitted with a device that holds them in the pulled out position.

The fixed current-carrying disconnecting contacts are to be covered automatically with the insulating baffles when the circuit breaker is pulled out.

14.6.3 Protective earthing is to comply with the Rules of Electrical Installations Arrangement and with the requirements of national standards.

14.6.4 Passages are to be provided along the distribution switchboards in order to perform examination of the switchboard and electrical equipment. The passage is to be at

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1 GOST 24040, GOST R 54585.
least 800 mm wide between the partition and the switchboard and at least 1000 mm between the parallel sections of the switchboard.

When such passages are intended for maintenance, then they are to be at least 1000 and 1200 mm wide respectively.

Such width is required regardless of type of protection against accidental touching made as solid doors, mesh or insulating handrails.

The doors, solid partitions and mesh partitions are to be of at least 1800 mm height.

Perforated or mesh partitions shall provide at least IP2X protection level.

The switchboards are to be fitted with two insulating handrails, one of them located along the switchboard at the height of 600 mm and another – at 1200 mm height.

14.6.5 The distance between the live parts being under voltage and the guard rails is to be at least as specified in Table 14.6.5.

<table>
<thead>
<tr>
<th>Nominal voltage, kV</th>
<th>Minimal height of passage, mm</th>
<th>Minimal distance between live parts and guard rails, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (3.3)</td>
<td>2500</td>
<td>Solid doors and partitions: 100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mesh partitions: 180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insulating handrails: 600</td>
</tr>
<tr>
<td>6 (6.6)</td>
<td>2500</td>
<td>Solid doors and partitions: 120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mesh partitions: 200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insulating handrails: 600</td>
</tr>
<tr>
<td>10(11)</td>
<td>2500</td>
<td>Solid doors and partitions: 150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mesh partitions: 220</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Insulating handrails: 700</td>
</tr>
</tbody>
</table>

14.6.6 The clearance between the live parts being under voltage with different potentials or between the live parts and the earthed metal parts or the outer casing by air is to be not less than that specified in Table 14.6.6.

<table>
<thead>
<tr>
<th>Voltage, kV</th>
<th>Minimal air clearance, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (3.3)</td>
<td>55</td>
</tr>
<tr>
<td>6 (6.6)</td>
<td>90</td>
</tr>
<tr>
<td>10(11)</td>
<td>120</td>
</tr>
</tbody>
</table>

14.6.7 The main distribution switchboard is to be fitted with disconnectors for splitting the collecting busbar system in at least two independent sections.

14.6.8 When a power source is required for the drive of the mechanism of automatic and other circuit breakers, then the power margin is to be sufficient for activation of all devices for at least two times.

14.7 TERMINAL BOXES

14.7.1 All the phase-ends of stator windings in generators and motors shall be brought out into the terminal box separated from the lower voltage box.

14.7.2 In the boxes, sockets and terminal boxes of electrical equipment no connections or wires for lower voltage are permitted.

14.8 TRANSFORMERS

14.8.1 The dry type transformers with earthed shields between higher and lower voltage windings are to be used.

14.8.2 De-energizing of the transformer from the high voltage side shall cause the switching off of the switch at the lower voltage side.

14.8.3 If an insulated neutral point is available at the lower voltage side of the transformer, then a spark trap device is to be provided between the neutral point of every transformer and the hull. The spark trap device shall be designed for not more than 80% of the minimal test voltage of the consumers fed from the given transformer.

14.8.4 The spark-gap may be connected in parallel with insulation monitoring apparatus for low-voltage equipment or a device detecting the insulation damage of that equipment. Such devices are not to impose the reliable operation of the spark-gap.

14.9 CABLE NETWORK

14.9.1 The three-phase current cable network shall be made of the three-core cables.

14.9.2 The cross-sectional area of the cable core for power circuits is to be at least 10 mm².
14.9.3 The design, type and permissible current loads of the cables used shall comply with the Rules of Electrical Installations Arrangement.

14.9.4 The cables are to be installed separately from the cables for voltage lower than 1000 V.

14.9.5 The following conditions are to be met when laying the cables:

1. Cable runs of different voltages may be laid jointly provided that the insulation of all cables laid jointly is designed for the highest voltage;

2. Cables are not to be laid across the accommodation spaces;

3. The clearance between the outer sheaths of the cables for different nominal voltages is to be at least the double outer diameter of the biggest one but at least 50 mm;

4. The cables laid outside the special electrical spaces are to be laid in earthed metal pipes or trunks or to be protected with earthed metal coatings.

Such cables may be laid without sheathing provided that they are fitted with solid metal armour which is to be earthed.

14.9.6 Installation of junction boxes as well as other types of connections aimed at elimination of cable breaks or extensions (splicing) is not allowed.
15 ELECTRICAL EQUIPMENT OF REFRIGERATING PLANTS

15.1 DISTRIBUTION OF ELECTRIC POWER

15.1.1 The electric drives of the refrigerating plants onboard the refrigerator ships are to be fed via separate feeders from the distribution switchboard of the refrigerator plant or from the main distribution switchboard. The refrigerating ventilators are to be fed from the distribution switchboard of the refrigerator plant or from other distribution switchboard fed from the main distribution switchboard. The generators' overload-protection device, specified in 7.2.7, is to shut down the drives of refrigerating plants after all the other consumers.

The electric drives of the emergency ventilators, specified in 9.7.7, Part IV of the Rules, shall not be fed from the same distribution switchboard as the electric drives of the main ventilators. The emergency ventilators' drive shall be fed from the main distribution switchboard or from the switchboard fed directly from the main one.

15.1.2 When using ammonia as the refrigerant, a device for emergency remote shut down of the refrigerating plant's distribution switchboard is to be provided in:

.1 control station of the refrigerating plant in the refrigerating machinery room;
.2 a place outside the spaces that may be filled with ammonia in the event of an accident in the refrigerating machinery room;
.3 outside near every exit from the refrigerating machinery room.

15.1.3 The devices for emergency remote shut down of the ammonia refrigerating plant's distribution switchboard are to simultaneously shut down the electric drives of the refrigerating compressors, when they are fed from the main distribution switchboard, to de-energize the main lighting circuit in the refrigerator machinery room and to actuate the electric drives of the emergency ventilators, the watering system, water screens and emergency lighting.

In addition, the devices intended for remote actuation of emergency ventilators, watering system, water screens and emergency lighting in any sequence without shutting down the refrigerating plant distribution switchboard shall be provided in the vicinity of the device for emergency remote shut down of the ammonia refrigerating plant's distribution switchboard.

15.2 VENTILATION AND EMERGENCY LIGHTING

15.2.1 When using ammonia as the refrigerant, the exhaust ventilators' electric motors of the emergency ventilation in the refrigerating machinery rooms installed in the exhaust channels are to be of explosion-proof type (see 2.10.2).

15.2.2 The ventilators' electric motors exposed to the air jet coming from the cooled spaces are to be of at least IP55 protection level.

15.2.3 When using ammonia as the refrigerant, then the explosion-proof lighting fixtures of emergency lighting (see 2.10.2) are to be provided in the refrigerating machinery rooms in addition to the main lighting. The emergency lighting is to be fed independently from the electric equipment and main lighting fixtures.
16 ADDITIONAL REQUIREMENTS FOR SPECIAL TYPES OF SHIPS

16.1 PASSENGER SHIPS

General requirements

16.1.1 The power supply systems of essential facilities (see 5.3) shall be designed in such a way that the fire in one vertical fire zone does not damage the power supply systems of the consumers located in any other vertical fire zone. This requirement is considered as fulfilled, when the main and emergency feeding lines of such consumers passing across any of such zones are located as far as possible from each other in vertical and horizontal directions.

16.1.2 The general alarm system is to consist of two separate groups: one for passengers and the other for the crew.

Passenger ships less than 25 m in length may be fitted with only one group of general alarm system.

16.1.3 The remote switches specified in 7.4, 7.7.3, 7.8.2 shall be protected against unauthorized access.

16.1.4 Onboard the ships fitted with remotely driven doors an indication of doors closing is to be provided in the wheelhouse. Such indication is to display the position of the doors (open/closed) by means of corresponding inscriptions.

A light and sound alarm is to be provided in the place of doors location. This alarm is to indicate the actuation of the closing drive and is to be active till the doors are completely closed.

Lighting

16.1.5 Only electrical equipment is to be used for lighting purposes.

16.1.6 The following spaces and areas are to be provided with lighting:

1. Life saving appliances storage areas, as well as the areas where such appliances are usually prepared for use;
2. Escape routes, areas designated for passengers including passages, entrances and exits, interconnecting corridors, elevators and deck ladders or hatches leading into accommodation spaces, as well as places where passenger rooms and accommodation spaces are located;
3. Places of markings location on the escape routes and emergency exits;
4. Other spaces designed for people with reduced mobility;
5. Places of fire extinguishers location and fire-fighting equipment control stations;
6. Areas of passengers, personnel and crew assembly in the event of emergency.

16.1.7 The emergency lighting for the following spaces and areas is to be provided in addition to that specified in 4.5.1:

1. Escape routes, passenger assembly areas including passages, entrances and exits, interconnecting corridors, elevators and deck ladders or hatches leading into accommodation spaces, as well as places where passenger rooms and accommodation spaces are located;
2. Spaces designed for people with reduced mobility.

16.1.8 In addition to the emergency lighting onboard the passenger ships including high-speed ships the escape routes in the areas with increased accident rate (corridors, ladders, exits, emergency exits) along their whole
length are to be marked with photoluminiscent or electric light signs indicating the escape direction.

16.1.9 In addition to that specified in 16.1.8 onboard the ships intended for transportation of persons with reduced mobility an additional visual and sound alarm and additional lighting are to be provided on the escape routes.

The lighting switches onboard the ships intended for transportation of persons with reduced mobility are to be arranged in accordance with the requirements of 5.2.8, Part XIII of the Rules.

16.1.10 The following requirements are applied for the escape light indicators and their location:

.1 all the escape light indicators shall have a colour (red or green) different from the surface of the deck or door on which they are arranged;

.2 in order to provide the observable outline along the whole escape route all the corridors shall be fitted with uninterruptible escape route marking except for those places where passages and doors to passenger rooms are located. The escape light indicators having observable outlines may be used for interruptible marking;

.3 the escape light indicators are to be arranged at least at one side of the corridor or on the wall not higher than 0.3 m above the deck or on the deck not more than 0.15 m apart from the wall. In the passages of more than 2 m width the escape light indicators shall be arranged at both sides;

.4 the escape light indicators in the dead-end corridors are to be made in the form of arrows with the distance of not more than 1 m from each other, or in the form of equivalent direction indicators showing the way to escape;

.5 the escape light indicators on all the ladders shall be arranged at least at one side of the corridor not higher than 0.3 m from the steps, that will allow to distinguish clearly every step for any person standing higher or lower of the given step. The escape light indicators shall be arranged at both sides, if the width of the ladder is 2 m or more;

.6 the escape light indicators shall lead to the handle of the exit door. Other doors shall not marked otherwise.

16.1.11 The electric escape light indicators are to meet the following requirements:

.1 the electric escape light indicators are to be connected to the emergency distribution switchboard in such a way that under normal conditions the power is supplied from the main power source and from the emergency one if required. In order to specify the power of the emergency source the electric escape light indicators shall be included into the list of emergency consumers;

.2 the electric escape light indicators are to be activated automatically or by one operation in the wheelhouse;

.3 the electric escape light indicators shall provide the following lighting parameters:

   indicators' active elements are to have the minimal brightness 10 cd/m²;

   point sources of midget lamps shall provide at least 150 mcd of average candle power of spherical surface with not more than 0.1 m distance between the lamps;

   point sources of LED systems shall have the minimal peak intensity 35 mcd. Angle of radiation shall be in accordance with the direction approximation and visibility. The distance between lamps is to be not more than 0.3 m;

   electro-luminescent systems shall operate during 30 minutes from the moment of shut down of the main power source to which they are to be connected in accordance with the requirements 16.1.11.1;

.4 all the electric escape light indicators shall be designed in such a way as to avoid the reduction of the escape routes marking efficiency in the event of failure of one lamp.

Safety equipment and devices

16.1.12 All passenger ships are to be equipped with intercommunication devices in accordance with 11.2 and Table 2.1.1, Part VII of the Rules. Such devices are to be provided in the service spaces and in the passenger assembly and evacuation areas where the direct communication with the wheelhouse is not available.

16.1.13 The loud-speaking communication system shall be audible in all the passenger
spaces. The system is to have power sufficient to make the communicated information clearly audible under the normal noise conditions. When the direct communication between the wheelhouse and the passenger areas and spaces is available, the loud-speaking system is not mandatory.

16.1.14 The ship shall be fitted with alert system, which is to include the following:

.1 alert system for the command personnel and the crew to be informed by the passengers, crew members or servicing personnel onboard the ship. The alert signals are to be sent only to the spaces intended for the command personnel and the crew. The alert signals may be switched off by the command personnel only. The alert signals may be activated from the following locations:

Every cabin;
corridors, elevators and stairtowers in such a way that the distance to the nearest alert switch does not exceed 10 m; every watertight compartment is to be fitted with at least one switch;
saloons, dining halls and other spaces intended for rest;
toilets intended for persons with reduced mobility;
machinery spaces, galleys and other fire dangerous spaces;
refrigerated dooms and other store spaces.
The alert switches are to be located at the height from 0.85 m to 1.10 m above the deck;

.2 alert system for passengers to be informed by the command personnel of the ship. The alert signals are to be clearly heard and distinguished without error in every space accessible by the passengers. The alert signals shall be available for activation from the wheelhouse and from the places where the crew members or the personnel are permanently present;

.3 alert system for the crew and servicing personnel to be informed by the command personnel. The alarm system specified in 11.3 is to be also audible in the spaces intended for crew members and servicing personnel rest, refrigerated rooms and other store spaces.

16.2 OIL TANKERS

General requirements

16.2.1 The requirements of the present Chapter apply to the electrical equipment of the following types of ships:

Bulk oil-carrying ships (see 2.2.61, Part 0 of the Rules) and equivalent to them (hereinafter — oil tankers);
ships intended for carriage of inflammable liquids and liquefied gases;
ships using neutral gas as fuel (see 1.1.1 of Interim technical requirements for ships using gas as fuel);
ships intended for work together with the abovementioned ships.

16.2.2 The spaces and areas in oil tankers are divided into explosive and non-explosive, fire-dangerous and fire-proof ones. The classification of explosive and fire-dangerous areas and spaces is given in 1.4, Part III of the Rules.

16.2.3 Distribution of electric power using hull as the return circuit as well as the systems with earthed neutral wire or pole is not allowed.

Protection level and protection types of electrical equipment

16.2.4 The level, explosion protection type, field of application and temperature class of electrical equipment shall comply with the national standard for explosion protected equipment¹ and have markings in accordance with Appendix 2.

16.2.5 In the explosive spaces and areas the installation of electrical equipment is not allowed except for:

.1 measuring, adjusting and warning devices of Exi spark-proof design;
.2 sensor, lamps and signal lanterns fitted with pressurized enclosure (Exp), with explosion-proof enclosure (Exd) or improved reliability against explosion (Exe);

¹ GOST R IEC 60079-0.
.3 Electric motors of improved reliability against explosion (Exe), fitted with explosion-proof enclosure (Exd) or with pressurized enclosure (Exp);
.4 Junction boxes of improved reliability against explosion (Exe) or fitted with explosion-proof enclosure (Exd);
.5 Fire alarm devices of explosion-proof design;
.6 Cables feeding the abovementioned equipment and devices provided that they are laid in steel pipes. The pipe connections to electrical equipment and to each other are to be gastight;
.7 Electric heating cables of explosion-proof design.
.8 Level and pressure sensors, monitoring devices and communication means of explosion-proof design (Exi) and cables connected to them.

16.2.6 The electrical equipment installed in the cofferdams of explosion hazardous areas adjacent to explosion hazardous cargo compartments and tanks is to be of Exi spark-proof design.

16.2.7 In the explosion hazardous areas on open deck above the cargo compartments and tanks along the whole breadth and within 3 m to the bow and to the stern from their end bulkheads and up to the height of 2.4 m above the deck it is allowed to install the following only:
- electrical equipment specified in 16.2.5 and 16.2.6;
- cable runs in gastight pipes.

16.2.8 The cables are to be laid in pipes in accordance with 12.6.

16.2.9 In the first category fire hazardous spaces the electrical equipment to be installed shall have the protection level not less than IP56.
In the second category fire hazardous spaces the electrical equipment to be installed shall have the protection level not less than IP55.

16.2.10 Onboard the ships carrying and pumping gasoline and crude oil in explosion hazardous spaces and areas the electrical equipment to be used shall be designed for operation in explosive mixtures of at least II B-T3 categories and groups (see Appendix 2).

**Electrical network and cable laying**

16.2.11 In explosive zones 0 and 1 the installation of the plug sockets is not allowed. In these spaces the hand lanterns of explosion-proof design with individual built-in power source may be used.

16.2.12 Portable electric hand tools and portable light operated in explosive areas shall be connected to power source outside such areas.

16.2.13 The cables in cargo compartments, tanks and cofferdams are to be laid in steel pipes having no connections in such spaces except for sealed connections with the equipment specified in 16.2.5.

16.2.14 Over the deck of cargo tanks outside the explosive areas the cables are to be laid in channels (trunks) or pipes in accordance with 12.4.

The cables in trunks are to be fastened in order to avoid side displacement.

When laying the cables in channels (trunks) across the explosive areas over the deck of the cargo compartments, the following requirements are to be met:
- The cables shall be laid in rows on the shaped protectors made of non-metal materials provided that their side displacement is not possible;
- The cables shall not contact with metal structures of the channel (trunk);
- The cables shall not be subject to permanent or reverse tensions caused by hull deformation; expansion loops shall be provided, the internal diameter of which shall be...
not less than 10 diameters of the cable having the largest diameter;

.4 the cables are to be protected against impact of the environment, waves, oil products and mechanical damages;

.5 the distance between cables and heat sources shall comply with the requirements of 12.4.1;

.6 the cable runs located in the gangways or in pipes within the space inside the zone 1, as well as the expansion loops shall not be arranged lower than 300 mm from the tanks' deck;

.7 all the metal sheathings or armour of the cables shall be earthed as per 2.10.11.

16.2.15 The flexible cables for portable electrical equipment used during oil skimming shall have metal braid covered with impermeable oversheath made of material resistant to oil products.

16.2.16 The cables shall be protected against oil products exposure.

16.2.17 In the devices for insulation measuring specified in 6.5.4 the ground leakage current shall not exceed 30 mA, and the inductance of ground connection in the device's circuit shall not exceed 60 mH.

**Lighting**

16.2.18 The pump room may be illuminated with explosion-proof lamps or through the tight portlights from the explosion-proof space. The portlight glass is to be at least 12 mm thick and be protected against mechanical damage with a guard mesh from both sides.

16.2.19 The pump room shall be fitted with at least two lighting groups fed via separated lines.

16.2.20 The explosion-proof lamps shall be arranged in such a way as to provide at least 100 mm clearance around them.

16.2.21 The lighting switches are to be located outside the explosion hazardous zones.

**Electrical heating**

16.2.22 Fixed electrical heating arrangements shall be located only outside the explosion hazardous zones 0, 1 and 2 of the oil tankers intended for carriage of inflammable liquids and liquefied gases with flash point up to 60 °C, and the pump rooms of the oil tankers intended for carriage of inflammable liquids and liquefied gases with flash point 60 °C and higher provided that the heating arrangements are fitted with thermoregulators.

**Earthing**

16.2.23 No current-carrying part is to be connected to the hull, other than earthings of condensers used for suppression of electrically induced radio interference, secondary windings of current transformers, as well as the insulation measuring and control devices.

16.2.24 All the electrical equipment irrespective of the nominal voltage value installed in the spaces and areas of explosion hazardous zones is to be earthed according to the requirements specified in 2.6.

16.2.25 Every oil tanker intended for carriage of inflammable liquids and liquefied gases shall be fitted with anti-static earthing devices for protection against sparking caused by static electricity.

The anti-static earthing is to be provided for all conducting (metal) parts of systems, particular devices and components (tanks, pumps, pipelines and pipe systems, routing and end accessories) with oil products, which are permanently or temporarily (washing devices or portable pumps) located in the explosion hazardous zones, spaces and areas.

16.2.26 When earthing the pipelines the continuity of earthing is to be provided. The pipelines shall be earthed to the hull at their beginning and end, as well as at each branch termination.

16.2.27 Special earthing for static electricity discharge is to be provided only when other types of earthing are not available (pro-
tective earthing, lightning-proof earthing, protection against radiointerference).

16.2.28 The structure of the anti-static earthing strips is to comply with the requirements for protective earthing of electrical equipment which are specified in 2.6.

The value of electric resistance between the hull and each of the elements isolated from each other shall not exceed $10^6$ Ohm, when the contact area of the instrument's measuring electrode (probe) and the surface of the equipment under test does not exceed 20 mm$^2$.

16.2.29 The following means of anti-static electricity discharge are to be provided at the entrances into the explosion hazardous zones, spaces and areas: unpainted handles, electrical plates, humid mats etc.

**Pump rooms**

16.2.30 It is required to provide interlocking of the power-on devices of electric motor of the cargo pump and electric drive of the pump room ventilation. Such interlocking is to provide the start of the electric motor only after the pump room is ventilated with the 10-fold air change.

16.2.31 Each electric motor of the cargo pumps is to be fitted with the remote shut down device located at the entrance into the pump room.

**Electric heating of viscous oil products**

16.2.32 The maximum temperature of the heating surface of the electric heater is to be at least by 10% lower than the flash point of the oil product to be heated.

16.2.33 The thickness of the oil product layer above the surface of the heating and current-carrying elements is to be at least 100 mm.

16.2.34 When the heating elements are isolated from the heated oil product, the insulation of the electric heater is to be at least 1 MOhm.

**16.3 SHIPS FOR CARRYING VEHICLES WITH FUEL IN THEIR TANKS AND ROAD TANKERS FOR INFLAMMABLE LIQUIDS**

16.3.1 The requirements of present Chapter apply to electrical equipment of holds and other spaces and areas intended for carriage onboard the cargo ships and ferries of vehicles with fuel in their tanks and road tankers for inflammable liquids.

16.3.2 The holds, spaces and areas specified in 16.3.1 are explosion hazardous spaces and areas.

16.3.3 The cables shall be protected against mechanical damage. The horizontally laid cables shall be arranged at the height of at least 450 mm above the flush deck or platform preventing from free penetration of gases below. Cable penetrations through the decks and bulkheads shall be gas-tight.

16.3.4 The electrical equipment installed in the exhaust ventilation ducts is to be explosion-proof — improved reliability against explosion (Exi, Åõð) or with explosion-proof enclosure (Exd).

16.3.5 The lighting fixtures installed in the holds and spaces specified in 16.3.1 shall be separated on at least two groups each of them being fed via different circuits.

16.3.6 In the holds and spaces located above the main deck, in the area located 450 mm above the deck or a platform preventing from free penetration of gases below it is allowed to install electrical equipment with at least IP55 level provided that the ventilation ensures the 10-fold air change per hour.

16.3.7 Electrical equipment with Exi, Exp, Exd and Exe protection types is to be installed in:

1. In the lower part of the spaces located above the main deck, in the area up to 450 mm above the deck a platform preventing from free penetration of gases below;

2. In the holds and spaces below the main deck.
16.4 SHIPS FOR CARRIAGE OF INSULATED CONTAINERS

Supply and distribution of electric power

16.4.1 The installed capacity of electrical equipment of insulated containers is to be taken for their rated power. The power consumption of electrical equipment of insulated container under nominal operating conditions shall not exceed 15 kW (18.75 kVA).

16.4.2 The device intended for protection for the generators against overload and specified in 7.2.7 shall provide the disconnection of insulated containers from the main distribution switchboard in the very end.

16.4.3 The electrical installations of insulated containers shall be connected to the special distribution facilities by means of plug sockets. These facilities are fed from the main distribution switchboard of the ship's power plant via separate feeders through the separating transformers.

16.4.4 The electric circuit of the plug sockets intended for feeding the electrical equipment of insulated containers is to have a nominal voltage of either 220/380 V of three-phase AC with 50 Hz frequency or 240/440 V of three-phase current with 60 Hz frequency.

Distribution devices and transformers

16.4.5 The secondary winding of separating transformers is to have an insulated neutral point.

16.4.6 Every distribution device shall be fitted with an apparatus to provide the following:

1. light alarm indicating voltage presence in the panels;
2. switching on/off of each feeder supplying the plug sockets;
3. protection against short-circuit currents in the outgoing feeders supplying the plug sockets;
4. measurement of the insulance value and the sound alarm indicating the invalid value of the latter.

Plug sockets and protective earthing

16.4.7 In the holds intended for carriage of insulated containers the plug sockets used for feeding the containers are to have at least IP 55, and IP 56 for open decks.

When electrical remote monitoring systems are used for monitoring the temperature, humidity and other parameters of insulated containers, it is allowed to install additional plug sockets in the holds or on the decks for connection of such monitoring devices.

16.4.8 The plug sockets for feeding the electrical equipment of insulated containers shall be fitted with a switch with interlocking preventing the connection and disconnection of the plug with the socket when the switch is in "ON" position. The plug socket is to have a plate indicating the voltage value.

16.4.9 The electrical equipment of insulated container is to be fed from the ship's electrical network at direct alternation of phases L1, L2, L3 according to the diagram given in Fig. 16.4.9.

16.4.10 The plug sockets intended for feeding the electrical equipment of insulated containers shall be designed for the following rated currents:

- 60 A — for 220 V, 50 Hz (or 240 V, 60 Hz);
- 32 A — for 380 V, 50 Hz (or 440 V, 60 Hz).

16.4.11 The design of plug connections shall prevent the possibility to connect the plugs for one voltage with the sockets for another voltage.

16.4.12 The plug socket intended for connection of earthing core of insulated con-
The container's flexible cable is to be earthed by means of earthing core of feeding line in the place where the power distribution facility of insulated containers is located.

16.5 CATAMARANS
16.5.1 At least one main power source is to be provided in each hull bode of a ship.
16.5.2 A main distribution switchboard is to be provided in each hull bode of a ship. However, only one main distribution switchboard may be provided if located above the main deck.
16.5.3 The busbars are to be sectioned according to the power supply of the hull bodies.
16.5.4 The emergency consumers of each hull body shall be fed from the emergency power source via separate feeders.

16.6 FLOATING CRANES
16.6.1 The accumulator rooms and boxes, as well as the emergency power source spaces in the floating cranes may be located below the main deck provided that the requirements of 4.3 and 8.5 are met.
16.6.2 In order to send the sound signals during cargo handling operations the crane is to be fitted with the sound alarm device to be controlled from the operator's cabin.
16.6.3 In order to prevent the spontaneous actuation of electric drive the zero protection is to be used.
16.6.4 The requirements for machinery and controls of cargo handling gear are specified in Chapter 6, Part V of the Rules.

16.7 FLOATING OBJECTS
16.7.1 At least two generators, main and auxiliary, used as main power sources shall be provided onboard the autonomous passenger floating objects and autonomous bulk oil-carrying floating objects. Additional power supply from external power source may be provided.
16.7.2 The supply and alarm systems of essential systems and facilities (see 5.3) onboard the floating hotels and hostels are to comply with the requirements specified in 16.1.1 – 16.1.2.
16.7.3 Every floating hotel is to be fitted with a stand-alone emergency power source which is capable to provide power for consumers during 30 minutes in accordance with 4.5.1.
16.7.4 When the floating objects is fed from the shore electric network with a dead-earthed neutral, all the ship circuits shall have a zero protection conductor with at least 50% of the phase conductor's admittance in all cases. The zero protection conductors shall be located within the same sheath with the phase conductors.
16.7.5 When the shore electric network with a dead-earthed neutral is used as a main power source, and the diesel generator – as the auxiliary one, the generator distribution system is to have a dead-earthed neutral.

16.8 DOCKS
Scope of application
16.8.1 The present Chapter applies to:
.1 electric drives and their control systems, monitoring and alarm systems which provide submergence and emergence of the dock;
.2 earthing facilities of a ship in the dock.
Protection level of electrical equipment casings
16.8.2 The protection level of the electrical equipment casings shall comply with Table 2.3.6 with due regard of the fact that the dry compartments of the dock superstructures are considered as spaces with high humidity IP 44, and the dry compartments and tunnels of pontoons and other similar spaces are considered as very wet spaces IP 55.

Earthing
16.8.3 Every docking ship is to be earthed to the dock hull with at least two special
16.8.4 In order to connect the dock hull with a shore earthing facility the dock is to be fitted with at least two flexible copper cables with a cross section of at least 70 mm$^2$ each and with devices for connection of these cables to the dock hull.

16.8.5 All the hull sections, pontoons, superstructures and similar dock structures are to be reliably electrically interconnected.

**Number and capacity of electrical power sources**

16.8.6 The main sources of electrical power for the docks shall be as follows:

- 1. generators;
- 2. shore electrical power system.

16.8.7 At least two generators shall be provided as the main electrical power sources for autonomous docks and a shore electrical power system in addition to them if necessary. For non-autonomous docks it is allowed to use only the shore electrical power system.

16.8.8 The capacity of the autonomous docks' main generators or the capacity fed from the shore power system is to be sufficient for providing the following operating conditions of the dock:

- 1. submergence;
- 2. entering a ship into the dock;
- 3. emergence;
- 4. emergency condition;
- 5. other conditions according to the dock's purpose.

16.8.9 The capacity of the autonomous docks' main generators shall provide safe submergence and emergence of the dock as well as entering and exiting of ships in the event of failure of one generator.

**Distribution of electric power**

16.8.10 In addition to those specified in 5.1.1 a single-wire AC or DC system may be used with the dock hull used as a return wire only for welding circuit, as well as for unsulance measuring and monitoring devices.

16.8.11 The following consumers are to be fed from the busbars of the main distribution switchboard via separate feeders in addition to 5.3.1:

- 1. control, alarm and monitoring system for dock submergence and emergence processes;
- 2. switchboards of electric drives of the ballast system outboard water valves;
- 3. feeder switchboards for welding plants;
- 4. feeder switchboards for docked ships.

16.8.12 Essential facilities and electric drives of machinery located in a superstructure not fitted with a power source shall be fed from a distribution switchboard arranged in such superstructure. Such switchboard shall be considered as an outer part of main distribution switchboard and shall be fed via two feeders from the latter. Cross section of each feeder is to be sufficient for feeding the essential facilities of the superstructure in the event of failure of one feeder. The feeding cable runs between the superstructures shall be laid in different spaces, if the dock's design allows it.

16.8.13 It is allowed to feed the navigation lights from the lighting switchboards.

16.8.14 When feeding a non-autonomous dock with voltage over 1 kV from the shore electrical network a device for connection of lower voltage feeder is to be provided in addition to such network. The device is to be designed for supply of power required when the dock is not in operation due to absence of repair works. The electric drive of at least one fire pump, which has the maximum capacity in comparison to others, is to be fed at full load, as well as all motors of clinket (valve) drives and lighting of the spaces are to be fed also.

When feeding a non-autonomous dock with voltage over 1 kV via two independent feeders, the low-voltage feeder is not required.

16.8.15 When feeding the dock from the low-voltage shore electrical network, two feeders and two power reception devices are
to be provided. One device — for feeding the consumers specified in 16.8.11, another — for consumers specified in 16.8.14.

16.8.16 The location and design of the devices for connecting the feeders from the shore electrical network shall:

.1 provide the cables laying at a distance from each other in order to avoid simultaneous damage of cables over 1 kV voltage and the low-voltage cables;

.2 prevent mechanical stress of the cables when submerging and emerging the dock;

.3 prevent the transmission of mechanical strains to the clamps to which the cables or wires are connected.

The devices intended for power reception from the shore electrical network should be located at different superstructures.

16.8.17 A warning sign indicating the voltage value is to be arranged prominently on the hull or on the door of the switchboard intended for power supply from external source.

16.8.18 The maximum permissible short-circuit power level is to be determined for every dock capable of being fed from the shore network. This level is to be indicated on the nameplate of the external source power switchboard.

16.8.19 The ships in the docks are to be fed from the power switchboards fixed in the dock.

16.8.20 Flexible cable feeding the docked ship is to have the cross section designed for the nominal current release setting on outgoing lines of the feeding switchboard of the docked ship.

Portable electrical lighting circuit

16.8.21 The plug sockets for portable lighting shall be installed in the following places in addition to those specified in 10.5:

.1 in the dry compartments of the superstructures, where the equipment and fittings of the submergence and emergence system are located;

.2 in the spaces on the safety deck, where the equipment of the submergence and emergence system is located;

.3 in the space of the central control station intended for control of submergence and emergence procedures;

.4 in the place of the mooring machinery electric drives location.

Service telephony

16.8.22 When other means of communication are not available, the telephones of the control group are to be provided. The telephones are to provide a clear two-way communication between the central control station and the following objects:

.1 mooring capstans control stations;

.2 emergency diesel generator room;

.3 main distribution switchboard room;

.4 main diesel generators room;

.5 transformer substation room;

.6 spaces where manual drives of the outboard water valves are installed;

.7 fire-fighting station.

Additionally, a paired communication is to be provided between the central control station and the machinery space.

16.8.23 It shall be possible to connect the telephone set to the shore telephone network.

General alarm

16.8.24 The general alarm is to be activated from the central control station room and from the room intended for attending personnel, if any.

Cable laying

16.8.25 When the slip deck is illuminated by lighting fixtures of water-proof type fed via the non-tight cables, then such cables are to be laid in a steel water-and-gastight pipes.

The pipes and their sealings shall be selected taking into account operation under pressure which shall be not less than the permissible pressure for the water-proof lighting fixture.
Channeling of electric power and installation of cable network at a single-wire distribution system

16.8.26 The points of connection of a conductor to the steel hull of the dock shall be easily accessible for monitoring and inspection of contact joints.

Such points shall be located on the structures having welding connection with the dock's hull.

16.8.27 Irrespective of electric power channeling system applied for welding circuit the welding station onboard the docked ship shall be fed via the two-wire system from the dock welding circuit.

It is not allowed to use the docked ship's hull as a return wire.

16.8.28 During the welding operations on the hull of the docked ship the cable with a potential opposite to electrode is to be connected to the hull in the vicinity of the welding area.

Emergency electrical installations

16.8.29 Every dock is to be fitted with emergency power source to provide power for all required consumers during at least 3 hours, and during 1 hour for non-autonomous dock.

16.8.30 The emergency source of electric power is to supply the consumers installed in the dock in accordance with 4.5.1, as well as the following consumers:

.1 electric drives of essential outboard water valves of the dock submergence and emergence system (opening and closing of the valves done at least twice);

.2 control and monitoring circuits of the submergence/emergence system;

.3 intercommunication and broadcasting means.

16.8.31 When the automatically started diesel generator is used as emergency power source, a local start shall be provided also.

16.8.32 All the emergency consumers shall be fed from the emergency distribution switchboard.

Where warranted the emergency diesel generator and the emergency distribution switchboard may be arranged in different spaces. It is allowed to use a section of the main distribution switchboard as an emergency distribution switchboard provided that the main distribution switchboard is located higher than the maximal permissible submergence line.

Electric drives of the dock submergence and emergence system

16.8.33 The electric drive of the outboard water valves of the submergence and emergence system shall not impair the valves' manual closing and opening. An interlocking device is to be provided which prevents the operation of electric drive when the valve is set to manual control.

16.8.34 The electric drive of the outboard water valve is to be fitted with local and remote indicators showing the end points of the valve. The drives of the outboard water valves distributing water by the pontoon sections shall be fitted with devices for adjusting the rate of valve opening.

16.8.35 When controlling the drives of the outboard water valves distributing water by the pontoon sections, it is recommended to provide both individual control of each valve and group control of portside and starboard valves.

16.8.36 The control circuits of the bilge (ballast) pump electric motor shall be fitted with local and remote control from the central post with indication of electric motor operation, and for electric motors with 20 A of nominal current and more (according to 6.5.3) — with monitoring of the motor load using the ammeter.

Equipment with voltage over 1 kV

16.8.37 The equipment with voltage over 1 kV shall comply with the requirements of Section 14 of the present Part of the Rules and with Rules of Electrical Installations Arrangement.

16.8.38 The equipment with voltage over 1 kV shall be arranged in special electrical spaces.
17 ELECTRICAL PROPULSION PLANTS

17.1 GENERAL REQUIREMENTS

17.1.1 The generators of electrical propulsion plants may be used for power supply of auxiliary electrical machinery and facilities provided that voltage and frequency are stable under all operating conditions including maneuvering in accordance with the requirements of 2.2.1.

17.1.2 Fixed lighting is to be provided below the electric motors of propulsion plants and the main generators.

17.1.3 Part of electrical propulsion machinery (motors and generators) located under the flooring shall have at least IP X6 protection level.

When they are located in a dry compartment or are protected against water by means of a water-tight foundation and when the compartment is fitted with an alarm indicating water penetration into it, then IP X3 protection level is to be provided.

17.1.4 It is allowed to feed the control, protection and alarm circuits of electric propulsion system from the exciters of the main electric propulsion machinery.

17.1.5 All the components of the DC electrical propulsion plant shall be designed for operation under the conditions of the propulsion motors stalling in "on" position during one minute.

17.2 SUPPLY VOLTAGE

17.2.1 The voltage value in the electrical propulsion plant system shall not exceed the values specified in Table 17.2.1.

<table>
<thead>
<tr>
<th>Circuit</th>
<th>Permissible supply voltage, V</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>AC</td>
</tr>
<tr>
<td>Main current of electrical propulsion plants</td>
<td>1200*</td>
</tr>
<tr>
<td>Control and alarm</td>
<td>220</td>
</tr>
</tbody>
</table>

* Voltage on generator's terminals or between any points of the circuit.

17.3 ELECTRICAL MACHINERY

17.3.1 Main electrical machinery fitted with closed-circuit ventilation system shall be equipped with thermometers for monitoring the temperature of the outgoing air and water.

The electrical machinery fitted with closed-circuit cooling system shall be equipped with light and sound alarm warning of the loss of the cooling medium flow at the output of cooling system.

17.3.2 A light and sound alarm is to be provided. Such alarm is to be activated when the temperature of the main electrical machinery exceeds the values specified in the technical documentation.

17.3.3 The air-cooled electric propulsion motors shall be fitted with two forced ventilators. Each of such ventilators is to have capacity sufficient to provide normal operating conditions for electric motor.

A light alarm indicating that the ventilators are in operation and a sound alarm indicating their shut down shall be provided.

17.3.4 Each water-pumped air cooler of electrical machinery shall be fitted with valves on suction and discharge lines, as well as an air cooler drainage device.
17.3.5 The ventilation air lines of the generators and electric propulsion motors with capacity over 250 kW are to be fitted with temperature monitoring devices at the air outlet from the machinery. Such devices shall provide sound and light signals transmission to the central control station when the air temperature exceeds the permissible value.

17.3.6 When the ventilation system is disconnected, the incoming air shall be free from oil, water and dust.

17.3.7 The generators of electric propulsion plants and electric propulsion motors shall be fitted with a heating system to maintain the air temperature inside the machinery for at least 3 °C higher than the ambient temperature.

17.3.8 The DC electrical machinery designed for actuating the propulsion plants are to have inspection ports for observation over the commutator and the brushes without dismantling the covers.

17.3.9 For the armatures heavier than 1000 kg a possibility to process the commutator without removing the armature from the machinery is to be provided.

17.3.10 If the bearings of the electrical propulsion plant machinery are lubricated under pressure, then the lubricating system shall be fitted with auxiliary pumps.

17.3.11 The lubricating system of the propulsion plant electric motor is to be fitted with a filter and a daily tank which provides oil supply to the bearings under hydrostatic pressure during 15 minutes of operation with switched-off pump, when the normal lubrication of the bearings is not provided during the inertial movement of the ship.

17.3.12 The electrical machinery lubricating system shall be fitted with alarm system which sends the signals to the control stations in the event of pressure loss in the oil line and the increase of oil temperature at the outlet.

17.3.13 The bearings of generators and electric motors of propulsion plants are to be fitted with alarm indicating that the bearing brass temperature exceeds the permissible value.

17.3.14 The excitation system of the electric propulsion plant machinery shall be fed from at least two electric power converters. When one of the converters is damaged, the rest of them shall provide electric power on a full scale for excitation even at the increased load required for maneuvering.

It is allowed to feed the excitation system of electric propulsion plant machinery from the busbars of the main propulsion switchboard provided that the power supply is available under any conditions in accordance with the above requirements.

17.3.15 In the DC electric propulsion systems the disconnection or interruption of the excitation winding of electric motor is to be accompanied by voltage disappearance from the armature winding.

17.3.16 The excitation circuits shall be fitted with a damper of magnetic field energy activated in the event of sudden shut down of the excitation windings.

17.3.17 The excitation and automatic control systems are to be designed in such a manner as to protect the electric motors of propulsion plants against excessive increase of revolution frequency in the event of breakage or baring of the propeller screw.

17.3.18 The generators which operate with semiconductor converters shall be so designed as to operate at the level of harmonic components specified in generators' documentation. For this purpose a power reserve is to be provided sufficient for preventing from the generator's temperature rise which does not occur at normal sine load.

17.3.19 The stator windings of generators and electric propulsion motors with nominal capacity over 500 kVA shall be fitted with temperature sensors.

17.4 SWITCHES IN MAIN AND AUXILIARY CIRCUITS

17.4.1 No automatic circuit breakers are allowed in the excitation circuits, except for those which perform de-excitation of the ma-
chinery at short circuit or damage in the main current circuit.

17.4.2 When it is required to provide a specific sequence of commutation operations, a reliable interlocking preventing the incorrect commutations is to be provided.

17.4.3 The switches intended for immediate commutations in the circuits of electric propulsion plant at voltage off shall be fitted with an interlocking device preventing their shut down in live condition or false switching on.

17.5 PROTECTION IN THE ELECTRICAL PROPULSION PLANT CIRCUITS

17.5.1 The electrical propulsion plants are to be protected against earthing of the current-carrying parts. The leakage current in the protection device shall not exceed 20 mA.

17.5.2 It is not allowed to use fuses as protection devices in the main and excitation circuits of electric motors of propulsion plants.

17.5.3 When the DC generators of propulsion plant are connected in series, a protection device is to be provided to prevent from changing the direction of the generator set rotation in the event of partial or total loss of torque by the primary mover.

17.5.4 The electrical propulsion plant shall have a zero protection against spontaneous start after activation of any protection.

17.5.5 The electrical propulsion plant shall be protected against short-circuit currents and against overloads. A sound and light alarm is to be activated prior to the start of operation of the overload protection.

17.5.6 Measures shall be taken for limitation and use of electric power generated by electric motor of the propulsion plant at transient conditions or when changing the direction of the propeller screw rotation if this power may cause excessive increase of the primary movers revolution frequency.

In the electrical propulsion plant systems fitted with frequency converter and AC electric motor the energy recuperation to the generator’s busbars is allowed provided that other consumers connected to the busbars of the given generator may use this energy. In order to absorb the corresponding part of recuperated energy and speed up the electric propulsion motor braking when reversing it is allowed to use "braking resistors". The amount of recuperated energy shall be limited by the automated control system of electrical propulsion plant in order to prevent the speed up of primary motors rotation above the permissible limit.

17.5.7 At spontaneous shut down of a primary mover of a generator operating in parallel to the common busbars or to one electric motor of the propulsion plant this generator shall be automatically disconnected by all poles or phases without interruption of propulsion plant power supply.

17.5.8 In the AC systems the generators and the electric propulsion motors of 1000 kV A capacity and higher shall be fitted with differential protection.

17.5.9 The checking, alarm and effective control circuits of electric propulsion system shall be protected against short circuit.

17.6 MEASURING INSTRUMENTS AND ALARM

17.6.1 The control boards/panels are to be fitted with the following measuring instruments providing monitoring of the system parameters affecting the operation of the electrical propulsion plant:

1. ammeter in main current circuit;
2. voltmeter in main current circuit;
3. ammeter in excitation circuit for systems with adjustable excitation;
4. voltmeter in excitation circuit for systems with adjustable excitation;
5. tachometer for motors of electric propulsion plants or propulsion shafts;
6. indicator "power generating plant is ready for operation of electrical propulsion plant";
7. indicator "power generating plant is not ready for operation of electrical propulsion plant";
8. indicator "control from central control station";
.9 indicator "control from wheelhouse";
.10 indicator "local control station";
.11 indication of generators energizing the electrical propulsion plant.

In the AC system the following devices shall be arranged in addition to the above:
.12 frequency meter;
.13 synchronizer for connecting the generators to parallel operation;
.14 wattmeter;
.15 indicator "limitation of electrical propulsion plant power" (receives data from frequency converter).

17.6.2 The electrical propulsion plant system shall be equipped with an insulance monitoring device. In the main current circuits the following is to be provided: insulance permanent monitoring, light and sound alarm activated in the event of insulance decrease.

17.6.3 Every control station is to be fitted with an indication of voltage availability in the control circuits.

17.6.4 If the control panel/board is fitted with measuring devices which use oil, steam or water, then measures shall be taken to prevent ingress of the above substances to the alive parts in the event of damage of such devices or their pipes.

17.7 ELECTRICAL PROPULSION PLANT CONTROL

17.7.1 When the control from the board or panel of the plant is performed using electric or hydraulic drive then the stop of the drive shall not be accompanied by the shut down of the plant, and every post of the board shall be ready for manual control.

17.7.2 If the ship is fitted with two or more remote control stations, each control station shall be fitted with an alarm indicating the station being which station is used for control. Apart from that the control stations shall be designed in such a way as to send the orders only from the control station in service.

17.7.3 The control station switch is to be fitted with an interlocking device preventing commutation from one control station to another without de-excitation of the propulsion plant. The commutation is to be carried out by setting the handle of the control station in service into "Stop" position. Regardless of the position of the control handle at the control station to be put into service the activation of the electric propulsion motor is to be carried out only through "Stop" position.

17.7.4 The control stations of electric propulsion plants shall meet the requirements of I.5, Part IV, of the Rules.

17.7.5 The control system of electric propulsion plant is to have an interlocking preventing actuation of the plant when the bar ring gear is also actuated.

17.7.6 When the generators of the power systems of electric propulsion plant operate in parallel, an automated control system of the power generating plant is to be provided.

17.7.7 In case of overload at the busbars of the main switchboard (frequency reduction, current and/or power overload) the power supplied to the electric propulsion plant shall be automatically limited in order to avoid deenergization of the busbars.

17.7.8 If the protection system shuts down one of the generators operating in parallel, then the automated control system of the power generating plant is to automatically reduce the power of electric propulsion plant in order to protect the remaining generators from the overload and ensure their operation. This requirement shall be applicable for the automatic switches at the busbars of the main switchboard.

17.7.9 If the parallel operation of the generators is not envisaged and the frequency converters of the electric propulsion motors are interconnected via DC link, it is required to provide leveling of currents of the frequency converters rectifiers in order to provide balanced load of the generators.

17.7.10 A failure of automatic functions of the electric propulsion plant control system shall lead to activation of the alarm warning system.
17.7.11 At least two control stations (remote and local) independent from each other are to be provided for the electric propulsion plant.

17.7.12 In case of damage, failure or loss of power in the control system at the remote control station of electric propulsion plant a control of the electric propulsion plant converters from the local control station shall be provided.

17.8 ELECTRICAL PROPULSION PLANTS WITH SEMICONDUCTOR CONVERTERS

17.8.1 The capacity of power sources and consumers connected to the busbars of electrical propulsion plant shall be selected with due regard of expected distortions on the busbars as well as additional distortions caused by the dissimetry of the main and high harmonics in the transient operating conditions of electric propulsion motor.

17.8.2 The main generators, semiconductor converters of electric propulsion motor and the accessories of main current circuits shall withstand the current overloads of at least 250% within 2 seconds. The converters shall withstand at least 150% of the rated current from electric propulsion motor during 1 minute.

17.8.3 The capacity of electric propulsion motors shall be selected with due regard of expected voltage distortions at the outlet of semiconductor converter.

17.8.4 The main generators and the electric propulsion motors are to ensure the specified technical characteristics according to ship’s purpose at voltage and current distortions caused by the operation of semiconductor converters.

17.8.5 The overload capability of the main generators and the electric propulsion motors shall meet the requirements of the onboard operating conditions. Measures shall be taken to compensate the decrease of the overload capability caused by induction of high voltage harmonics during operation of semiconductor converters.

17.8.6 The power filter capacitors used in semiconductor converters to improve the quality of electric power shall be fitted with discharging devices.

17.8.7 The consumers sensitive to the harmonicity of supply voltage shall be fed from separate sources or fitted with local suppression devices of high harmonics down to technically reasonable level regardless of the permissible value of the non-linear distortion factor.

17.8.8 The current ripple factor $K_n$ of electric propulsion motors of AC/DC plants, when fed by rectified current, shall be determined as follows:

$$K_n = \sum_{v=2}^{n} \frac{I_{v}}{I_{dn}},$$  \hspace{1cm} (17.8.8)

where $n$ — harmonic number,

$I_{dn}$ — constant component of rectified current,

$I_{v}$ — effective current of $v$th harmonic component.

The current ripple factor for electric propulsion motors designed for operation from DC generators shall not exceed 2%.

17.8.9 The dynamic slowdown current shall not exceed 200% of the rated current.

17.8.10 The semiconductor converters shall meet the requirements of 6.9, Part VI, of the Rules.

17.8.11 At least two semiconductor converters are to be provided for the electric propulsion plant. These semiconductor converters shall be fully independent and installed separately.

17.8.12 Each converter is to have a separate control system.

17.8.13 Two galvanic isolated speed sensors are to be provided for each control system. For the electric propulsion plants with power less than 500 kVA in the systems with a frequency converter it is allowed to monitor the speed using data received from frequency converter.

17.8.14 The converters are to have overload capability that provides the appropriate
torque, capacity and reactive power (for AC systems) required during starting, maneuvering and emergency shut down conditions.

The converters' protection shall not be activated in case of short-term overloads and changes (drops) of rotation frequency.

17.8.15 Malfunctions of the converters' cooling system shall not lead to the shut down of all converters of the ship's electric propulsion plant.

17.8.16 The feedbacks of the converter are to control (limit) the current in such a way that none of the components is damaged even when the converter is connected to the motor with locked rotor or its terminals are short-circuit.

17.8.17 In the "frequency converter – AC electric motor" systems the converter is to provide the following types of protection:
- .1 overheat protection of frequency converter;
- .2 short-circuit protection between the output phases;
- .3 power supply phase failure;
- .4 protection from current overload between the output phases and the hull;
- .5 overvoltage protection in DC link;
- .6 protection from power supply over(under-)voltage;
- .7 motor phase failure.

17.9 ELECTRIC CLUTCHES

17.9.1 The electromagnetic and electroinduction clutches are covered by all the requirements of the previous sections as well as the requirements for electrical machinery as far as practicable.

17.9.2 The design of electric clutches shall allow their dismantling without disassembling the drive motor or the reduction gear.

17.9.3 The design and arrangement of electric clutches shall allow free access for maintenance, replacement of brushes and measuring of air clearance without dismantling the clutches.

17.9.4 The drive motor bearings or the driven gear bearings shall be designed in such a way as to prevent the ingress of lubricating oil inside the clutch.

17.9.5 The clutch connection system shall be designed in such a way as to avoid transmission of excitation to the clutch during start or reverse of the main engine.

17.9.6 When a number of driving motors are in operation for one common transmission, the excitation system of electric clutches shall have an interlocking device preventing simultaneous actuation of driving motors rotating in opposite directions.

17.9.7 The excitation windings of electric clutches are to be protected against overvoltage.

17.9.8 The excitation circuit of electric clutches shall be fitted with:
- .1 two-polar circuit breaker;
- .2 magnetic field damper;
- .3 protection device against short-circuit current.

17.10 DESIGN OF ELECTRIC PROPULSION PLANT

17.10.1 The electric propulsion plants are to be designed for the ship's operating conditions specified in 3.1.1.

The electric propulsion plant shall be so designed that a failure of a component of power part or control system does not cause the shut down of the electric propulsion motors. The capacity required for operation of electric propulsion plant shall be restored within 30 seconds after loss of power.

17.10.2 The electric propulsion plant consists of the following components:
- .1 main generators of electrical propulsion plant – at least two;
- .2 main distribution switchboard split in two parts with an intersectional circuit breaker;
- .3 power transformers for converting the voltage of main generators into the voltage of semiconductor converters (if specified by the design of electric propulsion plant) – one transformer for each converter;
- .4 electric propulsion motor powered by its semiconductor converter;
- .5 control system.
17.10.3 The electric propulsion plants with one electric propulsion motor shall meet the following additional requirements:

1. Synchronous and asynchronous motors are to have two systems of stator windings capable to disconnect independently from their semiconductor frequency converter. Two frequency converters shall be provided – one for each stator winding system. Each semiconductor frequency converter is to be designed for at least 50% of the rated power of electric propulsion plant.

2. DC motors are to be of double-armature (double-commutator) type. Each armature winding is to be designed for at least 50% of the rated power of electric propulsion plant and is to be fed by its independent converter.

17.10.4 Braking or locking devices shall be provided for the propulsion shaft.

In the "frequency converter – AC electric motor" systems it is allowed to apply dynamic braking provided that it will not cause overheating of motor windings.

17.10.5 The alarm warning signal is to be provided at each operating control station. This signal is to warn of a malfunction in the system of electric propulsion plant.

17.11 ELECTROMAGNETIC COMPATIBILITY OF ELECTRIC PROPULSION PLANTS

17.11.1 The electric propulsion plant is to operate without failures and malfunctions under the influence of electromagnetic interference and is to meet the requirements specified in Appendix 15 of RTSC.

17.11.2 If harmonic distortions exceed 10% during operation of electric propulsion plant, then appropriate filtration and interference-free performance of connected consumers is to be provided.

18 SPARE PARTS AND SUPPLY ITEMS

18.1 SPARE PARTS

18.1.1 The nomenclature and number of spare parts for the electrical equipment are specified in the delivery specifications according to the technical documentation.

18.1.2 The spare parts shall be designed in such a way that their use should not require any additional processing or adjustment.

18.1.3 The spare parts shall be located in accessible places, fastened and marked.

18.2 SUPPLY ITEMS

18.2.1 Every ship fitted with electrical power sources of more than 3 kW capacity shall be equipped with portable voltammeter, ohmmeter or combined instrument for measuring current strength, voltage and resistance, with high-resistance ohmmeter and load nippers in case of AC current use.
PROTECTION LEVELS OF ELECTRICAL EQUIPMENT

1 In accordance with GOST 14254 the designation of protection level of electrical equipment shall include the following:
   conventional sign IP;
   digital designation of protection level for attending personnel against touching the moving parts of the equipment and against ingress of solid foreign objects inside the casing (Table A1.1-1);
   digital designation of protection level against ingress of water inside the casing (Table A1.1-2).

2 If a protection level is not required for the product, then "X" sign is put in the conventional sign instead of the designation of protection level which is not required and is not tested.

Table A1.1-1

<table>
<thead>
<tr>
<th>Protection level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No protection against touching alive or moving parts of the casing, as well as no protection of equipment against ingress of solid foreign objects</td>
</tr>
<tr>
<td>1</td>
<td>Protection against accidental touching alive or moving parts inside the casing with a significant surface area of human body. No protection against deliberate access to these parts</td>
</tr>
<tr>
<td></td>
<td>Protection of the equipment against ingress of large-size solid foreign objects with diameter 50.0 mm and more</td>
</tr>
<tr>
<td>2</td>
<td>Protection against finger touching alive or moving parts inside the casing</td>
</tr>
<tr>
<td></td>
<td>Protection of the equipment against ingress of medium-size solid foreign objects with diameter 12.5 mm and more</td>
</tr>
<tr>
<td>3</td>
<td>Protection against touching alive or moving parts inside the casing by tools, wire or similar objects with thickness 2.5 mm and more</td>
</tr>
<tr>
<td></td>
<td>Protection of the equipment against ingress of small-size solid foreign objects with thickness 2.5 mm and more</td>
</tr>
<tr>
<td>4</td>
<td>Protection against touching alive or moving parts inside the casing by tools, wire or similar objects with thickness 1 mm and more</td>
</tr>
<tr>
<td></td>
<td>Protection of the equipment against ingress of small-size solid foreign objects with thickness 1 mm and more</td>
</tr>
<tr>
<td>5</td>
<td>Full protection of personnel against touching alive or moving parts inside the casing</td>
</tr>
<tr>
<td></td>
<td>Protection of the equipment against harmful dust deposits</td>
</tr>
<tr>
<td>6</td>
<td>Full protection of personnel against touching alive or moving parts inside the casing and full protection of the equipment against dust ingress</td>
</tr>
</tbody>
</table>

Table A1.1-2

<table>
<thead>
<tr>
<th>Protection level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No protection</td>
</tr>
<tr>
<td>1</td>
<td>Protection against condensate drops. Water dropped vertically on the casing shall not adversely affect the equipment inside the casing</td>
</tr>
<tr>
<td>2</td>
<td>Protection against water drops. Water dropped on the casing at an angle not exceeding 15° from the vertical shall not adversely affect the equipment inside the casing</td>
</tr>
<tr>
<td>3</td>
<td>Protection against rain. Rain dropped on the casing at an angle not exceeding 60° from the vertical shall not adversely affect the equipment inside the casing</td>
</tr>
</tbody>
</table>
Protection level | Description
---|---
4 | Protection against splashes. Water splashed on the casing from any direction shall not adversely affect the equipment inside the casing
5 | Protection against water jets. Water jet ejected from the nozzle tip on the casing at any direction shall not adversely affect the equipment inside the casing
6 | Protection against waves on the deck. When the casing is washed by waves, the water shall not penetrate inside the casing under the test conditions agreed by the customer and manufacturer
7 | Protection at submergence. Water shall not penetrate inside under the pressure and test time conditions agreed by the customer and manufacturer
8 | Protection at unlimited long-time submergence. The pressurized water shall not penetrate inside the casing under the pressure conditions agreed by the customer and manufacturer

**APPENDIX 2**

**CLASSIFICATION OF EXPLOSIVE MIXTURES**

1. In accordance with GOST R IEC 60079-0, when designating the protection level the explosive gas-air and vapour-air mixtures are classified as in Table A2.1 with regard to the size of maximal experimental safe clearance (MESC).

2. Explosive gas-air and vapour-air mixtures are subdivided into six groups depending on their self-ignition temperature as specified in Table A2.2.

3. The explosion-proof electrical equipment may have the explosion protection types specified in Table A2.3.

---

**Table A2.1**

<table>
<thead>
<tr>
<th>Mixture category</th>
<th>Mixture name</th>
<th>MESC, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Mine methane</td>
<td>Over 1.0</td>
</tr>
<tr>
<td>II</td>
<td>Industrial gases and vapours</td>
<td>—</td>
</tr>
<tr>
<td>II A</td>
<td>Ditto</td>
<td>Over 0.9</td>
</tr>
<tr>
<td>II B</td>
<td>«</td>
<td>Over 0.5 to 0.9</td>
</tr>
<tr>
<td>II C</td>
<td>«</td>
<td>Up to 0.5</td>
</tr>
</tbody>
</table>

**Table A2.2**

<table>
<thead>
<tr>
<th>Group of explosive gas-air and vapour-air mixtures</th>
<th>Self-ignition temperature, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Above 450</td>
</tr>
<tr>
<td>T2</td>
<td>From 300 to 450</td>
</tr>
<tr>
<td>T3</td>
<td>From 200 to 300</td>
</tr>
<tr>
<td>T4</td>
<td>From 135 to 200</td>
</tr>
<tr>
<td>T5</td>
<td>From 100 to 135</td>
</tr>
<tr>
<td>T6</td>
<td>From 85 to 100</td>
</tr>
</tbody>
</table>

**Table A2.3**

<table>
<thead>
<tr>
<th>Explosion protection types</th>
<th>Type symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explosion-proof enclosure</td>
<td>d</td>
</tr>
<tr>
<td>Spark-proof electrical circuit</td>
<td>ia, ib, ic</td>
</tr>
<tr>
<td>«e» type protection</td>
<td>e</td>
</tr>
<tr>
<td>Enclosure pressurization or purging</td>
<td>p</td>
</tr>
<tr>
<td>Enclosure oil immersion</td>
<td>o</td>
</tr>
<tr>
<td>Enclosure powder filling</td>
<td>q</td>
</tr>
<tr>
<td>Special type of explosion protection</td>
<td>s</td>
</tr>
<tr>
<td>Automatic protecting shutdown</td>
<td>—</td>
</tr>
</tbody>
</table>
CABLE TEST FOR FLAME RETARDANCE

1 The tests are carried out in order to check the flame retardance of insulated cable or wire.

2 The test specimens are cable or wire sections (600±25) mm long. Prior to the test the specimens shall be kept at (23±5) °C temperature and (50±20) % humidity for at least 16 hours. If the cable or wire is coated with paint or varnish, the specimen shall be kept at (60±2) °C temperature during 4 hours before the test.

3 The test chamber is a metal box (450±25) mm long, (300±25) mm width and (1200±25) mm height without the front side. The test chamber floor shall be protected with a layer of mineral insulation. The test chamber shall be arranged in a space free from draughts and fitted with toxic gas (generated during combustion) disposal systems.

4 Prior to the test the burner shall be mounted on a horizontal surface in such a way that the flame is directed strictly upwards. The overall length of the flame is to be 125 mm and the length of internal blue-colored part – 44 mm. The work of the burner is to be checked by inserting a copper wire with (0.710±0.025) mm diameter and at least 100 mm length at right angle to the flame at a distance exceeding the end of internal blue-colored part of the flame by 10 mm and in such a way that the wire end is located above the edge of burner’s nozzle. The temperature of the flame is to provide melting of the copper wire within the time limits from 4 to 6 seconds.

5 The specimen shall be fastened using copper wire to two horizontal supports (Fig. A3.5-1) in such a way that the distance between the lower edge of the upper support and the upper edge of the lower support is (550±5) mm. The lower end of the specimen shall be approximately 550 mm apart from the chamber floor. The burner shall be located in such a way that the tip of the internal blue-colored cone of the flame touches the surface of the specimen at a distance approximately 75 mm higher than the lower clutch.

Fig. A3.5-1. Arrangement of a specimen in the test chamber:
1 — metal chamber; 2 — support bar and fastening of copper wire; 3 — specimen; 
A — distance between chamber floor and specimen's lower end (approx. 50 mm).
The angle between the axis of burner's nozzle and the specimen vertical axis shall be 45° (Fig. A3.5-2). The internal blue-coloured part of the flame is to be at a distance of 10 mm apart from the specimen.

Fig. A3.5-2. Application of burner's flame to the specimen:
1 — lower edge of upper support; 2 — specimen

6 The time, during which the specimen is permanently exposed to the flame, shall be as specified in Table A3.6. In the end of the test the burner shall be removed and its flame shall be extinguished.

<table>
<thead>
<tr>
<th>External diameter $D$ of specimen, mm</th>
<th>Flame exposure time, s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 25</td>
<td>60</td>
</tr>
<tr>
<td>From 25 to 50</td>
<td>120</td>
</tr>
<tr>
<td>* 50 * 75</td>
<td>240</td>
</tr>
<tr>
<td>Over 75</td>
<td>480</td>
</tr>
</tbody>
</table>

7 After the burning stops the specimen shall be carefully wiped with a cloth.

If the specimen's surface has no damages, the presence of soot on its surface after wiping is allowed. Softening or deformation of non-metal material shall not be taken into account. The distance between lower edge of the upper support and the beginning of specimen's charred part shall be measured with accuracy of 1 mm.

The beginning of the charred part shall be defined as follows. The cable surface is pressed with a sharp object, e.g. knife blade. The place where the elastic surface of the specimen changes to a brittle one is determined as the beginning of the charred part.

8 It is considered that the cable or wire has passed the test when the specimen has not caught fire or when the specimen stops burning after the test flame is removed and the traces of fire did not reach the upper end of the specimen.

When the flame spreads downwards up to the point located at a distance more than 540 mm from the lower edge of the upper support, it is considered that the cable or wire has not passed the test.

If the specimen has not passed the test, two more tests are to be carried out. If the results of these two tests are satisfactory, then it is considered that the cable or wire has passed the test.
Part VII

RADIO COMMUNICATION EQUIPMENT
1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION

1.1.1 This Part of the Rules covers technical requirements to radio communication equipment for inland and river–sea navigation ships as well as requirements to components and parameters of this equipment.

1.1.2 This part of the Rules applies to products, ships being designed and ships in construction in accordance with 1.5, Part 0 of the Rules, unless otherwise provided, the ships and products in service are covered by the requirements of the Rules according to which they were built (manufactured).

1.2 TERMS AND DEFINITIONS

1.2.1 The following terms are used in this Part of the Rules:

1. Emergency position-indicating radio beacon (EPIRB) means a mobile service station, the emissions of which are intended to facilitate search and rescue operations;

2. Start-up time means a period of time necessary for radio equipment to become operational as measured from the moment of energizing the equipment;

3. Inner road within harbour water area means a section of port water area within the established boundaries sheltered from waves by natural coastline or external breakwater structures for ships berthing;

4. Main VHF radio telephone station means a station for transmission and receipt of distress alerts, navigation warnings, meteorological forecasts, medical, urgent and other messages as may be required for navigation safety;

5. Global Maritime Distress and Safety System (GMDSS) means an international radio communication system developed by the International Maritime Organization (IMO), requirements to which are brought to amendments 1988–1989 to Chapter IV “Radio Communication” of the International Convention for the Safety of Life at Sea, 1974 and to this Part of the Rules;

6. Length of the ship means length of a ship at design waterline;

7. GMDSS identities mean maritime mobile services identity, the ship’s call sign, INMARSAT identities and serial number identity which may be transmitted by the ship’s equipment and used to identify the ship;

8. INMARSAT means an organization established by the Convention on the International Maritime Satellite Organization adopted on 3 September 1976; since 9 December 1994 it is an International Mobile Satellite Organization;

9. Maritime safety information means navigational and meteorological warnings, meteorological forecasts and other urgent safety-related messages broadcast to ships;

10. Convention means the International Convention for the Safety of Life at Sea, 1974, as amended;

11. COSPAS-SARSAT means an international system for search and rescue of ships and aircraft in distress using near-polar orbiting satellite system;

12. Sea area Al means within the radio-telephone coverage of a VHF coast station which provides continuous digital selective call (DSC) alerting;
1.3 Sea area A2 means an area other than sea area A1 within the radio-telephone coverage of an MF coast station, which provides continuous digital selective call (DSC) alerting;
1.4 Sea area A3 means an area other than sea areas A1 and A2 within the coverage of INMARSAT geostationary satellite system, which provides continuous distress alerting;
1.5 Sea area A4 means an area other than sea areas A1, A2 and A3;
1.6 NAVTEX means an international automated alerting system; its stations broadcast, in coordinated manner, every four hours some maritime safety information (navigation warnings, meteorological warnings, information on search and rescue operations as well as other information affecting navigation safety within range of these stations); its automatically receive the said information at 518 kHz by means of narrow-band direct-printing (NBDP) telegraphy in English;
1.7 Continuous watch means an uninterrupted radio watch except for short intervals when the ship radio capability is impaired or blocked by its own communications or when the radio equipment is under periodical maintenance, repair or checks;
1.8 Man-portable radio station means a radio station designed for radiotelephone communication between a life-saving appliance (LSA) and the ship, support of mooring and specific operations, transmission of emergency commands from the wheelhouse; it has its own power source and adapted for operation when carried;
1.9 MF/HF radio station means a radio station operating within the medium and short wave bands;
1.10 Mobile earth station means an earth station in the mobile satellite service intended to be used underway or at rest at unspecified points;
1.11 Interferences mean the effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon receipt in a radio communication system, manifested by any performance degradation, misinterpretation or loss of information, which could otherwise be avoided in the absence of such unwanted energy;
1.22 Portable radio station means a man-portable radio station with weight not exceeding 1 kg;
1.23 Radio equipment means technical facilities designed for communication and broadcasting;
1.24 General radio communication means service and public correspondence traffic, other than distress, urgency and safety messages, conducted by radio;
1.25 Enhanced group calling (EGC) means a service for broadcasting distress, safety and urgency messages via INMARSAT mobile satellite communications system;
1.26 Radio Regulations means a document being an appendix or considered as an appendix to the latest effective revision of the International Telecommunication Convention;
1.27 Standby power source means a storage battery independent of power installation and ship's electric system, which is designed for supplying radio communication equipment in case of malfunction of ship's main and emergency electric power sources;
1.28 Security alert system means a system which generates and transmits a hidden signal or message on security breach or that a ship is under threat of unauthorized intrusion to an authorized organization;
1.29 Rescue unit means an object (ship, helicopter, etc.) manned with trained personnel and equipped with arrangements for search and rescue operations;
1.30 Ship earth station means a mobile earth station in the maritime mobile satellite service installed on board the ship;
1.31 Narrow-band direct-printing (NBDP) telegraphy means communication technique using automated telegraphy equipment, which complies with the relevant recommendations of the International Telecommunication Union (ITU);
1.32 Two-way VHF radiotelephone apparatus means a VHF apparatus designed for communication between
buoyant life-saving appliances (LSA) and a ship as well as between buoyant life-saving appliances and a rescue unit;

33 Digital selective calling (DSC) means a way of communication complying with recommendations of the International Radio Consultative Committee and using digital codes; this allows a radio station to establish communication and transmit information to another station or a group of stations;

34 Operational VHF radio-telephone station means a radio station designed for transmission and receipt of service messages.

1.3 GENERAL REQUIREMENTS TO RADIO EQUIPMENT

1.3.1 Every self-propelled river–sea navigation ship in service shall be fitted with radio equipment able to provide the following:

.1 transmission of ship-to-shore distress alerts by at least two separate and independent means, each using a different radio communication service;

.2 receipt of shore-to-ship distress alerts;

.3 transmission and receipt of ship-to-ship distress alerts;

.4 transmission and receipt of search and rescue coordinating communications;

.5 transmission and receipt of safety information when in voyage;

.6 transmission and receipt of on-scene communications;

.7 transmission and receipt of position finding;

.8 transmission and receipt of signals for position finding;

.9 transmission and receipt of shore-based communication systems and networks;

.10 transmission and receipt of wheelhouse-to-wheelhouse messages.

With respect to those operations, provisions shall be made to prevent making false distress signals.

1.3.2 Every self-propelled inland navigation ship shall be fitted with radio equipment able to provide the following:

.1 transmission of shore-to-ship distress alerts;

.2 receipt of shore-to-ship distress alerts;

.3 transmission and receipt of ship-to-ship distress alerts;

.4 transmission and receipt of safety information when in voyage;

.5 transmission and receipt of navigation and other ship data in alert systems, navigation conditions compliance control systems and navigation safety systems, if these data are to be transmitted by ships navigating within the coverage area of such systems.

1.3.3 Serviceability of radio equipment on board river–sea navigation ships shall be provided as follows:

.1 for ships fitted with radio equipment in accordance with 2.2.1 and navigating within sea areas A1 or A1+A2, serviceability of radio equipment is to be provided by one of the following methods:

- redundancy of equipment (see Table 2.2.1);
- shore-based maintenance and repair;
- afloat maintenance and repair by the ship radio officer having the radio operator's first or second class certificate;
- or combination of these methods.

For ships fitted with radio equipment in accordance with 2.2.3 and navigating within sea areas A1 or A1+A2, serviceability of radio equipment is to be provided by means of shore-based maintenance and repair;

.2 For ships fitted with radio equipment in accordance with 2.2.1 and 2.2.3 and navigating within sea areas A1+A2+A3 as well as A1+A2+A3+A4, serviceability of radio equipment is to be provided by two following methods:

- redundancy of equipment (see Table 2.2.1);
- shore-based maintenance and repair;
- afloat maintenance and repair by the ship radio officer having the radio operator's first or second class certificate;

.3 provision shall be made for necessary tools, spare parts and measuring (test) equipment on board each ship for maintenance and
repair of radio equipment regardless of its maintenance and repair methods;

.4 on board each ship engaged on voyages within sea areas A1+A2+A3 or A1+A2+A3+A4 there shall be always kept descriptions, operating manuals for each type of radio equipment, as well as provision shall be made for necessary tools, spare parts and measuring (test) equipment for maintenance of radio equipment;

.5 for ships engaged on voyages within sea areas A1 or A1+A2, the scope of technical documentations, tools, instruments, spare parts and measuring (test) equipment is to be stated by the manufacturer in technical documentation for the equipment;

.6 where serviceability of radio equipment is provided by combination of methods, one of which being shore-based maintenance and repair, an agreement on shore-based maintenance with equipment manufacturer or an enterprise authorized by the manufacturer shall be available on board the ship, or a written declaration/plan indicating the method of shore-based maintenance shall be submitted. Provision shall be made for maintenance and repair of radio equipment in sea areas where such ships navigate.

1.3.4 Radio equipment may be replaced with that of the same type without the need in approval by the River Register if such a replacement does not cause change in cable rerouting/replacement or equipment relocation.

1.3.5 Radio equipment not covered in Table 2.1.1, 2.2.1 and 2.2.3 may be installed on board ships as additional equipment provided that:

.1 the requirements with respect to electromagnetic compatibility, electrical safety, permissible heating of cases and absence of harmful radiations as stipulated by these Rules are complied with;

.2 the requirements of Part VI of these Rules with respect to its connection to the ship’s power mains are complied with;

.3 results of reliability checks for equipment fasteners designed for its safe operation under heel, trim and roll conditions according to 6.1.2 are satisfactory;

.4 results of checks of arrangement and installation for compliance with requirements of 4.1, 4.5, 4.10, 5.4 and 5.5 and checks of access for repair and maintenance of equipment installed in accordance with 2.1.1, 2.2.1 and 2.2.3 are satisfactory;

.5 documentation on its installation agreed upon with the River Register is available.
2 RADIO EQUIPMENT

2.1 RADIO EQUIPMENT FOR SHIPS OF M, O, P AND I CLASSES

2.1.1 Each self-propelled ship, with regard to how communication for safe navigation within the ship navigation area is arranged, in order to comply with requirements stated in 1.3.2, shall be fitted with radio equipment according to Table 2.1.1.

<table>
<thead>
<tr>
<th>Radio equipment</th>
<th>Quantity with regard to category of navigation water area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
</tr>
<tr>
<td>1. MF/HF radio station or ship earth station</td>
<td>1</td>
</tr>
<tr>
<td>2. Main VHF radiotelephone station (300.025 to 300.5 MHz)^9</td>
<td>1</td>
</tr>
<tr>
<td>3. Operational VHF radiotelephone station</td>
<td>1^4</td>
</tr>
<tr>
<td>(300.025 to 300.500, 336.025 to 336.500 MHz)</td>
<td></td>
</tr>
<tr>
<td>4. Portable/man-portable VHF radiotelephone station (300.025 to 300.225 MHz)^6,9</td>
<td>3</td>
</tr>
<tr>
<td>5. Radar transponder^10</td>
<td>1</td>
</tr>
<tr>
<td>6. Public address and broadcasting device</td>
<td>1</td>
</tr>
</tbody>
</table>

1 No radio equipment is needed on board ships engaged on voyages within continuous coverage of shore-based VHF radiotelephone station systems, port water area, road, as well as engaged on voyages as part of a convoy or on operations as part of a group of ships, provided that such a convoy or a group of ship includes ships equipped with complete set of radio equipment required for navigation within respective area and the permanent radio communication by means of VHF radiotelephone stations is maintained with these ships.

2 Satellite EPIRB of COSPAS-SARSAT system may be fitted instead of MF/HF radio installation or ship earth station, provided that voyage, navigation and meteorological information is received by means of other equipment on board the ship.

3 For ships of P and I class less than 25 m long installation of a portable/man-portable MF/HF radiotelephone station supplied from ship's mains and connected to the external stationary antenna may be sufficient. Such a radiotelephone station may not replace the radiotelephone station given in 4 Table or may not be such a station.

4 Required only for passenger ships and ships with a length of 25 m and above or ships with main engines power of 367 kW and above.

5 Required only for passenger ships with a length of 25 m and above.

6 Frequency range of a portable/man-portable VHF radiotelephone station may be 300.025 to 300.225, 336.02 to 336.225 MHz.

7 Required for passenger ships only.

8 Where only main VHF radiotelephone station is installed on board the ship, its frequency range shall be 300.025 to 300.500, 336.025 to 336.500 MHz.

9 For passenger ships: of O class: when the crew consists of 2 persons — 2 sets, when the crew consists of 3 and more persons – 3 sets; of P class: when the crew consists of more than 1 person — 2 sets, of I class — 1 set.

The ships in service shall be fitted with radio stations according to the requirements by the time of ordinary survey of the ship after 01.01.2017 but not later than 19.07.2021.

10 Not required for ships engaged on voyages within port water area or road.
2.1.2 Non-self-propelled ships manned with crew or specific personnel shall be equipped with radio equipment according to Table 2.1.1 as ships of Í class. In addition to Note 3 of Table 2.1.1 it is permitted to equip the ship (irrespective of ship's length) with a portable (mobile) VHF radiotelephone station instead of main VHF radiotelephone station provided that the ship's mains is not available onboard the ship. In this case when it is not possible to charge the accumulator batteries onboard the ship, a set of accumulator batteries is to be available onboard the ship. The total capacity of the batteries shall ensure the operation of the radio station during the whole time of crew or special personnel presence onboard the ship expected that the radio station is to operate continuously during 24 h: at least 1 h for transmission and 24 h for receipt. Where satellite EPIRB of COSPAS-SARSAT system is installed instead of MF/HF radiotelephone on board non-self-propelled ships, it is permitted not to have other means of reception of voyage, navigation and meteorological information.

Non-self-propelled ships in service are to be fitted with radio equipment according to the requirements of the present paragraph by the time of ordinary survey of the ship starting from 01.01.2017 but not later than 19.07.2021.

2.1.3 Inland navigation ships, which navigate within maritime traffic areas, shall have a VHF radiotelephone station with maritime mobile service frequencies. This station shall be permanently supplied from the ship's electric power source throughout the period when the ship is within the maritime traffic area.

2.1.4 Ships shall be provided with operating documents for radio equipment.

2.2 RADIO EQUIPMENT FOR SHIPS OF M-III, M-IIP AND O-IIP CLASSES

2.2.1 In order to comply with requirements stated in 1.3.1, each passenger ship and each ship of gross tonnage of 300 and above engaged on international voyages shall be fitted with radio equipment according to Table 2.2.1.

<table>
<thead>
<tr>
<th>Radio equipment</th>
<th>Quantity per ship</th>
<th>in inland waters</th>
<th>within sea areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Main VHF radiotelephone station (300.025 to 300.500 MHz)</td>
<td>1</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2. Operational VHF radiotelephone station</td>
<td>1</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>(300.025 to 300.500, 336.025 to 336.500 MHz)</td>
<td></td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3. Portable/man-portable VHF radiotelephone station</td>
<td>2</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>(300.025 to 300.225 MHz)</td>
<td></td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4. VHF radio installation:</td>
<td></td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>DCS encoding device</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>receiver for DSC watch</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>radiotelephone station</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>5. MF radio installation (1,4):</td>
<td></td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>DCS encoding device</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>receiver for DSC watch</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>radiotelephone station</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>6. MF/HF radio installation:</td>
<td></td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>DCS encoding device</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>receiver for DSC watch</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>telephony and NBDP radio receiver</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>telephony and NBDP radio transmitter</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>increased fidelity direct-printing equipment</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>terminal direct-printing apparatus</td>
<td>1</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>7. INMARSAT ship earth station</td>
<td>1</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>8. NAVTEX receiver</td>
<td>1</td>
<td>1</td>
<td>18</td>
</tr>
</tbody>
</table>

Table 2.2.1
End of Table 2.2.1

<table>
<thead>
<tr>
<th>Radio equipment</th>
<th>Quantity per ship</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in inland water-ways</td>
</tr>
<tr>
<td>9. EGC receiver</td>
<td>—</td>
</tr>
<tr>
<td>10. Direct-printing telegraphy HF receiver for receipt of maritime safety information</td>
<td>—</td>
</tr>
<tr>
<td>12. VHF EPIRB</td>
<td>—</td>
</tr>
<tr>
<td>13. Distress position indicator: ship's radar transponder or ship's of automatic identification system (AIS) transmitter</td>
<td>—</td>
</tr>
<tr>
<td>14. Command public address device</td>
<td>1</td>
</tr>
<tr>
<td>15. Distress position finding device: LSA radar transponder or LSA AIS transmitter</td>
<td>2</td>
</tr>
<tr>
<td>16. LSA two-way VHF radiotelephone apparatus</td>
<td>—</td>
</tr>
<tr>
<td>17. Two-way VHF radiotelephone apparatus for aircraft communication</td>
<td>—</td>
</tr>
<tr>
<td>18. Security alert system</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: see 2.2.2 with number corresponding to footnote number.

2.2.2 When using Table 2.2.1, the following shall be considered:

.1 if a ship is engaged on voyages within sea area A1, in addition to radio equipment mentioned in Table 2.2.1 for this area, it shall be fitted with a second independent distress alerting arrangement: this may be either the second VHF DSC radio installation without special receiver for continuous DSC watch on channel 70, or VHF EPIRB, or MF DSC radio installation (if the ship is engaged on voyages within sea area covered by shore-based MF DSC radio stations), or HF DSC radio installation, or INMARSAT ship earth station, or satellite EPIRB of the COSPAS-SARSAT system. If the ship is engaged on voyages within sea areas A1+2 or A1+2+A3, in addition to radio equipment mentioned in Table 2.2.1 for these sea areas, either additional INMARSAT ship earth station, or satellite EPIRB of the COSPAS-SARSAT system, or HF DSC radio installation (unless installed as a main one specified in Table 2.2.1 for sea areas A1/A2/A3) may be used as a second independent distress alerting arrangement. If the ship is engaged on voyages within sea areas A1+2+A3+A4, a satellite EPIRB of the COSPAS-SARSAT system may be used as a second independent distress alerting arrangement. Where serviceability of equipment on board the ships is provided by redundancy, the second independent distress alerting arrangement may be omitted provided that it is available in the redundant equipment;

.2 combined radio installation or radio installation as a separate device may be used;

.3 continuous listening watch may be used on VHF channel 16;

.4 mentioned equipment is not required if the MF/HF radio installation is available;

.5 where radio telephone station does not provide for transmission and receipt of general radio messages at operating frequencies at 1605 to 4000 kHz, provision shall be made for a separate radio installation or MF/HF radio installation for transmission and receipt of general radio messages by means of radiotelephony or direct-printing telegraphy, or INMARSAT ship earth station;

.6 mentioned equipment is not required if the INMARSAT ship earth station is available;

.7 where MF/HF radio installation does not provide for transmission and reception of general radio messages at operating frequencies of 1605 to 4000 kHz and 4000 to 27500 kHz, provision shall be made for a separate radio installation for transmission and reception of general radio messages by means of radiotelephony or direct-printing telegraphy;
.8 mentioned receiver is mandatory if the ship is engaged on voyages within any area covered by NAVTEX;
.9 mentioned equipment is allowed as part of INMARSAT ship earth station;
.10 the receiver is mandatory if the ship is engaged on voyages within any area covered by INMARSAT geostationary satellites and not covered by NAVTEX;
.11 the mentioned receiver may be installed instead of EGC receiver on ships engaged on voyages exclusively within the area where maritime safety information is broadcast by means of HF direct-printing telegraphy;
.12 one of satellite EPIRBs of COSPAS-SARSAT system shall be of free floating type;
.13 a single EPIRB may be installed if the distress alerting is provided from the usual steering position by means of at least two separate and independent arrangements using different types of communication corresponding to a ship navigation area;
.14 equipment configuration shall comply with requirements in 2.1.1;
.15 VHF EPIRB may be provided instead of EPIRB of COSPAS-SARSAT system on board ships engaged on voyages exclusively within sea areas A1;
.16 ship’s radar transponder or ship’s AIS transmitter may be one of LSA radar transponders or LSA AIS transmitters;
.17 for non-passenger ships of gross tonnage less than 500, two sets of two-way VHF radiotelephone apparatus and one LSA radar transponder or LSA AIS transmitter are sufficient;
.18 where serviceability of equipment is provided by redundancy, the second set of such equipment shall be fitted. All the redundant equipment shall be connected to separate antennas, to main, emergency and standby electric power sources, and be readily available;
.19 depending on sea navigation area, INMARSAT ship earth station may be installed instead of redundant MF radiotelephone;
.20 redundant set of INMARSAT ship earth station is not required if MF/HF radio installation is installed as a redundant arrangement;
.21 for ships engaged on occasional voyages in the sea area A4 and equipped with MF/HF radio installation, the redundant MF/HF radio installation may be replaced with INMARSAT ship earth station;
.22 ship engaged on voyages within sea areas A1+A2 and equipped with INMARSAT ship earth station shall be fitted with receiver for DSC watch at frequency of 2187.5 kHz;
.23 each passenger ship, at the position from which the ship is normally steered, shall be fitted with local two-way radio communication arrangement using aircraft frequencies 121.5 MHz and 123.1 MHz for the purposes of search and rescue operations;
.24 two sets are recommended, one set being man-portable;
.25 to be available on board passenger (including high-speed) ships and cargo (including high-speed) ships of gross tonnage of 500 and above engaged on international voyages;
.26 if the ship’s crew consists of one person — 1 set, if the crew of a passenger ship or a ship carrying dangerous goods consists of 3 or more persons — 3 sets.

2.2.3 Every ship not engaged on international voyages and every ship with gross tonnage less than 300 engaged on international voyages shall be fitted with the following radio equipment:
.1 for inland waterways according to Table 2.2.1;
.2 for voyages within sea area A1:
VHF DSC radio installation;
free floating satellite EPIRB of COSPAS-SARSAT system;
ship’s radar transponder or AIS transmitter;
LSA two-way VHF radiotelephone apparatus, two sets;
command public address device;
.3 ships engaged on voyages within sea areas A1+A2 shall be fitted, in addition to mentioned in 2.2.3.2, with the following radio equipment:
MF or MF/HF DSC radio installation;
NAVTEX receiver. Ships intended for permanent operation outside the coverage area of NAVTEX shall be fitted with EGC receiver or direct-printing telegraphy HF receiver for receipt of maritime safety information if the ship is engaged on voyages exclusively within an area where maritime safety information is broadcast by means of HF direct-printing telegraphy;

when the ship is engaged on voyages within sea areas A1+A2+A3 or A1+A2+A3+A4, the following shall be installed, in addition to radio equipment mentioned in 2.2.3.2:

MF/HF DSC radio installation;

INMARSAT-C ship earth station with EGC receiver and GLONASS/GPS receiver;

NAVTEX receiver with regard to its application as stated in 2.2.3.3.

Radio equipment of ships fitted under this paragraph shall be compliant with requirements of 2.2.2.2, 2.2.2.3, 2.2.2.6, 2.2.2.18 to 2.2.2.20, 2.2.2.26.

2.2.4 Every ship intended for navigation inside the port water area shall be fitted with radio equipment for sea area A1 in accordance with 2.2.3 except for free floating satellite EPIRB of COSPAS-SARSAT system.

2.2.5 Non-self-propelled manned ships intended to be towed/pushed at sea shall be fitted with radio equipment for sea area A1 according to 2.2.3.2 except for command public address device.

2.2.6 For oil tankers, oil skimming vessels, gas carriers and chemical tankers, transmitter power at the carrier frequency shall not exceed 500 W in the antenna. The peak power of transmitter shall not exceed 1000 W.

Portable/man-portable VHF radiotelephone stations on these ships shall have an explosion group stated in Table A2.3 Appendix 2 Part VI of these Rules and comply with requirements of 6.1.32.

2.2.7 In addition to mentioned in 2.1.1, 2.2.1 and 2.2.3, the ships shall be provided with equipment used in alert systems, navigation conditions compliance control systems and navigation safety systems, if such an equipment is mandatory for ships (or group of ships) operated within coverage areas of these systems.

2.2.8 In order to comply with requirements of 2.2.1 and 2.2.3 with respect to distress alerting by at least two separate and independent radio arrangements, refer to Table 2.2.8.

<table>
<thead>
<tr>
<th>Sea areas</th>
<th>Radio equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>VHF DSC radio installation, VHF EPIRB or satellite EPIRB of COSPAS-SARSAT system</td>
</tr>
<tr>
<td>A1+A2</td>
<td>VHF DSC radio installation, MF DSC radio installation, satellite EPIRB of COSPAS-SARSAT system</td>
</tr>
<tr>
<td>A1+A2+A3 (option 1)</td>
<td>VHF DSC radio installation, MF/HF DSC radio installation, INMARSAT ship earth station, satellite EPIRB of COSPAS-SARSAT system</td>
</tr>
<tr>
<td>A1+A2+A3 (option 2)</td>
<td>VHF DSC radio installation, MF/HF DSC radio installation, satellite EPIRB of COSPAS-SARSAT system</td>
</tr>
<tr>
<td>A1+A2+A3+A4</td>
<td>VHF DSC radio installation, MF/HF DSC radio installation, INMARSAT ship earth station, satellite EPIRB of COSPAS-SARSAT system</td>
</tr>
</tbody>
</table>
3 POWER SOURCES

3.1 POWER SOURCES FOR RADIO EQUIPMENT FOR SHIPS OF M, O, P AND J CLASSES

3.1.1 The main power for radio equipment required by the present Part of these Rules shall be provided from ship’s power plant.

3.1.2 Main VHF radiotelephone station, MF/HF radio station and ship earth station of mobile satellite service shall be supplied from ship’s emergency power source, in addition to main power from the ship’s mains.

3.2 POWER SOURCES FOR RADIO EQUIPMENT FOR SHIPS OF M-CII, M-IIP AND O-IIP CLASSES

3.2.1 Radio equipment shall be supplied according to Table 3.2.1.

<table>
<thead>
<tr>
<th>Radio equipment</th>
<th>Power source</th>
<th>Power source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>main</td>
<td>emergency</td>
</tr>
<tr>
<td>1. VHF radio installation:</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>DCS encoding device</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>receiver for DSC watch</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>radiotelephone station</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>2. MF radio installation:</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>DCS encoding device</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>receiver for DSC watch</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>radiotelephone station</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>3. MF/HF radio installation:</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>DCS encoding device</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>receiver for DSC watch</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>telephony and NBDP radio receiver</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>telephony and NBDP radio transmitter</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>increased fidelity direct-printing equipment</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>terminal direct-printing apparatus</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>4. INMARSAT ship earth station</td>
<td>+</td>
<td>+ 1,2</td>
</tr>
<tr>
<td>5. NAVTEX receiver</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6. EGC receiver</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>7. Direct-printing telegraphy HF receiver for receipt of maritime safety information</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>8. Satellite EPIRB of COSPAS-SARSAT system</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>9. VHF EPIRB</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>
### 3.2.2 Standby power sources for radio stations shall not be used for supplying power to other consumers except for emergency lights of radio room.

### 3.2.3 Standby power sources shall provide for concurrent operation of VHF radio installation and, depending on sea areas, for which the ship is equipped, either MF radio installation, or MF/HF radio installation, or INMARSAT ship earth station for at least 1 hour.

Concurrent powering of MF and HF radio installations from standby sources is not required.

For ships engaged on voyages exclusively within port water area, the standby power source shall ensure concurrent operation of radio equipment for at least 1 hour.

### 3.2.4 If data are to be entered continuously from ship navigation or other equipment in order to provide for proper operation of radio installation, provision shall be made for continuous input of such information in case of failure in the main or standby ship electric power source.

Provision shall be made for visual and audible alarm on changeover to standby source in the wheelhouse.

### 3.2.5 For calculation of capacity of standby power source, the averaged discharge current shall be determined as a sum of three values:
.1 0.5 of current consumption in transmission mode;
.2 current consumption in reception mode;
.3 current for powering of additional consumers.

In order to consider possible decrease in capacity of standby power source during its operation, the calculated capacity shall be increased by 40%.

3.2.6 Provision shall be made for automatic charging device for a standby power source. This charging device shall ensure its recharging within max. 10 hours to the required minimum level.

3.2.7 Automatic charging device shall be provided with activation visual alarm.

Provision shall be made for audible and visual alarm in the wheelhouse to indicate when charging voltage or current are beyond the limits specified in technical documentation of storage battery manufacturer for automatic charging conditions. Provision shall be made for only manual acknowledgment and deactivation of audible alarm. The alarm shall be capable of being automatically reset after the normal charging conditions have been restored. Alarm failure shall not interrupt storage battery charging or discharging.

3.2.8 Automatic charging device shall be readily available within at least 5 s after activation or power interruption is restored.

3.2.9 Automatic charging device shall be designed so as to be protected against damage in case of broken or disconnected cables as well as short-circuit of storage battery terminals. Where this protection is provided by electronic means, it shall be capable of being reset after remedy of open circuit or short-circuit fault.

3.2.10 The rated current of charging device shall be determined in the equipment manufacturer's technical documentation as a sum of following values:
.1 0.1 of current consumption in transmission mode;
.2 current consumption in reception mode;
.3 current for powering additional consumers;
.4 rated storage battery charging current.
4 ARRANGEMENT OF RADIO EQUIPMENT AND INSTALLATION OF CABLE NETWORK

4.1 GENERAL REQUIREMENTS

4.1.1 Radio equipment of each radio installation shall:

.1 be so arranged that no harmful interference of mechanical, electrical or other origin affects its proper use;

.2 be so arranged as to ensure electromagnetic compatibility and avoid harmful interaction of radio installation with other equipment and systems;

.3 be arranged so that to ensure safety and operating conditions as established by technical documentation;

.4 be protected against water, temperature variations and other environmental conditions that may affect serviceability of radio installation;

.5 be provided with lighting independent of main and emergency electric power sources and purposed for illuminating radio installation controls;

.6 be spaced so that not to be closer than the distance between radio installation and compass as specified in the manufacturer's technical documentation.

All radio equipment of ships of М-СП, М-ПР, О-ПР, М and О classes, which is mandatory under the present Part of these Rules (including emergency and standby power sources), shall be arranged so that to ensure its serviceability in case of flooding up to the bulkhead deck level.

4.1.2 Provision shall be made for applying Convention-compliant symbols where two-way VHF radiotelephone apparatus and LSA AIS transmitter, each ERIPB or radar transponder are installed, stored and arranged.

4.1.3 Depending on radio equipment components and arrangement of communication on board ships, provision shall be made for special-purpose spaces for radio equipment and its power sources, namely radio room, radio equipment room, power equipment room and battery room.

4.1.4 Radio equipment may be installed in the wheelhouse provided that its operation does not cause change in magnetic compass readings, produce noise with sound pressure level not exceeding 60 dB (A) or impede maintenance of other equipment. In such a case requirements of 4.2.2.1, 4.2.11, 4.2.14.2, 4.2.16, 4.2.17, 4.3.2, 4.3.3, 4.3.5.2 to 4.3.5.7, 4.3.8, 4.3.9 and 4.3.11 shall be complied with.

4.1.5 For arrangement of storage batteries and converters, requirements of 2.8, 8.5 to 8.7 Part VI of these Rules shall be complied with.

4.1.6 Metal or metal-lined bulkheads, ceilings and decks of ship's spaces where radio equipment is installed shall be connected to each other and to the hull and ensure continuity of screening. For non-metal ships, screening lining shall have electrical connection with the rubbing strip or otherwise grounded.

4.1.7 All radio equipment shall be installed so that to be accessible for maintenance and repair. Radio equipment shall be properly secured to prevent displacement at maximum permissible operating heel and trim as well as in case of dramatic shocks and shaking.

4.1.8 For arrangement of radar transponders on board inland navigation ships, refer to requirements of 4.9.2.
4.2 RADIO ROOM

4.2.1 Radio room shall be located in a space adjacent to the wheelhouse (see 1.2.1.25 Part III of these Rules).

4.2.2 Radio room shall be arranged so that:
 .1 to ensure leading out antennas when they are as far as possible from the metal parts of the ship;
 .2 to be as far as possible from devices and spaces with high noise level, heat sources (see 4.2.4).

4.2.3 Radio room shall be located and arranged so that it is not used as a passage to spaces not related to radio equipment or as a cabin for permanent accommodation. Radio operator’s/GMDSS radio officer’s cabin shall be located in a space adjacent to the radio room (see 1.2.1.25 Part III of these Rules).

4.2.4 Bulkheads, ceilings and doors of the radio room shall be provided with acoustic and thermal insulation made of non-combustible materials.

4.2.5 Radio room deck shall be provided with electric insulating covering.

4.2.6 Radio room doors shall be arranged so that to provide a short cut for exit to an open deck. The doors shall be sized and arranged so to provide access for maintenance and repair of radio equipment. The door shall be at least 600 mm wide. Radio room doors leading to the open deck shall be designed to open outwards. The radio room shall be accessible from the interior spaces of the ship.

4.2.7 The radio room shall be provided with heating and air conditioning systems to maintain air temperature within 18 °C to 23 °C. Steam heating is not allowed in the radio room.

4.2.8 The radio room shall be provided with ventilation.

4.2.9 The radio room shall be provided with natural and artificial lighting. Emergency lighting of the radio room shall provide for illumination of at least 50 lx of clock face and front panels of the radio equipment. Luminous lamps are not allowed.

4.2.10 Transit electric cables or wires or transit pipelines are not allowed to be laid through radio room.

4.2.11 Provision shall be made for at least two socket outlets with indication of their purpose in the radio room: one outlet shall be connected to the ship’s main lighting mains, the other to the emergency lighting mains.

4.2.12 The voice two-way communication shall be provided between the radio room and wheelhouse.

4.2.13 Where PABX is provided, provision shall be made for telephones connected to PABX in the radio room and radio operator’s/GMDSS radio officer’s cabin.

4.2.14 The following shall be installed in the radio room:
 .1 radio operator’s/GMDSS radio officer’s desk;
 .2 marine clock with the second hand;
 .3 lamp of general group of calls.

4.2.15 Radio operator’s/GMDSS radio officer’s desk shall be installed so that during operation the operator is faced toward the ship’s bow and to provide for natural lighting of the free desk surface from the front and left side.

4.2.16 The desk top shall be sized so that after radio equipment is fitted, the surface of the desk near the radio operator’s/GMDSS radio officer’s workstation remains free to allow him keeping records by handwriting or keyboard typing. The desk top shall be 750 mm above the deck.

4.2.17 The face of clock installed in the radio room shall be at least 125 mm in diameter with clock hands (hour, minute and second) concentric.

The clock time error per 24 hours under conditions specified in 4.2.7 shall not exceed 30 s.

4.2.18 Clock shall be installed in front of radio operator/GMDSS radio officer when at his workstation.
4.3 ARRANGEMENT OF RADIO EQUIPMENT IN THE RADIO ROOM

4.3.1 Radio equipment and supporting auxiliary equipment shall be arranged in the radio room.

4.3.2 Storage batteries and equipment not related to radio communication are not allowed in the radio room except for those specified in 4.1.5.

4.3.3 No resistors of charging devices, which dissipate more than 500 W during storage battery charging, or resistors with cases heating above 60 °C are allowed in the radio room.

4.3.4 Radio equipment in the radio room shall be arranged so that radio operator/GMDSS radio officer while sitting at his workstation could be able to do the following:
   .1 activate and deactivate radio equipment;
   .2 use receiver and transmitter controls;
   .3 listen to received messages with recording by handwriting or keyboard typing;
   .4 keep transmission using a radiotelephone;
   .5 observe instrument readings and position of radio equipment controls;
   .6 observe clock readings;
   .7 use a voice communication system;
   .8 when radio equipment is controlled from the workstation, its controls shall not be more than 750 mm away from the shoulder of the radio operator/GMDSS radio officer.

4.3.5 When radio equipment is arranged, the following is to be ensured:
   .1 proper illumination of desk free surface near radio operator's workstation and equipment controls;
   .2 as minimum as possible length of antenna radio cables from entries to transmitters or to their matching units, duly confirmed by drawings and calculations;
   .3 possibility to switch antennas;
   .4 as minimum as possible length of cables connecting separate parts of radio equipment, duly confirmed by drawings and calculations;
   .5 possibility for pulling-out frames and opening equipment doors. In any position of frames and doors, distances to each other, bulkheads and near standing equipment shall be at least 30 mm;
   .6 access to output terminals of equipment and groundings;
   .7 safety of people according to requirements of technical documentation for radio equipment.

4.3.6 Remote control consoles as well as starting and control devices of transmitters shall be arranged in accordance with requirements of 4.3.4.8.

4.3.7 Distance between separate radio equipment units as well as between radio equipment and bulkheads shall be at least 30 mm.

4.3.8 Non-combustible gaskets installed between resistors of charging devices and bulkheads shall be at least 20 mm away from bulkheads to ensure free circulation of air.

4.3.9 All passages in the radio room shall be at least 600 mm wide.

4.3.10 Equipment shall be fastened to bulkheads with shackles, brackets or bolts welded to them. Equipment having weight less than 15 kg may be secured directly to the bulkhead plating using wood screws.

4.3.11 Spare parts for radio equipment shall be kept in the radio room and secured at the designated places.

Spare parts lockers may be arranged in the radio equipment room or power equipment room.

4.3.12 In the radio room, provision shall be made for placing a board with instructions on activation of radio equipment so that alert and distress signals could be transmitted on air by untrained personnel.

4.4 RADIO EQUIPMENT ROOM

4.4.1 Radio equipment room (designed for remotely controlled radio equipment) with respect to its layout on board the ship, design,
heating, ventilation as well as main and emergency electric lighting shall comply with requirements imposed on the radio room. Natural lighting is not required in the radio equipment room.

4.4.2 In the radio equipment room, provision shall be made for a table for repair work with drawers for store spare parts, tools, supplies and documentation, as well as chair or arm-chair.

4.4.3 Above the table, provision shall be made for a single wall-mounted lamp and at least two socket outlets with indication of their purpose: one outlet shall be connected to the ship’s main lighting mains, the other to the portable lighting mains.

4.4.4 Radio equipment shall be arranged in the radio equipment room so that to be accessible for inspection, maintenance and dismounting in case of replacement.

4.5 ARRANGEMENT OF RADIO EQUIPMENT IN WHEELHOUSE

4.5.1 Radio equipment installed in accordance with 4.1.3 in the wheelhouse shall be arranged so that to be accessible for inspection, maintenance and dismounting in case of replacement. Where radio equipment is installed, provision shall be made for clock complying with requirements of 4.2.17, 4.2.18 as well as main and emergency electric lighting.

4.5.2 Main controls of VHF radiotelephone shall be arranged so that to be accessible and the operator is faced to the ship’s bow when using them.

4.5.3 In order to comply with the requirements for arrangement of radio equipment, in the wheelhouse of every river – sea navigation ship, in addition to 4.1.4, 4.5.1 and 4.5.2, provision shall be made for a place for control and operation of GMDSS equipment as well as for internal communication during ship navigation – radio workstation or a separate space for radio equipment (see 4.1.3) with remote controls located in the wheelhouse.

4.5.4 The radio workstation mentioned in 4.5.3 shall be arranged in the aft of the wheelhouse to allow officer on watch a full view of the navigation conditions while operating radio equipment.

4.5.5 Where radio workstation mentioned in 4.5.3 is separated from the remaining part of the wheelhouse by a bulkhead, this bulkhead shall be made of glass or be fitted with windows.

4.5.6 There shall be no lockable door between the radio workstation mentioned in 4.5.3 and remaining part of the wheelhouse. To avoid dazzling effect of light sources at night, provision shall be made for a curtain at the radio workstation.

4.5.7 At the radio workstation mentioned in 4.5.3, provision shall be made for a table, a clock in accordance with requirements of 4.2.17, a working chair with deck fixing arrangement, as well as main lighting and lighting from a standby power source.

4.5.8 Controls of radiotelephone channels as well as those for generation and transmission of distress and safety alerts, when the VHF radio installation operates in the DSC and radiotelephone mode, shall be located in the forward part of the wheelhouse.

Provision shall be made for arrangements for radio communication from bridge wings. In order to comply with this requirement, man-portable VHF radio equipment may be used.

4.5.9 For river – sea navigation ship, a stationary two-way VHF radiotelephone apparatus for aircraft communication shall be arranged in the wheelhouse.

4.5.10 In the wheelhouse of the river – sea navigation ship provision shall be made for placing operating instructions on using DSC, as well as instructions on handling radio installations in emergency situations and for using these instructions when handling radio installations. In addition, GMDSS Operating Guidance for Masters of Ships in Distress Situations developed by International Maritime Organization (IMO) and procedures for
cancellation of false distress alerts shall be placed.

4.5.11 For river–sea navigation ship, provision shall be made for MF radio installation, MF/HF radio installation, INMARSAT ship earth station as well as VHF, MF and MF/HF radio installations and INMARSAT ship earth station intended for redundancy in the radio workstation mentioned in 4.5.3.

4.5.12 In the wheelhouse provision shall be made for placing information on call sign, ship station identity and other codes used during operation of radio equipment and for using this information when handling radio installations.

4.5.13 NAVTEX receivers, INMARSAT EGC receivers and HF NBDP receivers for receipt of maritime safety information shall be arranged in the radio workstation mentioned in 4.5.3.

4.5.14 For passenger river–sea navigation ships the following requirements are to be additionally complied with:

1. a distress alert panel shall be fitted in the radio workstation mentioned in 4.5.3. This panel shall contain either a single button, which is pressed to give a distress alert using all radio installations installed on board the ship, or a single button for each radio installation. The panel shall allow for displaying indication that a button/buttons was/were activated. Provision shall be made for arrangements to prevent accidental pressing of button/buttons. Where EPIRB is used as a second distress alerting arrangement and is incapable of being activated remotely, provision shall be made for the additional EPIRB in the radio post;

2. information on ship's position shall be continuously and automatically transmitted to all corresponding radio equipment to be used for initial distress alerting when the button/buttons on the distress alerting panel is/are pressed;

3. distress alert receipt alarm panel shall be fitted in the radio workstation mentioned in 4.5.3. This panel shall be provided with visual and audible distress alert receipt warn-}

ings with indication of a radio service through which these alerts were received.

4.5.15 Radio equipment installed for redundancy on board ships engaged on voyages within sea areas A1+ A2+A3 and A1+A2+A3+A4 is not required to be connected to the distress alerting panel, if this equipment can transmit distress alert and is arranged in the radio post.

4.5.16 A satellite EPIRB intended to be used as a second independent distress alerting arrangement and not capable of being activated remotely shall be arranged in the radio workstation so that to be accessible for distress alerting, be released manually and transferred to any lifeboat or liferaft.

4.6 POWER EQUIPMENT ROOM

4.6.1 Power equipment room where converters for radio equipment are arranged shall be located at the radio room deck level or above in such a place to provide for minimum length of cable routes to the radio room as confirmed by drawings and calculations.

4.6.2 Power equipment room shall be of adequate size for convenient arrangement of equipment. Clear height of the power equipment room shall not be less than 2 m. Deck of the power equipment room shall be covered with electric insulating material.

4.6.3 The power equipment room shall be provided with ventilation, heating and electric heating complying with requirements of 10.12 Part IV and 9 to 10 Part VI of these Rules.

4.6.4 Electric devices in the power equipment room shall be at least 100 mm above the deck subject to requirements of 2.8 Part VI of these Rules.

4.7 BATTERY ROOM

4.7.1 Battery room or cabinet where storage batteries supplying radio equipment are arranged shall be located at the radio room deck level or above in such a place to provide for minimum length of cable routes to the radio room as confirmed by drawings and
calculations. The battery room shall have an exit to the open deck.

4.7.2 Design, lighting, heating and ventilation of battery room as well as arrangement of storage batteries shall comply with requirements of 2.8, 8.5 to 8.7, 10.1 to 10.6 Part VI and 10.12 Part IV of these Rules.

4.8 ARRANGEMENT OF PUBLIC ADDRESS AND BROADCASTING EQUIPMENT

4.8.1 Main microphone station of duplex or simplex public address device shall be installed in the wheelhouse.

4.8.2 Megaphone control devices (one-way public address device for communication with neighbouring ships or shore) shall be installed in the wheelhouse. Megaphone shall be arranged above the wheelhouse where it is capable of turning for acoustic propagation in any direction.

4.8.3 The public address device shall provide communication of the wheelhouse with central control station, main engine local control station, bow and stern anchoring and mooring control stations, steering gear actuator local control station, propulsion motor local control station.

4.8.4 On board passenger ships equipped with public address and broadcasting device in accordance with 2.1.1, 2.2.1 and 2.2.3, there shall be at least three main broadcasting lines:
   1. a deck line designed for connection of loudspeakers installed on open decks;
   2. a service line designed for connection of loudspeakers installed in service and accommodation spaces for the crew (see 1.2.1.26 Part III of these Rules);
   3. a passenger line designed for connection of loudspeakers installed in passenger spaces and in corridors and at platforms adjacent to these spaces.

4.8.5 For passenger ship provision shall be made for public address microphone station to transmit service orders through broadcasting lines, which is installed in the room intended for watchkeeping when in port. If there is no room for watchkeeping, this equipment shall be installed at the embarkation and disembarkation area.

4.8.6 Where main public address microphone station and broadcasting device’s units are structurally integrated, such a device is to be installed in the wheelhouse. For radio broadcasting, a tape recorder and record players installed outside the wheelhouse may be connected to the public address device integral with broadcasting device.

4.8.7 Loudspeakers fitted in accommodation and service spaces shall be provided with volume controls. Plug adapters are not allowed.

4.8.8 A short-circuit in one or more loudspeakers of broadcasting line shall not cause transmission of messages through other broadcasting channels to be interrupted.

4.8.9 A command public address device on board each river–sea navigation ship shall have at least three main broadcasting lines. Each of these lines shall have at least two loops of flame retardant cable, which are separated over the entire length and connected to two separate and independent amplifiers.

4.8.10 Minimum sound pressure level while transmitting emergency messages with the ship underway under normal conditions shall be as follows:
   1. at least 75 dB (A) in interior rooms;
   2. at least 80 dB (A) on open decks.

4.8.11 The command public address device shall be designed to prevent electric and acoustic feedback or other interferences.

4.9 ARRANGEMENT OF EPIRBs, RADAR TRANSPONDERS, AIS TRANSMITTERS, VHF APPARATUSES

4.9.1 A free floating satellite EPIRB and a VHF EPIRB intended to be arranged on board ship shall be fitted on open deck to prevent their displacement under extreme operating conditions and to be capable of floating free if the ship sinks. They shall be
accessible for manual release and distress alerting as well as for transfer to any lifeboat or liferaft.

4.9.2 Radar transponders and ship’s LSA AIS transmitters shall be installed in areas to be capable of being transferred to any lifeboat or liferaft, or there shall be a single radar transponder or AIS transmitter at each lifeboat or liferaft.

For ships having at least two radar transponders or AIS transmitters and equipped with free-fall lifeboats, there shall be one radar transponder or AIS transmitted in such a lifeboat, and the other shall be arranged to be capable of being used on board the ship and transferred to any other lifeboat or liferaft.

4.9.3 A two-way VHF radiotelephone apparatus shall be kept in the wheelhouse or in other space not locked during voyage, if the equipment is capable of being transferred to any other lifeboat or liferaft from this space. The apparatus shall be arranged at the radio post.

4.9.4 The stationary two-way VHF radiotelephone apparatus of a lifeboat shall be arranged according to requirements of Part V of these Rules so that not to impede its performance when the lifeboat is flooded up to upper thwart level.

4.9.5 Where storage batteries are provided as a external electric power source of the stationary two-way VHF radiotelephone apparatus of life-saving appliances, they shall be arranged in lockers complying with requirements of 8.5 Part VI of these Rules and protected to IP68.

4.9.6 Illumination of the front panel of the stationary two-way VHF radiotelephone apparatus of the lifeboat shall be at least 50 lx. Electric lighting of this panel shall be powered from storage batteries mentioned in 4.9.5.

4.9.7 Provision shall be made for charging storage batteries mentioned on 4.9.5 in the lifeboat, as well as from the ship's electric power source. The flexible cable for connection of storage batteries to the charging device from the ship's electric power source shall provide for release of this connection without any tool when emergency lifeboat launching is required.

4.10 CABLE NETWORK INSTALLATION

4.10.1 Installation of radio equipment cable network and measures to protect radio signal reception against interference produced by electric devices shall be performed according to requirements of 2.6, 2.7, 12 Part VI of these Rules as amended by this Chapter.

4.10.2 Power cables laid into radio room for powering radio equipment from the ship's power plant shall not be used for powering loads not related to radio equipment. At the switchboard in the radio room provision shall be made for connection of radio equipment installed in accordance with 2.1.1 for inland navigation ships, and in accordance with 2.2.1 and 2.2.3 for river–sea navigation ships.

4.10.3 In the radio room provision shall be made for a device capable of continuously monitoring of ship's mains voltage.

4.10.4 If there is no radio room on board the ship, the radio equipment switchboard may be installed in the radio room subject to requirements of 4.10.2.

4.10.5 Where cables enter the apparatus, their shieldings shall be connected to the equipment case.

4.10.6 Insulation resistance of any laid cable disconnected from radio equipment at both ends shall be at least 20 MΩ regardless of its length.

4.10.7 All cable network related to radio arrangements and public address and broadcasting equipment shall be made with cables having a continuous shielding.
5 ANTENNA ASSEMBLIES AND GROUNDING

5.1 GENERAL REQUIREMENTS

5.1.1 Antennas of any type suitable for continuous most effective use of radio equipment regardless of ship course may be installed on board ships. Antennas shall be resistant to mechanical and climatic factors under ship operating conditions (see 6 to 13 Appendix 15 to RTSC).

5.1.2 Ship antennas installed on board inland navigation ships shall withstand wind speed of up to 29 m/s and up to 60 m/s for river–sea navigation ships. Ship speed and other factors are not taken into account to this end.

5.1.3 For beam antennas, a flexible strand made of copper or a copper-based alloy shall be used. For calculation of minimum diameter of beam antenna strand required to comply with requirement of 5.1.2, bending deflection shall be taken to be equal to 6% of antenna length between suspension points.

5.1.4 Each antenna beam shall be made of a one piece of an antenna strand. If the antenna design does not allow for making a downlead and beam from a one piece of a strand, they shall be connected by splicing or by means of connections providing for their electrical contact.

5.1.5 To ensure proper performance of the beam antenna, basic load from the downlead shall not be applied directly to the downlead tail area.

5.1.6 Beam antenna downlead near the entry shall be fastened to a stay equipped with insulators and be connected to the entry by means of copper or brass cap. Cap shall be connected to the downlead by soldering or cold press-fitting.

5.1.7 The device intended for suspension of the beam antenna shall be capable of its lowering and hoisting as well as tension control from the deck (superstructure top, wheelhouse top).

5.1.8 When fitting multi-beam antennas, provision shall be made for hoisting and lowering each beam separately. Beams shall be at least 700 mm apart from each other.

5.1.9 Flexible halyards shall be used for hoisting and lowering beam antennas. For ships carrying flammable cargoes the halyards shall be attached in an explosion safe area and be made of non-combustible materials. Steel ropes used for this purpose shall be electrically connected to the hull.

5.1.10 Antenna insulators rated for working voltages fed from radio installation shall be used for insulation of antennas.

5.1.11 Insulation resistance of antennas relative to hull shall be at least 10 MΩ and in case of increased humidity at least 1 M.

5.1.12 Transmitting antennas shall be designed to allow for operation of any connected radio transmitter at maximum emitted power and input voltages.

5.1.13 Receiving and transmitting antennas shall be arranged so that to protect receivers against interference when transmitters are operating with maximum power.

5.1.14 Antenna wires and downleads shall not be less than 1 m from pipes, masts or other metallic parts of the ship. Antennas
shall be installed so that not to be in contact with metallic structures of the ship under any operating conditions. Distance between antenna insulator chains and pipes shall be at least 2 m.

5.1.15 Self-supporting antennas above the superstructure shall be designed to be folded or lowered to the superstructure level.

5.1.16 Beam antennas secured on the folding masts shall be designed not to be lowered before folding the mast and subsequently hoisted after restoring the mast.

5.1.17 For oil tankers and equivalent ships, insulators shall be fitted into steel mast rigging (shrouds, jackstays, ropes for hawser and horn, etc.) so that to be maximum 6 m apart, and the distance between the deck and lower insulator is at least 3 m and not more than 4 m. In order to reduce power losses during operation of radio transmitters, rigging shall be divided by insulators for all ships.

5.1.18 Antennas of broadcasting and television receivers shall be located as far as possible from all service antennas to the extent allowed by the ship design.

5.1.19 In L-type and T-type beam antennas provision shall be made for arrangements to prevent breakage in case of tension, for example, a runner with mechanical safety arrangement in antenna halyards.

Breaking force of the mechanical safety arrangement shall be max. 0.3 of that of the antenna strand. Safety arrangement shall be as such to release antenna tension and prevent its contact with superstructures, rigging and hull.

5.1.20 While radio stations are controlled remotely, provision shall be made for arrangements for automatic grounding of antennas when the equipment is switched off. Antenna grounding device may be controlled remotely from the radio station control console.

5.1.21 Provision shall be made for transmitting and receiving antennas on board each ship equipped with MF/HF radio station, if radio station transmitter and receiver are provided for separate antennas. For folding masts, additional antennas not extending beyond the ship shall be provided.

5.1.22 Provision shall be made for a common antenna for all broadcasting receivers. Radio communication and navigation antennas are not allowed to be used as antennas for broadcasting receivers.

5.1.23 To ensure operation of radio equipment mentioned in Tables 2.1.1, 2.2.1 and 2.2.3, on board each ship provision shall be made for necessary antennas for operation of the following equipment:

- VHF radiotelephone stations;
- VHF receiver for DSC watch;
- MF radiotelephone station;
- MF receiver for DSC watch;
- MF/HF receiver for radiotelephone and telephony and NBDP receiver; and
- INMARSAT ship earth station and EG C receiver antenna;
- INMARSAT ship earth station and EGC receiver antenna;
- MF/HF receiver for DSC watch and telephony and NBDP MF/HF radio receiver;
- NAVTEX receiver and HF NBDP receiver for receipt of maritime safety information.

5.2 ANTENNAS OF INMARSAT SHIP EARTH STATION

5.2.1 Antenna of INMARSAT ship earth station shall:

- be arranged so that to ensure continuous tracking of satellite;
- be arranged in the upper part of the radar antenna mast or at the designated mast;
- be arranged so that to be accessible for maintenance;
- be arranged in a plane other than that of radar antenna.

5.2.2 For directional antennas of INMARSAT ship earth station provision shall be made for exclusion of shadow angles above 6° caused by ship structures within a radius of 10 m from antenna.

For nondirectional antennas provision shall be made for exclusion of shadow angles above
2° caused by ship structures within a radius of 1 m from antenna.

5.2.3 When installing the antenna of INMARSAT ship earth station, the following safe distances to other antennas and magnetic compass shall be provided:
.1 more than 5 m to HF antenna;
.2 more than 4 m to VHF antenna;
.3 more than 3 m to magnetic compass.

5.2.4 Antenna of INMARSAT earth ship station shall be installed to exclude shadow angles degrading radio equipment performance forward and aft of the ship up to –5° and starboard and portside up to –15°.

5.2.5 Where two antennas of INMARSAT earth ship station are installed, they shall be at least 1 m apart in the vertical plane.

5.3 ANTENNA OF VHF RADIOTELEPHONE STATION

5.3.1 Antenna of VHF radiotelephone station shall have a vertical polarization.

5.3.2 Antenna of VHF radiotelephone station shall be arranged as high as possible according to the ship design but not higher than air terminal. This antenna shall ensure unobstructed propagation of electromagnetic field.

5.4 ANTENNA CABLE LEADS AND LAYING INSIDE SPACES

5.4.1 Cables of radio transmitting antennas shall be laid into ship interior spaces through specific leads with insulators rated for operating voltage except for cases when antenna routing inside the space is made with radio frequency cable using radio frequency couplings.

5.4.2 Lead of transmitting antenna shall be designed to provide for its connection and disconnection without any tool.

5.4.3 Leads of transmitting antennas shall be installed in areas providing a short cut for cable laying to radio transmitters inside, to be confirmed by drawings and calculations. Where the lead and antenna connected to it are installed in the area intended for passage of people, they shall have fencing within 1800 mm preventing contact with them. Where lead columns are installed, provision shall be made for condensate drainage from internal cavities of the structure.

5.4.4 In order to avoid power losses, fencing made of electric insulating materials shall be used. Where metallic fences are used, they shall be grounded to the hull.

5.4.5 Radio frequency paths of MF/HF radio transmitters shall be made of radio frequency cable.

If the radio equipment design provides for unshielded cables/conductors from transmitter to antenna (or a switching or matching unit), these cables/conductors located in the radio room or wheelhouse shall be shielded. Cables/conductors located in the screened room other than radio room or wheelhouse are not required to be shielded.

5.4.6 The switching gear of transmitting antenna shall be circuitted and designed so that to prevent electric connection of antenna loop of transmitter with that of receiver or other transmitter.

5.4.7 Cables of receiving and transmitting antennas shall be of radio frequency type and ensure continuity of coverings.

Antenna switching devices, switches, lightning arrestors and other devices connected to these cables shall be of shielded type. Cables shall not cause signal attenuation above 3 dB.

5.4.8 Radio frequency cables of receiving and transmitting antennas shall be lead out to the open deck and connected to antennas by means of a waterproof or tight contact device, which provides for electric connection and access for checking its condition.

5.4.9 For each antenna not intended for continuous operation in working position, provision shall be made for a switching device inside the room allowing the antenna to be set to working, isolate and grounded positions.

5.4.10 Each receiving antenna shall be provided with protection device in order to pro-
tect the receiver input against atmospheric discharges. Where a matching system is used between receiving antenna and radio frequency cable, an atmospheric discharge protection devices shall be connected upstream of matching system input (from the antenna side).

5.4.11 Remote control of antenna switching process shall provide for manual switching of antenna.

5.5 GROUNDING

5.5.1 Working / high frequency grounding intended for operation of radio transmitters installed in the radio room shall be made in the form of a copper bus laid in a short cut from antenna switching device to metal bulkhead or deck electrically connected to the hull, with branches to transmitter grounding clamps. The length of the bus coming from transmitter to bulkhead or deck connection point shall be max. 1500 mm.

5.5.2 Working grounding of receivers installed in the radio room shall be made with a copper bus or flexible bronze/copper strand wit cross section at least 6 mm², laid in a short cut (as confirmed by drawings and calculations) from the receiver to the main grounding bus of transmitters or directly to the metal bulkhead electrically connected to the hull.

5.5.3 Working grounding of radio navigation, public address and broadcasting equipment and other radio equipment outside the radio room shall be made in accordance with requirements of the present Part of the Rules imposed on working grounding of receivers or transmitted installed in the radio room.

5.5.4 For non-metal ships, a common working grounding for the whole radio equipment shall be made in the form of a tinned copper or brass plate with area of at least 0.5 m² and at least 4 mm thick connected to the hull external surface below the lightest draught line.

5.5.5 Metal cases of radio equipment shall be electrically connected to the hull. Grounding wire shall be max. 150 mm long.

5.5.6 Protective grounding of lower ends of mast standing rigging shall be made with a strand of the main rope or by means of flexible metal conductors. Conductors shall have soldered lugs to be fastened to the hull with two screws or by welding. The hull connection areas shall be painted.

5.5.7 Total resistance of all electric connections of any grounding shall not exceed 0.02 Ω.

5.5.8 Grounding devices of radio equipment shall not be used as lightning conductors.
6 REQUIREMENTS TO RADIO EQUIPMENT

6.1 GENERAL REQUIREMENTS

6.1.1 Radio equipment shall be designed for operation in accordance with 6.1.2 and be able to withstand mechanical and climatic tests defined by national standards.

6.1.2 Radio equipment shall remain operable at heel of up to 22.5° and trim of up to 10° (with those heel and trim occurring simultaneously), as well as at roll of up to 22.5° with rolling period of 7 to 9 s and pitch of up to 10° from vertical line.

Radio equipment shall also remain operable when exposed to vibration, humidity and temperatures with parameters and values stated in 2.2.2, 2.2.3 and 2.2.5 Part VI of these Rules.

Radio equipment shall be designed to be connected to the ship's power mains. Radio equipment whose power voltage differs from that of the ship's mains shall be fitted with appropriate devices, which enable its connection to the ship's mains. Radio equipment shall remain operable under ship's power source voltage variations in accordance with 6.1.30.

Protection degree of the equipment shall not be less than stated in Table 2.3.6 Part VI of these Rules depending on its location.

Portable/man-portable radio equipment shall be designed to be resistant when exposed to sea water, oil and solar radiation (see 12, 13, 15 and 16 Appendix 15 RTSC).

6.1.3 The equipment shall be designed so that its main units may be replaced without need in additional calibration or set-up and installed so that to be accessible for inspection, maintenance and repair.

6.1.4 The equipment shall have a protection against overcurrent, overvoltage, and short-term accidental power source reverse polarity.

6.1.5 All current-carrying parts of radio equipment except for antenna leads and grounding conductors shall be accessible after opening only. Then, neither conductor of radio equipment shall be under voltage above 50 V relative to other conductors or to the earth. Capacitors in the high voltage circuits shall be capable of being self-discharged.

6.1.6 Radio equipment shall be circuited and designed to be functionally tested when opened. Provision shall be made for protection against electric shock (see 2.1.11 Part VI of these Rules).

6.1.7 Provision shall be made for clamps for grounding at all cases of radio equipment.

6.1.8 Metal parts on the external side of the radio equipment shall be electrically connected to its case.

6.1.9 Cables shall be connected to radio equipment in such a way as to maintain continuity of shielding. Provision shall be made for securing the cable on the equipment case.

6.1.10 Twist locks, thumbscrew dog or latches, which are capable of being opened or unscrewed without any tool, shall be used for fastening hinged or extended frames, removable panels and doors to the radio equipment case.

6.1.11 To avoid falling out loose hinged or extended frames of radio equipment because

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1 GOST 16019, GOST R IEC 60945.
of ship roll or heel, provision shall be made for bidirectional safety stops.

6.1.12 Controls and indications of any radio equipment shall be located at front panel of the equipment case.

Controls shall be as such to prevent their accidental activation and deactivation and change of settings of radio equipment.

6.1.13 All controls shall provide for setting up of radio equipment. Provision shall be made to prevent access to controls not required during operation (except for those required for control of radio equipment in emergency situations).

The function and operation of radio equipment controls shall be marked with appropriate symbols and/or inscriptions contained in technical documentation for equipment.

6.1.14 The ON, START, SCALE UP, etc. positions of radio equipment controls shall correspond to handles set to the upper position, pushed off or to the right, knobs turned clockwise and upper or right-hand buttons pressed. The OFF, STOP, SCALE DOWN, etc. positions of radio equipment controls shall correspond to handles set to the lower position, pulled or to the left, knobs turned counterclockwise and lower or left-hand buttons pressed.

6.1.15 Graduation of main scales, inscriptions, notations as well as positions of indicators and controls on radio equipment shall be clearly visible at a distance of 700 mm.

6.1.16 Provision shall be made for lighting on equipment itself to enable distinguishing controls and taking indicator readings and to reduce intensity of light emitted by the equipment.

6.1.17 Internal wires as well as structural parts of radio equipment shall be connected to exclude spontaneous disconnection under vibration, roll or heel conditions (see 6, 8 Appendix 15 RTSC).

6.1.18 Internal wiring of radio equipment shall be made with multicoloured wires for designation of different circuits.

6.1.19 There shall be a spare wire in each flexible hose which connects individual parts of radio equipment. In addition, provision shall be made for a spare wire per ten wires in the hose.

6.1.20 Internal components of radio equipment shall be marked consistent with schematic circuit diagram and wiring diagram. Function of output terminals shall be specified on the case of radio equipment; for power circuits, voltage and polarity shall be specified.

6.1.21 Controls of radio equipment shall be protected against mechanical damages should the radio equipment be put with its front panel facing down to the supporting surface.

6.1.22 Fasteners of removable and hinged panels and frames of radio equipment shall be designed as such to be integral with its panels and frames.

6.1.23 Plug-in connections used in radio equipment shall be designed to prevent their improper connection and fitting into wrong sockets.

6.1.24 Voltage between contacts of microphones and head telephone sets shall not exceed 55 V, voltage relative to earth shall not exceed 30 V.

6.1.25 Radio equipment shall be circuited and designed to prevent damages caused by improper action sequence with controls or by reverse polarity of power source.

6.1.26 In radio equipment and remote control consoles provision shall be made for arrangements indicating faults or critical mode in essential circuits of radio equipment as well as on energization and high voltage supply.

6.1.27 Grounding (connection to case) of ship's mains and storage batteries through radio equipment circuit is not allowed.

6.1.28 Insulation resistance of radio equipment power circuits shall comply with requirements of 1 Appendix 5 RTSC).

6.1.29 Temperature of radio equipment cases during operation shall not exceed 60° C.
6.1.30 Radio equipment shall be operable in the event of change in ship’s mains power in accordance with 2.2.1 Part VI of these Rules.

If radio equipment is supplied with power from multiple electric power sources, provision shall be made for switches for automatic changeover from one power source to the other. These arrangements are not required to be included into equipment if they are provided as part of the ship’s power system.

6.1.31 Radio equipment power circuits shall be provided with replaceable fuse links or circuit-breakers. Fuses shall be designed to prevent any contact with their current-carrying parts while replacing fuse links. Time required for access to fuses shall not exceed 5 s.

6.1.32 Only explosion-proof portable/movable VHF radiotelephone stations of a certified safe type not less than “explosion-proof electric equipment” are allowed for operation in explosive spaces and areas on board oil tankers and equivalent ships. Radio stations of the basic type may be operated outside the explosive area.

6.1.33 Visual alarm of radio equipment located in the wheelhouse shall correspond to requirements of 6.1.16 Part VI of these Rules.

6.1.34 Radio equipment intended for distress alerting shall be designed so to prevent unintentional distress alerting.

Controls for radio equipment emergency operation shall be closed with a cover. Switches located on the emergency panel shall be distinctly coloured.

6.1.35 Radio equipment intended for distress alerting shall be as such to provide for preparation and making of distress and safety alert from the ship steering position.

6.1.36 In radio equipment intended for distress alerting, any distress alert shall result in actuation of visual and audible alarms indicating that the radio equipment transmits distress alert signal until its operation is stopped manually.

6.1.37 Radio equipment intended for distress alerting shall include built-in automatic data input arrangements for updating ship position and the date and time of fix.

For equipment having no built-in positioning devices, provision shall be made for a device for interfacing with an external electronic positioning system.

Radio equipment shall have arrangements for manual input of ship position and the date and time of fix.

Provision shall be made for audible and visual alarms, which actuate when no information is received from electronic positioning device or, in case of manual input, when these data were not updated for last 4 hours. Any ship position information not updated for more than 23.5 hours shall be deleted from memory.

Position information in INMARSAT ship earth station not updated more than 24 hours shall be highlighted with colour or otherwise.

6.1.38 In radio installations intended for distress alerting, distress alert shall be given by two independent actions (raising protective cap or cover is considered as the first action, pressing the distress alerting button is considered as the second action) using the only specially designated button isolated from controls used for equipment operation (functional buttons, keyboard keys). This button shall not be used for purposes other than distress alerting.

This button shall be red, marked with DISTRESS inscription and protected against unintentional activation.

If an opaque cover or cap are used to protect the distress alerting button from unintentional activation, it shall also have DISTRESS inscription. Distress alert button shall be closed with spring-loaded cover or cap fastened to equipment (for example, with hinges). The distress alerting shall not require removal of seals or breaking the cover/cap.

Activation of distress alert button shall be accompanied by audible and visual alarm.

The distress alert button shall be held pressed at least for 3 s, while the intermittent audible and visual signals shall start immediately. Within 3 seconds of holding the button, distress alert transmission shall start and in-
termittent audible and visual signals shall turn steady. Provision shall be made for interruption of repeated transmission of distress alert. Such an action shall not interrupt distress alert or distress alert during its transmission but shall prevent its repeated transmission.

6.1.39 In radio installations intended for distress alerting, provision shall be made for audible and visual alarm actuating upon receipt of distress call or urgency call or call having a distress category. The alarm shall be of non-disabled type and be capable of being acknowledged manually.

6.1.40 A minimum safe distance from magnetic compasses for installation of equipment unit shall be specified in operating documentation or on each unit.

6.1.41 All marine VHF, MF and HF transmitters shall be designed for continuous operation for at least 6 hours with duty cycle (total emission duration to total pause duration ratio) of 2:1.

6.1.42 With respect to electromagnetic compatibility, radio equipment shall comply with requirements of 2.7 Part VI of these Rules.

6.1.43 Radio equipment shall be designed to have arrangements for its fixing in place and keep serviceable at heel, trim and roll in accordance with requirements of 6.1.2.

6.2 TECHNICAL REQUIREMENTS TO RADIO COMMUNICATION MEANS

6.2.1 Radio communication means shall receive and transmit safety-related messages and meet the following requirements:

1. activation shall be performed by a single action;
2. starting time of tuned transmitter shall not exceed 5 s;
3. frequency retuning within the same subrange shall be performed within max. 15 s;
4. failure in automatic frequency tuning device shall not exclude manual frequency adjustment;
5. changeover from one type of radiation to the other shall be performed by a single action.

6.2.2 Transmitter remote control console designed to be located outside the radio room shall be provided with controls to enable radio transmission without controls located on the transmitter itself.

6.2.3 Radio communication means shall be designed to detect and remedy faults and to meet the following requirements:

1. internal elements shall be clearly visible with the case opened;
2. internal elements shall be arranged so that to be repaired and replaced;
3. metallic shields as well as covers and doors of shielded assemblies inside the case shall be capable of being opened without tools.

6.2.4 Radio transmitter permissible frequency deviations, RF bandwidth and out-band radiation spectra shall comply with standards approved by decision of the State Commission for Radio Frequencies.

6.2.5 For class H3E and J3E emissions, the upper side band shall be used.

6.2.6 For class J3E emissions, the carrier suppression shall be at least 40 dB less than peak power of transmitter. For class H3E emissions, the full carrier shall be emitted with carrier suppression 6±2 dB less than peak power.

6.2.7 Levels of carrier spurious amplitude and frequency modulation shall comply with requirements of national standards.

6.2.8 In case of class H3E and J3E emissions, unwanted emission power supplied to the transmitting antenna at any discrete frequency during operation of transmitter at the full peak power shall comply with requirements stated in Table 6.2.8.

1 Regulations 17-13, 18-13, 19-13.
2 GOST 12252, GOST 22580, GOST 22579, GOST 26897.
6 Requirements to Radio Equipment

### Table 6.2.8

<table>
<thead>
<tr>
<th>Spacing Δ between unwanted emission frequency and assigned frequency* (kHz)</th>
<th>Minimum attenuation below peak power (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 to 4.5</td>
<td>31</td>
</tr>
<tr>
<td>4.5 to 7.5</td>
<td>38</td>
</tr>
<tr>
<td>over 7.5</td>
<td>43 and unwanted emission power is not to exceed 50 mW</td>
</tr>
</tbody>
</table>

* Assigned frequency in a single-band channel shall be 1400 Hz higher than the carrier.

#### 6.2.9
Acoustic frequency band of transmitters designed for emissions classes H3E and J3E shall be from 350 to 2700 Hz with permissible amplitude variation of max. 6 dB.

#### 6.2.10
Modulation depth of transmitters for emission class H3E shall be at least 80%. Modulation depth caused by foreign voltage sources shall not exceed 5%.

Modulation of transmitters for emissions class J3E shall be so that intermodulation components do not exceed values stipulated by national standards.

#### 6.2.11
All transmitters with rated power above 20 W shall be provided with an indicator allowing for continuous monitoring of antenna current during transmission. Failure in the indicator shall not result in open circuit fault of antenna loop.

#### 6.2.12
The transmitter shall be tuned to any frequency required by the present part of the Rules with the frequency well locked.

#### 6.2.13
Antenna break or short-circuit to case as well as feed of powerful HF signal shall not cause damages degrading the performance of transmitter.

#### 6.2.14
Intermediate frequency shall not cause interference in the secured call and distress international frequency bands.

#### 6.2.15
In this Section, the following classification is adopted for receiver bands by high/intermediate frequency measured at a level of 6 dB:

- **Wide band**: ±3000 Hz
- **Medium band**: ±1500 Hz
- **Narrow band**: ±600 Hz
- **Very narrow band**: ±100 Hz
- **Single-band**: ±350 to ±2700 Hz

#### 6.2.16
Receiver’s LF path band shall be, except for cases specified in technical documentation, at least 300 to 2700 Hz for output voltage irregularity of 6 dB within the band above 1000 Hz.

#### 6.2.17
The receiver power circuits shall be provided with devices to protect against interference produced by ship’s electric equipment.

#### 6.2.18
Input circuits of receivers shall be protected against voltages induced by operating ship transmitters.

#### 6.2.19
Receivers shall be designed so that to connect an RF cable to the antenna clamp with continuity of shielding maintained.

#### 6.2.20
All ship receivers shall be designed for continuous 24-hour operation.

#### 6.2.21
The following shall be included into radiotelephone station:

- .1 transmitter/receiver with antenna;
- .2 integral or remote control console/consoles with microtelephone handset and integral or remote loudspeaker.

#### 6.2.22
Man-portable VHF radiotelephone station with rechargeable power source shall be provided with arrangement for its charging from ship’s mains.

### 6.3 MF/HF RADIO INSTALLATION

#### Ships of M, O, P and J classes

#### 6.3.1
Operating parameters of transmitter shall comply with those stated in Table 6.3.1.

#### 6.3.2
Where radio installation is provided with an integral or a separate automatic radiotelephone alerting device, the latter shall comply with requirements of 6.3.7 to 6.3.12.

#### 6.3.3
The transmitter shall be complete or shall have an integral dummy antenna.

#### 6.3.4
Basic operating parameters of receiver shall comply with those stated in Table 6.3.4.

---

1. GOST 12252, GOST 22580, GOST 22579, GOST 26897.
### Transmitter parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency band (kHz)</td>
<td>1605 to 3800; 4000 to 15000 min.</td>
</tr>
<tr>
<td>Number of frequencies within ranges of 1605 to 3800 and 4000 to 15000 kHz</td>
<td>Discrete grid with 100 Hz pitch</td>
</tr>
<tr>
<td>Emission class</td>
<td>H3E, J3E and J2B</td>
</tr>
<tr>
<td>Standard dummy antenna for determination of rated power within 1605 to 3800 kHz:</td>
<td>capacity (pF) 300, active resistance (Ω) 4</td>
</tr>
<tr>
<td>Standard dummy antenna for determination of rated power within 4000 to 8800 kHz:</td>
<td>active resistance (Ω) 75, Peak power within 1605 to 3800 kHz (W) min 30</td>
</tr>
</tbody>
</table>

**Note:** It shall be possible to reduce peak power.

### Receiver parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency band (kHz) (discrete frequency grid with 100 Hz pitch may be used instead of smooth band)</td>
<td>1605 to 3800; 4000 to 15000 min.</td>
</tr>
<tr>
<td>Emission classes</td>
<td>H3E, J3E and J2B</td>
</tr>
<tr>
<td>Sensitivity (µV)</td>
<td>Not less than 6 µV e.m.f. with signal-to-noise ratio at receiver output is 20 dB</td>
</tr>
<tr>
<td>Selectivity:</td>
<td></td>
</tr>
<tr>
<td>Squaresness ratio at 60 dB / 6 dB for wide band</td>
<td>Max 4</td>
</tr>
<tr>
<td>for medium band</td>
<td>Max 5</td>
</tr>
<tr>
<td>Intermediate frequency and image channel attenuation of signal receipt (dB)</td>
<td>min 60</td>
</tr>
<tr>
<td>Nonlinear distortion factor (%)</td>
<td>Max 10</td>
</tr>
</tbody>
</table>

### 6.3.6 The receiver shall be rated for connection of head telephone sets and loudspeakers with power of at least 0.5 W.

### 6.3.7 Automatic radiotelephone alerting device shall enable the MF/HF radiotelephone to automatically transmit the signals specified in 6.3.8 and 6.3.9.

### 6.3.8 Radiotelephone alert signal given by automatic alerting device shall consist of dual-tone acoustic frequency sine-wave oscillations being transmitted alternatively and continuously within max. 1 min and min. 30 s. Frequency of one tone shall be equal to (2200±33) Hz, frequency of the other tone to (1300±19.5) Hz.

Each tone duration shall be equal to (250±10) ms. Interval between the tones shall be max. 4 ms. Stronger tone to weaker tone amplitude ratio shall be within 1 to 1.2.

### 6.3.9 Automatic transmission of radiotelephone alert signals shall be cyclic with intervals between two subsequent cycles approximately equal to a single cycle. Automatic alerting device shall be capable of transmitting alert signals until disabled.

### 6.3.10 Automatic alerting device shall be started by a single action. Starting duration shall not exceed 5 s.

### 6.3.11 Automatic alerting device shall come complete with instruction on its activation and monitoring.

### 6.3.12 Automatic alerting device shall be designed so that to make its inadvertent activation impossible. Provision shall be made for disabling of automatic alerting device any time to transmit a distress message.

### Ships of M-CII, M-IIP and O-IIP classes

### 6.3.13 Radio installation shall provide for the following categories of alerts using radiotelephony and DSC for:

- .1 distress, urgency and safety alerting;
- .2 transmission of information related to ship operation;
- .3 transmission of other information.
6.3.14 Radio installation shall provide communication when operated in the radio-telephone and NBDP mode for:
   .1 distress, urgency and safety alerting;
   .2 transmission of information related to ship operation;
   .3 transmission of other information.

6.3.15 Where radio installation is intended only for distress alerting, as well as communication in distress and for safety, requirements of 6.3.13.2, 6.3.13.3, 6.3.14.2 and 6.3.14.3 may be omitted.

6.3.16 Radio installation shall comprise the following:
   .1 equipment stated in 6.2.21;
   .2 integral or remote narrow band direct-printing device;
   .3 integral or remote DSC device;
   .4 receiver for continuous DSC watch at frequencies of 2187.5, 8414.5 kHz and at least one of distress and safety frequencies in DSC system: 4207.5, 6312, 12577 or 16804.5 kHz. The receiver shall enable one of these distress and safety frequencies in DSC system to be selected.

6.3.17 The transmitter shall be capable of operating within frequency band of 1.605 to 27.5 MHz. The number of operating frequencies shall not be less than 18: for radio telephony: 2182, 4125, 6215, 8291, 12290 and 16420 kHz; for NBDP: 2174.5, 4177.5, 6268, 8376.5, 12520 and 16695 kHz; for DSC: 2187.5, 4207.5, 6312, 8414.5, 12577 and 16804.5 kHz.

6.3.18 The transmitter shall provide the following emission classes: J3E, H3E and J2B or F1B.

   For transmitters produced after 1 July 2002, emission class H3E is not required.

6.3.19 Radio installation shall be provided with arrangements to automatically prevent overmodulation.

6.3.20 During normal modulation, peak envelope power for emission class J3E or H3E or mean transmitter power for emission class J2B or F1B shall be as follows:
   - at least 60 W for any frequency within the operating band;
   - max. 400 W for MF band;
   - max. 1500 W for HF band.

6.3.21 If mean output power of transmitter exceeds 400 W, when the transmitter is switched to MF frequencies, this power shall be automatically reduced down to 400 W or less.

6.3.22 Radio installation shall be capable of operating at frequencies of 2182 kHz and 2187.5 kHz within one minute after activation.

6.3.23 The receiver shall be capable of discrete tuning within the band of 1.605 to 27.5 MHz. A receiver tuned to fixed frequencies (at least 18) may be used:
   - for radio telephony: 2182, 4125, 6215, 8291, 12290 and 16420 kHz;
   - for NBDP: 2174.5, 4177.5, 6268, 8376.5, 12520 and 16695 kHz;
   - for DSC: 2187.5, 4207.5, 6312, 8414.5, 12577 and 16804.5 kHz.

6.3.24 The receiver shall be capable of receiving upper side band with emission classes J3E, H3E, J2B and F1B.

6.3.25 After warming up, receiver frequency shall remain within ±10 Hz of the tuned/set frequency.

6.3.26 The receiver sensitivity for class J3E and F1B emissions shall not be less than 6 µV when signal-to-noise ratio at receiver output is 20 dB. For NBDP and DSC, error index per character of max. 10^-2 shall be obtained for signal-to-noise ratio of 12 dB.

6.3.27 The receiver shall provide power of at least 2 W to the loudspeaker and at least 1 mW to microphone handset.

6.3.28 Where DSC and NBDP devices are not integral, in radio installation provision shall be made for inputs/outputs for transmission/reception of DSC and NBDP signals.

6.3.29 Adjacent-channel selectivity of the receiver shall be at least 60 dB for interference offset by ±6 kHz.

   Side channel selectivity shall be at least 80 dB.
Intermodulation selectivity relative to 1 µV shall be at least 70 dB.

Nonlinear distortion factor shall not exceed 7%.

6.3.30 Provision shall be made for signal automatic gain control.

6.3.31 DSC shall be capable of decoding and encoding, composing and verifying DSC formats.

6.3.32 If received messages are not immediately printed, storage memory shall be as such to store at least 20 received distress messages in the DSC device memory. The messages shall be stored in the memory until they are read and shall be deleted in 48 h after receiving.

6.3.33 Where a receiver with scanner for continuous watch on multiple DSC distress channels is used, all selected channels shall be scanned within 2 s, and watch time on each channel shall provide for detection of a sequence of dots preceding each DSC. Scanning is stopped only as soon as dots transmitted at 100 Baud are detected.

6.3.34 The narrow band direct-printing device shall be capable of operating in circular and selective call modes on single-frequency distress channels intended for NBDP.

6.3.35 The narrow band direct-printing device shall comprise the following:

1. arrangements for decoding and encoding messages;
2. arrangements for composing and verification of messages to be transmitted;
3. arrangements for recording received messages.

6.3.36 Self-identification data shall be stored in the NBDP device. Provision shall be made for protection against data tampering.

6.3.37 Radio installation shall be capable of being controlled from built-in or remote control console/ consoles.

Where two remote control consoles are provided, a priority shall be given to the console located at the place where the ship is controlled.

6.3.38 The radio installation control system shall be capable of:

1. activation of DSC distress call. DSC distress call activation shall have a priority over any other operations;
2. acknowledgment of received DSC distress call;
3. relaying DSC distress call;
4. switchover to frequencies of 2182 and 2187.5 kHz. These frequencies shall be marked on tuners and controls;
5. autoselect of emission class (J3E/H3E) when switching to frequency of 2182 kHz;
6. autoselect of emission class (J2B/F1B) when switching to distress and safety frequencies of DCS and NBDP devices specified in 6.3.17 and 6.3.23;
7. emission classes shall be switched using not more than one control;
8. provision shall be made for independent tuning of receiver and transmitter frequencies. The tuning process shall not impede usage of transceivers.

6.3.39 Transceiver controls shall operate so as not to cause side and outband emissions.

6.3.40 Provision shall be made for indication of entered and received DSC formats. The data displays shall be sized to fit at least 160 characters in at least two rows.

6.3.41 It shall be possible to test audible and visual alarm.

6.3.42 Provision shall be made for indication of transmission and reception frequencies.

6.3.43 Manually tuned radio installation shall be provided with devices to enable its fine adjustment.

6.3.44 Self-identification data shall be stored in the DSC device memory and shall be displayed for verification purposes. These data shall be unchangeable without special-purpose tool.

6.3.45 Provision shall be made for regular verification of DSC device without emitting signals.
6.3.46 Where radio installation is to be preheated for normal operation, power shall be supplied to preheating circuits when radio installation is de-energized.

Preheating circuit switch shall be properly marked. It shall be protected against accidental deactivation.

Operating temperature shall be reached within 30 min after power on.

6.3.47 Where a delay in power supply to any part of the transmitter after its activation is required, this delay shall actuate automatically.

6.4 VHF RADIO TELEPHONE STATION

6.4.1 VHF radiotelephone station mentioned in 2.1.1 shall be compatible with VHF radio communication system for inland waterborne transport and meet requirements of the national standard1.

6.4.2 VHF radiotelephone station shall be capable of radio communicating within the bands specified in Table 2.1.1 using emission class G3E (F3). Frequency grid pitch shall be equal to 25 kHz.

6.4.3 The main VHF radiotelephone station shall have at least three channels including distress, safety and call channel (300.2 MHz, channel 5). Operating radio station shall be capable of operating at any channels within bands stated in Table 2.1.1 and providing operating modes in accordance with communication arrangement.

6.4.4 Maximum frequency deviation corresponding to 100 % modulation depth shall be as close as possible to ±5 kHz, but shall not in any case exceed ±5 kHz.

6.4.5 Frequency response of transmitter modulator shall have precorrection (rise towards high frequencies) of 6 dB per octave with subsequent backward correction in receiver.

6.4.6 Acoustic frequency band shall not exceed 3000 Hz.

6.4.7 Transmitter's radiated power shall be max. 25 W. It shall be possible to reduce the power down to 1 W. Radiated power of portable/man-portable VHF radiotelephone station shall be max. 2 W.

6.4.8 Mean power of any side radiation caused by modulation products on any channel shall not exceed 10 µW, and mean power of any side radiation at any discrete frequency shall not exceed 2.5 µW.

6.4.9 Receiver sensitivity at signal-to-noise ratio of 12 dB shall be at least 1.0 µV.

6.4.10 Radio station receiver output shall be rated for loudspeaker with power of at least 0.5 W and microtelephone handset (or manipulator). The loudspeaker shall be incorporated into radio station case.

6.4.11 The receiver's high/intermediate frequency band at 6 dB shall ensure reception of a signal with maximum frequency deviation of 5 kHz.

6.4.12 Nonlinear distortion factor of receiver shall be max. 7 %.

6.4.13 Two-signal selectivity of receiver shall be such as the attenuation of signal received ±25 kHz off the resonance frequency shall be at least ±75 dB.

6.4.14 Adjacent and side channel selectivity of the receiver shall be at least 70 dB.

6.4.15 Radio station shall be capable of being switched to the 300.2 MHz channel (channel 5) by a single action.

6.4.16 Switchover from simplex to duplex operation and vice versa shall be automatic with switching to the selected channel.

6.4.17 Channels shall be displayed or indicated according to enumeration established by authorized state executive authority of the Russian Federation.

6.4.18 On the 300.2 MHz (channel 5) channel provision shall be made for minimum power of 50 µW on the loudspeaker, when volume control is set to the zero position.

1 GOST 12252.
6.4.19 VHF radiotelephone station shall have a noise suppressor capable of being disabled and fitted with an adjuster.

6.4.20 VHF radiotelephone station may come complete with arrangements allowing for radio communication directly from bridge wings.

6.4.21 Relative instability of transmitter frequency shall be not worse than 7\( \times 10^{-6} \), for portable/man-portable station not worse than 10\( \times 10^{-6} \).

6.4.22 VHF radiotelephone station shall be designed to be powered from the main and emergency power sources meeting requirements of 3.1.2.

6.4.23 The loudspeaker shall be capable of being disabled automatically during duplex operation/radiation.

6.4.24 Transmitter bandwidth at minus 30 dB at frequency grid pitch of 25 kHz shall be max. 18.8 kHz.

6.4.25 Transmitter side emission shall be max. 2.5 \( \mu \)W.

6.5 PUBLIC ADDRESS AND BROADCASTING DEVICE

6.5.1 Public address device shall provide for duplex or simplex communication of wheelhouse with main control stations (see 4.8.3), as well as allow orders be transmitted to service spaces, passenger compartments and to open decks through broadcasting arrangements of broadcasting device.

6.5.2 At least three lines shall be connected to the public address device.

6.5.3 The public address device shall have the main microphone station in the wheelhouse and microphone stations near public address communication subscribers.

6.5.4 Public address stations within spaces with noise level above 90 dB (A) shall be provided with additional visual alarm.

6.5.5 On board ships of M and O classes, provision shall be made for one-way public address devices for communication with nearby ships and shore. On ships of 300 gross tonnage or less, public address system on the upper deck may be used instead of one-way public address device.

6.5.6 Public address device shall be able to:

.1 broadcasting communication with at least three microphone stations;

.2 broadcasting through at least three broadcasting lines to all accommodation spaces (see 1.2.1.22 Part III of these Rules) and open decks;

.3 broadcasting from radio receiver, tape recorder, record player, as well as from local and remote microphones;

.4 transmission of orders throughout all broadcasting lines, concurrently or separately, from microphone stations of public address system, as well as from local and remote microphones. Broadcasting shall be capable of being disabled automatically when local or remote microphones are enabled from microphone stations of public address system;

.5 monitoring of transmission quality in each broadcasting line;

.6 transmission of orders through broadcasting lines with volume controls of loudspeakers set to minimum or to the OFF position.

6.5.7 In order to transmit orders through broadcasting arrangements, all control operations (activation, switching broadcasting lines, reset of programs and activation of forced broadcasting) shall be performed remotely from microphone stations of the public address device.

6.5.8 Provision shall be made for a visual alarm when broadcasting lines are connected to equipment of the public address microphone post for transmission of orders.

6.6 COMMAND PUBLIC ADDRESS DEVICE

6.6.1 The command public address device shall be capable of interrupting, from the wheelhouse, any signal transmitted from the other microphone station or broadcasting or audio recording.
Provision shall be also made for automatic interruption of broadcasting or audio recording upon activation of ship’s general alarm system.

6.6.2 The command public address device shall be protected against unauthorized use.

6.7 MF RADIO INSTALLATION

6.7.1 MF radio installation required in 2.2.1 and 2.2.3 shall comply with requirements of 6.3.13, 6.3.18, 6.3.19, 6.3.21, 6.3.22, 6.3.24 to 6.3.27, 6.3.29 to 6.3.32, 6.3.37, 6.3.39 to 6.3.47.

6.7.2 MF radio installation required in 2.2.1 shall be capable of radio communicating in the radiotelephone mode for:

.1 distress, urgency and safety alerting;
.2 transmission of information related to ship operation;
.3 transmission of other information.

6.7.3 Where radio installation is intended only for distress alerting and distress and safety communicating, requirements of 6.3.13.2, 6.3.13.3, 6.7.2.2 and 6.7.2.3 do not apply.

6.7.4 Radio installation shall include:

.1 transmitter/receiver with antenna;
.2 integral or remote control console/consoles with microtelephone handset and integral or remote loudspeaker;
.3 integral or remote DSC device;
.4 receiver for continuous watch at frequency of 2187.5 kHz (DSC).

6.7.5 The transmitter shall be capable of operating within the band of 1605 to 4000 kHz. The number of operating frequencies shall not be less than two: 2182 and 2187.5 kHz.

6.7.6 For normal modulation, peak envelope power for class J2B or F1B emissions shall be at least 60 W.

6.7.7 The transmitter shall come complete with a standard dummy antenna: $C = 300 \text{ pF}$, $R = 4 \Omega$.

6.7.8 The transmitter shall be capable of discrete tuning within the band of 1605 to 4000 kHz. The receiver tuned to fixed frequencies (at least two, 2182 and 2187.5 kHz) may be used.

6.7.9 If the DSC device is not integral, provision shall be made for a separate output for digital selective calling signals.

6.7.10 The radio installation control system shall ensure the following:

.1 activation of DSC distress call. DSC distress call shall be activated to provide its priority over other functions of the radio installation control system;
.2 manual relaying DSC distress call;
.3 switchover to frequencies of 2182 and 2187.5 kHz. These frequencies shall be marked on tuners and controls;
.4 autoselect of emission class (J3E/H3E) when switching to frequency of 2182 kHz;
.5 autoselect of emission class (J2B/F1B) when switching to frequency of 2187.5 kHz.

6.7.11 Emission classes shall be switched using no more than one control.

6.7.12 Provision shall be made for independent tuning of receiver and transmitter frequencies. The tuning process shall not impede usage of transceivers.

6.8 VHF RADIO INSTALLATION

6.8.1 VHF radio installation required in 2.2.1 shall be capable of producing the following categories of alerts using radio telephony and NBDP:

.1 distress, urgency and safety alerting;
.2 transmission of information related to ship operation;
.3 transmission of other information.

6.8.2 VHF radio installation required in 2.2.1 shall enable radio communication when operating in the radiotelephone mode for:

.1 distress, urgency and safety alerting;
.2 transmission of information related to ship operation;
.3 transmission of other information.

6.8.3 Radio installation shall include:

.1 transmitter/receiver with antenna;
.2 integral or remote control console/consoles;
.3 microphone with RX/TX push-button switch, which may be combined with a telephone in the telephone handset;
.4 integrated or remote loudspeaker;
.5 integrated or separate DSC device;
.6 DSC watch receiver capable of continuous watching on channel 70.

Additional receivers may be fitted in the radio installation.

6.8.4 The DSC device shall be capable of operating on channel 70 and shall consist of:
arrangements for decoding and encoding DSC messages;
arrangements for composing DSC message;
arrangements for verification of prepared message prior to transmission;
arrangements for displaying data in the received call.

The DSC device shall meet the following requirements:
.1 if received messages are not immediately printed, storage memory shall be as such to store at least 20 received distress messages in the DSC device memory. The messages shall be stored in the memory until they are read and shall be deleted in 48 h after receiving;
.2 DSC distress call activation shall have a priority over any other operations;
.3 Self-identification data shall be stored in the DSC device memory and shall be displayed for verification purposes. These data shall be unchangeable without special-purpose tool;
.4 provision shall be made for periodical verifying the DSC device without emitting signals;
.5 with modulated DSC signal of 1 µV at input of receiver connected to DSC device, the DSC device shall decode the message with maximum permissible error index of $10^{-2}$ (at output).

6.8.5 Radiotelephone station included into VHF radio installation shall meet the following requirements:
.1 radio station shall be designed for operation at maritime mobile service frequencies within band of 156 to 174 MHz using class G3E (radiotelephone channels) and G2B (DSC channel 70) emissions. Frequency spacing shall be equal to 25 kHz;
.2 radio station shall operate:
within band of 156.3 to 156.875 MHz on simplex channels;
within band of 156.025 to 157.425 MHz for transmission and within band of 160.625 to 162.025 MHz for reception on duplex channels;
.3 radio station shall have at least five channels including channel 70 (156.525 MHz), channel 6 (156.3 MHz), channel 13 (156.65 MHz), channel 16 (156.8 MHz);
.4 maximum frequency deviation corresponding to modulation depth of 100% shall not exceed ±5 kHz;
.5 frequency modulation shall have a pre-correction of 6 dB per octave with subsequent backward correction in receiver;
.6 acoustic frequency band shall not exceed 3000 Hz;
.7 radio station shall send signals to antenna with vertical polarization. Radiations shall be nondirectional in the horizontal plane;
.8 the rated power of transmitter shall be min. 6 W and max. 25 W. The transmitter shall have a device for reducing power from 1 to 0.1 W except for channel 70 (156.525 MHz);
.9 the mean power of any side emission caused by modulation products in any other channel of the International maritime mobile service shall not exceed 10 µW while mean power of any other side emission at any discrete frequency within the band of International maritime mobile service shall not exceed 2.5 µW;
.10 sensitivity of receiver at signal-to-noise ratio of 20 dB shall be at least 2 µV;
.11 radio station receiver output shall be rated for loudspeaker with power of at least 0.5 W and microtelephone handset. Provision shall be made for disabling loudspeaker without affecting output acoustic power of handset;
12 the loudspeaker shall be disabled automatically during duplex operation/emission. Provision shall be made to prevent electric and acoustic feedback in the handset;

13 switchover from one channel to another shall be made within 5 s. Switchover from transmission to reception and vice versa shall not exceed 0.3 s;

14 receiver shall be provided with a manual volume control, which allows for varying output power;

15 on channel 16 (156.8 MHz), provision shall be made for a device providing a minimum power of 59 mW on loudspeaker when volume control is set to zero;

16 provision shall be made for a noise suppressor capable of being disabled on the front panel of radio station;

17 provision shall be made for a two-position switch to enable the whole VHF radio installation with visual indication on its activation;

18 provision shall be made for a visual indication on carrier frequency transmission;

19 radio station shall be able to display the number of channel, which it is tuned to. Information on the channel number shall be visible in all lighting conditions. Control console shall have channel 16 indicated;

20 radio station may come complete with arrangements allowing for radio communication directly from bridge wings;

21 radio station shall not emit signals when channels are being switched over;

22 the TC/RX control shall be operated so as not to cause any side or outband emissions;

23 provision shall be made for devices allowing for changeover to reception mode from transmission mode using RX/TX switch. Devices with no manual control may be provided for operating on duplex channels;

24 the receiver's high/intermediate frequency band at 6 dB shall provide for reception of a signal with maximum frequency deviation of ±5 kHz;

25 receiver's nonlinear distortion factor shall be max. 7 %;

26 adjacent channel selectivity shall be at least 75 dB;

27 intermodulation selectivity shall be at least 70 dB;

28 where there is no scanning mode, provision shall be made for a device for switching the radio station back to channel 16 (156.8 MHz) when microtelephone handset is fitted to its standard place;

29 switchover from simplex to duplex operation and vice versa shall be automatic when appropriate channels are transited to;

30 receiver's output power shall be suppressed in the transmission mode during simplex operation;

31 radiotelephone station provided with multichannel watch/scanning device shall meet the following requirements:

  provision shall be made for a two-channel monitoring with automatic scanning priority and additional channels;

  where selection of priority channel is not provided, channel 16 (156.8 MHz) shall be considered as priority channel;

  numbers of both scanned channels shall be marked;

  transmission shall not be possible in the scanning mode;

  upon deactivation of scanning device, transmitter and receiver shall automatically switchover to the selected additional channel;

  provision shall be made for a manual switchover to the priority channel with one control only.

  Scanning characteristics shall meet the following requirements:

  priority channel shall be scanned with the rate of at least once every two seconds;

  if the signal is received on a priority channel, receiver shall remain on this channel during the whole length of the signal;

  if the signal is received on an additional channel, the priority channel shall continue to be scanned so that receipt on an additional channel is not interrupted for more than 150 ms;

  if the signal fails to be received on a priority channel and the signal is received on an
additional channel, the time of stay on an additional channel shall be at least 850 ms; provision shall be made for indication of a channel where the signal is received.

6.9 ENHANCED GROUP CALLING RECEIVER

6.9.1 Enhanced group calling (EGC) receiver shall provide for continuous receipt of the following message types:
- messages to all ships;
- messages via INMARSAT system;
- messages to a group of ships;
- individual messages;
- geographically addressed messages.

6.9.2 The EGC receiver shall be provided with arrangements for a fixed tuning to any of 20 reception channels with numbers stored in the EGC receiver memory. Four channels out of them are assigned permanently:

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>Channel number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1537.10</td>
<td>10840</td>
</tr>
<tr>
<td>1537.70</td>
<td>11080</td>
</tr>
<tr>
<td>1537.72</td>
<td>11088</td>
</tr>
<tr>
<td>1541.45</td>
<td>12580</td>
</tr>
</tbody>
</table>

6.9.3 Sensitivity of EGC receiver shall be at least 23.0 dB/kW.

6.9.4 The equipment shall be capable of printing the received information. The received EGC messages shall be stored in memory, with indication that the message has been received, for subsequent printing, except for messages mentioned in 6.9.8 and 6.9.11 to be printed immediately after receipt.

6.9.5 The EGC receiver shall be designed as a single unit or be combined with other devices. Components of other devices such as antenna, low-noise amplifier and ship earth station frequency converter may be used as a component of the receiver.

6.9.6 The EGC receiver shall be provided with arrangement for manual input of the following:
- ship position data, NAVAREA code (where the ship navigates) for receipt of area group calls;
- individual identifier (ID) and group identifier (ENID);
- automatic input of ship coordinates from navigation equipment and their automatic conversion into geographic area may be provided.

6.9.7 The EGC receiver shall have a separately supplied memory device to store data on selected types of received messages, ship coordinates, NAVAREAs, geographic areas and receiver identifier within at least 6 months.

6.9.8 The EGC receiver shall be provided with audible and visual alarm on receipt of distress and urgency category messages. Provision shall be made for an adequate visibility of the received message indication from the ship steering position. The audible alarm shall be designed to be of non-disabled type. Upon actuation, the alarm shall be capable of being reset to the monitoring status manually from received message displaying and/or printing position.

6.9.9 The EGC receiver shall be provided with indication on incorrect tuning to the EGC carrier frequency or on lack of synchronization.

6.9.10 Received messages shall be printed out regardless of errors during reception. The printer shall print a low line mark if a character is received corrupted.

6.9.11 The operator shall have control over printing or non-printing of service groups, except for codes of the following messages, which shall be always printed upon reception by the EGC receiver:
- navigational and meteorological warnings and forecasts;
- information on search and rescue of ships in distress;
- shore-to-ship distress alerts sent by shore-based radio stations to a definite or indefinite geographic area where the ship is voyaging.

6.9.12 The equipment shall not print the message repeatedly if this message was received without errors.
6.9.13 The printer shall be capable of reproducing all characters of the International Telegraph Code (ITC-5), printing at least 40 characters in a row, and hyphenating automatically when a word can not fully fit into a current row. Upon completion of printout, line feed shall be made five times.

6.9.14 Switchover between different ship’s power sources to the EGC receiver or any power supply interruption within 60 s shall not require repeated manual setting the equipment to the operating mode or lead to loss of received messages stored in memory.

6.9.15 In addition to requirements stated in the present part of these Rules, the EGC receiver shall meet technical requirements of the International Mobile Satellite Organization and be type approved by INMARSAT.

6.9.16 Provisions shall be made to exclude antenna shadow angles degrading EGC receiver performance forward and aft of the ship up to –5° and starboard and portside up to –15° in the horizon plane.

For nondirectional antennas, provisions shall be made for exclusion of shadow angles above 2° in the horizontal plane caused by ship structures within a radius of 1 m from antenna.

6.9.17 Where a stabilized directional antenna is used, provisions shall be made to exclude shadow angles in accordance with 5.2.2 and 6.9.16.

6.10 NAVTEX RECEIVER

6.10.1 NAVTEX receiver shall comprise two radio receivers, signal processing unit and one of the following devices:

1. built-in printer;
2. displaying unit with connector for interfacing with the printer and non-volatile memory for received messages;
3. non-volatile memory for received messages connected to other navigation systems.

6.10.2 NAVTEX receiver shall receive information on service areas and types of messages excluded from reception by operator and/or a data displaying unit shall be readily available at all times.

6.10.3 The equipment shall come complete with one receiver operating at 518 kHz of the NAVTEX International Service and the second receiver capable of operating concurrently with the first one at least at two other NAVTEX frequencies. The receiver operating at 518 kHz shall have priority in respect of output of the received information to displaying unit or printer. The printing or displaying messages received by one of receivers shall not impede the progress of information reception by both receivers.

6.10.4 Sensitivity of the receiver shall be so that error index per character shall be lower than 4 % for a source with electromotive force of 2 µV and active resistance of 50 Ω.

6.10.5 Each NAVTEX receiver shall have a non-volatile memory to store at least 200 messages of 500 characters each in average (printed and non-printed). Provision shall be made to preclude from deletion of any saved message. When the memory is full, provision shall be made for automatic deletion of the oldest messages to record the new messages.

6.10.6 For NAVTEX receiver provision shall be made for saving of marked messages in the non-volatile memory. These messages shall take up max. 25 % of the non-volatile memory and shall not be overwritten by new messages. Provision shall be made for removing a permanent storage mark from the messages, which may be then subsequently overwritten by newly received messages as the memory is getting full.

6.10.7 NAVTEX receiver shall be capable of storing of at least 200 identifiers of messages for each receiver.

Upon expiry of the storage period between 60° and 72nd hours, message identifier shall be automatically erased from the memory. If the number of received messages exceeds the equipment memory, the earliest identifiers of received messages shall be deleted automatically.

NAVTEX receiver shall store only identifiers of messages, which were received cor-
The messages with error index per character lower than 4 % are considered as received correctly.

6.10.8 Information on service areas and types of messages stored in memory of equipment shall be kept within 6 hours after power breakdown.

6.10.9 For receipt of search and rescue messages, alarm in the normal ship steering position shall actuate. This alarm shall be reset only manually.

6.10.10 The displaying unit and/or printer shall be capable of displaying and/or printing of at least 32 characters in a row.

6.10.11 Where the displaying unit is provided in NAVTEX receiver, it shall meet the following requirements:

1 indication of new received messages shall be displayed until acknowledged or within 24 hours after receipt;
2 text of the new received messages shall be displayed;
3 the displaying unit shall be capable of displaying of at least 16 rows of text;
4 the displaying unit’s readings shall be readable from the distance as stated in 6.1.15;
5 where there is no printer, the displaying unit shall be arranged at the ship steering position.

6.10.12 If automatic line feed entails division of a word, this shall be indicated in the displayed/printed text.

6.10.13 While displaying received messages by means of the displaying unit, provision shall be made for automatic display of message end with a line-feed character added automatically or any other way of delineation. Upon printing the received message, the printer or a unit interfaced with it shall automatically insert line-feed characters.

6.10.14 Equipment of NAVTEX receiver shall be capable of displaying/printing asterisk if the character is received corrupted.

6.10.15 If the printer is not integral, provision shall be made for selection of the following information to be printed:

1 all messages as they are received;
2 all messages stored in the non-volatile memory;
3 all messages received at definite frequencies, areas or having definite codes;
4 all messages displayed on a displaying unit;
5 messages selected from those appearing on the display.

The NAVTEX receiver shall be provided with an interfacing unit for connection with the printer.

6.10.16 The equipment shall be fitted with performance test arrangements for radio receiver, data displaying unit, printer and non-volatile storage memory.

6.10.17 NAVTEX receiver shall come complete with interfacing unit for interfacing with other radio and navigation equipment and transmission of received data to this equipment.

6.10.18 All interfaces with other navigation and radio equipment shall comply with national standards.

6.11 HF NBDP RECEIVER FOR RECEPTION OF MARITIME SAFETY INFORMATION

6.11.1 HF NBDP receiver for reception of maritime safety information (the receiver, here below in the chapter) shall comprise a radio receiver, signal processing unit, printer and automatic and manual frequency tuning controls.

6.11.2 The receiver shall be capable of operating at frequencies of 4210, 6314, 8416.5, 12579, 16806.5, 19680.5, 22376, 26100.5 kHz. The receiver may be operated at additional frequencies provided for international and national NAVTEX services (518, 490 and 4209.5 kHz).

6.11.3 Provision shall be made for performance testing of receiver, signal processing

unit, printer and arrangements for automatic frequency retuning if the latter are provided in the receiver.

6.11.4 The equipment shall be capable of storing at least 255 message identifiers. Upon expiry of the storage period between 60th and 72nd hours, message identifier shall be automatically erased from the memory. If a number of received messages exceeds the memory size, the earliest message identifiers shall be deleted automatically.

6.11.5 Provision shall be made for audible and visual alarm at the steering position for displaying search and rescue messages. This alarm shall be deactivated only manually.

6.11.6 Information on service areas and types of messages stored in memory of equipment shall be kept within 6 hours after power breakdown.

6.11.7 Sensitivity of the receiver shall be so that error index per character does not exceed $10^{-2}$ for a source with electromotive force of 6 $\mu$V.

6.11.8 Provision shall be made for monitoring over printing or non-printing service groups of messages, navigational and meteorological warnings, search and rescue information and individual specific warnings, which are transmitted by a shore-based radio station in the ship navigation area.

6.11.9 Provision shall be made for receipt of information on service areas and types of messages excluded from reception.

6.11.10 Only identifiers of correctly received messages shall be stored in the receiver. The message is considered as received correctly if the error index per character is lower than 4 %.

6.11.11 Printer shall be capable of printing of at least 32 characters in a row.

6.11.12 Signal processing device and printer shall provide for line feed if this word can not be fully fitted within a row.

The printer shall automatically perform line feed upon completion of message printing.

6.11.13 The equipment shall print an asterisk if the character is received corrupted.

6.11.14 If the equipment includes arrangements for automatic frequency retuning, provision shall be made for a universal coordinated time clock with accuracy of $\pm 1$ s to be connected to the reprogrammable storage memory containing a frequency sequence and transmission schedules for all radio stations engaged in transmission of maritime safety information to HF receiver by means of NBDP.

6.12 INMARSAT SHIP EARTH STATION

6.12.1 The ship earth station shall receive and transmit data for:

1. distress, urgency, safety and general alerting;
2. coordination of actions during search and rescue operations;
3. transmission of information on navigation safety.

6.12.2 The ship earth station shall not have external controls, which may allow for changing its identification number.

6.12.3 Provision shall be made to give a distress alert in the telephony mode or in the data transmission mode from the ship steering position and from any position provided by the ship design for purposes of distress alerting. In addition to that, where a specific room for radio communication is provided, arrangements for distress alerting shall be provided in that room. Distress alerting arrangements shall comply with 6.1.38.

Unless other distress, urgency and safety alert receivers or signal relaying arrangements are provided and the existing level of telephone or printer signals is not adequate for receipt of such messages, the ship earth station shall be capable of giving of audible and visual alarm.

6.12.4 The changeover between ship’s power sources or any power supply interruption within 60 s shall not require manual resetting of the ship earth station to the operating mode or result in deletion of received messages from the ship earth station memory.
6.12.5 If the ship earth station includes the enhanced group calling device, its specifications shall meet the requirements to the enhanced group calling equipment (6.9).

6.12.6 The ship earth station shall have a self-test system and provide for automatic activation of audible and/or visual alarm in case of:
- loss of antenna tracking to satellite;
- malfunction of radio station;
- no power supply or activation of a standby source.

6.12.7 The ship earth station shall be capable of testing the distress alerting function without actually transmitting the alerts.

6.12.8 In addition to requirements mentioned in the present part of these Rules, the ship earth station shall meet technical requirements of INMARSAT and be type approved by INMARSAT.

6.13 GENERAL REQUIREMENTS TO EPIRBs

6.13.1 In addition to requirements of 6.1, VHF EPIRBs and satellite EPIRBs of COSPAS-SARSAT system shall meet the requirements of the present Section.

6.13.2 EPIRB shall be capable of being activated automatically after free floating.

6.13.3 EPIRB shall:
- be capable of being activated by an untrained person and have a weight of max. 20 kg;
- be fitted with arrangements preventing its accidental activation;
- be designed so that its electric parts are of waterproof type to the depth of 10 m for at least 5 minutes;
- be able to withstand temperature changes up to 45° C when immersed. The EPIRB shall remain serviceable when exposed to water, condensation or moisture;
- be capable of being activated and deactivated manually;
- be fitted with arrangements indicating the signals emission;
- be capable of floating in vertical position and have a positive stability;
- be able to withstand drop in water from height of 20 m without sustaining any damage;
- be yellow/orange and have a reflective surface coating or stripes;
- be provided with a buoyant line suitable for use as a towing hawser, which shall be stowed to exclude its entanglement during free floating of EPIRB;
- be provided with a lamp with luminosity of 0.75 Cd capable of being automatically switched on in the dark for a short period to indicate the EPIRB position;
- be designed to be resistant when exposed to sea water, oil and solar radiation (see 12, 13, 15 and 16 Appendix 15 RTSC).

6.13.4 The EPIRB shall be designed to be serviceable under the following ambient conditions:
- temperature of –20 to +55° C;
- icing;
- relative wind speed up to 50 m/s;
- after storage at temperature of –30 to +70° C.

6.13.5 EPIRB shall be capable of being manually activated locally. Provision shall be made for a remote activation from the wheelhouse when the EPIRB is installed in the float-free mounting.

6.13.6 The EPIRB shall be externally marked with the following:
- manufacturer data;
- radio equipment number or codename assigned for type approval testing;
- serial number of radio equipment;
- year of manufacturer;
- kind of current and voltage of power supply;
- brief operating instructions in English and Russian;
- expiry date of storage battery shelf life;
- identification number (for satellite EPIRB of COSPAS-SARSAT system);
- safe distance from magnetic compass;
- date of the next due shore-based maintenance.
6.13.7 EPIRB shall be designed to be serviceable within at least one year without maintenance.

6.13.8 The shelf life of the storage battery used as an EPIRB power source shall be at least two years. The storage battery is subject to replacement if at the time of survey of the ship radio equipment its remaining shelf life is less than 12 months. The storage battery shall be marked with date of manufacture and maximum shelf life.

6.13.9 In order to test the performance of EPIRB with dummy antenna, provision may be made for connection of external power source.

6.13.10 EPIRB shall be designed to be released and floating free when submerged to a depth of 4 m or more at any heel or trim angle.

6.13.11 The satellite EPIRB shall not be automatically activated after it has been manually removed from the release gear.

6.13.12 If the satellite EPIRB is to be activated manually, distress alerting shall be performed by two independent actions (see 6.1.38) using a dedicated switch only.

Such a distress alerting switch shall be duly marked and protected against its unauthorized activation.

6.13.13 Satellite EPIRB shall be tested and have a document certifying that its serviceability has been tested following a procedure established by an authorized state executive authority of the Russian Federation.

6.14 Satellite EPIRB of COSPAS-SARSAT System

6.14.1 Satellite EPIRB shall transmit a distress alert to near-polar orbiting satellites and homing signals by means of integral beacon.

6.14.2 Provision shall be made for testing of EPIRB without using the satellite system.

6.14.3 The power source shall have a capacity sufficient for operation of the satellite EPIRB for at least 48 hours.

6.14.4 Distress alert signal shall be transmitted by the satellite EPIRB at an assigned band frequency of 406 MHz.

6.14.5 The satellite EPIRB shall have non-volatile memory to store the invariable part of a distress message.

6.14.6 Six figures of the ship station identifier shall form part of all EPIRB messages.

6.14.7 The satellite EPIRB shall have a frequency of 121.5 MHz for homing.

6.14.8 The type of satellite EPIRB of COSPAS-SARSAT system shall be approved by COSPAS-SARSAT.

6.15 VHF EPIRB

6.15.1 VHF EPIRB shall transmit a distress alert. VHF EPIRB and radar transponder operating at frequency of 9 GHz may be structurally combined in a single unit. Radar transponder shall comply with requirements to LSA radar transponders (see 6.16).

6.15.2 VHF EPIRB shall be of automatic free floating type and capable of being tested on board with no distress alert actually emitted.

6.15.3 The power source shall have a capacity sufficient for operation of VHF EPIRB for at least 48 hours.

6.15.4 VHF EPIRB shall meet the following requirements:

1. distress alert signals in DSC system shall be transmitted at a frequency of 156.525 MHz using a class G2B emission;

2. relative frequency stability shall not exceed \(10^{-6}\);

3. bandwidth shall be at least 16 kHz;

4. output power shall be at least 100 mW;

5. for transmission and reception, antenna with horizontal and circular polarization shall be used;

6. frequency modulation with preemphasis of 6 dB per octave (phase modulation) with subcarrier frequency modulation shall be used;
.7 a subcarrier frequency of 1700 Hz with modulation frequencies of 1300 and 2100 Hz shall be used;
.8 deviation of frequency of 1300 and 2100 Hz shall be within ±10 Hz;
.9 modulation rate shall be 1200 Baud;
.10 modulation index shall be (2.0±10)%.

6.15.5 DSC format and sequence of message transmission shall comply with Radio Regulations (see 1.2.1.26).

6.16 SHIP’S AND LIFE-SAVING APPLIANCE’S RADAR TRANSPONDER

6.16.1 Radar transponder shall enable positioning of the ship in distress by transmitting signals displayed at radar screen as a series of equally spaced points.

6.16.2 Radar transponder shall comply with requirements of 6.13.3.1 to 6.13.3.4, 6.13.3.8 to 6.13.3.10, 6.13.3.12 as well as:
.1 be fitted with audible and visual arrangements for performance testing and arrangements to warn the personnel in distress that the radar transponder is being activated by radar;
.2 be capable of being activated and deactivated manually. Provision may be made for its automatic activation. Where the test using radar at frequency of 9 GHz is performed on board the ship, operation of the radar transponder shall be restricted to a few seconds to avoid interference with other shipborne or airborne radars and to avoid energy consumption of power sources;
.3 have a readiness mode indication;
.4 have a positive buoyancy unless it is incorporated into a floating life-saving appliance;
.5 have an external surface safe for the floating life-saving appliance.

6.16.3 Radar transponder shall be designed to remain serviceable at temperature of –20 to +55° C. It shall remain serviceable after storage at temperature of –30 to +65° C.

6.16.4 The transponder antenna shall be installed so that to be at least 1 m above the water level. In order to comply with this requirement, a pole or other similar device shall be kept in the lifeboat or life raft pocket, as well as illustrated installation instructions for radar transponder.

6.16.5 For transmission and reception, antenna with horizontal polarization shall be used.

6.16.6 Radar transponder shall receive and transmit signals at a distance of at least 5 nautical miles (9.26 km) when interrogated by radar with antenna mounted at a height of 15 m. The radar transponder shall also receive and transmit signals at a distance of at least 30 nautical miles when interrogated by an airborne radar with pulse power of at least 10 kW installed on board an aircraft flying at a height of 1000 m.

6.16.7 The radar transponder shall be marked as provided in 6.13.6 (except for 6.13.6.5) with regard to 6.13.8, as well as with name and call sign of the ship.

6.17 FREE FLOATING EMERGENCY RADIO EQUIPMENT RELEASE AND ACTIVATION ARRANGEMENTS

6.17.1 Free floating emergency radio equipment release and activation arrangements shall enable automatic release from the ship in distress and automatic activation.

6.17.2 Free floating emergency radio equipment release and activation arrangement shall:
.1 be capable of actuating the release mechanism at a depth of 4 m or more at any heel and trim of the ship;
.2 remain serviceable at temperatures from –30 to +65° C;
.3 be made of corrosion-resistant materials compatible with each other in terms of contact corrosion to prevent from damage or malfunction of the radio equipment mounted in. Galvanizing or other forms of metallic coating on parts of the release unit is not permitted;
.4 be designed to prevent release of the radio equipment when seas wash over the unit;
.5 be designed to be resistant when exposed to sea water, oil and solar radiation (see
12, 13, 15 and 16 Appendix 15 RTSC) and shall not be exposed to the above media at its location on board the ship;

.6 remain operable when exposed to shocks and vibrations with parameters stipulated in 2.2.5 Part VI of these Rules;

.7 where the ship navigates within areas of possible icing, be designed to prevent from ice formation in such a way that can prevent radio equipment release;

.8 be arranged so that to make impossible entrapment of the emergency radio equipment by structures of the ship in distress;

.9 have instructions on the hull on manual release of the radio equipment.

6.17.3 For radio equipment, which requires an external power source and/or data input source, the connection shall so designed to enable free release and activation of radio equipment.

6.17.4 Provision shall be made for service-ability tests of free floating emergency radio equipment release and activation arrangements without radio equipment activation.

6.17.5 Provision shall be made for manual release of free floating emergency radio equipment from the release gear.

6.17.6 Free floating emergency radio equipment release and activation device shall be externally marked with the due date of the next inspection or replacement.

6.18 TWO-WAY VHF RADIOTELEPHONE APPARATUS OF LIFE-SAVING APPLIANCES

6.18.1 Two-way VHF radiotelephone apparatus (hereinafter, the apparatus) is purposed for on-scene communication between floating life-saving appliances, between floating life-saving appliances and ship, as well as between floating life-saving appliances and rescue unit (see 1.2.1.29). Portable/man-portable apparatus for radio communication on board the ship may be used if capable of operating at frequencies other than those stated in Tables 2.1.1 and 6.18.4.

6.18.2 Portable/man-portable apparatus shall be designed as a single/one piece unit including:

.1 transmitter, receiver, antenna and power source;

.2 control unit with reception / transmission push-button switch;

.3 microphone and loudspeaker.

6.18.3 Portable/man-portable apparatus shall be designed as to:

.1 be activated by a person with no special training;

.2 be activated by a person wearing gloves;

.3 be activated by one hand (except for selection of a channel);

.4 remain serviceable in case of falling down onto a hard surface from height of 1 m;

.5 remain watertight at a depth of 1 m for at least 5 minutes;

.6 remain serviceable after temperature change up to 45° C due to immersion in water;

.7 be resistant to sea water, oil and solar radiation (see 12, 13, 15 and 16 Appendix 15 RTSC);

.8 have no sharp corners or other casing components able to damage the floating life-saving appliance;

.9 be able to be fastened to clothes and to have a belt to be suspended to a wrist or neck;

.10 be resistant to damage or malfunction in case of falling into water (see 17 Appendix 15 RTSC).

Man-portable/portable apparatus shall have yellow or orange colour or have a yellow/orange marking stripe around the case.

6.18.4 The apparatus shall operate at frequency of 156.8 MHz (channel 16) and at least on one additional channel of the maritime mobile service.

6.18.5 Simplex radiotelephone channels shall be used in apparatus.

6.18.6 The apparatus shall have a class G3E emission.
6.18.7 The apparatus shall be provided with a two-position switch with visual indication on its activation.

6.18.8 The receiver shall be provided with the volume control.

6.18.9 Provision shall be made for a noise suppression unit (damper) and channel switch.

6.18.10 Provision shall be made to switch channels and display information on a selected channel.

6.18.11 Provision shall be made for adequate visibility of selectable channel 16 in any lighting conditions.

6.18.12 The apparatus shall be capable of being set into operating state for max. 5 s after activation.

6.18.13 Output power of transmitter shall be minimum 0.25 W and maximum 2 W. If output power of transmitter exceeds 1 W, provision shall be made for a device reducing power down to 1 W or less. When the apparatus is used for internal communication, output power of transmitter shall not exceed 1 W.

6.18.14 Sensitivity of receiver for signal-to-noise ratio of 12 dB shall be at least 0.5 µV.

6.18.15 The antenna shall have vertical polarization and circular pattern in the horizontal plane. The antenna fault shall not result in damage of apparatus.

6.18.16 Signal power at the loudspeaker output shall be as such to provide its audibility at ambient noise level of 70 dB (A).

6.18.17 The apparatus shall remain serviceable at temperature of −20 to +55° C and after storage at temperature of −30 to +70° C.

6.18.18 Power source shall be incorporated into the apparatus. External power supply devices may be provided for the apparatus.

6.18.19 Where the power source is to be replaced/recharged during operation, the apparatus shall be provided with additional/backup primary battery to be used in case of distress. This battery shall be fitted with a non-removable seal (nonrecoverable enclosure) to indicate that the battery was not used.

Where the electric power source is not to be replaced during operation, the apparatus shall be provided with primary battery. Such an apparatus shall be fitted with a non-removable seal to indicate that the battery was not used.

The primary battery shall have a capacity sufficient for operation for at least 8 hours at the highest output power with duty cycle of 1:9. Duty cycle is defined as cycle comprising transmission for 6 s, reception above receiver’s threshold level for 6 s, and reception below receiver's threshold level for 48 s. Service life of primary battery shall be at least two years. The batteries shall be coloured or marked in accordance with 6.18.3.10 if designated as non-replaceable in operation.

The batteries not to be used in distress shall be coloured and marked any way other than that of 6.18.3.10.

A brief operating instruction and expiry date of service life of primary battery, name and call sign of the ship shall be available externally on the apparatus.

6.19 MAN-PORTABLE TWO-WAY VHF RADIO TELEPHONE APPARATUS FOR AIRCRAFT COMMUNICATION

6.19.1 Man-portable two-way VHF radiotelephone apparatus for aircraft communication (hereinafter, the apparatus) shall provide on-scene communication between the ship and aircraft.

6.19.2 The apparatus shall include:

.1 integral transmitter/receiver including antenna and power source;

.2 integral control unit with reception/transmission push-button switch;

.3 microphone and loudspeaker.

6.19.3 The apparatus shall:

.1 be activated by a person with no special training;

.2 withstand fall down onto a hard surface from height of 1 m;
.3 be capable of operating at ambient noise level of at least 90 dB (A);

.4 have a colour other than that of man-portable two-way VHF radiotelephone apparatus of life-saving appliances (see 6.18.3.10);

.5 provide amplitude modulation and operation at frequencies of 121.5 MHz and 123.1 MHz;

.6 have a two-position switch fitted with visual alarm on its activation;

.7 be provided with manual volume control for a receiver to vary output acoustic power;

.8 be capable of switching frequencies and visibly indicating the selected channel number in any lighting conditions;

.9 be ready for operation not more than in 5 s after activation.

6.19.4 Open circuit fault or short-circuit of antenna shall not result in damage of apparatus.

6.19.5 Carrier frequency power shall be minimum 50 mW and maximum 1.5 W.

6.19.6 Signal output power shall be adequate for listening at ambient noise level of at least 90 dB (A).

6.19.7 In the transmission mode, output acoustic signal of the receiver shall be suppressed.

6.19.8 The apparatus shall be powered by integral primary battery, which may be replaced during operation. In addition, the apparatus may be powered from an external electric power source.

6.19.9 Shelf life of primary battery shall be at least two years.

6.19.10 In addition to requirements of 6.16.7, the apparatus shall be externally marked with the following:

.1 “For emergency communication with aircraft only” inscription;

.2 name and call sign of the ship.

6.20 STATIONARY TWO-WAY VHF RADIOTELEPHONE APPARATUS FOR AIRCRAFT COMMUNICATION

6.20.1 Stationary two-way VHF radiotelephone apparatus for aircraft communication (hereinafter, the apparatus) shall provide on-scene communication between the ship and air rescue unit/units (see 1.2.1.29).

6.20.2 The apparatus shall include:

.1 transmitter and receiver;

.2 antenna mounted on the equipment or individually;

.3 microphone with reception/transmission push-button switch and loudspeaker.

6.20.3 The apparatus shall:

.1 be activated by a person with no special training;

.2 be capable of operating at ambient noise level of at least 90 dB (A);

.3 provide amplitude modulation and operation at frequencies of 121.5 MHz and 123.1 MHz;

.4 have a two-position switch fitted with visual alarm on its activation;

.5 be provided with manual volume control for the receiver to vary output acoustic power;

.6 be capable of switching frequencies and visibly indicating the selected channel number in any lighting conditions;

.7 be ready for operation not more than in 5 s after activation.

6.20.4 Open circuit fault or short-circuit of antenna shall not result in damage of apparatus.

6.20.5 Carrier frequency power shall be minimum 50 mW and maximum 1.5 W.

6.20.6 Signal output power shall be adequate for listening at ambient noise level of at least 90 dB (A).

6.20.7 In the transmission mode, output acoustic signal of the receiver shall be suppressed.

6.20.8 The apparatus shall be powered from the ship’s main electric power source. In
addition, provision shall be made for powering from an emergency electric power source.

6.20.9 Integral primary battery, which may be replaced during operation, may be used instead of electric power source stated in 6.20.8.

6.20.10 Shelf life of primary battery shall be at least two years.

6.20.11 In addition to requirements of 6.13.6, the apparatus shall be externally marked with the following:

.1 "For emergency communication with aircraft only" inscription;
.2 expiry date of service life of primary battery;
.3 name and call sign of the ship.

6.21 GMDSS INTEGRATED RADIO COMMUNICATION SYSTEM

6.21.1 Integrated radio communication system is a system where individual radio communication aids and installations are used as sensors, i.e. have no own control panels, and provide output data and receive commands from points referred to as the radio workstations.

These points are referred to as the GMDSS radio workstations if they are capable of controlling and monitoring all the onboard equipment and installations of GMDSS and for general radio communication.

6.21.2 Integrated radio communication system shall meet applicable functional requirements of GMDSS (see 1.3.1) as well as all functional requirements for each individual radio communication aid. No functional requirements to individual radio communication aids shall impede compliance with any other functional requirements to other radio communication aids integrated into the radio communication system.

6.21.3 All functional requirements to equipment of the integrated radio communication system shall comply with operating requirements stipulated by the present Part of these Rules to individual equipment included into the integrated radio communication system.

6.21.4 Failure in one type of radio equipment included into the integrated radio communication system shall not affect more than one sensor of radio communication aids or more than one radio workstation.

6.21.5 The integrated radio communication system shall:

.1 include at least two radio workstations each linked with sensors of GMDSS radio communication aids via local area network or hardwired communication system;
.2 include at least two printers;
.3 have means for automatic update of ship position and time in addition to manual data input;
.4 have an electric power source preventing the accidental deactivation of any part of the integrated radio communication system;
.5 have GMDSS fault detection means with alarm activation;
.6 be protected against computer viruses.

6.21.6 GMDSS radio workstations shall:

.1 have an identical user interface and identical access to each sensor function;
.2 operated independently;
.3 provide for simultaneous operation of at least two sensors of radio communication aids;
.4 transmit distress alerts made only by a button specially designated for each sensor of radio communication means; this button shall not be used for any other purpose. The appearance of this button shall differ from others, and the button shall be protected against inadvertent activation; distress alert shall be made by two independent actions (see 6.1.38) with activation of alarm notifying on activation of alert signal. Each distress alert button shall not be electrically linked to the local area network or hard wired communication system of the integrated radio communication system. Provision shall be made to interrupt or make a distress alert at all times (see 6.1.38).
6.21.7 VHF radio installation may be included/integrated in the integrated radio communication system only subject to requirement of 4.5.8.

6.21.8 Additional radio workstations intended for general radio communication only shall not have access to distress alert functions and shall not impede transmission of a distress alert. The radio communication aids from GMDSS radio workstations shall have a priority over other additional radio workstations.

6.21.9 Additional sensors not required for GMDSS radio communication aids shall not impede or degrade performance of distress alert and alert signal functions.

6.22 SECURITY ALERT SYSTEM

6.22.1 Security alert system shall be provided on board ships for transmission of the ship-to-shore alert on security condition in order to notify an organization authorized by the state executive authority of the Russian Federation that the ship security is under threat or is breached. Security alert system shall include at least two actuation positions, one located in the wheelhouse and the other according to the ship security plan. Provision shall be made for a continuous alert from these positions until it is deactivated and/or reset. The system shall provide for a hidden transmission of the signal for alerting the authorized organization on shore. The signal transmission mode shall not be accompanied by alarm on board the ship and shall not make an alert to other ships.

6.22.2 Functions of the security alert system may be performed using GMDSS radio installations and other systems intended for general radio communication or system specially designed for this purpose.

6.22.3 The security alert system shall be protected against inadvertent activation. Activation of security alert system shall not require preliminary removal of any seals or opening covers.

6.22.4 The actuation of the security alert system shall entail activation of the radio communication system so that the transmission of alert does not require any tuning of the radio communication system (tuning channels, selection of operating modes or menu). The operation of security alert system activation controls shall not result in actuation of alarm on board the ship.

6.22.5 Operation of the security alert system shall prevent degrading functional characteristics of GMDSS radio installations required by the present part of these Rules.

6.22.6 An alert generated by the security alert system control shall contain a unique code/identifier to indicate that the alert is made not in accordance with GMDSS distress procedures. The signal shall contain an identifier of the ship and current ship position and the date and time of fix.

6.22.7 In the security alert system, provision shall be made for serviceability testing without actually transmitting any alert signal.

6.23 SHIP’S AND LIFE-SAVING APPLIANCE’S AUTOMATIC IDENTIFICATION SYSTEM TRANSMITTER

6.23.1 Automatic identification system (AIS) transmitter for search and rescue shall transmit messages with coordinates, static information and safety-related information for ship in distress.

6.23.2 The format of transmitted messages shall be compatible with the AIS equipment, be recognized and displayed on receivers within the AIS transmitter coverage range. The transmitted messages shall differ from those of AIS equipment.

6.23.3 The AIS transmitter shall:
   .1 be activated by a person with no special training;
   .2 be fitted with arrangements preventing its accidental activation;
   .3 be provided with visual and/or audible indication of operation;
   .4 be capable of being activated and deactivated manually. Automatic activation ar-
rangements may be used along with manual activation;

.5 be able to withstand drop in water from height of 20 m without sustaining any damage;
.6 be watertight to a depth of 10 m for at least 5 minutes;
.7 remain watertight and serviceable under temperature variation by 45° C during immersion;
.8 have a positive buoyancy unless it is a component of a floating life-saving appliance and be provided with a buoyant line if the AIS transmitter has a positive buoyancy;
.9 be designed to be resistant when exposed to sea water, oil and solar radiation (see 12, 13, 15 and 16 Appendix 15 RTSC);
.10 be coloured in yellow/orange;
.11 have an external surface safe for the floating life-saving appliance;
.12 have a device for hoisting AIS transmitter antenna at a height of at least 1 m above sea level. This device shall be accompanied with illustrated instructions on antenna deployment;
.13 have a transmitted message repetition interval not exceeding 1 minute;
.14 be equipped with integral coordinate unit to transmit current position in each message;
.15 provide for functional test of transmitter using the set parameters and their initial values.

6.23.4 The AIS transmitter shall have a primary battery capacity sufficient for operation for at least 96 hours at temperature of –20 to +55° C and serviceability testing the radio equipment.

The AIS transmitter shall have its unique identification number to ensure integrity of data transmission line within VHF band.

6.23.5 The AIS transmitter shall be designed to be operable under ambient temperature of –20 to +55° C and to sustain no damage when stored at temperature of –30 to +70° C.

6.23.6 The AIS transmitter shall be capable of being detected at a distance of at least 5 nautical miles (9.26 km).

6.23.7 The AIS transmitter shall continue transmitting message even if position and time data from the position fix system are lost or corrupted.

6.23.8 The AIS transmitter shall begin transmitting message within 1 minute after activation.

6.23.9 The shelf life of the primary battery shall be at least two years, and it shall be replaced if at the time of survey of the ship radio equipment its remaining shelf life is less than 12 months.

6.23.10 The AIS transmitter shall be externally marked with the following:
.1 manufacturer data;
.2 navigation equipment type number or codename assigned for type approval testing;
.3 serial number of navigation equipment;
.4 year of manufacturer;
.5 operating instructions;
.6 name and call sign of the ship;
.7 expiry date of service life of primary battery.

6.24 STATIONARY TWO-WAY VHF RADIO TELEPHONE APPARATUS FOR LIFE-SAVING APPLIANCES

6.24.1 Stationary two-way VHF radiotelephone apparatus for life-saving appliances (hereinafter, the apparatus) shall provide for on-scene communication between floating life-saving appliances, between floating life-saving appliances and ship, and between floating life-saving appliances and rescue unit.

6.24.2 The apparatus shall include:
.1 transmitter and receiver;
.2 antenna mounted on the apparatus (or provision shall be made for its separate installation);
.3 microphone with reception / transmission push-button switch and loudspeaker.

6.24.3 The apparatus shall:
.1 be activated by a person with no special training;
.2 be activated by a person wearing gloves;
.3 withstand exposure to shocks and vibrations with parameters stipulated in 2.2.5 Part VI of these Rules;
.4 be watertight to a depth of 1 m for at least 5 minutes;
.5 remain watertight under temperature variation by 45°C during immersion;
.6 be designed to be resistant when exposed to sea water, oil and solar radiation (see 12, 13, 15 and 16 Appendix 15 RTSC);
.7 have an external surface safe for the floating life-saving appliance;
.8 be capable of operating at ambient noise level of at least 70 dB (A);
.9 be designed to install on the floating life-saving appliances without special-purpose tool or fixtures;
.10 comply with requirements of 6.18.4 to 6.18.19.

6.24.4 In the transmission mode, output signal of the receiver shall be muted.

6.24.5 Where a microphone is provided in the apparatus, the receiver volume control shall not affect the output microphone power.

6.24.6 The apparatus shall be externally marked with the following:
.1 operating instructions;
.2 numbers of channels;
.3 name and call sign of the ship;
.4 expiry date of service life of primary battery.
Part VIII

NAVIGATIONAL EQUIPMENT
1 GENERAL REQUIREMENTS

1.1 SCOPE OF APPLICATION

1.1.1 The present Part of the Rules contains the norms of the navigational equipment for the inland and river-sea self-propelled ships and technical requirements for it.

1.1.2 The requirements of this Part of the Rules apply to ships under design and construction, as well as ships in service constructed on or after 1 July 2002.

Ships in service constructed before 1 July 2002 shall comply with the requirements of those Rules, according to which they were constructed, unless otherwise is specified in the later editions of the Rules and in the statements of amendments and changes, as well as with requirements of 1.3.9 to 1.3.13.

1.1.3 The requirements of this Part of the Rules are mandatory for the ships engaged on coastal navigation. Requirements of the international conventions and agreements, which the Russian Federation acceded to, are mandatory for the ships engaged on international navigation.

1.2 TERMS AND DEFINITIONS

1.2.1 The following terms are used in this Part of the Rules:

1 Automatic identification system (AIS) means a system that provides continuous automatic exchange of static and dynamic (navigational) information between ships, as well as between ships and shore-based stations, for the purpose of navigational safety;

2 Night vision equipment means an electronic system that provides safe navigation during the hours of darkness through assisting in detection of above-water objects, which may pose hazard for navigation;

3 Display base means a scope of information of a system electronic navigational chart, which cannot be removed from screen. This information is continuously displayed on the screen in any navigation areas. This information is not sufficient for navigational safety;

4 Image redrawing time in an electronic navigational chart and information display system means a time from the start of redrawing to completion of redrawing;

5 Image refreshment time in an electronic navigational chart and information display system means a time from operator's action to completion of respective redrawing;

6 Global navigation satellite system (GNSS) means a system designed to find coordinates and velocities of objects and position fix time relative to Universal Time Coordinated (UTC);

7 Depth means a vertical distance from the water surface to ground;

8 Display means an electronic mean for displaying information in the alphabetical, numerical or graphical form;

9 Acquisition means selection of a target (targets) for radar tracking;

10 Visibility zone means a horizontal angle, within which observation of environment is possible from the workstation in the wheelhouse;

11 Integrated navigational system (INS) means a combination of the ship's navigational equipment for cooperative
processing and displaying information received from these means, as well as for automatically testing integrity/reliability of the navigational information;

.12 **Time division multiple access (TDMA)** means a way of information transmission in multiple-access communication systems with specified time of message transmission for each station;

.13 **Observation** means one of the main functions of the navigator to be carried out by sight and hearing, as well as using ship equipment, to assess navigational situation and risk of collision;

.14 **Navigational equipment** means ship equipment installed on board the ship for solving navigational tasks;

.15 **Data carrier** means a device designed for data storage and reading with the use of respective equipment;

.16 **Generalized display** means a combined displaying information from two or more navigational devices or systems;

.17 **Waypoint** means a point on the specified path of the ship, whose designation and coordinates were entered in control software of GNSS, Inland ECDIS/ECDIS or ECS receiver;

.18 **Radio module** means a module (an AIS component) for reception and transmission of information on the VHF communication channel;

.19 **Raster navigational chart** means a facsimile copy of the paper chart or a collection of charts, prepared and distributed by an authorized hydrographic service;

.20 **Voyage data recorder (VDR)** means a device designed for collection, recording and storage of voyage data including: data coding and recording equipment; interfaces to data sensors; data carrier in protective container; main and integral standby power sources;

.21 **Backup officer** means a ship operator who is to be called whenever ship operator keeping underway watch needs assistance;

.22 **Wheelhouse** means a space accommodating the main ship steering station where observation over environment, ship steering, and control of ship equipment and systems are carried out;

.23 **Sea watch alarm system** means equipment for monitoring psychophysical state of the navigator on underway watch in the wheelhouse;

.24 **Electronic Chart Display and Information System for Inland Navigation (Inland ECDIS)** means a navigational information system, which, together with the respective backup equipment, displays information from system electronic navigational chart and ship position received from navigational equipment, for route planning and ship steering. Inland ECDIS includes its software, operating system and computer hardware, as well as interface and backup equipment;

.25 **System electronic navigational chart (SENC)** means a database obtained by transformation of an electronic navigational chart to include corrections and other information as may be entered by the navigator. This database is used in the Inland ECDIS/ECDIS to generate the chart image on the display to provide navigational safety;

.26 **EPA** means electronic plotting aid;

.27 **ATA** means automatic tracking aid;

.28 **ARPA** means automatic radar plotting aid;

.29 **Standard display** means SENC information, which shall be represented at first display of the chart in the Inland ECDIS/ECDIS and enable route planning or ship steering by the navigator depending on the information level;

.30 **Remote heading transmission device** mean an electronic device that receives ship heading from the sensor and transmits it to other navigational equipment;

.31 **Navigation bridge** means a wheelhouse deck including open or closed areas on the sides (bridge wings) where the local control stations may be located;

.32 **Log and/or echo sounder trunk** means a dedicated watertight space in the ship hull below the waterline with a watertight enclosure;

.33 **Electronic chart display and information system (ECDIS)** means a system combining information from
the system electronic navigational chart (SENC) with ship position data received from the navigational sensors, for preliminary and in-route plotting and displaying other navigational information;

34 Electronic navigational chart (ENC) means a database standardized in contents, structure and format and generated for use in the Inland ECDIS/ECDIS by authorities received from the state hydrographic service. ENC shall include all the mapping information as may be required for navigational safety and enable entering additional data normally included in the pilot charts, atlases and other navigation guidelines.

35 Electronic Chart Display System (ECDS) means a system designed for working with official navigation charts of inland waterways in order to monitor the ship movement and information support of navigation.

1.3 NAVIGATIONAL EQUIPMENT COMPOSITION

General requirements

1.3.1 Navigational equipment installed on board ships including ships in service, above the norms specified in 1.3 in order to enhance navigational safety shall comply with the requirements in 6.1 Part VII of the Rules, 2, 3 of this Part, and shall be surveyed by the River Register.

Requirements to I, II, III and IV class ships

1.3.2 To determine the navigational equipment and outfit, the ships are divided into three groups:

I — ships of 300 gross tonnage or more;
II — ships 25 m long or more with 300 gross tonnage or less;
III — ships less than 25 m long.

Gross tonnage and length of a tugboat designed for pushing or alongside towing shall be taken equal to gross tonnage and length of whole convoy.

1.3.3 Ship navigational equipment composition shall be taken according to the norms specified in Table 1.3.3 depending the navigation basin category and ship category.

1.3.4 It is allowed not to install the speed and travelled distance indicators, gyrocompasses, autopilots and directional stabilizers, echo sounders and rate-of-turn indicators, as well as other navigational equipment not specified in Table 1.3.3.

1.3.5 It is allowed to install fixed navigational equipment with combined functions (radar + echo sounder + electronic chart system) with technical characteristics not below those specified for the ships of M-III, M-IIIP and O-IIIP classes on board ships with maximum 12 persons (including the crew members) and ships with length of less than 25 m, except for the passenger ships and ships carrying hazardous cargoes.

1.3.6 All the self-propelled inland ships operated in the areas with active cardinal system of the navigational equipment of the International Association of Lighthouse Authorities shall be fitted with a heading finding and displaying device.

Requirements to M-III, M-IIIP and O-IIIP class ships

1.3.7 Self-propelled ships shall be fitted with navigational equipment according to Table 1.3.7.

1.3.8 It is allowed not to install an automatic radar plotting aids (ARPA), rate-of-turn indicators, automatic heading and course keeping systems, devices for measuring and indicating speed and travelled distance over ground in forward and transverse directions.

1.3.9 Ships built before 1 July 2002, not later than the first annual survey carried out after 1 July 2002, shall be fitted with a GNSS receiver or a radio navigation system receiver suitable for continuous usage in the ship operation areas.

1.3.10 All passenger and cargo ships of gross tonnage of 3000 and more engaged on international voyages and constructed after 1 July 2002 shall be fitted with a voyage data recorder.
### Table 1.3.3

**Norms of navigational equipment for M, O, P and J class ships**

<table>
<thead>
<tr>
<th>Item</th>
<th>Table basin category and ship category</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
</tr>
<tr>
<td>1. Standard (master) magnetic compass</td>
<td>1</td>
</tr>
<tr>
<td>2. Steering (secondary) magnetic compass</td>
<td>1</td>
</tr>
<tr>
<td>3. Radar</td>
<td>1</td>
</tr>
<tr>
<td>4. GLONASS or GLONASS/GPS receiver able to receive GLONASS or GLONASS/GPS differential corrections</td>
<td>1</td>
</tr>
<tr>
<td>5. AIS transponder</td>
<td>1</td>
</tr>
</tbody>
</table>

1. In case of remote transmission of readings, including through optical line, from the standard (master) magnetic compass to the main steering station, it is allowed not to install a steering (secondary) magnetic compass.

2. Ships of M class and of length less than 20 m and ships of O class not fitted with a steering (secondary) magnetic compass shall be fitted with a boat magnetic compass with the card diameter of not less than 75 mm.

3. On the ships on board of which installation of a magnetic compass is not provided, the boat magnetic compass card diameter shall be sufficient to be read at a distance of not less than 70 cm.

4. Only passenger ships and ships carrying dangerous cargoes, irrespective of gross tonnage.

### Table 1.3.7

**Norms of navigational equipment for the M-Cl, M-II and O-II class ships**

<table>
<thead>
<tr>
<th>Item</th>
<th>Ship gross tonnage</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than 150</td>
<td></td>
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<tr>
<td></td>
<td>150 and more</td>
<td></td>
</tr>
<tr>
<td></td>
<td>300 and more</td>
<td></td>
</tr>
<tr>
<td></td>
<td>500 and more</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3000 and more</td>
<td></td>
</tr>
<tr>
<td>1. Master magnetic compass²</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2. Secondary magnetic compass</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>3. Heading transmission device</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4. Gyrocompass or other non-magnetic device to determine and display the heading⁴</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>5. Radar with:</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Electronic plotting aid (EPA)⁶</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Automatic tracking aid (ATA)⁷</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>6. GLONASS or GLONASS/GPS receiver</td>
<td>1⁷</td>
<td>1</td>
</tr>
<tr>
<td>7. Electronic chart display and information system (ECDIS)³</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>8. Echo sounder</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>9. Log</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>10. Automatic identification system (AIS) equipment⁸</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>11. Voyage data recorder (VDR and S-VDR)¹⁰</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>12. External audible signal reception equipment</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

1³ In case of the ships on which installation of a magnetic compass is not provided, the boat magnetic compass card diameter shall be sufficient to be read at a distance of not less than 70 cm.

2⁴ Only passenger ships and ships carrying dangerous cargoes, irrespective of gross tonnage.
### Table 1.3.7

<table>
<thead>
<tr>
<th>Item</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Sea watch alarm system</td>
<td>— 1 1 1 1 See 1.3.12</td>
</tr>
<tr>
<td>14. Automatic heading/course keeping system</td>
<td>— — — — 1\textsuperscript{1,2} Required on the ships of gross tonnage of 10000 and more</td>
</tr>
<tr>
<td>15. Radar reflector</td>
<td>1 — — — — On the ships navigating in darkness</td>
</tr>
<tr>
<td>16. Night vision equipment for high-speed craft</td>
<td>— 1 1 1 1 Two chronometers shall be installed on the passenger and special purpose ships of gross tonnage of more than 300</td>
</tr>
<tr>
<td>17. Navigational sextant</td>
<td>— — 1 1 1 Not required on the ships not engaged on international voyages.</td>
</tr>
<tr>
<td>18. Chronometer</td>
<td>— — 1 1 1</td>
</tr>
<tr>
<td>19. Ship identification and long-range tracking system</td>
<td>— — 1 1 1</td>
</tr>
</tbody>
</table>

\textsuperscript{1} Applies to passenger ships irrespective of their dimensions.

\textsuperscript{2} Or some other mean irrespective of any power source and suitable for finding the heading and transmitting it to the main steering station and other equipment.

\textsuperscript{3} Not required if the ship is fitted with a gyrocompass providing able to transmit heading to the equipment referred to in 5, 7, 10 and 11 of this Table.

\textsuperscript{4} Heading shall be transmitted to the equipment referred to in 5, 7, 10 and 11 of this Table. Heading shall be visually indicated at the emergency station, if any, by a gyrocompass repeater.

\textsuperscript{5} Minimum effective diameter of the radar indicator image display shall be 180 mm for the ships of gross tonnage of less than 500, and 250 mm for the ships of gross tonnage of 500 and more.

\textsuperscript{6} EPA and ATA are not required if Automatic Radar Plotting Aids (ARPA) is installed.

\textsuperscript{7} Passenger ships and ships carrying vital and dangerous cargoes irrespective of their dimensions.

\textsuperscript{8} Not required on the ships not engaged on international voyages, if updated paper navigational charts are available for preliminary and in-route plotting throughout the voyage.

\textsuperscript{9} Not required in cargo ships of gross tonnage of 500 and less not engaged on international voyages.

\textsuperscript{10} Passenger ships engaged on international voyages shall be fitted with a voyage data recorder irrespective of their dimensions.

\textsuperscript{11} May be omitted on the ships of gross tonnage of less than 1600 constructed before 1 July 2002.

\textsuperscript{12} May be omitted.

Cargo ships of gross tonnage of 3000 and more engaged on international voyages and constructed before 1 July 2002 may be fitted with a simplified voyage data recorder (S-VDR).

1.3.11 The following ships engaged on international voyages shall be fitted with the electronic chart display and information system (ECDIS):

.1 passenger ships of gross tonnage of 500 and more;

.2 cargo ships of gross tonnage of 3000 and more.

1.3.12 Cargo ships of gross tonnage of 150 and more and passenger ships irrespective of their dimensions constructed on 1 July 2002 or after this date shall be fitted with a sea watch alarm system.

Cargo ships of gross tonnage of 150 and more and passenger ships irrespective of their dimensions constructed before 1 July 2002 shall be fitted with a sea watch alarm system within the following time frames:

.1 passenger ships – not later than the first survey after 1 January 2016;

.2 cargo ships of gross tonnage of 3000 and more — not later than the first survey after 1 January 2016;

.3 cargo ships of gross tonnage of 500 and more and less than 3000 — not later than the first survey after 1 January 2017;

.4 cargo ships of gross tonnage of 150 and more and less than 500 — not later than the first survey after 1 January 2018.
1.3.13 Passenger ships including high-speed passenger craft irrespective of their dimensions and cargo ships including high-speed cargo craft of gross tonnage of 300 and more engaged on international voyages shall be fitted with a ship identification and long-range tracking system (hereinafter referred to as the System).

It is allowed not install the System on the ships fitted with the automatic identification system equipment and designed for navigation solely within the sea area A1, irrespective of their date of construction.

For the definition of the sea areas A1, A2, A3 and A4, see 1.2.1.12 to 1.2.1.15 Part VII of the Rules.

1.3.14 ECDS designed for working with official navigation charts of inland waterways does not supersede Inland ECDIS/ECDIS and paper navigation maps. ECDS shall comply with the requirements in 1.1.2 Part VI of the Rules.

When using ECDS on mobile hardware (notebook, tablet), the later shall comply with the requirements in 1.1.2.2 Part VI of the Rules.
2 LOCATION OF NAVIGATIONAL EQUIPMENT

2.1 GENERAL REQUIREMENTS

2.1.1 Navigational equipment shall be installed in such a way as to enable its operation according to the requirements of technical documentation and access for maintenance, repair and survey.

2.1.2 The main devices of the navigational equipment shall be installed in dry spaces. Maintenance of equipment and taking readings at the devices shall be provided. Power and auxiliary equipment shall be installed in the power equipment room or in enclosure of a dry space not preventing operation or maintenance of other equipment.

2.1.3 Navigational equipment and its cable network shall be located so that not to cause inadmissible (exceeding 0.5°) change in readings of magnetic compasses installed on board the ship.

The power equipment room with navigational equipment converters shall be located in a space adjacent to the wheelhouse (spaces sharing bulkheads and deck plating) or in the radio equipment room, if any. The power equipment room shall be located so that acoustic noise from the operating units is not heard in the wheelhouse.

2.1.4 The space (trunk) designed for log or echo sounder vibrators shall comply with the following requirements:

a. the trunk shall be watertight;

b. the trunk dimensions shall be sufficient for maintenance of the installed equipment by one person;

c. a sliding door or a manhole sized to at least 400 × 600 mm with a watertight cover shall be provided for access into the trunk;

d. a ladder shall be provided for descending into the trunk;

e. a socket outlet for a 12 V portable lamp and the main lighting switch shall be placed at the entrance to the trunk;

f. a cock shall be installed at the outside on the upper part of the trunk;

g. when devices to be installed in the trunk require cutouts in the bottom, strength of the bottom plating shall not be compromised.

2.2 RADAR LOCATION

2.2.1 Radar's main indicator (a device to display radar and additional navigational information) shall be installed in the wheelhouse at the navigator's workstation. Images shall be displayed under all the light conditions which may occur in ship operation.

Additional indicator (if any) shall be installed so that to provide radar information to the workstation where plotting operations are carried out.

If the radar control panel is a separate device, then functioning of the radar controls shall be provided from all the workstations fitted with radar and additional navigational information displaying equipment.

The radar indicator shall be so located that to allow the navigator to observe navigational conditions on the indicator and steer the ship from the steering station.

2.2.2 The transceiver and other radar equipment may be installed in the wheelhouse, if power flow density of RF radiation, mechanical noise level and electric radio interference level do not exceed the norms set
by the sanitary regulations\textsuperscript{1} and 2.7 Part VI of the Rules. If the said norms are exceeded, the equipment shall be installed in a dedicated screened room.

2.2.3 The navigator shall be provided with information on the radar pattern and the shadow sectors.

2.2.4 If a second radar is provided, its indicator shall be also installed in the wheelhouse. This way, the main radar indicator shall be installed closer to the starboard and the second radar indicator closer to the portside.

2.2.5 The radar antenna shall be installed on a dedicated mast/pedestal to provide maximum target detection range and the required horizon view in 360°.

The antenna placement height shall also provide target detection at short range, also in noise conditions caused by water surface oscillations and by re-reflection related to radio wave propagation.

The antenna shall be placed high enough so that the power flow density of RF radiation on the manned open decks does not exceed the permissible level set by the sanitary regulations\textsuperscript{2}.

2.2.6 In the direction from the antenna right ahead, the length of the shaded water surface shall not exceed two lengths of the ship or 250 m, whichever is less, irrespective of draught, trim or type of carried cargo.

No shadow sectors shall take place from the right ahead to 22.5° abaft the beam at each side.

Any two shadow sectors separated by an angle of 3° or less shall be considered as one shadow sector.

No individual shadow sectors exceeding 5° shall take place in the remaining horizon arc. The sum of the shadow sectors shall not exceed 20°.

2.2.7 Antennas of two ship radars shall be located so that the shadow sectors are minimized and the radars do not cause interference to each other during simultaneous operation.

2.2.8 When two radar antennas are within 3 m from each other, they shall be separated in vertical plane by not less than 1 m.

2.2.9 The radar antenna location shall be selected so to minimize electromagnetic radiation reflections from any ship structures or deck cargo.

2.2.10 The radar antenna shall be installed at a distance specified by the manufacturer from RF radiation sources and other radio transmitting/receiving antennas.

2.2.11 If radar antenna is installed on a dedicated mast, the platform for its maintenance and repair shall have a minimum area of 1 m\textsuperscript{2}, appropriate (see 2.2.5) height, and rails that do not obstruct antenna rotation. The mast structure, with the antenna and platform taken into account, shall be designed for operating conditions with vibration and impacts regulated in 2.2.5 Part VI of the Rules.

2.2.12 Radar antenna lower edge shall be at least 500 mm higher than any rail of the platform.

2.2.13 If antenna is located in any accessible place, it shall be installed at a height of at least 1800 mm above the deck, ladder or other place where men may present. That deck and other possibly manned places shall not lay in the radar scanning sector with electromagnetic radiation flow density exceeding the norm set by the sanitary regulations\textsuperscript{3}.

2.2.14 Antenna mounting accessories and radar antenna itself shall be located so that to meet the requirements to safe distance to the magnetic compass as specified in the technical documentation for the antenna.

2.2.15 Anyway, antenna shall be placed / installed in such a way that to enable inspection and repair of its any part.

\textsuperscript{1} SanPiN 2.1.8/2.2.4.1358-03, SanPiN 2.5.2-703-98.

\textsuperscript{2} SanPiN 2.1.8/2.2.4.1383-03.

\textsuperscript{3} SanPiN 2.1.8/2.2.4.1383-03.
2.2.16 The rigging insulators dividing the guys into uneven sections 2 to 6 m long shall be installed in all the guys of the mast carrying the radar antenna. If the guys cannot be insulated, they shall be electrically connected to the hull.

2.2.17 When installing the radar, all the shielded cables shall be laid according to the radar manufacturer's technical documentation and with respect to requirements in 12, Part VI of the Rules.

2.2.18 Type and length of cables shall be determined by the radar manufacturer to minimize the signal attenuation.

2.2.19 In order to reduce electromagnetic noise effects, all the cables between the radar antenna and other devices shall be laid along the straight paths, with due respect to cable laid to other equipment.

Cables shall be crossed at the right angle.

2.2.20 Cables shall be laid at not closed than 0.5 m from high voltage sources.

2.2.21 In order to avoid moisture penetration into the cables, all the junctions located on the open deck shall be at least IP56.

2.2.22 Cables and microwave transmission lines shall be laid with respected minimum inner bending radius as set forth in 12.4.17 Part VI of the Rules.

2.2.23 Cables and microwave transmission lines shall be laid in separate cable ducts in accordance with radar manufacturer's technical documentation.

2.3 MAGNETIC COMPASS LOCATION

2.3.1 Magnetic compass shall be placed and installed so that its vertical plane passing through the lubber line does not deviate from the centre plane or a plane parallel thereto by more than 0.2°.

2.3.2 In order to avoid noise that may distort the readings, magnetic compass shall be placed away from magnetic and electromagnetic field sources at a distance not less than specified in the compass and equipment manufacturer's technical documentation.

2.3.3 The steering (secondary) magnetic compass shall be placed in the wheelhouse so that its readings could be taken from the steering position and access to the compensation device could be provided.

2.3.4 The standard (master) magnetic compass shall be installed on the bridge, in a place where visual bearings could be taken to objects within the sector of not less than 230° (115° to each side from the right ahead direction). The compass shall be accessible from all the sides.

2.3.5 Any equipment apart from those initially designed to be placed nearby those compasses may be installed only upon agreement with the River Register.

2.3.6 Two-way communication shall be provided between the places or rooms with the standard (master) and steering (secondary) magnetic compasses and the main and emergency (if any) steering stations.

2.3.7 When data from the standard (master) magnetic compass shall be transmitted through optical line, the following requirement shall be met:

periscope screen shall be located at the navigator's eye level and at a distance not more than 1.2 m from him;

the periscope mast shall not generate dead areas for the navigator.

2.4 GYROCOMPASS LOCATION

2.4.1 Gyrocompass main device, converter and power switchboard shall be installed in a dedicated room (gyrocompass room) located at the level of one of the actual waterlines at such a distance from the midship section centre line plane that requirements in 3.4.1 and 3.4.2 are met. The small-size main device of the gyrocompass combined with the control panel may be located in the wheelhouse or in the chartroom.

2.4.2 No equipment unrelated to the navigational equipment may be installed in the gyrocompass room.

2.4.3 The gyrocompass room, shall have, except for the main electric lighting, emer-
2 Location of Navigational Equipment

2.4 Location of Navigational Equipment

2.4.1 The gyrocompass room shall have a two-way communication with the wheelhouse.

2.4.2 The gyrocompass room ventilation shall prevent air flow influence on the gyrocompass's sensitive element.

2.4.3 Access to the gyrocompass main device shall be provided from all the sides for inspection and repair.

2.4.4 The gyrocompass main device as well as repeaters (designed for visual direction finding) shall be installed so that the straight line passing through 0° and 180° on azimuth dial is parallel to the centreline plane within 0.2°.

2.4.5 The repeater for visual direction finding shall be installed in the wheelhouse so that direction finding is enabled within the relative bearing of at least 115° to each side. It is allowed to install one repeater on each bridge wing instead of single repeater in the wheelhouse. Those repeaters shall be so arranged to enable direction finding in any direction within the relative bearing of 180° to each side.

2.4.6 The steering repeaters shall be located in the places where ship is steered. They shall be located so that navigator could easily read and use them.

2.4.7 The power units and their control equipment shall be installed in the power equipment room (if any) or in the same room with the main device in such a way then to enable measurements of the power unit revolution frequency and maintenance of bearings. The power unit remote control station shall be located in the room with the gyrocompass main device or in the wheelhouse/chartroom.

2.4.8 It is allowed to use the same repeaters when a gyrocompass and a magnetic compass with remote electrical transmission of the readings are provided. In this case, a display panel with inscription “Repeaters are showing data from the magnetic compass” and “Repeaters are showing data from the gyrocompass” shall be installed in the wheelhouse to get switched over depending on the compass type.

2.4.9 Water cooled gyrocompasses not suitable for operation with cooling water temperature exceeding 30 °C shall receive water for cooling from a dedicated cooler installed on board the ship.

2.5 AUTOPILOT AND DIRECTIONAL STABILIZER LOCATION

2.5.1 The autopilot or directional stabilizer control console shall be installed near the manual steering station to enable their maintenance and switching between automatic to manual control.

2.5.2 The control console combining automatic and manual control shall be installed in the wheelhouse in the centreline plane or at a distance compliant with requirements in 3.6.

2.6 ECHO SOUNDER LOCATION

2.6.1 A depth indicator shall be installed in the wheelhouse and an echograph in the wheelhouse or chartroom. Those devices shall be located in places accessible for maintenance and repair. It is allowed to install only the depth indicators in the wheelhouse.

2.6.2 The echo sounder sensors shall be installed under the ship bottom at a distance of 0.2 to 0.75 of the ship length from the bow as measured along the minimum operating draught waterline, and at such a distance from the sides and ends that prevents their exposure at roll and air bubble ingress.

2.6.3 No ultrasonic emitters of other devices operating simultaneously with the echo sounder as well as any hull projections, inlets or discharges or other structures interfering with the echo sounder shall be located near the echo sounder sensor.

2.6.4 Measures shall be taken to prevent progress of contact corrosion on the hull as a result of sensor installation.
2.6.5 The echo sounder sensors shall be installed so that their radiating and receiving surfaces are parallel to the horizontal plane and are at the same level when the ship has no heel and trim. This requirement applies to portable sensors too.

2.6.6 The echo sounder sensors installed in bottom openings shall be located so that their surfaces are flush with external shell plating. Where it is impossible to install sensors in the horizontal position because of hull curvature, the fore-to-aft fairings shall be used.

2.6.7 Where echo sounder sensors are to be installed in a dedicated tank without any cutout in the bottom, the tank shall be filled with water.

2.6.8 The echo sounder sensors may be located in special spaces named moonpools. The structure of the moonpool cover shall prevent sparking.

2.6.9 The radiating surface of echo sounder sensor shall never be painted or subjected to mechanical stresses (impacts, friction, etc.).

2.6.10 In order to eliminate electromagnetic interferences, the "sensor - receiver - amplifier" line shall be laid at least 1 m away from the "sensor - transmitter" line (when the echo sounder does not utilize a combined sensor) and at least 0.5 m away from other electrical devices and parallel cables. Both lines shall be shielded.

2.6.11 High voltage relay box shall be installed in a dry place accessible for maintenance and repair and shall be protected against dust and mechanical stresses according to Appendix 1, Part VI of the Rules. It shall not be located in the holds carrying coal, cotton or other inflammable cargoes.

2.6.12 When echo sounder sensors are placed in cofferdams of cargo and fuel tanks, in the double bottom compartments and ventilated tunnels under cargo compartments of the oil tankers, they shall be located in a dedicated water-and-gastight enclosure, which is a hull structure. The cables shall be laid according to the requirements in 2.10, Part VI of the Rules.

The sensors installed in the said spaces shall have a maintenance-free design.

2.6.13 Local and global strength of the hull shall be provided when installing the sensors in the hull.

2.6.14 Dedicated tanks for echo sounder sensors shall be tested for tightness after installation on board the ship according to Appendix 10 of RTSC.

2.6.15 Access shall be provided from the ship interior spaces for inspection of the cable boxes and for sensor resistance measurements.

2.6.16 The echo sounder power equipment (converter, transformers, etc.) shall be installed in the power equipment room or in a dedicated enclosure in the ship interior heated spaces.

2.7 LOG LOCATION

2.7.1 The primary speed transducers shall be installed in the ship bottom, in the place of intersection of the base plane and centreline plane so that the transducers are not exposed during roll at minimum draught and the water flow lines are parallel to each other and to the centreline plane.

2.7.2 Transducers fixed in bottom openings shall be secured in the welded pads. The welded pad securing method shall not weaken the hull.

2.7.3 The speed and travelled distance indicators shall be installed at the navigator's workstation. The speed indicator shall be installed in the wheelhouse (on the ship steering station) and at the main engine control station, if any.

2.7.4 No projections or system inlets or discharges that can affect parallel water flow lines around the hull shall be present aforesaid the log's underwater receiver.

2.7.5 Transducers may be installed in retractable bottom arrangements or fixed. Their longitudinal axes shall be parallel to the centreline plane within 1°.
2.7.6 Retractable bottom arrangements of the primary transducers shall be located in a moonpool complying with the requirements in 2.1.4.

2.7.7 If generalized TV-type displays of navigational information are provided in the wheelhouse, it is allowed not to install separate speed and travelled distance repeaters, except for the speed repeaters installed at the ship steering station.

2.8 LOCATION OF THE ANTENNAS AND RECEIVERS OF THE RADIO NAVIGATION SYSTEMS AND GLONASS, GPS, GLONASS/GPS, GALILEO SYSTEMS

2.8.1 The radio navigation system receivers shall be installed in the place of navigational plotting so that ship position could be visible from the navigator’s workstation.

2.8.2 The radio navigation system receiver antennas shall not be installed below the large-sized metal ship structures and shall be at least 3 m away from any transmitting antennas.

If the ship dimensions do not allow to locate GLONASS/GPS antenna more than 3 m away from any transmitting antennas, then the distance between these antennas shall not be less than 1 m horizontally and 0.7 m vertically.

2.8.3 Antennas shall not be installed at the mast tops, in the places subject to vibration, under the ship deck structures and rigging, as well as near the heat or smoke sources.

2.8.4 The GNSS receiver antenna place shall be selected to enable tracking of satellite constellation. This place shall be at least 1 m above the horizontal surfaces of the ship structures.

2.8.5 The GNSS receiver antenna shall not be located in the main beam of the radar emitting pattern. The distance between antennas shall not be less than that specified in the technical documentation for the equipment.

2.9 RATE-OF-TURN INDICATOR LOCATION

2.9.1 The main device of the rate-of-turn indicator shall be installed on a hard foundation in the power equipment room or radio equipment room adjacent to the wheelhouse; it shall be placed in the centreline plane and be oriented along this plane. The upper surface of the foundation shall be parallel to the base/horizontal plane. Vibration and temperature differences shall not be present in the place of installation.

2.9.2 The main device may be placed in the wheelhouse if magnetic fields produced by this equipment do not distort magnetic compass readings by more than ±0.5° and the acoustic noise level does not exceed the norms set by the sanitary regulations.

2.9.3 The rate-of-turn indicator devices shall be located in the wheelhouse so that navigator could easily read them and could have an access to their controls.

2.9.4 The rate-of-turn indicator repeaters shall be installed at the steering station so that they could be read simultaneously with observing navigational conditions ahead, as well as above radar indicator, at the bridge wings and at the top bridge wings, if ship steering is provided from these places.

2.10 LOCATION OF THE ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEM FOR INLAND NAVIGATION (INLAND ECDIS)

2.10.1 Inland ECDIS shall be installed in the wheelhouse at the ship steering station so that to provide access to the information displays, system controls and radar, as well as observation over environment, for safe navigation under any operating conditions.

2.10.2 Making changes in the in-route plotting from a remote indicator (if any) shall not be possible.

1 SanPiN 2.5.2-703-98.
2.11 SHIP PATH CONTROL SYSTEM LOCATION

2.11.1 The control console of the ship track control system supporting the manual steering system shall be connected to the manual steering station by mechanical or electrical link.

2.11.2 The combined automatic and manual control console shall be installed in the wheelhouse in the centreline plane to enable its maintenance and switching between the automatic and manual steering.

2.11.3 Remote control stations of the system shall be installed on the bridge wings or in other places specified by the ship design.

2.12 AUTOMATIC IDENTIFICATION SYSTEM LOCATION

2.12.1 AIS equipment shall be installed in the wheelhouse so that to enable use of its controls and indicator along with simultaneous observation of radar indicators, Inland ECDIS/ECDIS and environment.

2.12.2 Individual units included in AIS and not requiring operational control may be installed in a room adjacent to the wheelhouse.

2.12.3 The output contacts of the device actuating in case of a failure in the AIS equipment shall be connected to an audible alarm device or to the ship warning alarm system.

2.12.4 AIS antennas shall be installed at a height sufficient for effective signal emission and reception at all the operating frequencies, and with no obstacles shall be around the horizon on the way of the electromagnetic field propagation.

2.12.5 The AIS UHF antenna shall be located so that the no conductive ship structures or powerful energy transmitters (radar or radio communication antennas) are located less than 2 m away from it. When placing the antenna at the same level with other antennas, they shall be at least 5 m away from each other. If the ship dimensions do not allow to locate the antennas at a distance more than 5 m, the distance between these antennas shall be not less than that specified in the technical documentation of the equipment manufacturer.

2.12.6 Coaxial and power cables shall be laid in separate pipes placed at least 10 cm from each other or in double steel plaiting which provides screening continuity. The cables shall be crossed at the right angle.

2.12.7 Antenna of AIS GNSS signal receiver shall be installed in a place where satellite signals can be received.

2.12.8 The coaxial cable between the antenna and AIS main unit shall be laid together with coaxial and power cables of any other purpose. The distance between such cables shall be at least 1 m.

2.13 VOYAGE DATA RECORDER LOCATION

2.13.1 VDR equipment shall be located in the wheelhouse or in an adjacent dry heated room.

2.13.2 A dedicated protective container with an end data carrier with recorded information shall be installed on the open part of the uppermost deck, e.g. on the open parts of the bridge wings, on the wheelhouse roof, in a place where it can float free in case of a collision or transport accident.

2.13.3 A fixed data carrier shall be located in a dedicated fixed protective container rigidly securing to the open deck.

2.14 EXTERNAL AUDIO SIGNAL RECEPTION EQUIPMENT LOCATION

2.14.1 The receiving microphones of the equipment shall be installed in the places with minimum acoustic noise from the ship's noise sources.

2.14.2 The external audio signal reception equipment indicator shall be installed in a place where it is visible from the ship steering station.

2.14.3 The equipment loudspeakers shall be located so that the broadcast external signals are audible from any place of the wheelhouse.
2.15 RADAR REFLECTOR LOCATION

2.15.1 The radar reflector shall be secured on board the ship using a rigid support or by suspending it on rigging.

2.15.2 The radar reflector shall be installed at a height at least 4 m above water. Preferred orientation of the reflector shall be marked on it.

2.16 INTEGRATED NAVIGATIONAL SYSTEM LOCATION

2.16.1 Integrated navigational system shall be installed in the wheelhouse so that navigator could operate the system's equipment and simultaneously observe the navigational conditions.
3 REQUIREMENTS TO NAVIGATIONAL EQUIPMENT

3.1 GENERAL REQUIREMENTS

3.1.1 Navigational equipment shall comply with requirements in 2.2 to 2.7, 4.5.1, Part VI and 6.1, Part VII of the Rules.

3.1.2 Navigational equipment shall remain serviceable under any operating conditions of the ship.

3.1.3 All the navigational equipment shall be designed for continuous 24-hour operation. Operating temperature shall be:
   0 to 45 °C for the main gyrocompass devices
   −4 to +40 °C for the speed log primary transducers and echo sounder vibrators submerged in water

3.1.4 All the navigational equipment and devices shall have the following degrees of protection:
   IP22 for equipment installed in closed dry service spaces;
   IP56 for equipment installed on the open decks and in cargo holds;
   IP68 for equipment installed in the double bottom spaces.
   For equipment installed in the closed dry service spaces at a distance more than 1 m from the doors and windows facing the open deck, IP21 protection is allowed.

3.1.5 The structure of the navigational equipment shall enable its maintenance and repair in the marine conditions by replacement of its main units without need in any special adjustment.

3.1.6 If the navigational equipment unit is connected to one or several units of other navigational equipment, the operating parameters of each equipment shall not change comparing to independent operation of such equipment.
   In case of data exchange loss, the navigational equipment shall continue performing other functions.

3.1.7 Operational controls of navigational equipment shall be located at a distance of not more than 700 mm from the leading edge of the navigational equipment. Their location shall prevent necessity of crossing or changing navigator's hands when simultaneously operating two controls.

3.1.8 Emergency functions shall be indicated on the navigational equipment front panel.

3.1.9 If digital keyboard for entering digital information from 0 to 9 is provided, the keys with figures shall be arranged according to recommendations of the Consultative Committee for International Telegraphy & Telephones (4 rows with 3 keys in each row).
   If alphanumeric keyboard is provided, the keys with figures from 0 to 9 shall be arranged according to provisions of the standards1.

3.1.10 Controls shall be grouped according to the functional features, and their unintended use shall be prevented by appropriate arrangement on the front panel.

3.1.11 Operating a control shall not cause distortion of the related indicator's reading when observation over this indicator is required during adjustment of the navigational equipment.

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3.1.12 The controls, whose unintended use may cause shutdown or damage of the navigational equipment or alarm actuation, shall be provided with protection against unauthorized access.

3.1.13 Design possibility of removing controls with additional functions or devices of the navigational equipment (not included in the installed navigational equipment set) or interlocking such controls in position shall be provided.

3.1.14 The device readings and inscriptions on the operational controls shall be readable at least from 1 m away. All other information shall be readable from at least 2 m away.

The instrument scales shall enable the use of the observed readings without applying any correction factor.

3.1.15 The navigational equipment arrangement and structure shall prevent damage of this equipment or a harm to people as a result of using the controls in a sequence not specified in the technical documentation for the equipment.

3.1.16 The navigational equipment shall have a design preventing erroneous human actions as follows:

1. All the actions which may cause irreversible processes in the navigational equipment shall require confirmation before applying;

2. In case of detecting erroneous human actions, the navigational equipment shall display a feedback with enabling the “cancel and/or restore” menu;

3. The navigational equipment shall display information on receiving signals from other systems or sources;

4. The navigational equipment shall have a recover function to set the specified equipment to the default state by navigator’s single action.

3.1.17 The image display devices shall display brief overview on the function being carried out. Information not complying with the task being carried out or additional text or graphics shall not be displayed. The following requirements are imposed on information display:

1. Menus shall be grouped by functional tasks;

2. Elements displayed simultaneously shall be grouped according to the sequence of their use. The navigator shall be provided with information on the sequence of actions when shifting from one part of menu to another;

3. A system device shall display entered data. All the information required by the navigator to perform necessary actions shall be available on the active display device;

4. Any operation mode when performing the actions shall be identified by the display device(s). The display device screen shall display each stage of work; there shall be provided the possibility to return to the menu initial state before commencement of this stage by navigator’s single action;

5. When performing the actions, feedback shall be enabled to return to the menu initial state. Feedback synchronization shall comply with the requirements of the actions being performed. If response to an action is delayed, information on such a delay shall be displayed on the display device;

6. The terminology of the water transport used in the Russian Federation shall be used to display information on the navigational equipment displays;

7. In case of quick help available, it shall be provided in the form of appendix to the task being carried out and shall be called by a sequence of actions as programmed.

3.1.18 The navigational equipment arrangement and design shall not prevent its functional testing with opened case using special-purpose tools. Protection against electric shock shall be provided in the circuits with voltage above 50 V. Warning inscriptions shall be made on the external and internal parts of the navigational equipment and its protective casings. The navigational equipment design shall enable opening its case only after switching off any voltage above 50 V.

3.1.19 Grounding clamps shall be provided on all the cases of the navigational equipment. The grounding clamps shall be provided on
the cases of the radar transceivers in a number sufficient to ground RF voltages.

The opening doors, retractable units and hinged panels accommodating instruments and/or other components shall be grounded with a flexible link.

3.1.20 Threaded connections shall be fitted with means against self-unfastening. Metal parts located on the external side of the navigational equipment case shall be electrically connected to the case.

3.1.21 The inscriptions describing the technical parameters and other data of the navigational equipment shall be applied on the equipment in a place where they are well readable.

3.1.22 The design of the plug-in connections in the navigational equipment shall prevent improper connection of plugs and sockets. The projecting pins of detached plug-in connections shall be deenergized.

3.1.23 The design of the navigational equipment shall prevent heating of the control knobs by internal heat to temperature exceeding the ambient temperature by more than 15 °C.

3.1.24 Light alarm on energizing and supplying voltage more than 50 V shall be provided in the navigational equipment.

3.1.25 Indication of the current operation mode shall be provided in the navigational equipment normally capable of operating in several operation modes.

3.1.26 Audible and/or visual alarm on operational fault shall be provided in the navigational equipment.

The said alarm shall also actuate when the navigational equipment reaches critical operation conditions able to result in loss of functionality.

If the alarm is displayed on a multicolour display device, the emergency alarm shall remain visible if one of the constituent colours is not available.

The level of the acoustic noise generated by the audible alarm at a distance of 1 m from its source shall be within 75 dB(A) to 85 dB(A).

The level of the acoustic noise generated by the navigational equipment during operation (when audible alarm is off) shall not exceed 60 dB(A) at a distance of 1 m from any part of the navigational equipment.

The types of alarm and alarmed faults or critical conditions shall be agreed with the River Register.

3.1.27 Adjustable highlight shall be provided for the navigational equipment or in the room where it is installed, enabling to distinguish the controls and to read indicators at all times.

Signal lamps or other visual inspection means shall be located in the navigational equipment or control consoles.

Transparent protective coatings on the navigational equipment shall not cause reflections which may impair reading information.

3.1.28 The colours of the signal lamps depending on the type of alarm shall comply with the requirements of Table 6.1.16, Part VI of the Rules.

3.1.29 Intensity of lighting, brightness of the signal, indicating and highlight lamps of the navigational equipment shall be adjusted to minimum level down to blackout, except for highlight of the warning alarm indicators and reset and switch on/off indicators, which shall be on and well visible under all the light conditions in the wheelhouse.

3.1.30 If a voice messaging is provided in the navigational equipment, it shall be a mean additional to indicators and warning alarm required in this Chapter.

Voice messaging loss shall not degrade serviceability of the provided indication and alarm systems.

The voice messages shall be articulated with the use of the terminology of the water transport used in the Russian Federation and shall be well audible in all the places within the wheelhouse where the navigator may be present during ship steering.

Means for testing and adjustment of voice message level, including means for voice message volume adjustment, shall be provided.
The voice message volume level shall not exceed the warning alarm volume level. Change of the voice message volume level shall require navigator’s approval.

The voice messages shall be interrupted when the related indication or warning alarm signals are acknowledged.

3.1.31 The operational software used in the navigational equipment shall comply with the requirements in 11.15.8, 11.15.13, 11.15.14 and 11.15.16, Part IV of the Rules, as well as with the following requirements:

.1 Data used during operation of the navigational equipment and stored in the system (database) shall be protected so that the modifications/changes in part of the data made by the navigator do not lead to loss of integrity or safety of the other part of the database;

.2 Default values shall be displayed at each restoration of the navigational equipment functionality;

.3 The core information display and update devices provided in the navigational equipment, as well as safety functions, shall not degrade the navigational equipment functionality in any operation mode;

.4 If the information submitted for processing is determined as invalid, alarm in the navigational equipment shall be generated;

.5 Means shall be provided in the navigational equipment for automatically testing, in the specified time intervals, functionality of the software and safety of the used data (as specified in the technical documentation for the navigational equipment), as well as for actuation of independent alarm in case of a stable fault when the system is not under automatic testing;

.6 Functional keys for accelerated access to selected actions shall be provided in the software user interface integrated in the navigational equipment;

.7 Technical documentation used for developing and testing the software integrated in the navigational equipment shall include description of the methodology used for improvement of software and model programs.

Such software and model programs shall comply with the following requirements:

Complex software shall have a structure that enables functional testing of the individual modules or groups of functionally interconnected modules. Safety functions shall have priority over other functions including control functions.

The software maintenance and update structure shall be developed so that functional testing of the equipment as well as detected errors and failures is provided;

.8 Maintenance and update of the navigational equipment software shall be possible on board the ship. Upon completion of maintenance, the software shall require no additional settings or adjustments.

Name and version of each separate program included in the navigational equipment software system shall be identified or displayed, upon command, on the navigational equipment display device.

If software is identified only with the use of the navigational equipment display device, the respective information shall be included in the ship technical documentation.

All the changes in the software made in the course of maintenance shall be also included in this documentation;

.9 The software developer shall submit a document confirming that the navigational equipment software is developed and tested according to the technical documentation and requirements specified in 3.1.31.8 (flowcharts, algorithm of data check and respective diagrams are available).

3.1.32 The navigational equipment shall remain serviceable when interrupting power supply for up to 60 s. No software failure or loss of data stored in RAM shall occur.

If power supply of the navigational equipment is provided from more than one power source, means shall be provided to switch between the sources. These means may be not a part of the navigational equipment.

3.1.33 Means shall be provided to protect the navigational equipment against current surges and overvoltages, and, for 5 minutes,
against power source wrong polarity or wrong phase order.

3.1.34 Insulation resistance of the navigational equipment power circuits measured between the conductors and equipment case as well as between the transformer windings shall be, depending on the test conditions, at least:
   - under normal climatic conditions, 20 MΩ;
   - at (55±3) °C and RH < 20 %, 5 MΩ;
   - at (40±2) °C and RH = (95±3) %, 2 MΩ.

3.1.35 Image viewing during the daytime shall be provided in the navigational equipment fitted with a CRT indicator.

3.1.36 Navigational equipment installed near the magnetic compass shall be marked with minimum safe distance from the compass. This is a distance, at which influence of any active navigational equipment (or individual unit) is so that deviation of magnetic compass on the upper deck does not exceed 5.4°/\(B_n\) and of magnetic compass in the wheelhouse does not exceed 18°/\(B_n\), where \(B_n\) is the horizontal component of the earth magnetic field strength (\(\mu\)T) at the compass location spot.

3.1.37 Interface with other radio- and navigational equipment as well as with the integrated navigational system shall be provided in the navigational equipment.

   Interface formats of the shipborne radio- and navigational equipment corresponding to the national and international standards shall be used for the digital information exchange\(^1\).

3.1.38 All the navigational equipment shall be displayed and submitted to the navigator in the decoded and processed form.

3.1.39 The electric intensity level of the noise radiated by the navigational equipment installed on board the ship shall not exceed the values specified in 2.7, Part VI of the Rules.

3.1.40 The navigational equipment designed so that fault diagnostics and further repair are possible down to the element base level, shall have a set of electrical and wiring diagrams as well as a list of components of this equipment.

   The operating documentation of the navigational equipment consisting of separate modules not suitable for repair on board shall contain a methodology for finding and replacing the faulty module.

   Besides, the documentation shall contain information enabling to check equipment performance against performance specifications set by the Rules, considering influence of such a test on other navigational equipment installed in the wheelhouse.

3.1.41 The navigational equipment shall be marked with the following information:
   - information on the manufacturer;
   - navigation equipment type number or codename assigned for type approval testing;
   - serial number of navigational equipment;
   - year of manufacture;
   - kind of current and voltage of power supply;
   - safe distance of the navigational equipment installation from the magnetic compass;
   - protection degree (IP) of the equipment protection enclosure.

3.1.42 The navigational equipment spare parts shall be stored in the conditions that exclude their damage and enable their transfer and identification as belonging to a specific type of equipment.

3.1.43 The radio navigation system receivers shall comply with the requirements in 6.1, Part VII of the Rules and shall provide:
   - accuracy of the ship position finding depending on the used system or radio navigation systems;
   - interfacing with the navigational equipment and integrated navigational system;
   - functional testing with the help of a built-in testing system;

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4 receiver input protection according to 5.4.10, Part VII of the Rules;
5 a 5 minute protection of the receiver against damage in case of short-circuit failure or ground failure of antenna, any input or output connection of the receiver, and any input or output of the receiving equipment;
6 performance under noise conditions;
7 use of compound (multi-channel) receivers handling signals of ground radio navigation systems and signals of the global navigation satellite systems with WAAS (Wide Area Augmentation System), EGNOS (European Geostationary Navigation Overlay Service) and MSAS (Multifunctional Satellite Augmentation System); SBAS (Space Base Augmentation System), as well as regional augmentation systems like Starfix, SkyFix and Eurofix/Skorpion.

3.1.44 IF receivers handling signals of ground radio navigation systems or compound (multi-channel) receivers able to handle signals of, among others, ground radio navigation systems are to be installed on board the ship, they shall comply with the requirements of this Part of the Rules.

3.2 REQUIREMENTS TO RADAR

3.2.1 A radar station (hereinafter referred to as the radar) for the ships of J1, P, O and M classes shall comply with the requirements in 3.2.2 to 3.2.23. Ships of O-P1P, M-P1P and M-C1P classes of gross tonnage of 300 and more, as well as on all the passenger ships of O-P1P, M-P1P and M-C1P classes shall be fitted, in addition to the radar required for navigation in inland waters, with an additional radar complying with the requirements in 3.2.24 to 3.2.82. It is allowed to use one radar for the ships of gross tonnage up to 3000, if it complies with the requirements in 2.1, 2.2, 3.1 and 3.2.2 to 3.2.82.

3.2.2 The radar shall provide detection and display of the ships, buoys, other surface objects and obstacles, as well as of coastline and navigational marks relative to the own ship by continuous scanning round the horizon in the relative and/or true motion modes.

3.2.3 When there are no radio interferences, rain and fog, and when wave height is below 1 meter, the radar indicator shall display various objects at distances as show in Table 3.2.3 provided that the radar antenna is 10 m above the water surface. All the objects shall remain visible in case of roll and pitch of ±10°.

<table>
<thead>
<tr>
<th>Objects and dimensions</th>
<th>Distance to object (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shore with height of 60 m above the water level</td>
<td>32</td>
</tr>
<tr>
<td>Ditto, 6 m</td>
<td>13</td>
</tr>
<tr>
<td>Ship of gross tonnage of 5000</td>
<td>13</td>
</tr>
<tr>
<td>Fitto, of 20</td>
<td>4</td>
</tr>
<tr>
<td>Buoy with reflective surface of 10 m²</td>
<td>4</td>
</tr>
</tbody>
</table>

3.2.4 The main performance parameters of shipborne radar with antenna height of 7 m above water level shall be not less than those specified in Table 3.2.4. All the parameters shall remain in case of roll and pitch of ±10°.

<table>
<thead>
<tr>
<th>Main performance parameters of radar</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum detection range</td>
<td>15 m</td>
</tr>
<tr>
<td>Distance resolution on 0.5 to 1.6 km scales</td>
<td>15 m</td>
</tr>
<tr>
<td>Distance resolution on other scales</td>
<td>1 % of the value on the set scale</td>
</tr>
<tr>
<td>Distance measurement error</td>
<td>10 m</td>
</tr>
<tr>
<td>Azimuth resolution</td>
<td>1.0° *</td>
</tr>
<tr>
<td>Azimuth measurement error</td>
<td>1.0°</td>
</tr>
<tr>
<td>Heading indication error</td>
<td>0.5°</td>
</tr>
</tbody>
</table>

* On ships of gross tonnage less than 1600 antennas with resolution of maximum 3.0° is allowed.

3.2.5 Image orientation on the radar indicator shall be switchable between "heading up" and "true north up".

3.2.6 The controls required for the radar functioning according to the requirements of this Chapter shall be provided at the radar indicator.
Arrangement, functioning method, place, arrangement with respect to each other, and dimensions of the controls shall comply with the requirements in 3.1.8 to 3.1.16. Unauthorized switch of the scale range from miles to kilometres and back shall be prevented. Inscriptions shall be made in Russian or with generally accepted symbols according to the River Register Guidelines P.028-2009 "Guidelines on Abbreviations and Symbols Used in Radio Communication and Navigation".

3.2.7 Measures shall be taken to suppress rain and wave reflections.

3.2.8 The radar startup time shall not exceed 1 minute. The radar shall be fully operational within 4 minutes after switching on. The standby mode shall be provided so that the radar could be set to the operation mode within 15 s.

3.2.9 The effective display diameter of the radar indicator without magnifier shall be at least 180 mm for the ships of gross tonnage of 300 to 1600 and at least 250 mm for the ships of gross tonnage of more than 1600. For the ships engaged on international voyages on Danube - Rhine inland waterway system, the radar screen diameter shall be at least 270 mm irrespective of the ship gross tonnage.

3.2.10 For the ships operating on inland waterways, the indicator shall have the following set of range scales: 0.5, 1.6, 2, 3.2, 4, 8, 16 and 32 km. Each scale shall have minimum 2 and maximum 6 fixed range rings. It is allowed to provide additional scales calibrated in kilometres or miles. Switching between kilometres and miles shall be provided.

3.2.11 Variable range mark with numerical readout in kilometres or miles shall be provided on the radar indicator. Range measuring accuracy with on-screen variable range mark shall not exceed 10 m on the 0.5 to 2.0 km range scales and 1.0 % of the scale rating for the next scales.

3.2.12 Brightness control for fixed and variable range marks shall be provided. Fixed range rings and variable range mark shall have thickness of less than 1 % of the effective display diameter and not exceeding 1 mm.

3.2.13 The radar indicator shall be fitted with an electronic (digital) or mechanical bearing finder to take bearings to detected objects, and the following requirements shall be also met:

Digital readout of the directions obtained with the help of electronic direction finder shall be displayed with at least four figures including one decimal place. Place for indication of this readout is not to be used to display other data. Notation of the measured value (relative bearing or true bearing) shall be displayed.

Azimuth scale shall be displayed along the perimeter of the effective display diameter. It is allowed to use linear or nonlinear azimuth scale.

Azimuth scale shall be marked every 5°, and the 5° and 10° marks shall be different. The figure marks shall be provided at least every 30°.

Measurement of the direction relative to the heading line (i.e. relative bearing) and relative to the true meridian (true bearing) shall be provided.

3.2.14 Own ship motion shall be displayed with an electronic heading mark on the display. Error of this mark shall not exceed 0.5°. The heading mark line width shall not exceed 0.5°.

3.2.15 Provision shall be made to temporarily disable the heading line image by the use of a switch with automatic reset to the enabled position.

3.2.16 An input shall be provided for the radar azimuth stabilization signal from the gyrocompass.

3.2.17 The radar antenna rotation speed shall be at least 18 min⁻¹. The antenna shall be in operation condition at relative wind velocity of 50 m/s.

The radar antenna rotation speed for the high-speed craft shall be at least 40 min⁻¹. The antenna shall be in operation condition at relative wind velocity of 70 m/s.
3.2.18 Shifting the origin to any point on the screen at a distance of not less than half of its radius shall be provided.

3.2.19 Means shall be provided to detect radar performance degradation relative to the calibrated value taken at the time of radar installation, as well as to readjust the radar when there are not targets.

3.2.20 The radar shall have an integrated performance testing system.

3.2.21 Radar antenna shall radiate high-frequency energy only when the radar is operating as intended. During repair or maintenance, an interlocking device shall be used to provide safety.

3.2.22 The own ship mark on the radar operating in the true motion mode shall be shifted both manually and automatically when the own ship mark is approaching 0.5 of the display radius. An alarm device shall be provided to warn that the ship mark has approached to 0.5 of the display radius.

3.2.23 In radars designed for operation in the true motion mode, the own ship speed may be entered from a speed meter and/or manually along with drift correction.

3.2.24 The radar on ships of О-ПР, М-ПР and М-СП classes shall provide support collision avoiding and navigational safety by detecting and displaying positions of other ships, surface objects and obstacles, navigation marks and coastline.

To reach the said goals, the radar shall provide:
- displaying radar video signals;
- indicating positions and motion data of the tracked targets;
- indicating own ship coordinates as received from the positioning equipment and brought to the reference coordinate system and fixed common reference point of own ship;
- displaying information on the targets as received from the AIS equipment;
- displaying electronic navigational chart data for monitoring own ship position.

3.2.25 The radar shall comply with the requirements of Table 3.2.25 irrespective of the type of ship where it is installed, used frequency band and type of display device.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ship gross tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than 500</td>
</tr>
<tr>
<td></td>
<td>500 to 10000</td>
</tr>
<tr>
<td></td>
<td>and high-speed craft of less than 10000</td>
</tr>
<tr>
<td>Minimum operational display area diameter, mm</td>
<td>180 250</td>
</tr>
<tr>
<td>Minimum display area, mm</td>
<td>195×195 270×270</td>
</tr>
<tr>
<td>Automatic target acquisition</td>
<td>— —</td>
</tr>
<tr>
<td>Minimum number of tracked radar targets</td>
<td>20 30</td>
</tr>
<tr>
<td>Minimum number of activated AIS targets</td>
<td>20 30</td>
</tr>
<tr>
<td>Minimum number of sleeping (non-activated) AIS targets</td>
<td>100 150</td>
</tr>
<tr>
<td>Trial manoeuvring</td>
<td>— —</td>
</tr>
</tbody>
</table>

3.2.26 The radar shall be capable of operating in the following frequency bands:
- X band — 9.2 to 9.5 GHz (wave length of 3 cm) for high resolution and good sensitivity with no clutter
- S band — 2.9 to 3.1 GHz (wave length of 10 cm) for sure detection and tracking with presence of interferences (rain, fog, sea clutter)

The frequency band in use shall be indicated.

3.2.27 The radar shall be functional under passive radio interference noise and shall be capable of measuring:
- range with error not exceeding 30 m or 1% of the maximum range of the range scale in use, whichever is greater;
- bearing with error not exceeding 1°.

3.2.28 The radar capability to detect target at least 8 times out of 10 scans (antenna revolutions) with probability of false detection not exceeding $10^{-4}$ shall be verified during its operation in the X and S bands under the following conditions:
- no clutter;
- antenna height of 15 m above sea level.
The minimum detection ranges for various targets in clutter-free conditions are specified in Table 3.2.28.

The minimum target detection ranges shall be achieved with the use of a regular antenna with the smallest aperture.

3.2.29 With own ship zero speed, no clutter, sea state of up to 2, and radar antenna height of 15 m above sea level, the navigational buoy specified in Table 3.2.28, shall be detectable at a horizontal distance to the antenna not exceeding 40 m. This target shall be displayed to the distance equal to one nautical mile without change of the adjustment control position, except for the range scale selector.

In case of several antennas, range corrections shall be automatically applied for each antenna.

3.2.30 The radar shall feature consistent target detection performance on all the working range scales under passive interferences.

The radar shall have means to enhance the visibility of targets under passive interferences at close ranges.

Technical documentation shall contain information on possible deterioration of detection performance (comparing to the values of the parameters specified in Table 3.2.28) for the following conditions:

- light rain (up to 4 mm/h) and heavy rain (up to 16 mm/h);
- sea state of 2 and 5;
- a combination of the said conditions.

Possible degradation in performance due to a long transmission line, actual antenna height or any other factors shall be stated in the technical documentation.

3.2.31 Means shall be provided in the radar design for the adequate suppression of unwanted echoes including clutter caused by sea, rain and other precipitations, clouds, sandstorms, as well as and interferences from other radars.

Manual or automatic anti-clutter functions shall be provided. A combination of automatic and manual anti-clutter functions is permitted.

A gain control function shall be provided to set smoothly the system gain and signal threshold level.

There shall be indication of the gain and all anti-clutter settings.

Table 3.2.28

<table>
<thead>
<tr>
<th>Target description</th>
<th>Height above sea level (m)</th>
<th>Detection range, NM, in the band</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shore line</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Ships of gross tonnage of more than 5000</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Ships of gross tonnage of more than 500</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Small-size ships with radar reflector(^1)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Navigational buoy with corner reflector(^2)</td>
<td>3.5</td>
<td>4.9</td>
</tr>
<tr>
<td>Navigational buoy(^3)</td>
<td>3.5</td>
<td>4.6</td>
</tr>
<tr>
<td>Small-size ships 10 m in length without radar reflector(^4)</td>
<td>2.0</td>
<td>3.4</td>
</tr>
</tbody>
</table>

1 Radar cross-section of radar reflector shall be 7.5 m\(^2\) for the X band and 0.5 m\(^2\) for the S band.
2 Radar cross-section of radar reflector shall be 10 m\(^2\) for the X band and 1 m\(^2\) for the S band.
3 Radar cross-section of navigation buoy shall be 5 m\(^2\) for the X band and 0.5 m\(^2\) for the S band. For the channel buoys with radar cross-section of 1.0 m\(^2\) (for X band) and 0.1 m\(^2\) (for S band) at a height of 1 m, detection range shall be 2.0 and 1.0 nautical miles respectively.
4 Radar cross-section of a 10 m long small-size ship shall be: 2.5 m\(^2\) for the X band and 1.4 m\(^2\) for the S band.
5 Radar reflectors are considered as point targets, ships as complex targets, and shore line as distributed targets (average height of rocky shore line is specified, but dependent on profile).
6 It is allowed to change the detection range depending on various factors like atmospheric conditions, target speed and aspect, target hull material and design.
3.2.32 Means shall be available to enhance target presentation on the display. The radar image shall continuously update with a delay of less than 100 ms. The radar signal processing principle and target displaying capabilities/limitations shall be specified in the technical documentation.

3.2.33 The radar of the X band (3 cm) shall be capable of detecting radar beacons and shipborne/LSA transponders operating in the relevant frequency band.

It shall be possible to disable those signal processing functions, including polarization modes, which may prevent radar transponders from being detected.

The signal processing mode shall be displayed on the radar screen.

3.2.34 Range and direction resolution shall be determined using the range scale of 1.5 NM or less, at calm water and at distances of 50 to 100 % of the rating of the selected range scale.

In so doing, the following requirements shall be met:

Two point targets on the same bearing line shall be displayed separately if they are 40 m or more apart;

Two point targets at the same distance from own ship shall be displayed separately if they are 2.5° apart.

3.2.35 The target detection performance shall not deteriorate when roll and/or pitch amplitudes do not exceed ±10°.

3.2.36 Means shall be available to monitor performance of the radar.

Capability of monitoring performance of the radar shall be retained when there are no targets.

The radar shall be adjusted with automatic adjustment means or manually. Means shall be available to determine a significant drop in radar performance relative to a calibrated standard established at the time of installation.

3.2.37 The radar shall be fully operational (operation mode) within 4 minutes after switching on.

The radar operation mode without transmission of electromagnetic energy (standby mode) shall be provided. The radar shall be fully operational within 5 s from the standby condition.

3.2.38 The results of all the radar measurements (target ranges, variable range marks, target bearings, cursor position and tracking data) shall be brought to a fixed common reference point of own ship.

When several radar antennas are installed on board the ship, correction of the antenna offset relative to the fixed common reference point of own ship shall be automatically applied.

Offset of any sensor submitting data to the radar shall be also applied automatically.

Own ship’s scaled outline shall be available on lower range scales. Position of the fixed common reference point and the active radar antenna shall be shown within this outline.

The image on the radar display shall be centred relative to the fixed common reference point of the ship, which all the radar bearings shall be measured from.

Range shall be measured in nautical miles. The results of measurements may be indicated in meters on lower range scales. Unambiguous indication of the measured ranges shall be provided.

All the radar targets shall be displayed on the radar display on the linear range scale. Display delays at change of the target position are prohibited.

3.2.39 The radar shall be capable of operating in the following range scales: 0.25; 0.5; 0.75; 1.5; 3; 6; 12 and 24 nautical miles. Additional range scales, including large-sized metric scales may be used.

The selected range scale shall be continuously displayed on the radar indicator.

3.2.40 The radar indicator shall display the fixed range rings regularly spaced from each other and from the origin. The distance between the fixed range rings shall be continuously displayed on the radar indicator.

Position of the fixed range rings shall be provided with error not exceeding 1 % of the
selected range scale or 30 m, whichever is greater.

3.2.41 At least two variable range marks with numerical readout shall be provided in the radar indicator.

The variable range mark shall enable measuring the range to an object with maximum error of 1% of the range scale in use or 30 m, whichever is the greater.

3.2.42 An azimuth scale designed to read bearings relative to the fixed common reference point of own ship shall be displayed on the smaller edge of the display space periphery.

The azimuth scale shall be numbered at least every 30° and shall have division marks every 5° and 10°. Divisions in 1° shall be displayed if they are provided by the technical documentation for the radar.

3.2.43 Own ship heading shall be displayed on the radar screen with an electronic heading line mark, which shall start from the fixed common reference point of own ship and reach the azimuth scale of the screen. The electronic heading line mark shall be displayed with error no exceeding 0.1°. When there are several radar antennas, corrections for radar antenna offset from the fixed common reference point of own ship shall be applied automatically for each antenna.

Provision shall be made to temporarily disable the heading line mark by the use of a switch with automatic reset to the enabled position. This function may be combined with disabling other graphics.

3.2.44 At least two electronic bearing lines (hereinafter referred to as the EBL) shall be provided in the radar indicator to measure bearing to any point object within 1° using the azimuth scale.

The EBL shall be capable of measuring radar heading angles and bearings. The bearing reference, relative to which measurements are taken, shall be indicated on the radar indicator.

It shall be possible to offset the EBL origin from the fixed common reference point of own ship to any point of the operational display area and to reset it EBL back to the fixed reference point by a single action.

It shall be possible to fix the EBL origin at any point of the display or to make the EBL origin moving with the speed of own ship.

EBL shall be capable of being smoothly guided on a selected object with measurement accuracy according to 3.2.11.

Each EBL shall have a numerical readout device with resolution sufficient to maintain measurement accuracy (see 3.2.13).

3.2.45 Displaying at least four independent parallel index lines shall be provided with possibility of truncating and/or disabling each of them. Besides, change in direction of and distance between those lines shall be possible.

3.2.46 There shall be means to measure distances and bearings of any point relative to any other point on the operational display area.

3.2.47 An electronic cursor shall be provided to mark any point on the screen. The cursor shall provide continuous readout of range and bearing of the point under cursor with respect to the fixed common reference point.

The cursor shall enable selection of targets, making or removal of graphical information, and selection of radar operation modes, functions, parameters and control menus outside the operational display area.

Means shall be provided to easily locate the cursor position on the display.

Cursor’s direction and distance measurement accuracy shall meet the relevant accuracy requirements for variable range mark and EBL.

3.2.48 The own ship’s heading shall be provided by a gyrocompass or an equivalent sensor, whose characteristics meet the requirements for the sensor type approved by the River Register.

Accuracy of the radar image orientation relative to true north shall not exceed 0.5° at any rate of turn the ship may likely experience.

Information on heading shall be displayed in numerical form with resolution similar to radar to gyrocompass interfacing precision.
The heading data shall be determined relative to the fixed common reference point of the ship.

3.2.49 The radar shall display information in the true motion mode having regard to motion parameters of own ship. Own ship mark on the display shall be automatically updated according to the following features:
- mark position on the indicator screen;
- time;
- or both of them.

Own ship mark position shall be updated for each antenna revolution.

The north up and heading up radar image orientation shall be provided. Type of the actual orientation and radar image mode shall be continuously displayed on the radar indicator.

3.2.50 Manual off-centring to any point on the screen within 0.5 of the radius from the centre of the radar display space shall be provided.

On selection of off-centred display, the selected antenna position shall be capable of being located to any point on the display within 0.75 of the radius from the centre of the operational display area.

Automatic offsetting own ship mark for maximum coverage area ahead of the ship shall be provided in the true motion mode.

Means shall be provided for presetting the origin position.

3.2.51 Two radar image stabilization modes shall be provided in the radar: relative to ground and relative to water.

The stabilization mode and active data sensors enabling implementation of the selected mode shall be displayed on the radar screen. The speed sensor shall comply with the requirements of the River Register to the respective stabilization mode.

3.2.52 Display of the target trails (afterglow) with variable (depending on extrapolation time) length of vectors shall be provided with indication of extrapolation time and display mode.

Selection of the target afterglow display mode shall be provided in the true or relative motion.

The trails shall be distinguishable from targets.

Either scaled trails or past positions or both shall be displayed within 2 revolutions of the radar antenna under the following changes:
- reduction or increase of range scale;
- change of the scan centre position;
- change of the display mode from true to relative motion and back.

3.2.53 The targets shall be displayed according to the established symbols specified in the River Register Guidelines P.028-2009.

The target information may be provided by the radar tracking function and/or by the target information from AIS equipment.

The number of the displayed targets shall comply with the requirements in Table 3.2.25.

If the number of the displayed targets approaches the limit value specified in this table, warning alarm shall automatically actuate.

Radar and AIS target data processing and display formats shall be compatible.

3.2.54 Data on the radar targets shall be received from the radar transceiver. The primary target data shall be filtered with anti-jamming means. Target acquisition for tracking may be manual or automatic.

Calculations related to target tracking shall be based on measurements of their position relative to own ship and their motion parameters. Other information sources may be also used to improve the tracking performance.

Target tracking shall be provided on range scales of 3, 6 and 12 nautical miles. Target tracking range shall be at least 12 nautical miles.

The radar shall be capable of tracking targets at their relative speeds equivalent to those of sea-going ships and river-sea navigation ships, including high-speed craft.

3.2.55 In addition to the requirements for processing and presentation of AIS targets, radar target data presentation shall be provided for the number of radar targets according to Table 3.2.25.
If the limit number of the targets is about to be exceeded, a warning alarm shall be activated. When the limit number of processable targets is exceeded, the radar performance shall not degrade.

3.2.56 Manual and automatic acquisition of radar targets shall be provided in the number specified in Table 3.2.25. Means to define the boundaries of the auto-acquisition zone shall be provided.

3.2.57 When a target is acquired, the radar shall present the trend of the target motion within one minute and the prediction of the target motion for next 3 minutes.

The radar tracking system shall automatically update data for all the tracked targets and shall keep tracking radar target distinguishable on the indicator screen for five of 10 sequential antenna revolutions.

The tracking system shall calculate smoothed vectors of target motion and detect the target manoeuvre commencement.

Cancelling tracking one or all the targets shall be provided.

Maximum possible accuracy of the target motion parameters shall be provided if the target moves smoothly and accuracy performance of the data sensors complies with requirements.

For ships capable of making up to 30 kn inclusively, the tracking facility shall present target relative motion trend after 1 minute of steady tracking and target motion parameters with accuracy specified in Table 3.2.57 after 3 minutes of steady tracking.

Significant accuracy deterioration is allowed:
- shortly after acquisition;
- during own ship manoeuvring;
- during target manoeuvring;
- failure in tracking and change of sensor accuracy.

Target range and bearing measuring accuracy shall not exceed:
- range — 50 m (or 1 % of the target range);
- direction — 2°.

For ships with speeds of 30 to 70 knots inclusive (high-speed craft) the above accuracy shall be provided at a target relative speed up to 140 knots inclusive.

Provision shall be made to stabilize the displayed image with respect to ground based on the fixed point target tracking.

3.2.58 Target data provided by the automatic identification system (AIS) are filtered for parameters to be defined by the navigator. AIS targets may be sleeping or activated. Activated targets shall be considered as similar to radar targets.

The total number of displayed AIS targets shall comply with the values given in Table 3.2.25. When the number of targets approaches the limit value, warning alarm shall automatically actuate.

3.2.59 To avoid data overflow on the display, provision shall be made for selecting data on sleeping AIS targets basing on the following criteria: target range, time and distance to the point of closest approach ($D_{CPA}$ and $T_{CPA}$), AIS target class (A, B), etc.

It shall not be possible to remove any AIS target from the display.

3.2.60 The means shall be provided to activate the sleeping AIS targets and to deactivate the earlier activated targets.

<table>
<thead>
<tr>
<th>Tracking time, min.</th>
<th>Measuring accuracy with 95 % probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>for relative heading</td>
</tr>
<tr>
<td>1 (motion trend)</td>
<td>11°</td>
</tr>
<tr>
<td>3 (target motion)</td>
<td>3°</td>
</tr>
</tbody>
</table>

* Whichever is greater.
** See 3.2.59.
Where the radar provides for the zones of AIS target automatic activation, these zones shall coincide with the zones of radar target acquisition for tracking. In addition to the beginning of activation the AIS targets when they entered in an established zone, sleeping AIS target may be automatically activated basing on preset criteria (target range, time and distance of closest approach, AIS target class (A or B)).

3.2.61 AIS target information shall be displayed on the radar as specified in Table 3.2.61.

3.2.62 The symbols for graphic presentation of AIS targets on radar displays shall comply with symbols as specified in the River Register Guidelines P.028-2009.

AIS targets shall be displayed as sleeping by default.

The heading and speed of a tracked radar target or AIS target shall be indicated by a predicted vector of adjustable length. Permanent indication of vector time and stabilization shall be provided.

The fixed common reference point of own ship shall be used for presentation of radar targets and AIS targets on the radar display.

To present activated AIS targets on close range from the own ship, means to present the scaled outline of an activated AIS target shall be provided.

It shall be possible to display the past track of activated AIS targets.

3.2.63 It shall be possible to select any tracked radar or AIS targets for alphanumeric display of this target data. The selected target shall be displayed on the radar by means of the symbol as given in the River Register Guidelines P.028-2009. If several targets data are requested, their identities and their sources (radar or AIS) shall be displayed.

The target message shall include:
- data source (radar or AIS);
- target range;
- target bearing;
- target course over ground;
- target speed over ground;
- distance $D_{CPA}$ and time $T_{CPA}$.

In addition, AIS target heading and rate of turn may be displayed.

For each selected tracked AIS target the following data shall be presented: target identification, navigational status (underway, at anchor, etc.) and position.

 Provision shall be made for displaying other additional data on the navigator's request.

If the received AIS information is incomplete, the missing information shall be indicated as “MISSING” in the target data field.

The data on selected target shall be displayed and continually updated until another target is selected for data display or until the window is closed.

Means shall be provided to present own ship data on the navigator’s request.

<table>
<thead>
<tr>
<th>Table 3.2.61 Presentation of AIS target information on the radar display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function</td>
</tr>
<tr>
<td>AIS on/off</td>
</tr>
<tr>
<td>Targets activation</td>
</tr>
<tr>
<td>$D_{CPA} / T_{CPA}$-based alarm</td>
</tr>
<tr>
<td>Lost target warning alarm</td>
</tr>
<tr>
<td>Combined radar/AIS targets</td>
</tr>
</tbody>
</table>

3.2.64 It shall be possible to select any tracked radar or AIS targets for alphanumeric display of this target data. The selected target shall be displayed on the radar by means of the symbol as given in the River Register Guidelines P.028-2009. If several targets data are requested, their identities and their sources (radar or AIS) shall be displayed.

The target message shall include:
- data source (radar or AIS);
- target range;
- target bearing;
- target course over ground;
- target speed over ground;
- distance $D_{CPA}$ and time $T_{CPA}$.

In addition, AIS target heading and rate of turn may be displayed.

For each selected tracked AIS target the following data shall be presented: target identification, navigational status (underway, at anchor, etc.) and position.

 Provision shall be made for displaying other additional data on the navigator's request.

If the received AIS information is incomplete, the missing information shall be indicated as “MISSING” in the target data field.

The data on selected target shall be displayed and continually updated until another target is selected for data display or until the window is closed.

Means shall be provided to present own ship data on the navigator’s request.
3.2.64 All warning alarms shall be displayed together with indication of their reason.
If calculated values $D_{CPA}$ and $T_{CPA}$ of a tracked radar target or activated AIS target are less than their specified limits, the following shall be provided:
- warning alarm activation based on these criteria;
- indication of targets related to activated alarm.
The preset $D_{CPA}/T_{CPA}$ limits specified for radar targets and AIS targets shall be identical. Alarm functionality shall be applied for all AIS targets.
Alarm functionality may also be applied to sleeping AIS targets, on the navigator’s request.
In case of detecting targets, which were not earlier detected, within the target acquisition and activation zone, these targets shall be identified and a warning shall be generated.
In case of a lost target being tracked, an alarm shall be given. If the target tracked is cancelled by a pre-determined range or other pre-set parameter, an alarm shall not be given. The last position of the lost target or target whose tracking is cancelled shall be indicated on the radar display.
It shall be possible to enable or disable the lost target alarm function for both radar targets and AIS targets. A clear indication shall be given if the target is lost and if the lost target alarm is disabled.
The last position of the lost AIS target shall be clearly indicated on the radar display.
The indication of the lost target shall disappear if the AIS signal is received again, or after the lost target alarm has been acknowledged. Means of recovering limited historical data from previous AIS reports on lost targets shall be provided.
3.2.65 It shall not be possible to have one physical target presented as 2 independent targets (radar target and AIS target).
If the association criteria are fulfilled such that the radar and AIS targets are considered as one physical target, then as a default condition, such target shall be displayed by the activated AIS target symbol and alphanumeric AIS target data.
The navigator shall have the option to change the default condition to display data and shall be permitted to select target data source (radar or AIS).
If the AIS and radar information become sufficiently different, the AIS and radar information shall be considered as two distinct physical targets: one activated AIS target and one tracked radar target shall be displayed. No warning alarm shall be raised.
3.2.66 On ships of 10000 gross tonnage and more the radar system shall be capable of simulating the manoeuvre, namely, shall provide a possibility of simulating the approach situations during the manoeuvre with due regard for own ship’s dynamic characteristics.
This operation mode of the radar shall be clearly identified.
The trial manoeuvre requirements are as follows:
- Own ship heading and speed shall be variable.
- A simulated manoeuvre time and countdown time shall be provided.
- Target tracking and indication of the actual target data.
- Trial manoeuvre shall be applied to all tracked radar targets and all activated AIS targets.
3.2.67 It shall be possible to manually display sketch maps of the navigation area, various navigation lines, own ship courses and geographical position.
It shall be possible to remove this data from the display by navigator’s single action.
The sketch maps may consist of lines, symbols and reference points, which shall comply with the specified requirements.
The displayed additional information shall not degrade the radar information. It shall be retained when the equipment is switched off and restored when a relevant equipment module is replaced.
3.2.68 The radar system may provide the means to display the electronic navigational
chart (ENC) to provide real-time navigation conditions monitoring.

The displayed ENC shall comply with the format set out in national standards and requirements of the International Hydrographic Organization (IHO).¹

It shall be possible to display information derived from ENC updates.

It shall be possible to display ENC by levels or categories of information, but not by individual chart symbols.

ENC shall be displayed in the same datum as the AIS and be referenced to the fixed common reference point of own ship. Scale and orientation of ENC and radar indication shall be identical.

It shall be possible to remove the ENC from display by navigator's single action.

The radar data display shall have priority over all other displayed data. Chart information shall be displayed such that radar information is not obscured or degraded and shall not clearly differ from other data.

Any malfunction of displayed ENC shall not affect the operation of the radar/AIS system.

### 3.2.69 Alarms and indications shall comply with requirements given in 3.1.17.

Alarm shall be provided to alert of “picture freeze”. Failure of any sensor interfaced to the radar, such as gyro compass, log, antenna position sensor, video signal, synchronizing signal, shall be alarmed.

In case of the radar failure, provision shall be made for transfer to available standby means or arrangements shall be made to continue the radar operation with some system functionality limitations.

### 3.2.70 When multiple radars operate jointly, the system shall safeguard against single point system failure.

When an integrated multiple radar system includes components of the same purpose, provision shall be made for switching between them.

The mode used to receive and process the radar information as well as the operational data on system status shall be indicated at each radar position.

#### 3.2.71 The radar system shall be capable of being switched “on” or “off” at the main system radar display or at an additional control position.

The radar control functions may be implemented as an individual control panel or with a programmed access (e.g. on-screen menu) or a combination of these.

The main control functions are as follows:
- radar standby/run;
- range scale selection;
- gain control;
- manual tuning function (if appropriate);
- suppression of rain clutter;
- suppression of sea clutter;
- AIS signal processing on/off;
- alarm acknowledge;
- marker control;
- electronic bearing line control;
- variable range marks control;
- display brightness control;
- radar target acquisition.

The primary functions, in addition to the main system radar display, may be operated at the remote control position.

#### 3.2.72 The radar design shall be so that to provide automatic performance testing and failure diagnosis.

The radar system shall include means to record the total operating hours for equipment and its components with a limited life.

Radar maintenance requirements shall be listed in the technical documentation.

#### 3.2.73 Provision shall be made to switch off automatically high-frequency radiation within the pre-set sectors.

These sectors shall be clearly indicated.

#### 3.2.74 The radar antenna shall be designed to operate reliably in wind speeds likely to be encountered on the class of ship on which it is installed.

Antenna lateral lobes shall comply with the requirements given in 2.7, Part VI of the Rules.

The radar rotation shall be such as to provide information update rate as appropriate for the ship where it is installed, as stated in 2.3.17.

Means shall be provided to stop antenna rotation and electromagnetic radiation.

3.2.75 The radar documents shall contain recommendations on the radar installation.

Measures shall be taken to avoid shadow sectors from right ahead up to relative bearings of 22.5° abaft the beam on each side.

The antenna shall be so located that the ship structures and deck cargo do not reflect electromagnetic radiation.

The antenna shall be located at such a height that to provide target detection at close range in adverse conditions of sea clutter.

The radar display shall be installed so that not to interfere visual observation of the situation ahead and to avoid display glare from light sources in the wheelhouse.

3.2.76 The radar system shall be capable of receiving the required information in NMEA format from:

- gyro compass or heading data transmitter;
- devices measuring speed and travelled distance;
- electronic position-fixing means;
- AIS equipment;
- other devices generating the same data and approved by the River Register.

3.2.77 Means shall be provided in the radar system to preclude the use of invalid data. The data validity shall be identified on the radar display.

The radar shall provide checking the integrity of data from external sensors.

The latency of checking and processing the input data shall not exceed 10 ms.

3.2.78 It shall be possible to provide radar information in standard format to other ship’s systems.

The radar system shall provide radar image output from the display to the voyage data recorder.

At least one isolated normally closed contact shall be provided for indicating general failure of the radar.

The radar shall have a bi-directional interface to the joint systems to facilitate communication so that alarms indicating failure of the radar can be transferred and audible alarms can be remotely muted.

3.2.79 In the event of failure in receiving input data necessary for operation of the radar, there shall be an appropriate indication. In the event of failure of heading indicator, the radar shall be able to continue operation in an "unstabilized heading up" mode.

The stabilization mode shall be changed automatically within 1 min after a failure of the heading indicator.

If automatic anti-clutter sea processing could prevent from detection of targets in the absence of azimuth stabilization, this processing mode shall be disabled automatically within 1 min.

An indication shall be given on the radar display when only relative bearing measurement mode is used.

In the event of failure of the device measuring speed through water, means for manual speed input shall be provided.

In the event of failure of devices measuring speed and travelled distance over ground, the equipment shall be switched to the speed through water sensor.

In the event of failure of electronic position fixing means, ENC shall be displayed if only at least a single reference point with known position is used or if ship position is manually entered.

In the event of failure of radar signal emission and reception equipment, the radar display shall continue to indicate AIS targets.

In the event of failure of AIS input information, the radar display shall indicate the radar video and target database.

In the event of failure of information from other ship’s systems interfaced to the radar, the radar shall keep operating as a standalone system.

3.2.80 The radar design shall include the target simulation function.

3.2.81 The technical documentation package to be supplied by the radar manufacturer
shall comprise the Radar operating manual in Russian, which shall contain the following information:

- recommended control/adjustment settings for different weather conditions and the station operating conditions;
- radar performance characteristics;
- failure procedures and contingency operation procedures;
- limitations of the display and tracking process and accuracy, including any delays in processing and presentation of information;
- using own ship heading and speed over ground/course over ground information for collision avoidance;
- conditions and limitations of target association and separate target presentation;
- criteria of selection for automatic acquisition of AIS targets and cancellation of activation;
- methods and limitations of displaying AIS targets;
- principles underlying the trial manoeuvre technology, including simulation of own ship’s manoeuvring characteristics, if provided
- list of alarms and indications;
- equipment installation and arrangement requirements;
- range and bearing measurement accuracies;
- special radar tuning and operator’s actions, e.g. for detection of SARTs;
- the value of the fixed common reference point of own ship in the information processing and presentation process.

3.2.82 Ship technical documentation shall contain description of radar, including factors affecting its characteristics.

Criteria of target selection and the accepted method of association and separate presentation of AIS and radar targets shall be specified.

Equipment installation and arrangement requirements, as well as factors, which may affect its characteristics, shall be listed in the technical documentation.

Abbreviations used for presentation of operating modes and other information on the radar display shall comply with abbreviations specified in the Russian River Register Guidelines R.028-2009.

3.3 REQUIREMENTS TO MAGNETIC COMPASS

3.3.1 Voltage of the compass main lighting shall not exceed 24 V.

3.3.2 The magnetic compass shall indicate the heading with accuracy:
- underway on calm water 1°
- at motion in any direction with angles of heel up to 22.5° and period of 6–15 sec.
- 5°

3.3.3 The card of the master and steering compasses shall allow for readout with up to 0.5° accuracy. The card scaling factor shall not exceed 1°.

3.3.4 The magnetic compass shall include a damping mechanism to provide the card stability under the ship’s vibrations and a device to maintain normal position of the compass bowl vertical axis.

3.3.5 The gimbaled compass bowl shall maintain its horizontal position when the binnacle is tilting up to 45° in any direction. The card shall remain free when the bowl is tilting in any direction to an angle no less than:
- for gimbaled compasses 10°
- for gimballess compasses 30°

3.3.6 The magnetic compass shall include a device for semicircular, quadrant, heeling and latitude correction. This device shall correct the compass deviation with an accuracy not exceeding 0.2°.

3.3.7 The magnetic compass design shall provide such deviation correction that residual deviation values do not exceed ±3° for the master compass and ±5° for the steering compass.

3.3.8 The magnetic compass shall have a binnacle and electric lighting of the card to make the card divisions visible. In addition to the basic lighting, provision shall be made for emergency lighting and for brightness adjustment function.

3.3.9 The height of binnacle of the master compass shall be such as the compass bowl
glass plane, including the supporting pad, is at a height not less than 1300 mm from the deck.

3.3.10 The master magnetic compass shall be fitted with a locator to take bearings to objects and celestial bodies visible from the ship with a readout accuracy of 0.25°. The locators of a new design shall provide direct taking bearings.

3.3.11 It shall be possible to read correctly the steering compass card at a distance not less than 1.4 m both in natural and artificial light. It is allowed to use magnifying devices.

3.3.12 The electric remote reading magnetic compass shall comply with the requirements given in 3.3.2 – 3.3.10 and shall provide heading to repeaters for indication.

3.3.13 The magnetic system of the master magnetic compass or magnetic sensing units may be used as a sensing element of the electric remote reading compass.

3.3.14 If the magnetic system of the master magnetic compass is used for remote reading, the device used for electric reading transmission to repeaters shall ensure no interferences for location, for heading and bearing readout from the compass card, and for deviation correction.

3.3.15 The sensing element shall include a deviation correction device in accordance with the requirements given in 3.3.6 and 3.3.7. The sensor and the whole electric remote reading system of the magnetic compass shall remain operable under the following ship motion conditions:

1. turning motion at the rate up to 6°/s;
2. yawing with period of 10 to 20 sec. and the greatest deviation from set heading of ±5°.

3.3.16 The difference between the readings of repeaters and the sensing element of the remote reading magnetic compass shall not exceed 1°.

3.3.17 Disabling remote signal transmission or particular repeaters failure shall not affect reading accuracy of the master compass and remaining repeaters.

3.3.18 Provision shall be made for audible alarm to signal a failure of follow-up system in the electric remote reading magnetic compass. The audible alarm shall be energized by a separate circuit.

3.3.19 The package of electric remote reading magnetic compass shall include the annunciator with inscriptions "Repeaters are showing data from the magnetic compass" or "Repeaters are showing data from the gyro-compass".

3.3.20 The optic remote reading magnetic compass shall be designed to display a directly reflected image of the card scale sector with visible graduations on the arc not less than 30°, and the lubber line fixed in the compass bowl casing. The device shall be provided to receive the card scale image from fore and aft sides of the periscope.

3.3.21 The periscope of the optic remote reading magnetic compass's optic path shall be so long as the installation of the compass on the pad, considering the periscope mast passing through the deck, shall allow for the screen location at the helmsman's eye level. Provision shall be made for the screen moving to 100–150 mm up and down from the middle position.

3.3.22 The screen shall be fitted with arrangement to protect it from bright sunlight or any other light, which can glare the card screen image. The screen image shall be visible day and night.

3.3.23 The design of the optic path and the screen shall provide that the image of the card scale sector remains clear during visual taking bearings, and when the compass helmet is closed.

3.3.24 It shall be possible to adjust and lock the screen position.

3.3.25 The optic path shall have at least IP56 protection degree. Measures shall be taken to prevent sweating on the path and
moisture condensation inside it, as well as to provide access to the optics for cleaning.

3.3.26 The boat magnetic compass shall comply with the following requirements:

1. The compass scaling factor shall be 1°, 2° and shall not exceed 5° subject to the card diameter;

2. The compass card shall be fitted with lighting;

3. Provision shall be made for the compass securing arrangement and a storage case;

4. The card diameter shall allow for readout.

3.4 REQUIREMENTS TO GYROCOMPASS

3.4.1 At latitudes up to 60° the gyrocompass mounted on a horizontal and fixed base shall comply with the following requirements:

1. The gyrocompass settling time shall not exceed 6 h;

2. A steady reading accuracy on any heading shall be limited to \( \pm 0.75 \times \sec Lat \), where \( Lat \) = geographic latitude, degrees; the root mean square of differences between particular heading readings and the average heading value shall be less than \( \pm 0.25 \times \sec Lat \);

3. A turn-on reading consistency shall be within \( \pm 0.25 \times \sec Lat \);

4. The compass follow-up rate shall be not less than 6°/sec.

3.4.2 The onboard gyrocompass operating at latitudes up to 60° shall comply with the following requirements:

1. The gyrocompass settling time shall not exceed 6 h under conditions of harmonic rolling and pitching up to 5° with a period of 6 to 15 sec at a maximum acceleration of 0.22 m/sec²;

2. The master compass reading accuracy shall be within \( \pm 1 \times \sec Lat \) under operating conditions subject to modification of the ship’s power mains and variation of magnetic fields on board the ship;

3. Reading accuracy related to quick change of the ship’s speed shall not exceed 2°;

4. Reading accuracy related to a quick 180 degree change of the ship’s heading at a speed up to 36 km/h shall not exceed 3°;

5. Residual error of readings after correction of effects related to speed, heading and latitude, where applicable, at a constant speed up to 36 km/h shall not exceed \( \pm 0.25 \times \sec Lat \);

6. Reading accuracy related to rolling up to 20°, pitching up to 10° and the ship’s yawing up to 5° with a period of 6 to 15 sec with maximum horizontal acceleration not exceeding 1 m/sec² shall not exceed \( \pm 1 \times \sec Lat \);

7. Differences between readings of repeaters and the master gyrocompass shall not exceed 0.5°.

3.4.3 The gyrocompass shall be completed with a heading recorder and a device to correct the compass readings to the ship’s speed and latitude of fix.

3.4.4 The gyrocompass follow-up system shall be designed so as to provide simultaneous operation of own repeaters and heading recorder, as well as repeaters of other navigation equipment.

3.4.5 The heading recorder shall provide timed heading record with an accuracy of 1 %.

3.4.6 The design of repeater cards, locators, lighting and other arrangements shall allow for heading and bearing readout in accordance with the requirements stated in 3.3.2, 3.3.3, 3.3.8 – 3.3.10.

3.4.7 Device for remote transmission of the true heading at latitudes up to 70°, provided that the used sensing element (heading sensor) remains operable under the ship’s operating conditions (including high-speed operation), shall comply with the following requirements:

True heading data shall be transmitted and displayed with an accuracy not exceeding 0.2°;

Static accuracy defined at the ship’s constant speed and direction shall be less than 1.0°;
Dynamic accuracy defined at rolling and pitching, vibration and variation of the ship’s speed shall not exceed 1.5°. If dynamic accuracy range exceeds 0.5°, its oscillation frequency shall be less than 0.033 Hz (with a period not exceeding 30 sec);

Error due to the ship’s heading change shall not exceed:

- 0.5° at heading change rate up to 10°/sec;
- 1.5° at heading change rate from 10 to 20°/sec;

Controls and regulators allowing for changing the true heading data, transmitted by the device, shall be protected from unintended interference;

Provision shall be made for indicating the manual correction input in data transmitted by the device;

Visual and (or) audible alarm shall be provided for warning the device failure and power supply interruption.

3.5 REMOTE HEADING TRANSMITTING DEVICE

3.5.1 The О-ПП, М-ПП and М-СП class ships of gross tonnage from 300 to 500 not fitted with a gyrocompass complying with the international requirements or with a dedicated device for finding and transmission of magnetic heading, shall be fitted with transmitting heading devices to support operation of other navigational equipment.

3.5.2 The remote heading transmitting device shall have performance characteristics conforming to the requirements given in 3.5.4 at least from 70°N to 70°S, if this range is not limited by the selected sensing element (heading sensor).

3.5.3 The remote heading transmitting device shall comply with the operation requirements both for conventional displacement ships and high-speed ships.

3.5.4 Under operating conditions given in the requirements to the heading sensors, the remote heading transmitting device operating together with the relevant sensing element shall provide the following accuracy:

- Heading data shall be converted with an accuracy not exceeding ±0.2°;
- The static error measured at permanent speed and direction of the ship shall not exceed ±1.0°;
- The dynamic error measured under the conditions of vibration, roll, pitch or change of speed shall not exceed ±1.5°. If the amplitude of the dynamic error exceeds ±0.5°, the dynamic error frequency shall not exceed 0.033 Hz (with a period of not exceeding 30 sec).

3.5.5 An alarm shall be provided to indicate a malfunctions of the heading transmitting device or a failure of the power supply.

3.6 REQUIREMENTS TO AUTOPILOT AND DIRECTIONAL STABILIZER

3.6.1 The autopilot and directional stabilizer shall provide that the ship maintains a selected heading with an accuracy not exceeding 1° at a speed ensuring normal ship’s manoeuvrability. Maximum deviation from the set heading shall not exceed ±1° at sea state up to 3, and ±3° at sea state up to 5.

3.6.2 Provision shall be made for automatic ship heading keeping with minimum number of rudder shifts.

3.6.3 Provision shall be made for unintentional power interruption light and audible alarm.

3.6.4 Audible alarm shall be provided to indicate the set heading deviation by ±3°, an alarm response tolerance shall not exceed 1°. In case of adverse weather conditions it shall be possible to shift the alarm threshold value by 6 to 9°.

3.6.5 The circuit and design of autopilot and directional stabilizer shall allow for changing over to manual control of steering gear from any control station in case of any damage of the automatic control system.

3.6.6 Changeover from one type of control to another shall be made by a single action within not exceeding 3 sec.
3.6.7 The autopilot and directional stabilizer control console shall be installed on the manual steering control station to provide their maintenance and switch from automatic to manual control.

3.6.8 The control console combining automatic and manual control shall be installed in the wheelhouse in the centreline plane.

3.6.9 The remote control stations shall be installed on the bridge wings or in other places used for switching to the ship steering from the remote control station.

3.7 REQUIREMENTS TO ECHO SOUNDER

3.7.1 The echo sounder shall be capable of measuring soundings under the ship’s bottom starting from 0.5 m.

3.7.2 The echo sounder shall have:
- shallow-water scale;
- deep-water scale with maximum depth not less than 50 m.

3.7.3 Sounding accuracy shall be not less than:
- 10 cm at depths up to 5 m;
- 2 % of measured depth at depths more than 5 m.

3.7.4 Sounding and sea bottom recording shall be continuous. Soundings shall be presented in two modes:
- graphic data to represent a seabed profile of the ship run with time mark discreteness not exceeding 5 min;
- numeric data to represent an instantaneous depth with values divisible by 0.1 m.

3.7.5 The priority shall be given to the graphical presentation of soundings to represent an instantaneous depth and its visual recording. The displayed record of soundings shall be visible within not less than 15 min.

3.7.6 The echo sounder indications may be recorded on paper tape or other media. Provision shall be made for recording the soundings with time marks for previous 12 h, and for all recorded data retrieval on shore.

3.7.7 The echo sounder shall provide audible and light depth control alarm. Manual setting of depth shall be gradual within the range from 0.5 to 5.0 m or on intermittent basis.

Provision shall be made for making ship draught corrections and sound-in-water speed corrections without stopping the ship or opening the device housing.

3.7.8 The echo sounder shall be switched on by a single action. The echo sounder startup time shall not exceed 30 sec, measuring scales switching shall be simultaneous for graphic and numeric data.

The echo sounder may include one or several emitters. Provision shall be made for indicating the used emitters.

3.7.9 The echo sounder shall be able to operate continuously. Its design shall include audible and light alarm warning on failures affecting displayed data validity.

3.7.10 If the ship design allows for the echo sounder operation as a part of complex navigation systems, the interface with these systems shall be provided by means of standard digital outputs.

3.7.11 It is allowed to operate echo sounders, whose performance characteristics differ from those given in 3.7.1 – 3.7.10 and in 3.7.12 – 3.7.15, for М-СП, М-ПР and О-ПР class ships outside inland waterways.

3.7.12 The echo sounder shall be capable of measuring soundings under the ship’s bottom starting with 1.0 m.

3.7.13 The echo sounder shall have:
- shallow-water scale covering 0.1 of depth range (1 to 20 m);
- deep-water scale with maximum depth not less than 200 m.

3.7.14 Sounding accuracy shall be not less than:
- 50 cm at depths up to 20 m;
- 2.5% of measured depth at depths more than 20 m.

The echo sounder performances shall not degrade at the ship rolling up to ±10° and
pitching up to ±5°. According to technical documentation, some omissions in readings are permissible when the ship is rolling more than 10° and (or) pitching more than 5°, or when the sea bed has rocky or steeply sloping character (over 15°).

3.7.15 The scale of graphic depth displaying shall be not less than:
- 1 m = 5 mm — on the shallow-water scale;
- 1 m = 0.5 mm — on the deep-water scale.

The displayed record of soundings shall be visible within not less than 15 min.

3.8 REQUIREMENTS TO LOG

3.8.1 The log shall continuously record the distance covered by the ship at any speed and continuously display the ship's speed data.

The log transmitting the ship speed data to a radar plotting aid (EPA, ATA, ARPA) and/or to the ship track control system shall be able to measure longitudinal speed through water.

3.8.2 Initial sensitivity of the log shall not exceed 0.2 km/h. The log shall measure the ship’s speed through water with an accuracy not exceeding 2% of actual ship speed or ±0.4 km/h, whichever is greater.

3.8.3 The speed indicators shall be of self-synchronous type. Differences between the ship speed indications from the master device and from repeaters shall not exceed 1.5% of upper limit of speed measured by the log. Differences between indications of travelled distance from repeaters and those from the master device shall not exceed 0.02 km, those between repeaters 0.04 km. The log shall have a sufficient number (not less than number of ship steering stations) of speed and travelled distance repeaters for safe navigation.

3.8.4 The log shall be completed with adjusting arrangements to allow for removing unacceptable errors in their readings after the log is installed on board the ship.

3.8.5 Speed data may be presented both in analog and digital form. Reading increment of the digital indicator shall not exceed 0.1 km/h, that of the analogous indicator with normal scale 0.5 km/h, that of analogous indicator with coarse scale 5 km/h.

3.8.6 Data on covered distance shall be presented in numerical form. The indicator shall cover the range from 0 to at least 9999.9 km with increment not exceeding 0.1 km, it shall have a resetting unit. Scales of the master device and repeaters shall be fitted with adjustable electric highlighting allowing for data readout day and night.

3.8.7 The log shall comply with the following requirements:

.1 Underwater retractable units of the log shall allow for their extending to operating position and retracting inside the hull by a single operator;

.2 The method of attaching the log units to the ship hull, their afloat replacement and possible damage of any part of underwater equipment shall not result in affecting the structural integrity of the ship hull or ingress of water inside it;

.3 If a retractable unit weighs more than 16 kg, its retraction inside the hull shall be provided by means of mechanical arrangements (winches, tackles, hoist blocks) or an arrangement for remote lifting and lowering an underwater part of the log, and control of such arrangement shall be from the wheelhouse. Lifting time shall not exceed 2 min.

An arrangement shall be provided for remote lifting and lowering an underwater unit of the log with control from the wheelhouse. In this case, provision shall be made for relevant limit switches to restraint lifting and lowering of the underwater unit in the retractable bottom arrangement, as well as for the bottom arrangement tightening, and light indication in the wheelhouse to indicate up and down positions of the underwater unit and closed position of the bottom arrangement, if so prescribed by technical documents and if applicable to the log design;

.4 The log shall be completed with a sufficient number of speed and travelled distance repeaters complying with the requirements given in 3.8.3. It is allowed to use speed and
travelled distance repeaters integrated into a single housing.

3.8.8 The log capable of measuring ship’s speed over ground and though the water shall be fitted with an operational switch and an operating mode indicator. The two-component log capable of measuring longitudinal and lateral speeds shall be provided with indication of operating mode and measured parameter.

3.8.9 The primary transducers of the log shall not cause interference for the operation of other ship navigation equipment.

3.9 REQUIREMENTS TO GNSS
GLONASS/GPS RECEIVER

3.9.1 The combined GLONASS and GPS receiver designed for navigation-purpose use on the ships with speed not exceeding 130 km/h (70 knots), shall include at least the following:

.1 antenna to receive GLONASS/GPS signals;
.2 combined GLONASS/GPS receiver and processor;
.3 means to calculate position (latitude, longitude);
.4 controls and interfaces;
.5 position display unit.

3.9.2 GLONASS/ GPS receiver shall provide:

.1 receiving and processing the signals provided by the Standard Positioning Service (SPS) with selective availability and GLONASS ranging code on, as well as calculating the ship’s position latitude and longitude in WGS-84 datum in degrees, minutes, thousandths of a minute and position fix time with regard to Universal Time Coordinated (UTC). Provision shall be made for converting WGS-84 coordinates to PZ-90 coordinates or coordinates of a datum provided in the used navigational chart

The receiver display unit shall indicate the coordinates conversion mode and datum used for displaying the ship’s position, if such function is prescribed by the technical documentation;

.2 operating on GPS L1 frequency signal and C/A code, and GLONASS L1 frequency signal and C code;
.3 the static mode precision such that ship’s antenna position is calculated with accuracy within 35 m for 95 % probability without a differential subsystem and within 10 m for 95 % probability with a differential subsystem and horizontal dilution of precision equal to 4 or positional dilution of precision equal to 6;
.4 the dynamic mode precision such that ship’s position is calculated with accuracy within 35 m for 95 % probability without a differential subsystem and within 10 m for 95 % probability with a differential subsystem and with horizontal dilution of precision equal to 4 or positional dilution of precision equal to 6 subject to sea state and navigation conditions;
.5 the opportunity to select automatically relevant satellites transmitting signals for calculating the ship’s position with an appropriate accuracy and data updating discreteness;
.6 searching and processing the satellite signals at variation of their input carrier frequency level from –130 dBm to –120 dBm. After the signals search being completed, the receiver shall keep working with carrier frequency signals level decreased to –133 dBm;
.7 the opportunity to receive the first measurements of coordinates with an appropriate accuracy within 30 min, if no actual database (almanac) is stored in the receiver memory;
.8 the opportunity to receive coordinates measurements with an appropriate accuracy within 5 min, if the actual database is stored in the receiver memory;
.9 re-searching the signals and calculating the fixed coordinates with an appropriate accuracy within 5 min, in the case, when emission of all GLONASS/GPS signals is interrupted for a period at least 24 h, but without power supply interruption;
.10 re-searching the signals and calculating the fixed coordinates with an appropriate accuracy within 2 min in case of power supply interruptions for up to 60 sec;
.11 re-searching a particular satellite signal and using it for calculating the fixed coordinates within 10 sec after signal locking for up to 30 sec;

.12 calculating the fixed coordinates and new data output to the display unit and interface for marine radio navigational aids with discreteness not exceeding 1 sec;

.13 the minimum resolution of displayed coordinates (latitude, longitude) up to 0.001 min;

.14 calculating, displaying and output to the interface the following: course over ground (COG), speed over ground (SOG) and UTC. The said output data shall have a time mark linked to the ship's position data.

The requirements to the accuracy of the course over ground and speed over ground shall be not less than operational requirements imposed on heading indicators (see 3.3.2) and speed and travelled distance meters (see 3.8);

.15 the opportunity to receive and to process correction signals provided by differential subsystem (DGLONASS/DGPS) complying with recommendations of the International Telecommunications Union (ITU) and national standard1.

3.9.3 The receiver shall provide indication when calculated position does not comply with the operational requirements given in 3.9.2.

3.9.4 The receiver shall provide indication within 5 sec when:

.1 The horizontal dilution of precision exceeds a stated limit value;

.2 New position is calculated within a time period exceeding 1 sec.

In the above cases until normal operation of the receiver is restored, the display unit shall indicate time and position of the last reliable position fix with visual indication of a reason, due to which position fix (calculation) was interrupted.

3.9.5 The receiver shall be provided with alarm warning on failure of position calculation.

3.9.6 The receiver shall provide for indication of differential operating mode, in case of:

.1 receiving the differential correction signals;

.2 including the differential corrections in the displayed ship's position.

3.9.7 The receiver shall provide indication about loss of use (integrity) and critical condition of the differential mode, as well as displaying the differential mode message on the display unit.

3.9.8 The equipment receiving signals from sea beacons transmitting differential corrections provided by GLONASS and GPS global positioning systems, which is designed for navigation-purpose use on the ships with speed not exceeding 130 km/h (70 knots) shall include at least the following:

.1 antenna to receive correction signals from DGLONASS and DGPS sea beacons;

.2 receiver of correction signals from DGLONASS and DGPS sea beacons, and processor;

.3 receiver control and data output interfaces.

3.9.9 The receiving equipment shall provide the following:

.1 receiving and processing the correction signals from DGLONASS and DGPS sea beacons within frequency band of 283.5 to 325 kHz;

.2 availability of means for automatic and manual station selection;

.3 data availability with delay not exceeding 100 ms after the signal receiving;

.4 receiving and processing a signal within not less than 45 sec under atmospheric noise conditions;

.5 availability of nondirectional antenna in the horizontal plane.

3.10 REQUIREMENTS TO GPS RECEIVER

3.10.1 GPS receiver designed for navigation-purpose use on the ships with speed not exceeding 130 km/h (70 knots) shall include at least the following:

.1 antenna to receive GPS signals; 
.2 GPS receiver and processor; 
.3 means to calculate position (latitude, longitude); 
.4 controls and interfaces; 
.5 position display unit and other outputs, if necessary.

3.10.2 GPS receiver shall provide the following:

.1 receiving and processing the signals provided by the Standard Positioning Service (SPS) with selective availability on, as well as for calculating the ship's position latitude and longitude in the World Geodetic System 1984 (WGS-84) datum in degrees, minutes, thousandths of a minute and position fix time with regard to Universal Time Coordinated (UTC). Provision shall be made for converting WGS-84 coordinates to coordinates of the datum in the used navigational chart. If such provision is prescribed by technical documentation, the receiver display unit shall indicate the coordinates conversion mode and the datum used to calculate the ship's position;

.2 operating on L1 (1575.42 MHz) frequency signal and C/A (Coarse/Acquisition) code. It is allowed to operate also on L2 (1227.6 MHz) signal with use of high-precision code P (Precise);

.3 the static mode precision, at which the ship's antenna position is calculated with accuracy within 100 m for 95% probability and with horizontal dilution of precision (HDOP) equal to 4 or positional dilution of precision (PDOP) equal to 6;

.4 the dynamic mode precision, at which the ship's position is calculated with accuracy within 100 m for 95% probability without a differential subsystem and horizontal dilution of precision equal to 4 or positional dilution of precision equal to 6 subject to sea state and navigation conditions;

.5 the opportunity to select automatically relevant satellites transmitting signals for calculating the ship's position with an appropriate accuracy and data updating discreteness;

.6 searching and processing the satellite signals at variation of their input carrier frequency level from –130 dBm to –120 dBm. After the signals search being completed, the receiver shall keep working with carrier frequency signals level decreased to –133 dBm;

.7 the opportunity to receive the first measurements of coordinates with an appropriate accuracy within 30 min, if no actual database (almanac) is stored in the receiver memory;

.8 the opportunity to receive the first coordinate measurement with an appropriate accuracy within 5 min, if the actual database is stored in the receiver memory;

.9 re-searching the signals and calculating the fixed coordinates with an appropriate accuracy within 5 min in the case of signals reception interruption for a period at least 24 h, but without power supply interruption;

.10 re-searching the signals and calculating the fixed coordinates with an appropriate accuracy within 2 min in case of power supply interruptions for up to 60 sec;

.11 calculating the fixed coordinates and new data output to the display unit and interface for marine radio navigational aids with discreteness not exceeding 1 sec;

.12 the minimum resolution of displayed coordinates (latitude, longitude) up to 0.001 min;

.13 calculating, displaying and output to the interface the following: course over ground (COG), speed over ground (SOG) and Universal Time Coordinated (UTC). The said output data shall have a time mark linked to the ship's position data.

The requirements to the accuracy of the course over ground and speed over ground shall be not less than operational requirements imposed on heading indicators and speed and travelled distance meters (see 3.9.2.14);

.14 the opportunity to receive and to process correction signals provided by GPS differential subsystem (DGPS) complying with recommendations of the International Telecommunications Union (ITU) and an appropriate standard of the Radio Technical Commission for Maritime Services (RTCM). If GPS receiver is fitted with a unit for receiving and processing the correction signals from differential subsystem, the precision in
static and dynamic modes shall be not less than 10 m for 95% probability (see 3.10.2.3 and 3.10.2.4).

3.10.3 The receiver shall provide indication when calculated position does not comply with the operational requirements given in 3.10.2.

3.10.4 The receiver shall provide indication within 5 sec when:
- the horizontal dilution of precision exceeds a stated limit value;
- new position is calculated within a time period exceeding 1 sec.

In the above cases until normal operation of the receiver is restored, the display unit shall indicate time and position of the last reliable position fix with visual indication of a reason, due to which position fix (calculation) was interrupted.

3.10.5 The receiver shall be provided with alarm warning on failure of position calculation.

3.10.6 The receiver shall provide indication of differential operating mode, in case of:
- receiving the differential correction signals;
- including the differential corrections in the displayed ship’s position.

3.10.7 The receiver shall provide indication about loss of use (integrity) and critical condition of the differential mode, as well as displaying the differential mode message on the display unit.

3.11 REQUIREMENTS TO GLONASS RECEIVER

3.11.1 GLONASS receiver designed for navigation-purpose use on the ships with speed not exceeding 130 km/h (70 knots), shall include at least the following:
- antenna to receive GLONASS signals;
- GLONASS receiver and processor;
- means to calculate position (latitude, longitude);
- controls and interfaces;
- position display unit.

3.11.2 GLONASS receiver shall provide the following:
- receiving and processing the signals provided by GLONASS Standard Positioning Service, and calculating the ship’s position latitude and longitude in PZ-90 (“Parameters of the Earth 1990”) datum with the position presentation in degrees, minutes, thousandths of a minute and position fix time with regard to Universal Time Coordinated (UTC). Provision shall be made for converting WGS-84 coordinates to PZ-90 coordinates or coordinates of a datum provided in the used navigational chart. If such means are available, the receiver display unit shall indicate the coordinates conversion mode and the datum used for displaying the ship’s position;
- operating under the Standard Positioning Service mode on L1 and C code frequencies;
- the static mode precision, at which the ship’s antenna position is calculated with accuracy within 45 m for 95% probability and with horizontal dilution of precision (HDOP) equal to 4 or positional dilution of precision (PDOP) equal to 6;
- the dynamic mode precision, at which the ship’s antenna position is calculated with accuracy within 45 m for 95% probability and with horizontal dilution of precision (HDOP) equal to 4 or positional dilution of precision (PDOP) equal to 6 subject to sea state and navigational conditions;
- the opportunity to select automatically signals transmitted by a relevant satellite for calculating the ship’s position with an appropriate accuracy and data updating discreteness;
- searching and processing the satellite signals at variation of their input carrier frequency level from –130 dBm to –120 dBm. After the signals search being completed, the receiver shall keep working with carrier frequency signals level decreased to –133 dBm;
- the opportunity to receive the first measurements of coordinates with an appropriate accuracy within 30 min, if no actual database (almanac) is stored in the receiver memory;
8. the opportunity to receive the first coordinate measurement with an appropriate accuracy within 5 min, if the actual database is stored in the receiver memory;
9. re-searching the signals and calculating the fixed coordinates with an appropriate accuracy within 5 min, in the case, when emission of GLONASS signals is interrupted for a period at least 24 h, but without power supply interruption;
10. re-searching the signals and calculating the fixed coordinates with an appropriate accuracy within 2 min in case of power supply interruptions for up to 60 sec;
11. calculating the fixed coordinates and new data output to the display unit and interface for marine radio navigational aids with discreteness not exceeding 1 sec;
12. the minimum resolution of displayed coordinates (latitude, longitude) up to 0.001 min;
13. calculating, displaying and output to the interface the following: course over ground (COG), speed over ground (SOG) and UTC. The said output data shall have a time mark linked to the ship's position data.

The requirements to the accuracy of the course over ground and speed over ground shall be not less than operational requirements imposed on heading indicators and speed and travelled distance meters (see 3.9.2.14);
14. the opportunity to receive and to process correction signals provided by GLONASS differential subsystem (DGLONASS).

If GLONASS receiver is fitted with a unit for receiving and processing the correction signals from a differential subsystem, the precision in static and dynamic modes shall be not less than 10 m for 95% probability (see 3.11.2.3 and 3.11.2.4).

3.11.3 The receiver shall provide indication when calculated position does not comply with the operational requirements given in 3.11.2.

3.11.4 The receiver shall provide indication within 5 sec when:
1. the horizontal dilution of precision exceeds a stated limit value;
2. new position is calculated within a time period exceeding 1 sec.

In the above cases until normal operation of the receiver is restored, the display unit shall indicate time and position of the last reliable position fix with visual indication of a reason, due to which position fix (calculation) was interrupted.

3.11.5 The receiver shall be provided with alarm warning on failure of position calculation.

3.11.6 The receiver shall provide indication of differential operating mode, in case of:
1. receiving the differential correction signals;
2. including the differential corrections in the displayed ship's position.

3.11.7 The receiver shall provide indication about loss of use (integrity) and critical condition of the differential mode, as well as displaying the differential mode message on the display unit.

3.12 REQUIREMENTS TO GALILEO RECEIVER

3.12.1 European GALILEO satellite navigation system receiver designed for navigation-purpose use on the ships with speed not exceeding 130 km/h (70 knots), shall include at least the following:
1. antenna to receive GALILEO signals;
2. GALILEO receiver and processor;
3. means to calculate position (latitude, longitude);
4. controls and interfaces;
5. position display unit.

If GALILEO receiver is a part of the integrated navigation system approved by the River Register, this system shall comply with the requirements given in 3.12.1.3 – 3.12.1.5, and additional means may be not needed.

3.12.2 GALILEO receiver shall provide the following:
1. receiving and processing the signals of measuring the position, speed and time on L1 frequency within the band of 1559 to 1591 MHz for a single-channel receiver, which shall generate sky-wave corrections; or
on L1 and E5a frequencies within the band of 1164 to 1215 MHz and 1559 to 1591 MHz, or on L1 and E5b frequencies within the band of 1164 to 1215 MHz and 1559 to 1591 MHz for a two-channel receiver, which shall provide dual-frequency processing of signals for generating sky-wave corrections.

GALILEO signals may be received and processed on three frequencies: L1, E5a and E5b;

1. calculating the ship's position latitude and longitude in WGS-84 datum with displaying the position in degrees, minutes, thousandths of a minute and position fix time with regard to UTC;
2. the static mode precision, at which the ship's antenna position is calculated with an accuracy within 15 m for 95% probability in the horizontal plane and 35 m for 95% probability in the vertical plane for single-channel receivers operating on L1 frequency; and within 10 m for 95% probability in the horizontal plane and 10 m for 95% probability in the vertical plane for two-channel receivers operating on L1 and E5a frequencies or on L1 and E5b frequencies at positional dilution of precision not exceeding 3.5;
3. the dynamic mode precision, at which the ship's position is calculated with the static mode precision subject to operational conditions;
4. the minimum resolution of displayed coordinates (latitude, longitude) up to 0.001 min;
5. time measuring accuracy within 50 ns from UTC;
6. the opportunity to select automatically relevant satellites transmitting signals for calculating the ship's position with an appropriate accuracy and data updating discreteness;
7. searching and processing the satellite signals at variation of their input carrier frequency level from –128 dBm to –118 dBm.

After the signals search being completed, the receiver shall keep working with signal level decreased to –131 dBm;
8. the opportunity to receive the first measurements of coordinates, speed and time with an appropriate accuracy within 5 min, if no actual database (almanac) is stored in the receiver memory;
9. the opportunity to receive the first measurements of coordinates, speed and time with an appropriate accuracy within 1 min, if the actual database is stored in the receiver memory;
10. the opportunity to re-search signals and to calculate fixed coordinates, speed and time with an appropriate accuracy within 1 min in case of signals reception interruption for a period at least up to 60 sec;
11. calculating the fixed coordinates and new data output to the display unit and interface for marine radio navigational aids with discreteness not exceeding 1 sec, and for high-speed craft not exceeding 0.5 sec;
12. calculating, displaying and output to the interface the following: course over ground (COG), speed over ground (SOG) and UTC with time mark referred to the ship's position.

The requirements to the accuracy of the course over ground and speed over ground shall be not less than operational requirements imposed on heading indicators and speed and travelled distance meters and shall be met under different dynamic conditions of the ship operation (see 3.9.2.14).

3.12.3 In addition GALILEO receiver shall have:
1. output for receiver failure indication;
2. bidirectional interface to allow communications when transmitting receiver alarm to an external system in such a way, that audible alarms can be acknowledged from that external systems;
3. means to process correction signals from GALILEO differential subsystem (DGALILEO), and indicating the reception of DGALILEO signals and their including in calculation of the ship's position.

3.12.4 The receiver shall provide indication about loss of GALILEO system use, when its technical characteristics are beyond the limits imposed by the requirements on conventional navigation in open sea, coastal water, near ports and inland water ways.
3.12.5 GALILEO receiver shall at least:

.1 provide indication, within 5 sec, in case of position calculation failure or, if new position is calculated within a period exceeding 1 sec. In the above cases until normal operation of the receiver is restored, the display unit shall indicate time and position of the last reliable observation with visual indication of a reason, due to which position fix was interrupted;

.2 use the receiver autonomous integrity monitoring (RAIM) to ensure integrity of technical characteristics complying with the implemented task.

3.12.6 In receivers processing the signals from the Safety of Life Service (SOL), integrity monitoring and notification algorithms shall be based on combination of GALILEO integrity message and the receiver autonomous integrity monitoring.

The receiver shall supply alarm within 10 sec from start of the event, if error threshold in the horizontal plane is exceeded by 25 m within more than 3 sec.

Event detection probability shall be over 99.999% for a three hour period (integrity risk not exceeding $10^{-5}/3$ h).

3.13 REQUIREMENTS TO RATE-OF-TURN INDICATOR

3.13.1 The rate-of-turn indicator shall comply with the requirements given in 1.3.1 and shall indicate rate and direction (starboard or port) of ship turning.

3.13.2 The rate-of-turn indicator may be a separate device or a part of other equipment or may receive data therefrom.

3.13.3 The rate-of-turn indicator shall not result in performance degradation of other equipment, to which it is connected, whether it is switched on or off.

3.13.4 Indicators and controls shall have highlighting with smooth adjustment of light brightness and allowance for its switching off at minimum brightness level position.

3.13.5 Provision shall be made for use of the rate-of-turn indicator both under automatic and manual control of the ship's motion.

3.13.6 If the rate-of-turn indicator goes outside the range of specified measuring accuracy, the warning alarm shall automatically switch on.

3.13.7 Provision shall be made for the external signalling connector to output signals in the following case:

.1 the rate-of-turn indicator is off;

.2 the rate-of-turn indicator fails;

.3 activating alarm warning on accuracy degradation exceeding admissible limits.

3.13.8 With regard to the Earth rotation influence, the indicated rate of turn shall not differ from the actual ship's rate of turn by more than 0.5°/min. +5% of the measured value.

3.13.9 The rate-of-turn indicator shall remain serviceable during the ship yawing in waves.

The indicator readings shall not differ from the mean actual rate of turn by more than 0.5°/min. at the ship rolling with an amplitude of ±5° and a period of 25 sec, and at the ship pitching with an amplitude of ±1° and a period of 20 sec.

3.13.10 The rate-of-turn indicator shall be ready for operation within 4 min from its activation. Provision shall be made for indication of its activation.

3.13.11 Rate of turn shall be displayed by means of a dial analog indicator with the top position of zero. It is allowed to use dials with alphanumerical characters. In any case the direction of turn shall be indicated.

3.13.12 The ship's turn to port shall be indicated to the left of the zero point, turn to starboard – to the right of the zero point. If actual rate of turn exceeds the dial limits, it shall be displayed on the indicator.

3.13.13 The dial size to every direction from zero shall be not less than 120 mm. The system shall have such sensibility that variation of rate of turn by 1°/min. corresponds to not less than a 4 mm interval on the dial.
3.13.14 Provision shall be made for a linear scale with a measuring range not less than ±30°/min. This scale shall have a factor of 1°/min. to each direction from zero and numerical characters every 10°/min. Each mark of 10°/min. shall be much longer than the mark of 5°/min., which in turn shall be longer than the mark of 1°/min. Marks and digits shall be red or white on black background. It is allowed to use extra linear scales.

3.13.15 Provision shall be made for adjustable damping of rate-of-turn indicator allowing for time constant variation range from 0 to 10 sec.

3.13.16 The rate-of-turn indicator units shall be supplied from the main and emergency power sources.

3.14 REQUIREMENTS TO PRESENTATION OF NAVIGATION-RELATED INFORMATION ON SHIPBORNE NAVIGATION DISPLAYS

3.14.1 If the display is multifunctional, provision shall be made for clear indication of its operating mode and primary function (radar, Inland ECDIS, ECDIS).

3.14.2 If an electronic navigation chart and radar image of environmental conditions are displayed together, both images shall use a fixed common reference point and match in scale, projection and orientation. Any mismatch shall be indicated.

3.14.3 The following range scales shall be provided on the display: 0.25, 0.5, 0.75, 1.5, 3, 6, 12 and 24 nm. Other range scales may also be provided. Actual range scale shall be indicated.

3.14.4 When range rings are displayed, the scale of each ring shall be indicated.

3.14.5 Only navigational information shall be permanently displayed in the range of the operational display area. Information windows, menus and other auxiliary information may be displayed only as a provisional measure for a period set by the navigator.

3.14.6 Radar display, tracked radar targets and Automatic Identification System (AIS) targets shall not be substantially degraded, masked or obscured by other presented information.

3.14.7 It shall be possible to temporarily suppress all graphic information from the display, retaining only radar image and target trails for a period set by the navigator.

3.14.8 The brightness of radar echoes and associated graphic symbols for tracked radar targets shall be variable.

It shall be possible to control the brightness of all displayed information. Brightness of graphics and alphanumeric data shall be controlled separately.

The brightness of the lubber line shall not be variable to complete extinction.

3.14.9 If the radar indicates vector chart data, it shall be possible to select separately elements of standard electronic navigation chart basing on categories or levels but not by individual chart symbols. The chart information shall be displayed complying with the operational requirements to the Inland ECDIS/ECDIS and the requirements of this Chapter.

3.14.10 When the electronic navigational chart is displayed on the radar presentation, its status, the source of updating and source of information shall be permanently indicated. Here, the radar information shall have priority.

3.14.11 The ENC graphic may be presented on the radar display, but it shall not substantially degrade, mask or obscure the radar image, tracked radar targets and AIS targets.

3.14.12 The electronic navigational chart and all updates to it shall be presented on the ECDIS display without any degradation of their information content.

3.14.13 Chart information shall not be substantially degraded, masked or obscured by other presented information.
3.14.14 It shall be possible to temporarily suppress all supplemental information from the display, retaining only ENC related information contained in the base of the display unit of the Inland ECDIS/ECDIS for a period set by the navigator.

3.14.15 It shall be possible to select a safe depth contour from the contour database provided by the electronic navigational chart. This selected safety depth contour shall be highlighted on the display.

3.14.16 It shall be possible to select a safety depth from the spot soundings presented on the chart. Soundings equal to or less than the safety depth shall be highlighted.

3.14.17 An indication shall be provided if the information is displayed at a larger scale than that contained in the ENC, or if own ship’s position is covered by an ENC of a larger scale than that provided by the display.

3.14.18 Overscaled areas displayed on the Inland ECDIS/ECDIS shall be identified.

3.14.19 Radar and target information displayed on the Inland ECDIS/ECDIS shall not substantially degrade, mask or obscure the chart information. Radar and target information shall be presented in accordance with the radar operational requirements and the requirements of this chapter.

3.14.20 Radar and target information shall be clearly distinguishable from the chart information. It shall be possible to remove this information by navigator’s single action.

3.14.21 Information from additional sources may be displayed on ECDIS but shall not substantially degrade, mask or obscure the chart information.

3.14.22 Additional information shall be distinguishable from the chart information. It shall be possible to remove this information by navigator’s single action.

3.14.23 It shall be possible to present information in any form at the navigator’s option. In this case it shall be possible for the navigator to present a composite radar and chart display with entering own ship’s data.

3.14.24 The form of information presentation shall comply with the requirements to radar (see 3.2) or chart information\(^1\). Presentation exceptions are referred to the sizes of presented area, as well as to windows and incuts of images of particular water area sections.

3.14.25 It shall be possible to adjust the contrast and brightness of the display as applied to the lighting conditions in the wheelhouse.

3.14.26 Provision shall be made for protecting the display from electromagnetic field effect at its location with regard to the requirements given in 2.7 Part VI of the Rules.

3.14.27 The operational display area of the chart presentation for in-route plotting shall be at least 270 × 270 mm.

3.14.28 The operational display area of the radar presentation shall be at least a circle of diameter of:

- 180 mm for ships with gross tonnage less than 500;
- 250 mm for the ships of gross tonnage more than 500 and high-speed craft of gross tonnage less than 10000;
- 320 mm for ships with gross tonnage more than 10000.

3.14.29 Displays intended for navigation information presentation shall be multicoloured, except where monochrome displays are permitted by the Rules.

3.14.30 Multicoloured displays including multifunction displays shall provide not less than 64 colours. Displays of logs, echo sounders and GNSS receivers may provide for presentation in less number of colours.

3.14.31 Displays mounted in the wheelhouse shall provide a minimum resolution of 1280 × 1024. For displays of particular devices, such as log, echo sounder and GNSS

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receivers, it is permitted to use the displays with less resolution.

3.14.32 The display shall support the reading of information simultaneously by at least two navigators, from standing and sitting positions under all lighting conditions in the wheelhouse.

3.14.33 The presentation of navigation information shall be consistent with respect to the equipment purpose prescribed by its technical documentation and to the place of display installation at the steering station according to 2 of this Part of the Rules.

3.14.34 Information and functions of controls shall be grouped according to purpose and approved technical documentation. To outline the priority information, sizes and colour of the image as well as its arrangement on the display shall be used.

3.14.35 The presentation of navigation information shall combine particularly the following data: a parameter, its measurement unit, information purpose and source, validity and integrity of displayed information.

3.14.36 The presentation of information shall be separated into an operational display area (e.g. chart, radar) and one (or more) user dialogue areas (e.g. menus, information data, control functions).

3.14.37 The presentation of alphanumeric data, text, symbols or other graphical information (e.g. radar image) shall support readability from typical user positions under all ambient light conditions likely to be experienced in the wheelhouse, and with due consideration to the night vision of the officer on watch.

3.14.38 Alphanumeric data and text shall not be presented using italic font. The font size shall be appropriate for the viewing distance from operating workstations in the wheelhouse.

3.14.39 Text shall be presented with no distortions.

3.14.40 In case of using a single display for information from navigation systems and equipment, alarms and indications presentation shall be consistent with regard to presentation of time, reason and source of alarm, as well as to current alarm state (e.g. acknowledged, unacknowledged).

3.14.41 The colours of alphanumeric characters, text, symbols and graphical information presented on the displays shall be contrast against the background under all lighting conditions in the wheelhouse.

3.14.42 It shall be possible to adjust the contrast, colour and brightness of the display as applied to the lighting conditions in the wheelhouse day, night and at twilight. At night information shall be presented on a dark matt background with highlight.

3.14.43 The background colour and contrast shall not affect colour and legibility of the displayed information.


Symbols used for presentation of chart information shall comply with symbols stated by International Hydrographic Organization (IHO).

3.14.45 Information may be coded using image colours. In such cases, the colour of different groups shall differ from each other.

3.14.46 The red colour shall be used for coding of alarm and emergency related information.

3.14.47 Colour coding shall be used in combination with changing in size, form and orientation of symbols.
Table 3.14.52

<table>
<thead>
<tr>
<th>Status</th>
<th>Alarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm unconfirmed</td>
<td>Red flashing</td>
</tr>
<tr>
<td>Alarm confirmed</td>
<td>Red</td>
</tr>
<tr>
<td>Critical alarms/warnings, e.g.</td>
<td>Yellow</td>
</tr>
<tr>
<td>invalid information</td>
<td>Not applicable (if any, green colour to be used)</td>
</tr>
<tr>
<td>Normal state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Attending</td>
</tr>
<tr>
<td></td>
<td>Acknowledged</td>
</tr>
<tr>
<td></td>
<td>Silence or short signal, unless</td>
</tr>
<tr>
<td></td>
<td>otherwise specified</td>
</tr>
<tr>
<td></td>
<td>Silence</td>
</tr>
</tbody>
</table>

3.14.48 For unacknowledged alarms information shall be displayed with flashing symbols.

3.14.49 The source, validity and, where possible, the integrity (completeness index) shall be indicated for each type of information. Invalid information shall be appropriately marked.

3.14.50 When colour coding is used, incomplete information shall be qualitatively marked by using yellow, and invalid information shall be qualitatively marked by using red.

3.14.51 Means shall be provided to immediately make the navigator aware of a presentation failure.

3.14.52 The operational status of displayed information shall comply with the requirements specified in Table 3.14.52.

3.14.53 Emergency and accident alarms, as well as event sequence shall be indicated in the alarm list. It shall be possible to set the priority of alarms received from multiple sources. Alarms that have been acknowledged shall be deleted from the list of alarms, but may be retained in an alarm history list.

3.14.54 When a single display is used to present information from multiple navigation systems and equipment, provision shall be made for consistent indication of the time of alarm occurrence, the cause of the alarm, the source of the alarm and the status of the alarm (e.g. acknowledged, not acknowledged) on the display.

3.14.55 Provision shall be made for presentation of own ship position data by means of a scaled conventional symbol or an unscaled symbol specified in the River Register Guidelines P.028-2009. The size of conventional symbol shall be consistent with the scale of navigational chart or be equal to 6 mm, whichever is greater.

3.14.56 The heading line or its displacement vector, shall originate at the position of the fixed common reference point of own ship.

3.14.57 The presentation of chart information published by a duly authorized organization (state hydrographic services or other authorized organizations) shall comply with the relevant national standards and IHO requirements.

3.14.58 Presentation of additional chart information shall comply with 3.14.57. There shall be a clear indication when the presentation is not in accordance with these requirements.


3.14.60 When data derived from different scale charts appear on the display, the boundary of such data shall be indicated.

3.14.61 The radar image shall be displayed using a basic colour (set by the manufacturer) to provide contrast image. Radar target echoes shall be visible on the electronic navigational

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1 GOST R IEC 61174:2001 (IEC 61174:2001),
GOST R IEC 62376:2010 (IEC 62376:2010),
chart background. The strength of echoes may differ by tones of the same basic colour. Provision shall be made for changing the basic colour according to the lighting conditions in the wheelhouse.

3.14.62 Target trails shall be distinguishable from true targets and clearly visible under all lighting conditions in the wheelhouse.

3.14.63 Target information may be provided by radar tracking and/or by reported target information from the AIS.

3.14.64 Tracking radar targets and AIS targets shall be carried out in compliance with the requirement to radars as specified in these Rules. The presentation of tracked radar and AIS targets shall comply with the requirements of this Chapter.

3.14.65 Interface protocols and format of radar and AIS target data shall comply with national and international standards.

3.14.66 There shall be an indication when the tracked and processed radar and/or AIS target capacity is about to be exceeded.

3.14.67 There shall be alarm signal when the tracked and processed radar and/or AIS target capacity has been exceeded.

3.14.68 Provision shall be made for specifying criteria to activate/filter the sleeping AIS targets. These criteria may be as follows: target range, time and distance to the point of closest approach \((D_{CPA} \text{ et } T_{CPA})\), class of AIS target \((A, B)\), etc.

3.14.69 If sleeping AIS targets are processed using such a filtering, constant indication shall be provided (see 3.14.68). The navigator shall be allowed to set target filtering criteria.

3.14.70 It shall be possible to remove individual AIS targets from the display.

3.14.71 If zones for the automatic activation of AIS targets are provided for the radar, they shall be the same as for automatic radar target acquisition, if available. Any defined zones shall be presented graphically on the display.

3.14.72 Sleeping AIS targets shall be automatically activated when navigating defined parameters (e.g. target range, CPA/TCPA or AIS equipment class).

3.14.73 AIS information shall be graphically presented either as activated or as sleeping targets. Target symbols shall comply with the symbols prescribed by the River Register Guidelines P.028-2009.

3.14.74 Course over ground and speed of tracked radar targets or AIS targets shall be indicated by vectors, which clearly shows the predicted motion. These vectors shall refer to the same time intervals for all the targets regardless of their source.

3.14.75 The presentation of vector symbols shall be consistent irrespective of the source of information. The vector presentation mode shall permanently indicate: operating mode (true / relative motion), stabilization mode (over ground / through water), time interval corresponding to vector length.

3.14.76 The orientation of the AIS target symbol shall indicate its heading. If the heading information is not received, the orientation of the AIS symbol shall be aligned to the course.

When the rate of turn and/or the turning direction are reported from the AIS, the manoeuvre of an activated AIS target shall be displayed.

3.14.77 A fixed common reference point shall be used for the referencing tracked radar/AIS targets and other information on the same display.

3.14.78 On large scale/low range displays, means to present a scaled outline of an activated AIS target shall be provided.

3.14.79 It shall be possible to display the past track of activated AIS targets.

3.14.80 A target selected for the display of its alphanumeric information shall be identi-
3.14.81 When data are presented on the display, provision shall be made for indication of the target status (AIS, radar, combined).

3.14.82 For each tracked radar target selected by the navigator the following data shall be presented in alphanumeric form: source (sources) of data, calculated range of target, calculated bearing of target, predicted target range and time to the closest point of approach, true heading of target, true speed of target. Additional target information shall be provided on request of the navigator.

3.14.83 For each selected AIS target, the following data shall be presented in alphanumeric form: source of data, ship’s identification, position and its quality, calculated range of target, calculated bearing of target, predicted target range to the closest point of approach, course over ground, speed over ground, operational state, target heading and rate of turn. Additional target information shall be provided on request of the navigator.

3.14.84 If the received AIS information is incomplete, the source of the missing data shall be indicated in the target data field.

3.14.85 Target data shall be continually displayed and updated, until another target is selected for data display or until the target data window is closed.

3.14.86 Means shall be provided to present own ship AIS data on request of the navigator.

3.14.87 The alphanumeric displayed data shall not obscure graphically presented information.

3.14.88 A clear indication of the status of the alarms and of the alarm criteria shall be given.

3.14.89 If CPA/TCPA is less than that determined by the navigator, provision shall be made for indication of dangerous radar target or AIS target. In such a case, the target shall be marked by symbol “Dangerous target”.

3.14.90 If the navigator has defined a radar target acquisition zone / AIS target activation zone, the targets entering this zone and the zone itself shall be indicated with the relevant symbol prescribed by the River Register Guidelines P.028-2009, and an alarm shall be given.

3.14.91 If an AIS target has been lost, its last position shall be clearly marked with a special symbol “Lost target”. The lost target alarm shall be given. If the tracking the previously lost target is resumed, that symbol shall be automatically replaced with a normal one. Acknowledgment of alarm shall cause removal of “Lost target” symbol from the display. There shall be a clear indication whether the lost target alarm function for AIS targets is enabled or disabled.

3.14.92 Two target symbols for the same physical target shall never be presented on the display. If data on the tracked radar targets and activated AIS targets are same, the activated AIS target symbol and alphanumeric data of this target shall be automatically displayed.

The navigator shall have an opportunity to change conditions of radar and AIS information association and to choose target presentation as from radar station data or from AIS reports.

3.14.93 If the tracked radar target and the activated AIS target are identified as two distinct targets (data do not match), such targets shall be displayed by different symbols. No alarm shall be activated.

3.14.94 The operational status of AIS information shall be presented in compliance with the requirements specified in Table 3.14.94.

3.14.95 A trial manoeuvre simulation shall be clearly identified by the relevant symbol positioned astern of own ship within the operational display area of the screen as prescribed by the River Register Guidelines P.028-2009.
3.14.94 Requirements to AIS information presentation

<table>
<thead>
<tr>
<th>Function</th>
<th>AIS operation mode</th>
<th>Information presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS on/off</td>
<td>AIS data processing is on</td>
<td>Alphanumeric or graphical</td>
</tr>
<tr>
<td>Off</td>
<td>Graphic</td>
<td></td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td></td>
</tr>
<tr>
<td>Sleeping AIS targets filtering</td>
<td>Filter status</td>
<td></td>
</tr>
<tr>
<td>Activation of AIS targets</td>
<td>—</td>
<td>Graphical</td>
</tr>
<tr>
<td>—</td>
<td>Activation criteria</td>
<td></td>
</tr>
<tr>
<td>$D_{CPA}$ / $T_{CPA}$ alarm</td>
<td>$D_{CPA}$ / $T_{CPA}$ criteria</td>
<td>Alphanumeric or graphical</td>
</tr>
<tr>
<td></td>
<td>Sleeping targets are activated</td>
<td></td>
</tr>
<tr>
<td>Lost target alarm</td>
<td>Function on/off</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$D_{CPA}$ / $T_{CPA}$ criteria</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lost target filter criterion</td>
<td></td>
</tr>
<tr>
<td>Radar and AIS target association</td>
<td>Function on/off</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Combined targets criterion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Default priority of target</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alphanumeric</td>
<td></td>
</tr>
</tbody>
</table>

3.15 REQUIREMENTS TO THE ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEM FOR INLAND NAVIGATION (INLAND ECDIS)

3.15.1 Inland ECDIS shall be capable of displaying all chart information prepared by an authorized organization in order to enhance navigational safety and to solve navigation tasks.

3.15.2 Inland ECDIS shall automatically generate alarms and indications related to displayed data or equipment failures as specified in Table 3.15.2.

3.15.3 For ships with gross tonnage of 1000 and more and for ships engaged on international voyages regardless of their gross tonnage, the size of the chart presented for voyage monitoring shall be not less than $270 \times 270$ mm, for ships with gross tonnage less than 1000, not less than $180 \times 180$ mm.

3.15.4 The display of Inland ECDIS shall provide the following:

1. number of colours — not less than 64;
2. resolution — not less than $1280 \times 1024$;
3. readout distance — not less than 1 m.

3.15.5 The following measurement units shall be adopted in the Inland ECDIS:

1. position — latitude and longitude in degrees, minutes, and tenths, hundredths and thousandths of a minute and/or in degrees and tenths and thousandths of a degree;
2. depth — meters and tenths of a meter;
3. height— meters and tenths of a meter;
4. range — nautical miles and tenths, hundredths and thousandths of a nautical mile and/or kilometres and tenths, hundredths and thousandths of a kilometre, or meters;
3.15.6 Information displayed on the screen shall be visible by at least two observers both by day and by night. It shall be possible to control brightness. Inland ECDIS shall provide at least two colour sets to display the chart and additional information by day and by night. Colour switching and brightness control shall not result in exit from the operation mode.

3.15.7 Whatever mode is selected, Inland ECDIS shall continuously display the following information:

- indicator of ship’s position fixing methods;
- current time and date;
- number of displayed ENC or number of volume and sheet;
- incoming ship’s position coordinates and correction indicator;
- ship’s course and speed over ground coming from a positioning system;
- heading;
- speed;
- depth;
- current scale;
- latest update date.

3.15.8 Inland ECDIS shall provide continuous direct-to-scale chart display with filling all operational display area with data from the available ENC database at any ship’s speed with screen redrawing time of 5 s max.

3.15.9 Inland ECDIS shall display all the SENC information.

3.15.10 SENC information available for display during route planning and ship voyage monitoring shall be divided into the following categories: display base, standard display, and other information.

3.15.11 The display base chart data shall include the following:

- shore line;
- dangerous depth contour for own ship, which shall be determined by the navigator;
- indication of isolated underwater dangers with depth values that are less than depth of dangerous depth contour;
- indication of isolated dangers, including bridges, antenna cables, etc. located within the safe depth area defined by the dangerous depth contour. Buoys and beacons also belong to such dangers whether they are used as aids to navigation or not;
- traffic regulation systems (crossing, a route segment where passing and overtaking of convoys and bulky ships are prohibited, one-way route segment, controlled route segment, etc.);
- units of measurement of height and depth;
- scale, orientation, and presentation mode.

3.15.12 Inland ECDIS shall present the standard display on the navigator’s request by his/her single action. When a chart is displayed for the first time, Inland ECDIS shall provide the standard display in the largest scale available in SENC for a navigation area. The standard display chart data shall include:

- display base;
- area of depths, including a tidal line;
- indication of fixed and floating aids to navigation;
- boundaries of fairways, traffic lanes, etc.;
- visual and radar references;
- roads;
- chart scale boundaries;
- indication of caution symbol.

3.15.13 Other information which shall be displayed on the navigator’s request:

- depth marks;
- submarine cables and pipelines;
- ferry routes;
- details of all isolated dangers;
- details of aids to navigation;
- contents of cautions;
- ENC publication date;
- geodetic datum;
- magnetic variation;
3.15.14 It shall be possible for the navigator to select a dangerous depth contour from among depth contours available in SENC. Inland ECDIS shall highlight the dangerous depth contour over other depth contours on the screen.

3.15.15 It shall be possible for the navigator to select a dangerous depth. Whenever depth marks are selected for display, Inland ECDIS shall highlight depth marks which are equal to or less than the dangerous depth set by the navigator.

3.15.16 ENC information and all update data shall be displayed on the screen with no distortions. It shall be possible to check loading of ENC data and update information into the SENC database.

3.15.17 Manual update data and data entered by the navigator shall be distinguishable from other displayed information.

3.15.18 Radar and other navigational data shall not degrade SENC information contents and shall be distinguishable from it.

3.15.19 If manual input of data referred to a datum other than the ENC datum is needed (manual update, user’s objects), Inland ECDIS shall save entered coordinates and datum attribute, but it shall display them in the chart datum.

3.15.20 The displayed radar information shall meet the following requirements:

- The radar picture and the chart picture shall have the same scale and orientation;
- The radar picture and the position received from a position fixing means shall both be adjusted automatically for antenna offset from the ship steering position (radar and respective receiver antennas);
- It shall be possible to manually match the radar picture to the chart picture;
- It shall be possible to delete the radar picture by navigator’s single action;

3.15.21 Possibility of “north up” and “heading up” orientation of SENC picture shall be provided. Other display modes are permitted.

3.15.22 Inland ECDIS shall provide the following chart and overlaid object display modes:

- “True motion” when the ship’s symbol moves against non-moving chart background within the current screen area;
- “Relative motion” when the ship’s symbol is kept within the centre of the screen or an assigned point of the screen area, and the chart with overlaid information moves synchronously with the ship motion.

The “north up” and “heading up” chart orientation shall be possible for each mode.

3.15.23 Switching to the next screen area display and preparation of this picture shall take place automatically: within the screen redraw cycle in the relative motion mode or when the ship’s symbol approaches the screen edge at a distance set by the navigator in the true motion mode.

3.15.24 It shall be possible to manually replace the chart being used and change the own ship’s position relative to the screen edge.

3.15.25 Inland ECDIS shall be capable of displaying ENC in scales complying with standard navigational chart scales from 1:500 to 1:200,000,000.

3.15.26 It shall be possible to increase and decrease the standard scales. Here, present and initial scales shall be indicated.

3.15.27 Inland ECDIS shall provide indication when:

- Information is displayed in a scale exceeding two-fold ENC scale;
- The ship’s position is covered by ENC data in a scale larger than the display scale.
ENC data and update representation shall conform to the national standard requirements to colours, signs and symbols and shall be distinguishable from the following displayed navigational elements and parameters used in Inland ECDIS:

1. own ship symbol: past track with time stamps according to the primary navigation means; past track with time stamps according to auxiliary navigation means;
2. true vector of heading and speed (over ground);
3. variable range mark and/or electronic bearing line;
4. cursor;
5. “Event” symbol: dead reckoned time and position; estimated time and place;
6. position coordinates and time;
7. danger highlighting;
8. clearing line;
9. reference point;
10. travelled distance;
11. planned heading and speed;
12. planned position with date and time;
13. boundaries of visibility of lights;
14. position and time of turn;
15. left and right edges of navigable pass.

SENC information displayed in the original ENC scale shall use sizes of symbols, figures and letters specified by the national standard mentioned in the footnote to 3.14.24.

Inland ECDIS shall allow the navigator to select whether the own ship is displayed in a scale of currently used chart or as a symbol.

In Inland ECDIS shall use the official ENC of the latest edition with all issued updates created by the authorized agency and complying with the national (international) standard requirements.

It shall be possible to prevent from making changes to ENC contents.

ENC updates shall be stored separately from ENC.

Inland ECDIS shall enable automatic and manual input of SENC update data. By whatever means updates are transmitted to Inland ECDIS, its input procedure shall not affect the chart display process.

Inland ECDIS shall record all update data, including time of inputting them into SENC.

Inland ECDIS shall allow the navigator to display updates to read their contents and to ensure that they have been entered into SENC.

It shall be possible for the navigator to plan a route and monitor the ship motion.

It shall be possible to carry out the preliminary plotting, including straight and curved route segments displayed in the present display scale.

It shall be possible to change the planned route, for example, by:

1. adding waypoints and reference points;
2. deleting waypoints and reference points;
3. changing position of waypoints and reference points;
4. changing sequence of waypoints and reference points.

It shall be possible to plan a reserve route together with the primary one. The route selected by the navigator shall be distinguishable from all other routes.

If the navigator plots a route through the dangerous depth contour, Inland ECDIS shall provide an appropriate indication.

If the navigator plots a route through the boundary of a prohibited area of navigation or a geographical area, in which special conditions of navigation exist as defined in 3.15.43, Inland ECDIS shall provide an appropriate indication.

Areas for which special conditions of navigation exist:

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.1 area of cables;
.2 area of aerial crossings;
.3 area of pipelines;
.4 area of anchorage;
.5 area where anchorage is prohibited;
.6 deepened area (split);
.7 restricted navigation area;
.8 caution area;
.9 prohibited fishing area;
.10 fishing area;
.11 prohibited passage and overtaking area.

3.15.44 It shall be possible for the navigator to set a limit for possible deviation of the ship from the planned route, which, when reached, shall automatically activate the deviation signal.

3.15.45 When the ship motion is monitored, the chart shall display the selected transit route and the ship’s position.

3.15.46 When the ship motion is monitored, it shall be possible to display any segment of inland waterway which does not show the ship’s position (for example, during analysis of a forthcoming transit route segment, transit route planning, etc.). If it takes place on the screen of the display, which is used for monitoring the ship motion, automatic monitoring functions (for example, current ship’s position fixing, signal generation and indication) shall not be interrupted. It shall be possible to switch to the current ship’s position display mode by navigator’s single action.

3.15.47 Inland ECDIS shall generate a warning signal or indication to inform that in a definite time set by the navigator the ship will cross the dangerous depth contour, boundary of prohibited navigation area, geographical area in which special conditions of navigation exist as defined in 3.15.43, or will reach the navigator-specified distance to the specified limitations.

3.15.48 If the ship deviation from the planned route exceeds the tolerance set by the navigator, a warning signal with indication of deviation side shall be generated.

3.15.49 The displayed ship’s position shall be derived from continuous position fixing performed by a system whose accuracy is consistent with the safe navigation requirements. If the ship design allows for a second independent position fix system, Inland ECDIS shall be capable of identifying discrepancies in position finding between the two sources.

3.15.50 Inland ECDIS shall provide indication if input from any connected positioning system is lost.

3.15.51 Inland ECDIS shall generate a warning to inform that the ship will, after a definite time or distance set by the navigator, reach a reference point on the planned route.

3.15.52 The coordinates received by the navigation equipment and ENC coordinates shall be presented in the same geodetic datum. If this requirement is not met, Inland ECDIS shall generate a warning signal.

3.15.53 It shall be possible to display a reserve route in addition to the selected route. The selected route shall be distinguishable from the other routes. While navigating, the navigator shall be enabled of changing the selected transit route or switching to the reserve route.

3.15.54 It shall be possible to display:
.1 time stamps on ship track line applied manually or automatically at interval of 1 to 120 minutes as specified by the navigator;
.2 appropriate number of points, bearing lines, variable and fixed range rings and other symbols required for navigating purposes and specified in 3.15.28.

3.15.55 It shall be possible to input geographical coordinates of any point and display them on demand. It shall be possible to select any point (mapped objects, symbols or ship’s position) on the display screen and read its geographical coordinates on the navigator’s request.

3.15.56 It shall be possible to manually correct the ship’s position. Manual correction data shall be displayed alphanumerically on the screen and maintained until altered by the operator and automatically recorded in Inland ECDIS.
3.15.57 When the ship crosses the navigable pass edge, Inland ECDIS shall generate a warning signal.

3.15.58 When generating all signals and indications about crossing a safety depth contour and entry into a prohibited area, as well as signals and indications listed in 3.15.2, Inland ECDIS shall use the navigation area charts of the largest scale available in SENC.

3.15.59 Inland ECDIS shall store and be capable of replaying the information specified in this para and required to reconstruct the travelled route and verify the official database used for last 12 hours of navigation. The following information shall be recorded at interval of 10 sec maximum:
- 1. past track of own ship: time, position coordinates, heading and speed;
- 2. information on official data used: ENC source, edition number, publication date, cell name and update history.

3.15.60 Inland ECDIS shall also record past track along all transit route with time stamps at interval of 4 h max. Possibility of tampering the recorded information shall be excluded.

3.15.61 Accuracy of calculations made by Inland ECDIS shall not depend on characteristics of navigational data sensors and shall match SENC accuracy.

3.15.62 When displayed, ENC data proportionality in latitude/longitude shall not change. Inland ECDIS shall be fitted with means for vertical and horizontal image adjustment. The residual error of display in this case shall not exceed 3 % of the screen diagonal size.

3.15.63 The accuracy of reading coordinates shall be not be worse than the electronic chart display resolution.

3.15.64 Inland ECDIS shall not degrade technical characteristics of any navigation equipment and radio equipment used as sensors. Connection of equipment shall not affect performance characteristics of Inland ECDIS specified in this Chapter.

3.15.65 Inland ECDIS shall be interfaced with navigation equipment so as to provide continuous ship positioning, generation of heading and speed, and input of radar information and information of ship’s rate-of-turn indicator.

3.15.66 If Inland ECDIS fails, the corrected set of paper charts shall be used to provide safety of navigation.

3.15.67 Inland ECDIS shall provide possibility of automatic connection to the emergency power source if the normal power source fails or is disconnected.

3.16 REQUIREMENTS TO ELECTRONIC CHART DISPLAY AND INFORMATION SYSTEM

3.16.1 These performance requirements for the Electronic Chart Display and Information System (ECDIS) shall apply to all ECDIS equipment to be installed on all ships of Ì-ÌÑÈ, Ì-ÌÎ and Î-ÌÎ class, which are covered by these Rules, when it is used both at the dedicated standalone workstation and at the multifunction workstation as a part of the integrated navigational system.

3.16.2 The performance requirements shall apply to ECDIS operation mode, ECDIS operating in the Raster Cart Display System (RCDS) mode and ECDIS redundancy means.

3.16.3 The chart data structure, format, encryption and presentation shall comply with the national standard and IHO requirements1.

3.16.4 In addition to the requirements of this Chapter, ECDIS shall comply with 3.14 and the applicable requirements of 6.1 Part VII of the Rules.

3.16.5 To provide effective safety of navigation, ECDIS shall be capable of displaying all SENC chart information issued and distributed in the name of the Government of the Russian Federation by the government authorized hydrographic offices.

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3.16.6 ECDIS shall provide possibility of updating the electronic navigational charts.

3.16.7 ECDIS shall provide all actions to be carried out for preliminary and in-route plotting with the ship position displayed.

The ship position shall be displayed continuously.

3.16.8 The ECDIS display may also be used to display the radar, radar tracked target and AIS information and other appropriate data layers to support in-route plotting.

3.16.9 ECDIS shall present the navigational information as the paper chart published by hydrographic offices authorized by the Government of the Russian Federation.

3.16.10 ECDIS shall provide appropriate alarms or indications with respect to the navigational information displayed or equipment malfunctions.

3.16.11 ECDIS may operate in the Raster Chart Display System mode. Here, requirements of 3.16.111 shall be met.

3.16.12 The chart information to be used in ECDIS shall be of the latest edition, as corrected with official updates and issued by the Government of the Russian Federation or by government authorized hydrographic office or other relevant government institution.

3.16.13 The SENC contents shall be adequate and up-to-date for all ship route.

3.16.14 It shall not be possible to tamper the information contents of ENC or SENC transformed from ENC.

3.16.15 Updates shall be stored separately from ENC.

3.16.16 ECDIS shall be capable of receiving official updates to the ENC data. These updates shall be automatically applied to SENC. By whatever means updates are received, the application (entering) procedure shall not interfere with displaying the chart currently in use.

3.16.17 ECDIS shall provide possibility of entering updates to ENC manually with simple means for update verification before this update is finally applied to the data.

Updates entered manually shall differ from ENC information and its official updates and shall not affect display legibility.

3.16.18 ECDIS shall store and display on demand update data (update archive) including time of application of update data to SENC. These update data shall include updates for each ENC until it is superseded by a new edition.

3.16.19 ECDIS shall allow the navigator to display updates in order to review their contents and to ascertain that they have been included in SENC.

3.16.20 ECDIS shall be capable of receiving both non-encrypted ENCs and ENCs encrypted in accordance with the IHO Data Protection Scheme.

3.16.21 ECDIS shall be capable of displaying all SENC information. Any ECDIS shall be capable of receiving and converting an ENC and its updates into a SENC.

ECDIS may also be capable of receiving a SENC resulting from conversion of ENC to SENC ashore in accordance with IHO requirements.

3.16.22 SENC information available for display during preliminary and in-route plotting shall be subdivided into the following three categories:

- display base;
- standard display;
- all other (additional) information.

3.16.23 The display base which is permanently shown on the ECDIS display shall consist of:

- .1 coast line (at high water);
- .2 dangerous depth contour selected by the navigator for own ship;
- .3 isolated underwater dangers of depths less than the dangerous depth contour selected by the navigator for own ship which lie within the safe waters limited by the dangerous depth contour;
- .4 isolated surface dangers which lie within the safe water limited by the dangerous
depth contour, such as fixed structures, overhead communication and power lines, etc;
.5 digital and linear scales and north arrow;
.6 units of depth and height;
.7 display mode.

3.16.24 The initial standard ECDIS display shall consist of:
.1 display base;
.2 tidal line;
.3 buoys, beacons, and other sea aids to navigation and fixed structures;
.4 boundaries of fairways, channels, etc;
.5 visual and radar prominent features;
.6 prohibited and restricted areas of navigation;
.7 chart scale boundaries;
.8 chart warnings;
.9 ship traffic separation schemes and ferry routes;
.10 archipelagic sea lanes.

3.16.25 All additional information which can be displayed the ECDIS display on the request of the navigator includes the following:
.1 individual depth marks;
.2 position of submarine cables and pipelines;
.3 details of all isolated dangers;
.4 details of all aids to navigation;
.5 contents of cautionary notes;
.6 ENC publication date;
.7 most recent chart update number;
.8 magnetic variation;
.9 chart graticule;
.10 object names.

3.16.26 ECDIS shall present the standard display by a single navigator action.

3.16.27 When ECDIS is switched on just after it is switched off or power fails, it shall return to the most recent information display selected manually.

3.16.28 It shall be possible to add or remove information to/from the ECDIS display by navigator’s single action. It shall not be possible to remove information contained in the display base.

3.16.29 For any navigator selected geographical position (e.g. under the cursor) ECDIS shall display on demand the information on the chart objects associated with this position.

3.16.30 It shall be possible to change the display scale in steps, e.g. by changing the chart scale or by changing the range scale in nautical miles.

3.16.31 It shall be possible for the navigator to select a dangerous contour from the depth contours available in SENC. ECDIS shall highlight the dangerous depth contour among other contours on the display, however:
.1 If the navigator does not specify a dangerous depth contour, it shall be set at 30 m by default.

If the dangerous depth contour specified by the navigator or that set at 30 m by default is not available in the SENC database, then the dangerous depth contour displayed by default shall be the nearest and deepest contour;
.2 If the dangerous depth contour in use becomes unsuitable due to a change in source data, the default dangerous depth contour shall be set as per the nearest and deepest contour;
.3 In any of the above cases, the dangerous depth contour indication shall be provided.

3.16.32 It shall be possible for the navigator to select a dangerous depth. ECDIS shall highlight depths equal to or less than the dangerous depth whenever individual depths are selected for display.

3.16.33 ENC and all updates to it shall be displayed without any degradation of their information content.

3.16.34 ECDIS shall provide means to ensure that ENC data and all updates to them have been correctly loaded into SENC database.

3.16.35 ENC data and updates to them shall be clearly distinguishable from other displayed information listed below:
1. own ship:
   - past track with time stamps for primary route;
   - past track with time stamps for secondary route;
2. vector for heading and speed over ground;
3. variable range marker and/or EBL;
4. cursor;
5. event:
   - dead reckoned position with time stamp
   - expected position with time stamp;
6. fixed position with time stamp;
7. position line with time stamp;
8. displaced position line with time stamp:
   - predicted tidal stream or current vector with velocity and time
   - measured tidal stream or current vector with velocity and time;
9. danger which special attention shall be paid to (danger highlight);
10. clearing line (a line passing clear off navigational dangers);
11. planned course and speed to destination point;
12. waypoint;
13. distance along planned course;
14. waypoint with planned date and time of arrival;
15. arc of visibility of lights for defined height of navigator’s eyes;
16. position and time of rudder shifting for manoeuvring.

3.16.36 ECDIS shall provide indication when:
1. the information is displayed in a larger scale than that contained in ENC;
2. own ship position is overlapped by an ENC of a larger scale than that currently provided by the display.

3.16.37 Radar information and/or general-purpose AIS information may be overlaid onto the ECDIS display from systems compliant with the relevant requirements of the Rules. Other navigational information may also be added to the ECDIS display. However, it shall not degrade the displayed SENC information and it shall be clearly distinguishable from the SENC information.

3.16.38 It shall be possible to remove the radar information, AIS information and other navigational information by navigator’s single action.

3.16.39 ECDIS and added navigational information shall use the same datum. If this is not the case, an indication shall be provided.

3.16.40 A radar picture and/or tracked target information may be included in the converted radar information.

3.16.41 If the radar picture is added to the ECDIS display, the radar picture and the chart shall match in scale, projection and orientation.

3.16.42 The radar picture and the position from the position sensor shall be adjusted automatically for antenna offset from the ship steering position.

3.16.43 It shall always be possible to display SENC in the “north up” orientation. Other orientations are permitted (e.g. a “heading up” orientation).

When such orientations are displayed, the orientation shall be altered in steps large enough to avoid blurred display of the chart information.

3.16.44 ECDIS shall provide for the true motion mode (the ship’s symbol moves against non-moving chart background). Other motion modes are permitted.

3.16.45 When the true motion mode is in use, transition to and generation of the next chart picture area shall take place automatically when the own ship’s symbol approaches the ECDIS display edge at a distance specified by the navigator.

3.16.46 It shall be possible to manually change the displayed chart area and the position of own ship relative to the ECDIS display edge.

3.16.47 If the area covered by the ECDIS display includes waters for which no ENC in a scale appropriate for navigation is available,
the areas representing those waters shall have a reference for the navigator to the paper chart or to the RCDS operation mode.

3.16.48 The IHO recommended colours and symbols shall be used to represent SENC information.

3.16.49 The colours and symbols other than those mentioned in 3.16.48, shall comply with the requirements specified in 3.14.

3.16.50 SENC information displayed in a scale specified in the original ENC shall use the specified sizes of symbols, figures and letters recommended by IHO.

3.16.51 ECDIS shall allow the navigator to select whether the own ship is displayed in a scale of currently used chart or as a symbol.

3.16.52 ECDIS shall be capable of displaying information required for:
   .1 preliminary plotting and supplementary navigation tasks;
   .2 in-route plotting.

3.16.53 The effective size of the chart displayed for in-route plotting shall be at least 270 × 270 mm.

3.16.54 The chart display shall be capable of meeting colour and resolution recommendations of IHO.

3.16.55 The method of presentation shall ensure that the displayed information is clearly visible to more than one navigator under light conditions normally experienced in the wheelhouse by day and by night.

3.16.56 If information categories included in the standard display are removed by the navigator, this shall be permanently indicated. The information categories removed from the standard display shall be restored on the navigator’s request.

3.16.57 It shall be possible to carry out preliminary and in-route course plotting.

3.16.58 The largest scale chart data available in SENC for the area given shall always be used by ECDIS for all alarms or indications of crossing the dangerous depth contour and of entering a prohibited area of navigation, as well as for alarms and indications according to Table 3.16.87.

3.16.59 It shall be possible to carry out preliminary plotting including both straight and curved route segments.

3.16.60 It shall be possible to correct preliminary plotting alphanumerically and graphically, including:
   .1 adding waypoints;
   .2 deleting waypoints;
   .3 changing a waypoint position.

3.16.61 It shall be possible to preliminarily plot one or more alternative routes in addition to the primary one. The primary route shall be clearly distinguishable from the other routes.

3.16.62 An indication shall be provided if the navigator plots a course across the own ship’s dangerous depth contour.

3.16.63 An indication shall be given if the navigator plans a route closer than a navigator specified distance from the boundaries of a prohibited area of navigation or a geographic area for which special conditions exist. The indication shall also be given if the navigator plots a course closer than a navigator-specified distance from a point object, such as a fixed or floating aid to navigation or isolated danger.

Special navigation condition areas are the following:
   traffic separation zones;
   inshore navigation zones;
   restricted areas of navigation;
   caution areas;
   offshore production areas;
   areas to be avoided;
   navigator defined areas to be avoided;
   military practice areas;
   seaplane landing areas;
   submarine transit areas;
   anchorage areas;
   marine farms/aquacultures;
   particularly sensitive sea areas.

3.16.64 It shall be possible for the navigator during preliminary plotting to specify a cross track limit of deviation from the planned
route at which an automatic off-track alarm shall be activated.

3.16.65 When in-route plotting is carried out, the selected transit route and the own ship’s position shall appear whenever the chart display covers that area.

3.16.66 When in-route plotting is carried out, it shall be possible to display sea areas that do not cover the ship’s position (e.g. for viewing the areas located ahead to improve preliminary plotting). If this is done on the display used for in-route plotting, the automatic in-route plotting functions (e.g. updating the ship’s position and generating alarms and indications) shall not be interrupted. It shall be possible to return to the area display covering the own ship’s position immediately by navigator’s single action.

3.16.67 ECDIS shall give an alarm if, within the navigator specified time, the own ship will cross the dangerous depth contour.

3.16.68 ECDIS shall give an alarm or indication, as selected by the navigator, if, within the navigator specified time, the own ship will cross the boundary of a prohibited area or of a geographical area for which special conditions exist.

3.16.69 An alarm shall be given when the navigator specified cross track error limit is exceeded.

3.16.70 An indication shall be given, if, continuing on her present course and speed, the own ship will pass closer than the navigator-specified distance from a danger (e.g. obstruction, wreck, or rock) that is shallower than the safe depth contour or from an aid to navigation.

3.16.71 The displayed ship’s position shall be derived from continuous position fixing performed by a system whose accuracy is consistent with the safe navigation requirements. If the ship design allows for a second independent position fix system, ECDIS shall be capable of identifying discrepancies in position finding between the two sources.

3.16.72 ECDIS shall provide an alarm when the input from position, heading or speed sources is lost. ECDIS shall also repeat, but only as indication, any alarm or indication given to it from position, heading or speed sources.

3.16.73 An alarm shall be given by ECDIS when the ship reaches a specified time or distance set by the navigator.

3.16.74 The positioning system and SENC shall use the same geodetic datum. If this is not the case, ECDIS shall give an alarm.

3.16.75 It shall be possible to display the primary route and the secondary routes simultaneously on the chart display. The primary route shall be clearly distinguishable from the other routes. It shall be possible for the navigator to modify the primary route or change it to an alternative route.

3.16.76 It shall be possible to display:

.1 time stamps along the plotted ship’s route that are set manually and automatically at intervals selected between 1 and 120 minutes;

.2 adequate number of points, free movable electronic bearing lines, variable and fixed range markers and other symbols required for navigation purposes and specified in 3.16.35.

3.16.77 It shall be possible to enter the geographical coordinates of any position into the system and then display that position on demand. In addition, it shall be possible to select any point (feature, symbol or position) on the chart display and read its geographical coordinates on demand.

3.16.78 It shall be possible to set the displayed position of the ship manually. This manual setting of coordinates shall be noted alphanumerically on the screen and maintained until altered by the navigator and automatically stored in the memory.

3.16.79 ECDIS shall provide the capability to manually enter and plot obtained bearing and distance lines of position (LOP), and calculate the resulting own ship’s position. It
shall be possible to use the resulting position as an origin for dead reckoning.

3.16.80 When in-route plotting is carried out, ECDIS shall indicate discrepancies between the position received from continuous positioning systems and position obtained by manual position fixing.

3.16.81 ECDIS shall store and be capable of replaying this information required to reconstruct the passed route and verify the official database used during the previous 12 hours of navigation. The following information shall be recorded at maximum intervals of one minute:

1. own ship’s time, position, heading and speed;
2. ENC source by which plotting has been performed, publisher name, publication date, chart tiles displayed, and update list.

In addition, ECDIS shall record the complete track for the entire voyage with the time stamps at intervals not exceeding 4 hours.

It shall not be possible to tamper the recorded information.

3.16.82 ECDIS shall have a capability to protect the recorded data of the previous 12 hours and the track over the entire voyage.

3.16.83 The accuracy of all calculations performed by ECDIS shall be consistent with the SENC accuracy and shall be independent of characteristics of devices which output data to ECDIS.

3.16.84 The accuracy of bearings and ranges drawn on the display or those measured between objects already drawn on the display shall not be less than the display resolution.

3.16.85 ECDIS shall be capable of performing and presenting the results of at least the following calculations:

1. true bearing and distance between two geographical coordinates;
2. geographical coordinates of a position from distance / bearing of a known position;
3. geodetic calculations such as spheroidal distance, rhumb line and great circle.

3.16.86 ECDIS shall be provided with means for automatic or manual onboard tests of its major functions. In case of a failure, the test shall display information to indicate a failed unit (module).

3.16.87 When ECDIS fails or the displayed information is distorted, it shall provide a suitable alarm or indication as required in Table 3.16.87.

3.16.88 ECDIS shall not degrade performance of any equipment being a source of input data. Nor shall connection of optional equipment degrade the performance of ECDIS regarding the requirements of this Chapter.

3.16.89 ECDIS shall be connected to the ship’s position fixing system, to the gyro compass and to the speed and travelled distance measuring device. For the ships not fitted with the gyro compass, ECDIS shall be connected to a remote heading transmitting device.

3.16.90 ECDIS may provide SENC information to external equipment.

3.16.91 ECDIS and all equipment necessary for its normal functioning shall be supplied with electrical power from the main and emergency sources.

3.16.92 Changing from one power supply source to another or any power interruption for a period of up to 45 seconds shall not require the system to be manually restarted.

3.16.93 Adequate redundant means shall be provided to ensure safe navigation in case of ECDIS failure. Such means shall provide the following functions:

1. enabling a safe take-over of ECDIS functions so that ECDIS failure does not lead to a critical situation;
2. providing safe navigation for the remaining part of the voyage after ECDIS failure and providing changeover to the redundant system in critical situation without loss of navigational chart information.
### ECDIS alarm and indication requirements

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* *Emergency alarm or warning alarm system is provided to warn of an insistent state with sound means or sound and visual means.*

** *Visual indication shall be provided to give information on the system or equipment state.*

3.16.94 The redundant means shall display in graphical (chart) form the relevant information on the hydrographic and geographic environment which is necessary for safe navigation.

3.16.95 The redundant means shall enable the preliminary plotting functions to be performed, including:

1. transferring the planned route originally performed on ECDIS;
2. correcting the planned route manually or transferring it from the plotter.

3.16.96 The redundant means shall enable a takeover of in-route plotting originally performed by ECDIS and provide the following functions:

1. plotting the own ship’s position automatically or manually on the chart;
2. taking courses, distances and bearings from the chart;
3. displaying the planned route;
4. displaying the time stamps on the ship’s track;
5. plotting an adequate number of points, bearing lines, range markers, etc. on the chart.

3.16.97 If the redundant means is an electronic device, it shall be capable of representing on its chart display the information equivalent to the standard display complying with the requirements of this Chapter.

3.16.98 The chart information to be used in the redundant means shall be of the latest edition and as corrected by official updates shall be issued by the Government of the Russian Federation or authorized hydrographic office or other relevant government institution in the name of the Government of the Russian Federation. The chart information shall meet IHO requirements.

It shall not be possible to tamper ENC contents.
The chart or chart data publisher and publication date shall be indicated.

3.16.99 The chart information displayed by the ECDIS redundant means shall be up-to-date for the entire voyage.

3.16.100 If an electronic redundant device is used, it shall provide indication when:
.1 Information is displayed in a larger scale than that contained in the database;
.2 Own ship’s position is overlapped with a chart of a larger scale than that currently used in the system.

3.16.101 If radar and other navigational information is added to the electronic redundant display, all the corresponding performance requirements of this Chapter shall be met.

If an electronic redundant device is used, the display mode and the next screen area display shall be in accordance with 3.16.43 to 3.16.47.

3.16.102 The redundant means shall be able to keep a record of the ship’s actual track, including positions and corresponding time stamps.

3.16.103 The redundant means shall keep operating under all environmental conditions while the ship is in operation.

3.16.104 Accuracy of all calculations shall meet the requirements of 3.16.86 to 3.16.88.

3.16.105 If an electronic device is used in the redundant means, it shall provide a suitable alarm or indication of system malfunction.

3.16.106 If an electronic device is used in the redundant means, it shall be designed in accordance with the ergonomic principles relevant for ECDIS.

3.16.107 If an electronic device is used in the redundant means:
.1 Its colours and symbols shall be in accordance with ECDIS colours and symbols requirements;
.2 Effective size of the chart displayed shall be at least 250 \times 250 \text{ mm} or 250 \text{ mm} in diameter.

3.16.108 If an electronic device is used:
.1 The redundant means power supply shall be separate from ECDIS;
.2 Power sources shall comply with the performance requirements for ECDIS in this Chapter.

3.16.109 If an electronic device is used in the redundant mean, it shall:
.1 be connected to systems providing continuous position fixing capability;
.2 not generate interference and distortions for any equipment providing input data from navigational sensors.

3.16.110 If radar picture overlay on a part of ENC chart information is used as a redundant element, the radar shall comply with the requirements of 3.2.

3.16.111 If ECDIS is used for displaying raster navigation charts, the additional requirements of this Chapter shall be met except for 3.16.20, 3.16.22, 3.16.29 – 3.16.32, 3.16.50, 3.16.54, 3.16.56, 3.16.58, 3.16.62, 3.16.63, 3.16.67, 3.16.68 and 3.16.70:
.1 When operating in RCDS mode, an appropriate set of up-to-date paper charts shall be carried on board and be readily available to the navigator.

This set of charts shall be in scale providing features of topography, depth, navigational dangers, aids to navigation, plotted routes, and determined travel lines in order to provide the navigator with information on general navigation circumstances.

The appropriate set of paper charts shall provide adequate look-ahead capability;
.2 The raster navigational charts (RNC) used in RCDS shall be of the latest edition originated and published by the Government of the Russian Federation or by the government authorized hydrographic office. RNCs not based on the World Geodetic System 1984 (WGS-84) or PZ-90 shall contain additional data, which make it possible to correct fixed position coordinates in order to properly
combine them with data of system RNC (SRNC);

\.3 SRNC contents shall be up-to-date for that part of the intended voyage not covered by ENC;

\.4 It shall not be possible to tamper RNC contents;

\.5 RCDS shall be capable of displaying all SRNC information;

\.6 SRNC information available for display during preliminary plotting and in-route plotting shall be subdivided into two categories:

RCDS standard display consisting of RNC and its updates, including chart scale, chart display scale, geodetic datum, and units of depth and height

any other information such as the navigator's notes;

\.7 It shall be easy to add to or to remove any information additional to RNC data such as navigator's notes and RCDS display notes. It shall not be possible to delete any information from RNC;

\.8 There shall always be an indication for ECDS equipment operating in RCDS mode;

\.9 It shall always be possible to display SRNC in usual “north up” orientation. Other orientations are permitted;

\.10 IHO recommended colours and symbols shall be used to represent SRNC information;

\.11 RCDS shall be capable of displaying the chart notes which are not located on the portion of the chart currently being displayed;

\.12 It shall be possible for the navigator to enter points, lines and areas, which will activate alarm. These features displayed shall not degrade SRNC information and shall be clearly distinguishable from SRNC information;

\.13 While in-route plotting is carried out, it shall be possible to display other areas that do not cover the ship position on the chart display (e.g. for looking ahead). If these actions take place on the display used for in-route plotting, the automatic final plotting as per 3.16.66 shall be continuous. It shall be possible to return to the area display covering the own ship’s position immediately by navigator's single action;

\.14 RCDS shall present only fixed coordinates referenced to WGS-84 or PZ-90 geodetic datum. RCDS shall output a warning if coordinates are not referenced to one of these data. If the displayed RNC cannot be referenced to WGS-84 or PZ-90 geodetic datum, then the respective continuous indication shall be provided;

\.15 RCDS shall allow the navigator to manually match SRNC with the ship position data;

\.16 It shall be possible to activate an alarm when the ship approaches a point, line or boundary of an area selected by the navigator within a specified time or distance;

\.17 RCDS shall be capable of transforming a local chart geodetic datum to WGS-84 geodetic datum and vice versa;

\.18 RCDS shall provide a suitable alarm or indication with regard to represented information or equipment malfunction as required in Table 3.16.111.

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</tr>
<tr>
<td>3.16.36.1</td>
<td></td>
<td>Information does not match the scale</td>
</tr>
<tr>
<td>3.16.36.2</td>
<td></td>
<td>RNC of a larger scale is available for the ship position area</td>
</tr>
</tbody>
</table>

Table 3.16.111
3.17 REQUIREMENTS TO SHIP TRACK CONTROL SYSTEM

3.17.1 The ship’s track control system in combination with the sensors providing information on ship’s coordinates, speed, heading and/or rate of turn shall, with steering capabilities taken into account, automatically keep the ship on the planned motion path over ground at different environmental conditions and ship speed from steerable minimum to 50 km/h and at ship’s rate of turn of 10°/s max.

Here, the ship control quality shall not be worse than that of manual control using the standard navigational aids on inland waterways.

3.17.2 Global navigation satellite positioning systems GLONASS/GPS and DGLONASS/DGPS shall be the main system for ship’s position fixing in the ship’s track control system.

3.17.3 The ship’s track control system may be operated in the ship’s heading control mode. In this case, it shall comply with the requirements imposed on the ship’s heading control system.

3.17.4 The ship’s track control system shall provide automatic control of ship motion to the specified waypoint or through the specified sequence of waypoints with the navigator-specified deviation from the track line.

3.17.5 The memory size shall be enough to store the navigation route database containing not less than 1000 waypoints. The database can be implemented either directly in the ship’s track control system memory or programmatically in the GNSS receiving equipment or by means of electronic navigational information and chart system.

3.17.6 The database (route) shall be agreed/approved by the authorized transport authority.

It shall not be possible to change the sequence of waypoints of the given navigation route entered into the system until:

1. planning of a new navigation route is completed and approved; .2 all the conditions of 3.17.9 are met.

3.17.7 The system shall provide possibility of automatic transition from one straight-line route segment to another by turning based on the given turning radius or radius calculated from ship’s rate of turn and linear speed.

3.17.8 The ship’s track control system shall be adjustable (manually or automatically) to ship steering capabilities changing as speed and loading conditions, as well as waterway and weather conditions change.

3.17.9 The system shall enable the navigator of the watch to automatically control the track only if the ship’s position, difference between course over ground and actual heading, and manoeuvring performance of the ship enable safe manoeuvring to the planned motion path.

3.17.10 The ship’s position with reference to the planned motion path shall be continuously monitored by another independent positioning system (device). This monitor may be not a component of the track control system. In case of normal visibility (more than 1 km), the ship’s position can be monitored by visual orientation using the coastal and floating aids to navigation, and in case of limited visibility, by visual orientation using the radar picture.

3.17.11 The system shall enable the navigator on the watch to quickly enter the lateral deviation from the planned track in excess of 200 m to the right and to the left from the ship steering station. The signal of lateral deviation shall be active until the ship returns to the planned track.

3.17.12 When the ship moves along the navigation route, a warning signal shall be provided at least one minute prior to change in heading and at the beginning of turn.

3.17.13 The ship’s track control system shall be fitted with a device which makes it possible for the navigator of the watch to acknowledge the heading change in the turning point. Lack of acknowledgement shall not affect automatic planned track keeping. An alarm shall be given if turning point approach
warning is not acknowledged within 30 s from its output time.

3.17.14 If the actual heading change signal is not acknowledged by the navigator of the watch within 15 seconds after the beginning of turn, an alarm signal shall be given to the watch below navigator to call him urgently to the wheelhouse.

3.17.15 It shall be possible to switch from the ship’s track control mode to the manual control at any rudder position and under any conditions, including the ship track control system failure, using one control and single action in time not exceeding 3 s.

Return to automatic ship’s track control shall take place only if requirement of 3.17.9 is met.

3.17.16 Manual switching from the track control mode to the heading control mode (if such mode is provided for in the technical documentation) shall be possible with one control and single action in time not exceeding 3 s.

The heading control system shall accept actual ship motion parameters at the moment of switching as preset ones.

Reverse change-over to automatic track control shall be possible only if requirement of 3.17.9 is met.

3.17.17 The system control panel shall provide indication of active ship control mode.

3.17.18 A device shall be provided to monitor actual heading value using an independent heading sensor. This monitor may be not a component of the ship track control system.

3.17.19 In case of loss or drop of voltage applied to the track control system which can affect its operational safety, an alarm shall be given.

3.17.20 The ship track control system shall provide:

- warning (with acknowledgement function) in case of no data provided from positioning and rate-of-turn/heading indication systems or failure of these systems;

- alarm if warning of no data from positioning and rate-of-turn/heading indication systems or failure of these systems is not acknowledged by the navigator within 15 s.

It shall not be possible for the system to use information from faulty sensors.

3.17.21 The system shall output an alarm in the following cases:

- deviation from ship track line and rate of turn exceeded preset values;

- ship’s speed through water decreased to a value which does not provide normal steering capabilities.

3.17.22 The track control system shall be capable of calculating a heading between subsequent preset waypoints and radius or rate of turn. In doing so, the system shall consider all limitations determined by the planned track of motion, condition of alarm and warning activation, and other ship control parameters.

3.17.23 The system control panel shall continuously display the following information:

- ship steering mode;

- technical condition of ship’s position, heading, speed and rate of turn sensors;

- course over ground, coordinates, speed, present heading and/or rate of turn and deviation from track line;

- closest and next to it waypoints;

- time and distance to closest waypoint on route;

- calculated heading of the next leg;

- reference designation of preset route.

Information mentioned in 3.17.23.3, 3.17.23.5, 3.17.23.6 and 3.17.23.7 shall be displayed in digital form.

3.17.24 It shall be possible to display the following information on demand:

- list of navigation route waypoints, including their numbers, coordinates, headings and distances between them, and calculated radiiuses of turns or rates of turns;

- preset limitations of ship’s track control mode and other control parameters.
Here, functionally related quantities (preset and actual ones, etc.) shall be displayed together.

3.17.25 All external communications of the track control system with other ship navigational systems shall be implemented in digital form according to the requirements of national and international standards.

3.17.26 All controls and indicators of the ship track control system shall have illumination so as to use the system at any time. Colours for light signalling shall comply with the requirements of 6.1.16 Part VI of the Rules. It shall be possible to control brightness of all indicators.

3.18 REQUIREMENTS TO SHIPBOARD AUTOMATIC IDENTIFICATION SYSTEM EQUIPMENT

3.18.1 The shipboard AIS equipment shall provide data exchange in the following operating modes:

1. mode of continuous independent self-organizing intership exchange of static (ship data) and dynamic (coordinates and motion parameters) information;
2. mode of automatic transfer of static and dynamic information with transfer periodicity assigned by coastal ship traffic control services and at assigned time intervals;
3. mode of automatic transfer of information on ship by request of coastal services and other ships (ship call sign and name, ship coordinates, presence of dangerous cargo, etc.).

3.18.2 The shipboard AIS equipment shall be composed of:

1. communication processor capable of operating in switching mode in short-range radio communication (VHF) and long-range radio communication systems;
2. a device for automatic selection of a frequency channel in the frequency band assigned to the maritime mobile service and operation in the selected channel;
3. at least one TDMA transmitter, two TDMA receivers and one digital selective call receiver (DSC) set up on VHF channel 70 of maritime mobile service;
4. means for data processing from radio-navigation system which enables resolution up to 0.0001 minute in WGS-84 datum;
5. means for automatic input of data from dynamic information sensors;
6. means for manual input, retrieval and display of information (minimum display);
7. means for checking transmitted and received data;
8. means for built-in operability testing;
9. built-in GNSS receiver enabling UTC synchronisation.

3.18.3 The shipboard equipment shall provide:

1. continuous automatic transfer of information to coastal and shipboard AISs;
2. reception and processing of data from coastal services and other ships;
3. transfer of messages in reply to high-priority or safety-related requests with minimum delay prescribed by the technical documentation;
4. transfer of information on ship manoeuvres and coordinates. Data refresh frequency shall comply with 3.18.7 to provide safe ship tracking by coastal services;
5. automatic activation of built-in GNSS receiver in case of failure of main positioning source and output of respective indication of built-in operability check means.

3.18.4 The shipboard AIS equipment shall use the Maritime Mobile Service Identity (MMSI).

3.18.5 The AIS equipment shall operate at VHF frequencies of maritime mobile service (156.025 to 162.025 MHz) with inter-channel frequency separation of 25 kHz and 12.5 kHz. After switched on, the shipboard AIS equipment shall operate by default on two international simplex channels: AIS-1 = 161.975 MHz (channel 2087) and AIS-2 = 162.025 MHz (channel 2088).
It shall be possible for the AIS equipment to change over to other channels by one of three methods:

1. manual changeover;
2. automatic changeover at commands from a coastal station in TDMA format;
3. automatic changeover at commands from a coastal station in DSC format.

3.18.6 The shipboard AIS equipment shall transmit and receive the following information:

1. static information:
   - IMO ship number;
   - ship call signal and name;
   - ship length and breadth;
   - type of ship;
   - location of radio-navigation system receiver antenna (bow or stern and starboard or port with reference to ship’s centreline);

2. dynamic information:
   - ship’s position with indication of measurement accuracy and integrity;
   - universal coordinated time;
   - course over ground;
   - speed over ground;
   - true heading;
   - ship’s rate of turn;
   - ship navigation condition: ship underway, at anchor, etc. by manual input;
   - additional information:
     - heel angle, roll and pitch (if any);
   - voyage information:
     - ship’s draught;
     - presence of dangerous cargo and its type (on request of authorities);
     - port of destination and expected arrival time;
3. safety information.

3.18.7 When operated offline, the shipboard AIS equipment shall provide the following information transfer intervals:

1. for static information, every 6 minutes and on demand;
2. for dynamic information, depending on change in speed and heading according to Table 3.18.7.2;

<table>
<thead>
<tr>
<th>Table 3.18.7.2 Dynamic information transmission intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship motion mode</td>
</tr>
<tr>
<td>At anchor or underway</td>
</tr>
<tr>
<td>Underway</td>
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3. for flight information, every 6 minutes, in case of change of voyage data and on demand;
4. for safety information, when required.

The shipboard AIS equipment shall be capable of processing up to 4500 messages per minute when operated in two channels.

3.18.8 Protection from inadvertent change of received and transmitted information shall be provided.

3.18.9 The shipboard AIS equipment shall be ready for operation in at most 2 minutes after switched on. This requirement does not apply to GNSS receiver warm-up time.

3.18.10 The AIS equipment inactivity time shall be automatically recorded in the non-volatile memory.

3.18.11 Minimum display requirements:

1. The display shall have at least 3 lines of data with 16 characters in each line which shall display at least the ship name, bearing and distance;
2. Bearing and range information shall not be indicated on horizontal displays;
3. The displayed information shall be visually accessible (picture illumination shall be provided);
4. It shall be possible to manually input the voyage messages and safety-related messages;
5. It shall be possible to display alarm information and information from the built-in operability check means and received safety messages and requests from long-range communication means.
3.19 REQUIREMENTS TO VOYAGE DATA RECORDER

3.19.1 The voyage data recorder (VDR) shall continuously and automatically record and store in a safe and retrievable form the information on ship’s position, readings of instruments and systems that characterize condition and operating modes of shipboard equipment, ship motion parameters and ship control commands, her actual state and environment.

3.19.2 The voyage data recorder design shall exclude possibility of intervening in its operation, quantity of data to be recorded, data themselves and already recorded data.

3.19.3 It shall be possible to record any attempts of unauthorized intervention in operation of VDR, validity of its data or data recording.

3.19.4 The method of recording shall make it possible to determine date and time of information recording when it is displayed on the special equipment and shall provide check of information being recorded for validity and activation of alarm in case of detection of an uncorrectable error.

3.19.5 VDR shall be capable of checking its performance characteristics (for example, during annual surveys or after repairs or maintenance of VDR) or any source of signal which shall be recorded in VDR.

Such check may be performed using a device intended for replaying recorded data on condition that all required information has been recorded correctly.

3.19.6 The recorded information medium shall consist of:

.1 a stationary (fixed) recording mean;
.2 a free floating recording mean;
.3 a long-term recording means providing long-term storage of recorded data.

3.19.7 Each recorded information medium shall:

.1 continue recording information during accident/incident;
.2 provide access to recorded information after accident and protection of information from physical or electronic intervention attempts aimed to change or delete data.

3.19.8 The fixed information recording means shall be located in a special fixed protective container designed so as to provide:

.1 rigid attachment to open deck of a ship and possibility of recovering it from a sunk ship manually or by means of underwater vehicle;
.2 protection and retrieval of finally recorded information after any ship incident under the following effects:

mechanical impact (semisine impulse with peak acceleration of 50 g and impact impulse duration of 11 ms);
fall of a rod of 100 mm in diameter and 250 kg in weight from height of 3 m;
low temperature fire (260 °C for 10 h);
high temperature fire (1100 °C for 1 h);
immersion into seawater for 30 days at depth of 3 m;
deep-sea immersion into seawater for 24 h at depth of 6000 m;
.3 storage of recorded information for not less than 2 years on completion of recording;
.4 availability of a sonar beacon working in frequency band of 25 to 50 kHz and providing its underwater detectability during 30 days from its activation time and possibility of applying a visible inscription in English: "VOYAGE DATA RECORDER — DO NOT OPEN — REPORT TO AUTHORITIES";
.5 fluorescent orange colour and reflective marking.

3.19.9 The free floating information recording means shall be located in a special protective container of free floating type and shall comply with the following requirements:

.1 It shall be fitted with attachments to catch and lift it from water;
.2 It shall enable storage of recorded information for not less than 6 months on completion of recording;
.3 It shall be designed so as to comply with requirements imposed to free floating satellite emergency position-indicating radio beacons (see 6.13 – 6.15, Part VII of the Rules);
.4 It shall be fitted with a light indicator and a radio transmitter to transmit signals for initial position finding during 48 h and further transmission of homing signal.

The battery capacity for simultaneous operation of light indicator and radio transmitter shall not be less than 7 days/168 h from time of separation and surfacing of the protective container.

3.19.10 The long-term information recording means shall provide access from the internal space of the ship.

3.19.11 VDR shall record the following information:

.1 date and time with discreteness providing recovery of events sequence. Date and time with reference to UTC shall be received from an external (not mounted on the ship) source, and the built-in VDR clock shall be synchronized with the real dates and times of events. When the external time source is unavailable, the built-in VDR clock shall be used. Recording shall indicate such information source. The method of recording shall be such that time reference of all other recorded information can be retrieved during replay with resolution and continuity enough to recover complete sequence of incidents;

.2 latitude and longitude of ship’s position, and used datum received from radio navigation system receiver with indication of its type and operating mode;

.3 ship’s speed through water and ship’s speed over ground with indication of measurement method and travelled distance from the ship log;

.4 heading indicated by the ship’s heading source;

.5 Voice conversations in the wheelhouse. Microphones shall be placed in the wheelhouse so as to cover all the working posts provided for by the wheelhouse design and to record conversations. Recording shall be such that normal conversational speech provides sufficient intelligibility during normal operation of the ship. This recording requirement shall be met on all working posts in the presence of single audible alarm signal in any place in the wheelhouse or any noise, including noise from faulty equipment, mounting or wind. This shall be obtained by using at least two speech recording channels. Microphones located out of the wheelhouse on the bridge wings shall record conversations via a separate additional channel;

.6 Conversations with other ships, objects and coastal services using VHF radio equipment shall be recorded via an additional separate channel;

.7 radar and auxiliary navigational data displayed on radar indicators mounted on the ship. The method of recording shall provide a capability of replaying the picture in the original recorded form with consideration of possible distortions related to information compression during recording;

.8 if the ship is equipped with an electronic chart display and information system, the voyage data recorder shall record electronic signals of currently used ECDIS display as the main navigation device. The method of recording shall provide a capability of replaying the picture in the original recorded form with consideration of possible distortions related to information compression during recording, and, besides, the source of chart data and its version;

.9 ship under-keel clearance with indication of set measurement scale and operating mode of echo sounder.

The navigational data displayed on the sonar data display (if provided for by the ship design).

The method of recording shall be such as mentioned in 3.19.11.7;

.10 all alarm signals in the wheelhouse;

.11 commands coming to the steering gear and their execution, as well as operating mode of heading or track control system with indication of control station and steering gear power unit(s);

.12 commands coming in the engine room and their execution (position of any engine telegraphs or handles of remote engine/propeller control, including ahead/astern motion indicators and used control station), as well as operating mode of auxiliary thrusters with indication of control station;
..13 condition of sea inlets in the ship’s hull within scope of information coming to the wheelhouse;
..14 condition of watertight and fire doors within scope of information coming to the wheelhouse;
..15 accelerations and strains in the ship’s hull in comparison with data values of which were preset by the navigator on the special equipment (if this equipment and appropriate sensors are available);
..16 wind speed and direction, including their true or relative values;
..17 all the AIS data;
..18 the voyage data recorder shall be connected to the electronic clinometer or, if unavailable, to the appropriate roll sensor having equivalent performance characteristics of measurements. The method of recording shall enable roll representation during display;
..19 data on VDR configuration (information on interface units and connection diagrams).

In addition to the above-stated requirements, the recorded information medium in the delivered VDR shall contain data that determine principle of VDR configuration and sensors which VDR is connected to.

These data shall be actualized and brought to full conformity with data of ship installation. They shall contain information on the sensor manufacturer, type, version number, identification and location, as well as information on the sensor data. Configuration data shall be permanently stored in the recorded information medium of VDR and protected from changes except for changes in VDR configuration made by an authorized person;

..20 If the ship is equipped with an electronic log, its information shall be registered too.

3.19.12 VDR may record other additional information. Here, recording of additional information shall not distort main information or affect its integrity.

3.19.13 VDR shall be capable of recording and storing information for at least previous 12 h of voyage.

3.19.14 Loss of VDR operability shall not affect operation of equipment and information sensors interfaced with VDR.

3.19.15 VDR shall be provided with main and emergency power supply.

If power supply from emergency power source fails, VDR shall continue recording voice conversations in the wheelhouse using its own accumulator batteries (with a charger) for 2 h and then recording of conversations shall be automatically stopped.

3.19.16 To retrieve recorded data and the subsequently display them VDR shall be capable of interfacing with an external portable computer. The interface format shall be compatible at least with one of the international formats, such as Ethernet, USB, Fire Wire or equivalent.

It shall be possible to retrieve recorded data for a selected period.

3.19.17 For each VDR mounted on the ship, a separate copy of software shall be provided in order to enable retrieval of stored data and replay of information on an external computer connected to VDR.

The software shall be compatible with the operating system of the external computer and shall be provided on a portable information storage, such as CD-ROM, DVD, USB storage, etc.

3.19.18 The portable information storage with a copy of software, instructions and any special elements required to connect the external computer to VDR shall be kept in immediate proximity from the main unit of VDR.

3.19.19 If VDR uses nonstandard formats or proprietary manufacturer’s standards for data storage, the software shall be provided directly in VDR or on a portable data storage to convert recorded data to open standard formats.

3.19.20 The technical documentation delivered with VDR shall contain instructions on connection of an external computer to VDR and use of the software.
3.19.21 The technical documentation shall contain information on location of interface unit of long-term information recording means and instructions on interface with it Russian/English language. The VDR documentation shall also contain requirement for the respective information and the abovementioned instructions to be placed near to the interface unit of the long-term information recording means.

3.20 REQUIREMENTS TO SIMPLIFIED VOYAGE DATA RECORDER

3.20.1 The simplified voyage data recorder (S-VDR) shall automatically and continuously record preselected data that characterize readings of navigation devices, operating modes of shipboard equipment, ship control commands and environment. Information shall be stored for 2 years from recording stop time.

3.20.2 The method of recording shall provide a capability of determining data recording date and time when it is displayed on a special device (portable computer).

3.20.3 The recorded information storage shall be located in a special container which can be rigidly attached to the ship hull or be of free floating type.

The container shall comply with the following requirements:

- It shall be capable of continuing information recording during an accident and accessing to recorded data after incident
- It shall protect information from changes and mechanical damages
- It shall have fluorescent orange colour and reflective marking and a device enabling to detect it.

3.20.4 The container rigidly attached to the ship hull shall comply with requirements of 3.19.4, except for impact tests.

3.20.5 The protective container of free floating type shall be:

- fitted with attachments to catch and recover it from water
- designed so as to be capable of surfacing.

3.20.6 The protective container of any type shall comply with requirements of 3.19.5, and the container of free floating type shall also comply with requirements of 3.19.6.

3.20.7 It shall be possible to record the following data:

- date and time with reference to UTC which shall be determined from an external (located out of ship) source or built-in clock with indication of information source with discreteness providing recovery of events sequence during investigation of accident causes;
- position latitude and longitude received from an electronic positioning system with indication of its type and operating mode and datum as well;
- ship’s heading by compass;
- ship’s speed data from the ship log with indication of method of measurement (through water or over ground);
- voice conversations in the wheelhouse and, whenever possible, ship announcements and alarm signals audible in the wheelhouse;
- radio conversations with other ships, objects and coastal services;
- data from AIS;
- all radar and auxiliary navigational data which are displayed at present on the main radar screen. The method of recording shall provide a capability of replaying the picture in the original recorded form with possible distortions related to information compression during recording;
- environment (can be recorded only according to AIS data if the shipboard radar is not interfaced with S-VDR devices);
- other additional information from the ship devices having digital output provided that it does not degrade recording and storage of main data.

3.20.8 S-VDR shall be designed so as to prevent inadvertent intervention in recorded information. Any intervention in operation of VDR shall be recorded in VDR.

3.20.9 The method of information recording shall provide check of validity and completeness of incoming data and alarm
signal when an unrecoverable error is detected.

3.20.10 S-VDR shall record and store information for previous 12 h of voyage until it is completely off.

3.20.11 S-VDR shall operate continuously and automatically. Means shall be available to provide integrity of data recorded during incident with minimum cessation of recording process.

3.20.12 To provide recording of events during accident, S-VDR shall be interfaced with an emergency power supply.

3.20.13 When the shipboard emergency power supply fails, S-VDR shall continue recording voice conversations in the wheelhouse during 2 h using its own standby power supply. After 2 h recording shall be stopped automatically.

3.20.14 Interface of S-VDR with information sensors shall not affect operation of information sensors interfaced with it, including the cases of S-VDR inoperability.

3.20.15 S-VDR shall provide interface with an external portable computer to retrieve the stored data and display the information. The interface format shall be compatible with format such as Ethernet and with USB and Fire Wire as well.

3.20.16 Each S-VDR installation shall be provided with the software, which allows of retrieving the stored data and replay the information on the connected external portable computer.

3.20.17 The S-VDR software shall be compatible with the operating system available in portable general-purpose computers and shall be provided on a portable information storage, such as CD-ROM, DVD, USB storage, etc.

3.20.18 The S-VDR set shall contain instructions on use of software and connection of external portable computer to S-VDR.

3.20.19 The portable storage containing the software, instructions and special parts required to connect the external portable computer shall be included in the equipment set and shall be kept in immediate proximity from the main unit of S-VDR.

3.20.20 If S-VDR uses nonstandard formats or proprietary standards for data storage, the software shall be provided in a portable storage or in S-VDR itself to convert stored data into open standard formats.

3.21 REQUIREMENTS TO RADAR REFLECTOR

3.21.1 The radar reflector (active or passive) shall have the radar cross-section complying with requirements of 3.21.2 to allow detecting it by the shipboard navigating radar operating in 9 GHz band (3 cm wavelength) and 3 GHz band (10 cm wavelength).

3.21.2 When the radar reflector is mounted at height of not less than 4 m above water level, the nominal radar cross-section shall not be less than 7.5 m² in 9 GHz band and 0.5 m² in 3 GHz band.

3.21.3 The nominal minimum radar cross-section shall be provided within total sector of 280° in horizontal plane.

3.21.4 The polar diagram of the radar reflector shall be such that any continuous sector, in which reduction of reflectivity below the nominal minimum level does not exceed 10° (zero area) with required distance of less than 20° between adjacent zero areas.

3.21.5 The radar reflectors capable of meeting the requirement of 3.21.2 at inclination angles of 20° and more to any side from the vertical line shall have the respective marking.

3.21.6 The minimum mounting height recommended by the radar reflector manufacturer (not less than 4 m) and the preferable mounting orientation shall be marked directly on the radar reflector.

3.21.7 The active radar reflectors shall comply with the requirements of International Telecommunication Union (ITU).
3.22 REQUIREMENTS TO INTEGRATED NAVIGATION SYSTEMS

3.22.1 The integrated navigation system (INS) shall comply with the requirements of the national and international standards.

3.23 REQUIREMENTS TO EXTERNAL AUDIO SIGNAL RECEPTION EQUIPMENT

3.23.1 The external audio signal reception equipment shall be installed on ships, on which lookout by hearing is possible only with reception of external audio signals inside the wheelhouse, because of operational conditions or wheelhouse design features.

3.23.2 The external audio signal reception equipment shall:
   - receive external audio signals in frequency band of at least 70 to 700 Hz from all directions;
   - transmit these signals acoustically to the wheelhouse;
   - determine and indicate approximate direction of a source of audio signals.

3.23.3 External audio signals shall be transmitted to the wheelhouse by means of one or several speakers.

3.23.4 When two or more speakers are installed, their acoustic intensity shall be adjusted so that the wheelhouse sound level exceeds noise level on the bridge wings at least by 10 dB(A).

3.23.5 In addition to microphones, amplifiers and speakers, the external audio signal reception equipment shall contain a display to visually display external audio signals and their approximate direction at least 3 s after they are received.

3.24 REQUIREMENTS TO SEA WATCH ALARM SYSTEM

3.24.1 The sea watch alarm system is used to monitor operation of the main steering position and detect incapability of the officer on watch that could result in an accident.

This is provided by transmitting optical and sound signals to draw attention of the officer on watch and then, if he does not react to them, by informing the master or the back-up officer.

3.24.2 Three system operation modes shall be provided for:
   1. "Manual ON" mode for continuous operation when the ship is underway in a voyage;
   2. "Automatic" mode when sea watch alarm system is automatically activated when the vessel is navigating by means of heading or track control system, and changed over to "Manual ON" mode as the heading/track control system is deactivated;
   3. "Manual OFF" mode. Sea watch alarm system can be switched on only by navigator's dedicated actions.

3.24.3 When the system is on, the following sequence of visual (optical) and sound signals shall be observed:
   1. After switched on, the system shall remain dormant for a master-specified period of 3 to 12 min and then it shall activate a light signal;
   2. If the officer on watch does not acknowledge the light signal, i.e. does not reset the system, for 15 sec, the system shall sound a first level audible alarm on the steering station;
   3. If the officer on watch does not reset the system 15 s after the first level audible alarm is initiated, the system shall additionally sound a second level audible alarm in the back-up officer’s and/or Master’s location;
   4. If the officer on watch does not reset the system 90 s after the second level audible alarm is initiated, the system shall sound a third level audible alarm at all navigating personnel locations of the ship;
   5. In vessels other than passenger vessels, the second level audible alarm may sound in all the above locations. If the second level audible alarm is sounded in this way, the third level alarm may be omitted;

In vessels of gross tonnage more than 3000, the delay between the second and third level alarms may be set to a longer value up to 3 min, to allow sufficient time for the back-up officer and/or Master to reach the wheelhouse.

3.24.4 It shall be possible to reset the sea watch alarm system or cancel any alarm signal from the wheelhouse only.

The system reset or alarm signal cancellation shall be possible by operator's single action and shall initiate the next dormant period.

Repeated activation of the reset device shall not prolong the dormant period or change the sequence of light and sound signals.

3.24.5 Means may be provided in the wheelhouse to immediately activate the second and third level audible alarms for emergency call of the back-up officer and/or the Master.

3.24.6 The alarm system shall be capable of achieving the timings with accuracy of 5% or 5 s, whichever is less, under all operational conditions.

3.24.7 If a malfunction of or power supply failure to sea watch alarm system is detected, this should be indicated. Provision shall be made to allow this indication be repeated on the common alarm and communication panel.

3.24.8 Sea watch alarm system shall have the following controls:

.1 means protected from unauthorized access to select the operation mode and the dormant period duration;

.2 a means of activating the “Emergency Call” signal if it is provided in the system;

.3 system reset means which shall be located on the main bridge posts and on its wings.

3.24.9 The system operation mode shall be indicated to the officer on watch.

3.24.10 The visual signal initiated at the end of the dormant period shall be flashing and visible from all positions in the wheelhouse. The colour of the visual signal shall be chosen so as not to impair night vision, and dimming facilities (although not to extinction) shall be incorporated.

3.24.11 The first level audible alarm which sounds on the bridge 15 s after the light signal is initiated shall draw attention of the navigator of the watch. It shall be possible to select its tone or modulation and volume level as well.

3.24.12 The additional second and third level audible alarms which sound sequentially in the locations of the Master, back-up officer and other crew members capable of assisting the officer on watch at the end of the first level audible alarm period shall have sound signal level of not less than 75 dB.

3.24.13 All equipment of the sea watch alarm system shall be tamper-proof so that no member of the crew may interfere with the system operation.

3.24.14 Reset devices shall be designed so as to exclude the possibility of their operation by any means other than activation by the officer on watch. Reset devices shall be illuminated at night and shall be mounted in the wheelhouse.

3.24.15 The sea watch alarm system shall be powered from the ship's main power supply. The malfunction indication means and the Emergency Call facility, if incorporated, shall be powered from a battery.

3.24.16 The sea watch alarm system shall have inputs and outputs for connection of light and audible alarm signals and additional system reset devices.

3.25 REQUIREMENTS TO LONG RANGE IDENTIFICATION AND TRACKING SYSTEM EQUIPMENT

3.25.1 The equipment of the long range identification and tracking system (hereinafter referred to as LRIT) shall automatically transmit the following information:

.1 ship identification number;

.2 ship’s position coordinates (latitude and longitude);
.3 position fixing date and time.

3.25.2 The LRIT equipment shall comply with the performance requirements of this Chapter and the requirements of 6.1 Part VII of the Rules.

3.25.3 The LRIT equipment shall:
.1 provide capability of automatic, without interfering of ship watch personnel, transmission of ship LRIT information to LRIT data centre. LRIT information shall be transmitted at 6 hour intervals;
.2 change over to transmission of LRIT information at an interval shorter than that indicated in 3.25.3.1 by remote control command from LRIT data centre if LRIT data receiver requesting LRIT information has determined LRIT information transmission intervals that differ from 6 hour interval;
.3 provide capability of transmitting LRIT information on receipt of polling commands;
.4 provide capability of direct connection to the shipboard GNSS receiver or the LRIT equipment shall incorporate a receiver capable of finding own ship position based on GNSS signals;
.5 be powered from the main and emergency power sources. If the shipboard radio equipment required in Part VII of the Rules is used as LRIT equipment, it shall be powered according to 3 Part VII of the Rules;
.6 be tested for stability to external mechanical and climatic effects and for electromagnetic compatibility with other shipboard electronic and electrical equipment.

3.25.4 The LRIT equipment shall meet the functional requirements stated in Table 3.25.4.

3.25.5 The LRIT equipment shall transmit LRIT information and enable a remote tuning using a communication system which provides coverage in all areas for which the ship is about to operate.

3.25.6 The LRIT equipment design shall provide capability of periodic operability check without transmitting LRIT information.

### Table 3.25.4

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Requirement and comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shipboard equipment identification number</td>
<td>Ship identification number (MMSI) used in shipboard radio equipment</td>
</tr>
<tr>
<td>Ship position data</td>
<td>Ship position coordinates (latitude and longitude) based on GNSS signals (in WGS-84 datum). Location: the LRIT equipment shall transmit own ship’s position coordinates (latitude and longitude) based on GNSS signals (in WGS-84 datum) without intervention of ship watch personnel. Position reports on polling command(^1): in reply to received polling command, the LRIT equipment shall provide a regular reporting of own ship position without intervention of ship watch personnel whatever the ship’s position is. Planned position reports(^2): it shall be possible to tune the LRIT equipment remotely for transmission of LRIT information at a definite interval: from minimum (15 minutes) to 6 hours. Information shall be transmitted to LRIT data centre without intervention of ship watch personnel whatever the ship’s position is.</td>
</tr>
<tr>
<td>Time stamp</td>
<td>Date and time(^3) of own ship’s position finding based on GNSS signals. In each LRIT information package transmitted the LRIT equipment shall transmit information on time(^3) of own ship’s position finding based on GNSS signals</td>
</tr>
</tbody>
</table>

\(^1\) Position reports on polling command mean transmission of LRIT information either as a result of a polling command or as a result of remote tuning of LRIT equipment for transmission at intervals other than those preset.\n\(^2\) Planned position reports mean transmission of LRIT information at preset time intervals.\n\(^3\) All time data shall be in UTC.
3.25.7 It shall be possible to switch the LRIT equipment off or to stop transmission of LRIT information (with a respective record made in the ship log) in the following cases:

.1 if the international agreements or regional rules provide for protection of navigational data;

.2 in exceptional cases and for time as short as possible if the Master considers that the operating LRIT equipment can endanger the ship safety or reduce her security level.

3.25.8 The LRIT system equipment shall provide possibility of decreasing the LRIT information transmission frequency or stopping the LRIT information transmission temporarily when the ship is docked for repair or refit, located in port or brought out of service for a long time if the Master or the Administration of the flag state made the decision to decrease the LRIT information transmission frequency to a single message a day or to temporarily stop transmitting such information with a respective record made in the ship log.

3.26 REQUIREMENTS FOR ELECTRONIC CHART DISPLAY SYSTEM

3.26.1 ECDS shall display distortionless information from the official navigation map of inland waterways.

3.26.2 The chart dimensions displayed shall be at least 180x180 mm.

3.26.3 The ECDS display shall have a resolution of at least 800x600 pixels and provide information reading at a distance not less than 1 m.
Part IX

REQUIREMENTS FOR SHIPS CARRYING DANGEROUS GOODS
1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION

1.1.1 This Part of the Rules sets the requirements for ships which carry in their cargo spaces and areas dangerous goods in bulk or in containers.

1.1.2 The requirements of this Part of the Rules apply to design and construction of ships intended to carry dangerous goods and to refit of ships of all classes in use.

1.1.3 If the requirements of this Part of the Rules are not identical to the requirements of the other Parts of the Rules for the same matter, the strictest requirements of the Rules shall apply.

1.1.4 In addition to the requirements of this Part of the Rules, the ships carrying dangerous goods in international voyages shall meet the applicable requirements of the international agreements ratified by the Russian Federation depending on ship design, type of carriage and carried dangerous goods.

1.1.5 Tugboats and/or pushboats which transport non-self-propelled ships with dangerous goods shall meet the applicable requirements of this Part of the Rules that are determined depending on design of non-self-propelled ship, type of carriage and carried dangerous goods.

1.2 TERMS AND DEFINITIONS

1.2.1 Common terms and definitions of the Rules are stated in 2.1 and 2.2 Part 0 of the Rules. The following terms are used in these Rules:

.1 Dangerous goods means substances, materials and products containing such substances and materials with properties which may create a threat to life and health of people, cause damage to the environment, damage or destroy material values during transportation.

This Part of the Rules uses dangerous goods classification set by the International European Agreement concerning the International Carriage of Dangerous Goods on Inland Waterway (ADN).

In view of hazard nature, dangerous goods are divided into the following classes.

Class 1 — explosive substances and articles. Subclasses:

1.1 — substances or articles which have a mass explosion hazard (explosion which affects almost the entire load instantaneously);
1.2 — substances and articles which have a projection hazard but not a mass explosion hazard;
1.3 — substances and articles that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard;
1.4 — substances and articles which present no significant hazard to people;
1.5 — very insensitive substances which have a mass explosion hazard;
1.6 — extremely insensitive articles which do not have a mass explosion hazard.

Class 2 — compressed gases, liquefied gases, and dissolved gases. Subclasses:

2.1 — flammable dangerous cargoes;
2.2 — non-flammable, non-toxic gases;
2.3 — toxic gases.

Class 3 — flammable liquids. Subclasses:

3.1 — liquids with low vapour flash point (below –18 °C);
3.2 — liquids with medium vapour flash point (from –18 °C to 23 °C, exclusive);
3.3 — liquids with high vapour flash point (from 23 °C to 61 °C).

Note. Vapour flash point shall be measured in closed cup.

Class 4 — flammable solids; substances liable to spontaneous combustion; substances which, in contact with water, emit flammable gases. Subclasses:
4.1 — flammable solids and solids, which are combustible through friction; self-reactive solids and liquids (which are liable to undergo a strongly exothermic decomposition as a result of high temperatures in transport or pollution) and similar; desensitized explosive substances (which may explode if not diluted sufficiently);
4.2 — substances liable to spontaneous combustion;
4.3 — substances which, in contact with water, emit flammable gases.

Class 5 — oxidizing substances and organic peroxides. Subclasses:
5.1 — oxidizing substances which, while in themselves not necessarily combustible, may, generally by yielding oxygen, cause, or contribute to, the combustion of other substances;
5.2 — organic peroxides which may be considered derivatives of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals.

Class 6 — toxic and infectious substances. Subclasses:
6.1 — toxic substances;
6.2 — infectious substances.

Class 7 — radioactive substances.

Class 8 — corrosive substances.

Class 9 — miscellaneous dangerous substances and articles;

Chemically dangerous goods means strong poisonous chemicals and their compounds (acids, alkalis, aldehydes, ethers, hydrocarbons, nitrates, peroxides, and metal compounds) which are toxic and capable, when unpacked and spilled, of causing chemical damages to life forms and environment;

D  a  n  g  e  r  o  u  s  g  o  o  d  s  v  a  p  o  u  r  d  e  s  i  g  n  p  r  e  s  s  u  r  e  \( p_0 \) means the maximum positive pressure at the top of the cargo tank.

Dangerous goods design temperature means the minimum temperature at which dangerous goods may be loaded or transported in the cargo tanks for selection of materials to be used to manufacture the cargo piping and cargo tanks. It shall be specified by the designer (design engineering firm) depending on properties of carried dangerous goods specified in dangerous goods documentation;

Dangerous goods containment system means a structural arrangement for containment of cargo including, where fitted, a primary and secondary barrier, associated insulation and any interbarrier spaces, and adjacent structures if necessary for the support of these elements. If the secondary barrier is a part of the hull structure, it may be a boundary of the hold space;

Secondary barrier means a liquid-resisting structure which is not a part of the hull and which accommodates a cargo tank. The secondary barrier is a component of the dangerous goods containment system designed to afford temporary containment of any envisaged leakage of liquid dangerous goods through the primary barrier and to prevent the lowering of the temperature of the hull structures;

Interbarrier space means a space between a primary and a secondary barrier, whether or not completely or partially occupied by insulation material;

Independent cargo tanks mean tanks the shell of which is not a part of the hull structures and does not contribute to the ship’s hull integrity. Independent cargo tanks are divided into the following types:

Type A is a cargo tank designed using ship-structural analysis procedures recognized by the River Register.

Type B is a cargo tank designed using model tests and analysis methods to determine stress levels, fatigue life and crack propagation characteristics.
Type C is a spherical or cylindrical cargo tank designed in accordance with the requirements of the Rules for pressure vessels;

9 Integral cargo tanks mean tanks which form structural parts of the ship’s hull and contribute together with the hull structures to the general ship strength;

10 High-pressure cargo tank means a cargo tank intended to carry dangerous goods at working positive pressure of at least 0.4 MPa;

11 Internal insulation cargo tank means a tank made of heat insulation materials which are capable of creating appropriate thermostatic conditions for dangerous goods storage and are supported by the structure of the adjacent inner hull or of an independent tank. The inner surface of the insulation is exposed to the dangerous goods;

12 Closed cargo tanks means a cargo tank equipped with a controlled vapour and gas discharge system in which pressure relief valves and vacuum relief valves are installed in free vapour and gas discharge way;

13 Open cargo tanks means a cargo tank equipped with a free-flow vapour and gas discharge system with flame arrester in which free vapour and gas discharge is not impeded, except for friction loss;

14 Gravity cargo tank means an integral or independent tank intended to carry dangerous goods at design positive pressure of 0.07 MPa max;

15 Pressure cargo tank means an independent tank intended to carry dangerous goods at design positive pressure exceeding 0.07 MPa. The pressure tank shall be configured so that pressure tank design procedures agreed by the River Register can be applied;

16 Membrane cargo tank means a cargo tank which consists of a membrane shell supported through insulation by the adjacent hull structures.

The membrane cargo tank is also a tank with non-metallic membranes or membranes incorporated in or connected to the tank insulation;

17 Semi-membrane cargo tank means a cargo tank which consists of a membrane shell, parts of which are supported through insulation by the adjacent hull structures, and deformations are compensated by all shell components connected at radius equal to 5 to 10 values of shell wall thickness;

18 Membrane means a thin-walled shell element used to manufacture the cargo tanks;

19 Cargo tank dome means the cargo tank top protruding over the weather deck or the tank cover when the dangerous goods containment system is located under the deck;

20 Gas-dangerous spaces or areas mean the following spaces or areas:

- spaces in the cargo area which do not ensure that their atmosphere is at all times maintained in a gas-safe condition;
- an enclosed space (see 1.2.1.5 Part III of the Rules) outside the cargo area through which any piping containing liquid or gaseous dangerous products passes, or within which such piping terminates, unless approved arrangements are installed to prevent any escape of dangerous product vapour into the atmosphere of that space;
- a space in which dangerous goods containment system and cargo piping are arranged;
- a hold space where dangerous goods are carried in the dangerous goods containment system reservoirs requiring a secondary barrier and spaces separated from such hold space by a single gas-tight steel boundary;
- a hold space where dangerous goods are carried in the dangerous goods containment system reservoirs not requiring a secondary barrier;
- cargo compressor and cargo pump rooms;
- an open deck area (a deck exposed to the weather) or a semi-enclosed space on the weather deck within 3 m of any cargo tank outlet, gas or vapour outlet, cargo pipe flanges or cargo valves or of entrances and ventilation

The thin-walled shell is a shell for which relation of minimum wall curvature radius to wall thickness exceeds 10 for cylindrical shells and 3.5 for spherical shells.
openings to cargo compressor and cargo pump rooms;

the weather deck over the cargo area and 3 m forward and aft of the cargo area on the weather deck up to a height of 2.4 m above the weather deck;

a zone within 2.4 m of the outer surface of the cargo containment system where such surface is exposed to the weather;

an enclosed or semi-enclosed (see 1.2.1.24 Part III of the Rules) space in which pipes containing liquid or gaseous dangerous goods are located;

a compartment for cargo hoses;

enclosed or semi-enclosed spaces having a direct opening into any gas-dangerous space or area.

A space accommodating gas detection equipment and a space in which exhaling gas is used as fuel are not considered gas-dangerous ones;

.21 Gas-safe spaces mean spaces other than gas-dangerous spaces and those where atmosphere is continuously maintained in fire-safe, explosion-safe and life and health friendly condition;

.22 Machinery spaces — see the definition in 1.2.1.26 Part III of the Rules;

accommodation spaces — see 1.2.1.22 Part III of the Rules;

adjacent spaces — see 1.2.1.25 Part III of the Rules;

machinery spaces — see 2.2.25 Part 0 of the Rules;

explosion-hazardous zone — see 2.1.1.6 Part VI of the Rules;

control stations — see 1.2.1.17 Part IV of the Rules;

.23 Cargo area means an area consisting of cargo areas below and above deck (main and additional parts) (Figs. 1.2.1.23-1 and 1.2.1.23-2), where:

Cargo area (part below deck) is a space between two vertical planes perpendicular to the centre plane of the ship, which comprises cargo tanks, hold spaces, cofferdams, double-hull spaces and double bottoms. These planes normally coincide with the outer transversal cofferdam bulkheads or end transversal hold bulkheads. Their intersection line with the deck is referred to as the deck boundary of the cargo area part below deck.

Cargo area (main part above deck) is a space above deck of 3 m high which is bounded at the sides by the plane located 3 m away of the longitudinal walls of the cargo tanks and fore and aft by planes inclined at 45° to the deck towards the cargo area, starting at the deck boundaries of the cargo area part below deck.

Cargo area (additional part above deck) is a space not included in the main part of the cargo area above deck comprising 1.00 m radius spherical segments centred over the ventilation openings of the cofferdams and service spaces located in the cargo area part below deck and 2.00 m radius spherical segments centred over the ventilation openings of the cargo tanks and pump rooms;

Fig. 1.2.1.23-1. Cargo area:
1 — deck; 2 — cofferdam vent openings; 3 — cargo area above deck additional part; 4 — cargo tank vent openings; 5 — deck boundary of cargo area part above deck; 6 — end cofferdams; 7 — cargo area below deck
Open-type gauge means an instrument used to take measurements through the cargo tank body openings. In doing so, a person taking measurements can be exposed to dangerous goods and/or their vapours.

Partly closed-type gauge means an instrument installed inside the tank and used to take measurements. When this gauge is used, a small quantity of cargo vapours or liquid which is not dangerous to human life and health may be discharged to the open air. As long as the gauge is not used, it shall be closed.

Closed-type gauge means an instrument used to take measurements, which is installed inside the cargo tank and, being a part of the closed system, prevents the cargo tank contents from discharge. Closed-type gauges are also instruments which are not installed inside the tank and prevent the cargo tank contents from discharge (for example, liquid flow meters in piping).

Fire smothering system means a fire extinguishing system based on gas fire extinguishing, but special liquid is applied to a space instead of gas and evaporates to form inert gas heavier than air.

Chemical tanker means a ship designed to carry chemically dangerous goods in bulk. Inland navigation chemical tankers are divided into two types, i.e. C and N. Type C tanker shall be built as a flush decked double hull ship without deck trunk. Type C tanker cargo tanks may be integral (formed by inner walls of double hull) or independent. Chemical tanker type is established depending on carried cargo properties and is specified in col. 3 of Table A1-1 in Appendix 1;

Ships of type 1, 2, 3 are chemical river–sea navigation tankers designed to carry chemically dangerous goods in bulk. Ship type is established depending on carried dangerous goods properties and is specified in col. 3 of Table A2-1 in Appendix 2;

Liquefied gas tanker means a ship designed to carry liquefied gases in bulk. Inland navigation liquefied gas tanker (type G tanker) is designed to carry gases specified in Table A1-1 of Appendix 1 under pressure or under refrigeration. River–sea navigation liquefied gas tankers depending on type of structural fire protection(see 6.8.1) are divided into four types: 1G, 2G, 2PG and 3G; liquefied gas tanker type is established depending on carried dangerous goods properties and is specified in col. 4 of Table A3-1 in Appendix 3.
2 GENERAL REQUIREMENTS

2.1 FIRE WATER MAIN SYSTEM

2.1.1 Ships carrying dangerous goods shall be equipped with the fire water main system meeting the following requirements:

.1 The fire water main system shall be fed from two independent fire pumps. A ballast pump may be used as one of fire pumps, if its capacity and pressure meet the fire pump-requirements specified in Part III of the Rules. Pumps, their drives and electrical equipment shall not be arranged in the same space;

.2 The fire water main system shall supply water under pressure specified in Part III of the Rules by continuously keeping the pressure in the main or by remotely starting the fire pumps from the wheelhouse and from the continuous watch keeping location when the ship is berthed or at anchor, as well as supply water in the main without additional opening of the valves in the pump room. A water pressure indicator shall be installed in the place of pump's remote start;

.3 The fire water main system for И, Ï, Ð and Ë class ships shall be fitted with a water main provided with at least three fire plugs located in the cargo area (a portion of the ship to be protected in accordance with the requirements of the Rules) above the deck and at least four fire plugs fitted with fire hoses with combined nozzles of at least 12 mm in diameter. Any portion of the deck within the protected area shall be simultaneously covered by at least two water jets from different hydrants.

For М-СП, М-ПР and О-ПР class ships carrying cargo in bulk or in containers, the fire water main system shall supply water in amount sufficient to feed four fire monitors with minimum cock pressure of 0.25 MPa to any portion of a void cargo space.

Quantity and location of fire cocks shall be such that at least two of required four water jets can be supplied through fire hoses to any part of void cargo space and all four water jets can be supplied through fire hoses to any part of ro-ro cargo space;

.4 Head and capacity of pumps shall enable simultaneous use of two spray nozzles from any part of the ship, and the water jet shall cover a distance of not less than the hull beam of the ship;

.5 A fire pump or a ballast pump may be available onboard the push-towed barges which do not have their own power installation. It is possible to use the fire water main system of the pushboat with remote start of the own pump from the wheelhouse connected to the fire water main system of the barge with flexible hoses.

2.2 FIRE SMOTHERING SYSTEMS

2.2.1 In addition to the requirements of 2.1.1, the machinery spaces (see 2.2.25 Part 0 of the Rules), as well as the pump room and the spaces accommodating the refrigeration system equipment for the tankers, shall be equipped with a fixed fire extinguishing system meeting the requirements specified in 2.2.2 to 2.4.3.

2.2.2 To provide fire protection in machinery spaces, oiler rooms and pump rooms, only fixed fire extinguishing systems using the following extinguishing agents are permitted:

- CO2 (carbon dioxide),
- HFC-227 ea (heptafluoropropane),
- IG-541 (52% nitrogen, 40% argon, 8% carbon dioxide),
- FK-5-1-12 (dodecafluoro-2-methylpentan-3),
mixture containing 73% ethyl bromide C\textsubscript{2}H\textsubscript{5}Br and 27% dibromotetrafluoroethane C\textsubscript{2}Br\textsubscript{2}F\textsubscript{4} (halon 114\textsubscript{2}) or mixture of C\textsubscript{2}H\textsubscript{5}Br and CO\textsubscript{2} (for fire smothering systems).

2.2.3 In addition to requirements stated in 2.2.2 and 2.3, the fire extinguishing systems using HFC-227\textit{ea} as a fire-extinguishing agent shall meet the following requirements:

1. If several spaces with different volumes are available, each space shall be equipped with its own (separate) fire extinguishing system;

2. Each reservoir with HFC-227\textit{ea} located in the space being protected shall be equipped with an overpressure preventing device. This device shall disperse the reservoir contents in the space being protected if this reservoir is exposed to fire while the fire extinguishing system is not activated;

3. Each reservoir with HFC-227\textit{ea} shall be equipped with a pressure monitor which outputs light and sound alarms to the wheelhouse in case of pressure drop in the gas-carrying medium reservoir. If the wheelhouse is unavailable, these alarms shall be given from the outside of the space being protected;

4. Reservoir filling ratio shall not exceed 1.15 kg/l.

HFC-227\textit{ea} specific volume shall be taken equal to 0.1374 m\textsuperscript{3}/kg;

5. After dispersion, HFC-227\textit{ea} concentration in the space being protected shall be at least 8% and at most 10.5% of the total volume of this space. HFC-227\textit{ea} shall be discharged for 10 s;

6. The fire extinguishing systems shall have no parts of aluminium.

2.2.4 In addition to requirements stated in 2.2.2 and 2.3, the fire extinguishing systems using IG-541 as a fire-extinguishing agent shall meet the following requirements:

1. If several spaces with different volumes are available, each space shall be equipped with its own (separate) fire extinguishing system;

2. Each reservoir with IG-541 located in the space being protected shall be equipped with an overpressure preventing device. This device shall disperse the reservoir contents in the space being protected if this reservoir is exposed to fire while the fire extinguishing system is not activated;

3. Each reservoir with IG-541 shall be equipped with a pressure monitor;

4. Reservoir filling pressure shall not exceed 20 MPa at temperature of +15 °C;

5. After dispersion, IG-541 concentration in the space being protected shall be at least 44% and at most 50% of the total volume of this space. IG-541 shall be discharged for 120 s.

2.2.5 In addition to requirements stated in 2.2.2 and 2.3, the fire extinguishing systems using FK-5-1-12 as a fire-extinguishing agent shall meet the following requirements:

1. If several spaces with different volumes are available, each space shall be equipped with its own (separate) fire extinguishing system;

2. Each reservoir with FK-5-1-12 located in the space being protected shall be equipped with an overpressure preventing device. This device shall disperse the reservoir contents in the space being protected if this reservoir is exposed to fire while the fire extinguishing system is not activated;

3. Reservoir filling ratio shall not exceed 1.15 kg/l.

FK-5-1-12 specific volume shall be taken equal to 0.0719 m\textsuperscript{3}/kg;

4. After dispersion, FK-5-1-12 concentration in the space being protected shall be at least 5.5% and at most 10% of the total volume of this space. FK-5-1-12 shall be discharged for 10 s;

5. Each reservoir with FK-5-1-12 shall be equipped with a pressure monitor, which outputs light and sound alarms to the wheelhouse in case of pressure drop in the fire-extinguishing agent reservoir. If the wheelhouse is unavailable, these alarms shall be given from the outside of the space being protected.

2.3 EQUIPMENT OF PROTECTED SPACES

2.3.1 The forced ventilation system in the space to be protected shall be shut down as
soon as the fire smothering system is activated.

2.3.2 Openings in the space to be protected shall be fitted with quick-closing devices (devices which are closed either automatically under gravity of spring force and quick-closing float or by turning the control). Open and closed positions of these devices shall be indicated.

2.3.3 Air escaping from the pressure-relief valves of the pressurized air tanks installed in the machinery spaces shall be evacuated to the open air.

2.3.4 Overpressure or negative pressure caused by diffusion of extinguishing agent shall not destroy the structural elements of the space to be protected. It shall be possible to safely equalize pressures.

2.3.5 It shall be possible to extract the extinguishing agent from protected spaces. If corresponding suction devices are fitted for this purpose, they shall not operate during fire extinguishing.

2.3.6 The extinguishing agent shall be routed to and distributed in the space to be protected by means of a permanent piping system. Piping installed in the space to be protected and valves and fittings it incorporates shall be made of steel.

The discharge nozzles shall be so arranged as to ensure regular distribution of the extinguishing agent in the space to be protected.

2.3.7 Automatically activated fire extinguishing systems are not permitted. It shall be possible to activate the fire extinguishing system from a suitable position located outside the space to be protected. Opening the extinguishing agent vessel valves and controlling the dispersion valve shall represent two independent operations.

2.3.8 The fire extinguishing system activating devices shall be supplied with power from two energy sources independent of each other. These energy sources shall be located outside the space to be protected. The control system cables located in the space to be protected shall be so designed as to remain capable of operating in the event of a fire for a minimum of 30 minutes.

2.4 ALARM SYSTEMS

2.4.1 The fixed fire extinguishing systems shall be equipped with warning systems (devices) which shall output light and sound signals when the fire extinguishing system is activated. The signals shall be output:

- for self-propelled ship — to pilot room;
- for fire smothering systems — to protected room and in front of its entrance;
- for non-self-propelled ship — to the constant watch post.

2.4.2 The warning system shall be activated automatically with the first activation of the fire extinguishing system. The warning system shall operate within the time until the system starts supplying the extinguishing agent, which shall not be less than 20 s, and shall not be deactivated for this time.

2.4.3 (shall be considered to have lost force.)

2.5 FIRE OUTFIT

2.5.1 The explosion-hazardous areas, spaces and rooms and the weather decks of the liquefied gas tankers and chemical tankers shall be provided with the fire outfit items as prescribed by the Rules, the design and material of which exclude possibility of sparking when these items are used.

For non-self-propelled unmanned liquefied gas tankers and chemical tankers the above requirements for the fire outfit items apply to the fire outfit items installed on open decks of tugboats and pushers which operate together with the specified tankers.

2.5.2 In addition to the fire outfit prescribed by the Rules, the ship shall be provided with the following protective equipment:

- for each member of the crew participating in loading and discharge operations, the protective equipment including: a pair of tight protective goggles and/or facepieces, aprons, a pair of special gloves with oversleeves, an
overall of chemically resistant material, and protective shoes;
a flammable gas detector with the instructions for its use;
a toximeter with the instructions for its use;
two breathing apparatuses.

2.5.3 For pushed convoys or side-by-side formations underway, it shall be sufficient, however, if the pushboat or the vessel propelling the formation is equipped with the protective equipment specified in 2.5.2.
3 SHIPS CARRYING DANGEROUS GOODS IN BULK OR IN CONTAINERS

3.1 CARGO SPACES

3.1.1 The ships carrying dangerous goods in bulk or in containers shall have double sides and double bottom within the cargo spaces. This requirement does not apply to the ships carrying dangerous goods on the deck only.

3.1.2 The cargo spaces of the ships carrying dangerous goods in bulk shall be made of materials that do not react with carried dangerous goods or shall be coated with isolating material that do not react with carried dangerous goods.

3.1.3 The cargo spaces on the ships, except for the ro-ro ships, shall not adjoin the accommodation and service spaces. Exception may apply to the service spaces with low fire hazard which are not parts of the machinery spaces: stores of incombustible material, spares, mechanical and electrical materials.

3.1.4 The bulkheads and the decks, which separate the machinery spaces from the cargo spaces, shall be of type A-60. The bulkheads of type A-0 are allowed if structural or other arrangements have been taken to place dangerous goods at distance of not less than 3 m from these bulkheads.

3.1.5 No heating appliances shall be installed in the holds.

3.1.6 It shall be possible to take air samples in the cargo spaces of the ships carrying dangerous goods, and the ship shall be fitted with equipment which allows of determining concentration of explosion-hazardous gases and vapours or oxygen in the cargo space.

3.1.7 Arrangements shall be made to prevent ingress of contaminated air into spaces with instruments during air sampling from the cargo spaces.

3.1.8 It shall be possible to measure temperature in the cargo spaces at different heights.

3.1.9 The hatch covers of the cargo spaces, which carry dangerous goods, shall be made of steel. The hatch covers shall be designed so as they can move with no impacts to exclude possibility of sparking. It shall be possible to retain the covers in the open position.

3.2 VENTILATION

3.2.1 The ventilation system shall meet the following requirements:

.1 It must be possible to ventilate each hold by means of two mutually independent spark proof (Exi) extraction fans having a capacity of not less than five changes of air per hour based on the volume of the empty hold. The holds may be provided with natural supply ventilation;

.2 The inlet openings of the extraction ducts shall provide air exchange in the hold and no dead air. The inlet openings of the extraction ducts shall be positioned at the opposite ends of the hold at different heights, and the lower opening shall be at least 50 mm clear off the bottom or tank top plating. The requirements of this Subpara do not apply if dangerous goods are carried in bulk;

.3 If dangerous goods are carried in bulk, extraction of vapours and gases shall be possible through the extraction piping;
.4 The ventilation system of a hold shall be arranged so that dangerous gases cannot penetrate into the accommodation and service spaces, wheelhouse and machinery space;

.5 Intake and outlet ventilation openings shall be fitted with flame-arresting fittings. Flow area of these fittings shall be not less than the cross-sectional area of the ventilation pipe.

3.2.2 Doors, hatches, and ventilation openings leading to the machinery and service spaces are not allowed in the fore wall of the superstructure.

3.2.3 The open top ships do not require the fixed ventilation system to be installed. When containerized or packaged dangerous goods are carried in the open holds, these ships shall be provided with portable fans to ventilate the holds, if damage occurred to a container or package, so that concentration of gases evolved from dangerous goods is less than 10% of lower explosive limit or, in case of toxic gases, less than maximum permissible concentration.

3.3 ENGINES AND GAS EXHAUST PIPING

3.3.1 Fuel with vapour flash point 60 °C and below for the main and auxiliary engines and boilers and that with vapour flash point not less than 43 °C for emergency diesel generators shall not be used.

3.3.2 The machinery space inlet ventilation openings and the engine air intakes which do not take air in directly from the machinery spaces shall be located not less than 2.00 m from the cargo area.

3.3.3 Sparking shall not be possible within the cargo area.

3.3.4 The gas exhaust piping of the boilers and main and auxiliary engines shall be equipped with spark extinguishers (spark arresters) and shall be located not less than 2.00 m from the cargo area.

3.4 FUEL TANKS

3.4.1 The double bottom spaces located within the cargo holds may be used as fuel tanks provided that the double bottom space height is not less than 0.6 m.

In this case, piping and openings of these fuel tanks shall not be arranged in the hold.

3.4.2 Height of fuel tank air pipes measured from the deck to the fluid level in the pipe when filled shall not be less than 500 mm.

3.5 DRAINAGE SYSTEM

3.5.1 The drainage systems of the cargo spaces which dangerous goods are carried in shall be independent (not connected with piping or pumps of machinery and other spaces) and shall be located within the cargo area. The spaces accommodating the drain pumps shall be equipped with independent forced exhaust ventilation providing at least 6-fold air exchange per hour and shall be separated from the adjacent spaces with a self-closing door.

3.5.2 The cargo space drain devices shall prevent creation of free water surface.

If this requirement is not met, the fire water main system may be used onboard the ship only the requirements of Part II of the Rules for ship stability with free water surface taken into account are met by results of calculation.

Meeting the requirements of Part II of the Rules for ship stability with free water surface taken into account shall also be verified if peculiarities of dangerous goods require possible fire to be extinguished with water until the cargo space is flooded or if dangerous goods on fire are inclined to dilution.

3.6 FIRE EXTINGUISHING SYSTEM

3.6.1 To cool the enclosed under-deck cargo spaces of the ships intended to carry dangerous goods of class 1, subclasses 1.1 to 1.6, a stationary water spraying system with delivery rate of 5 L/min per square meter of the cargo space area shall be installed or the cargo space shall be flooded with the fire water main system mentioned in 2.1.1. For the cargo spaces of not more than 100 m² in area, fire hoses may be used for those pur-
poses to deliver water with delivery rate specified above.

3.6.2 To disperse fire-extinguishing agent over racks of service spaces where explosive substances are stored, a water sprinkling system may be used. This system shall be fed with water from the fire main. Pumps and power sources to be used shall be located out of the space being protected.

3.6.3 The sprinkling system may be used to flood the explosives stores.

3.6.4 The capacity of pumps serving the drencher shall be at least 24 L/min per square meter of the total area of the protected space.

3.6.5 The cargo spaces shall be equipped with a gas fire extinguishing or fire smothering system. This requirement does not apply to carriage of non-combustible or low inflammability dangerous goods or dangerous goods for which the gas fire extinguishing or fire smothering system is ineffective. Such dangerous goods are listed in Table 3.6.5.

3.6.6 In addition to fire-extinguishers available on the ship the cargo spaces shall be provided with two additional fire-extinguishers with fire-extinguishing agents the type of which is suitable and the quantity of which is enough for localizing inflammations and extinguishing possible fires in the cargo spaces on the ships carrying dangerous goods, but at least 12 kg of dry powder or equivalent quantity of another fire-extinguishing agent.

3.7 FIRE DETECTION SYSTEM

3.7.1 The cargo spaces protected with the water spraying system, aerosol and gas fire extinguishing system and fire smothering system shall be equipped with an automatic fire detection system meeting the requirements of 11.4 Part VI of the Rules.

3.8 ADDITIONAL FIRE SAFETY REQUIREMENTS

3.8.1 Electrical lighting fittings only are allowed outside of the accommodation spaces and wheelhouse.

### Table 3.6.5

<table>
<thead>
<tr>
<th>Substance description</th>
<th>U.N. No.</th>
<th>Danger class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Silicon aluminium, uncoated powder*</td>
<td>1398</td>
<td>4.3</td>
</tr>
<tr>
<td>2. Aluminium nitrate**</td>
<td>1438</td>
<td>5.1</td>
</tr>
<tr>
<td>3. Ferrosilicon aluminium, powder (including bricks)*</td>
<td>1395</td>
<td>4.3</td>
</tr>
<tr>
<td>4. Aluminium cast by-products*</td>
<td>3170</td>
<td>4.3</td>
</tr>
<tr>
<td>5. Ammonium nitrate**</td>
<td>1942</td>
<td>5.1</td>
</tr>
<tr>
<td>6. Barium nitrate**</td>
<td>1446</td>
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</tr>
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<td>7. Potassium nitrate**</td>
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<td>8. Calcium nitrate**</td>
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<td>5.1</td>
</tr>
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<td>9. Magnesium nitrate**</td>
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<td>5.1</td>
</tr>
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<td>10. Sodium nitrate**</td>
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<td>5.1</td>
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<td>11. Mixture of sodium nitrate and potassium nitrate**</td>
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<td>12. Radioactive material, low specific activity (LSA-I)*</td>
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<tr>
<td>13. Radioactive material, surface contaminated objects (SCO-I)*</td>
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<td>14. Lead nitrate**</td>
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<td>15. Sulphur*</td>
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<td>16. Ammonium nitrate fertilizer**</td>
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<td>17. Ammonium nitrate fertilizer**</td>
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<td>18. Ferrosilicon with 30% or more but less than 90% silicon (including bricks)*</td>
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</tr>
<tr>
<td>19. Zinc slag*</td>
<td>1435</td>
<td>4.3</td>
</tr>
</tbody>
</table>

* Gas fire extinguishing and fire smothering system is not required (low inflammability of goods).
** Gas fire extinguishing or fire smothering systems are ineffective.

### 3.9 ELECTRICAL EQUIPMENT

3.9.1 The electrical equipment installed in the cargo spaces of the ships carrying dangerous goods shall be of the following type of explosion protection:

1. intrinsically safe electrical circuit “i” (Exi)
2. pressurized enclosure “p” (Exp)
3. explosion-proof enclosure “d” (Exd)
4. explosion protected increased safety “e” (Exe).

Nonexplosion-proof lighting fittings and floodlights may be installed in such spaces to illuminate the hold provided that the switchboard of this lighting network has a
removable non-fusible jumper to deenergize the network.

3.9.2 Electrical equipment in the cargo holds shall meet the requirements of 2.10 Part VI of the Rules for group of explosive mixtures of dangerous goods with air T4 and mixture category IIB (see Appendix 2 Part VI of the Rules).

3.9.3 Electrical equipment to be used in the explosion-hazardous zone on the deck shall be of explosion-proof design applicable to category and group of most explosive mixture of dangerous goods vapours with air.

3.9.4 The switches shall exclude possibility of unauthorized (accidental) activation. The sockets in the explosion-hazardous zone shall be designed so that connection and disconnection from the electric circuit can be possible only when they are de-energized. These sockets shall be protected from mechanical damages.

3.9.5 Portable cables can be used:
   .1 for intrinsically safe electric circuits (Exi),
   .2 for connection of navigation lights and gangway lights,
   .3 for connection of containers carrying dangerous goods,
   .4 for connection of bilge fans,
   .5 for connection of electrically-driven hatch covers.

3.9.6 When portable cables are used, they shall meet the requirement of 2.10.9 Part VI of the Rules. These cables shall be at most 18 m long and shall be laid in such a way as to prevent damage to them.

3.9.7 The storage batteries shall be installed outside of the explosion-hazardous zones in accordance with the requirements of 8.5 Part VI of the Rules.

3.10 DOUBLE SIDE SPACE

3.10.1 The spacing between the side and the internal longitudinal bulkhead of the cargo space (double side space) shall be not less than 0.8 m.

This spacing may be reduced to 0.6 m if the following requirements are met:
   .1 in case of longitudinal side framing system:
      frame spacing shall not exceed 0.6 m,
      partial bulkheads with cutouts for passage of people shall be installed in the frame plane along the side with spacing of at least 1.8 m
   .2 in case of transversal side framing system:
      at least two side stringers shall be installed with spacing of 0.8 m max between them or between the upper stringer and the deck. The height of the stringers shall not be less than the height of the web frames, and the sectional area of the stringer flange shall not be less than 15 cm².

The stringers shall rest on the transversal partial bulkheads fitted with spacing of 3.6 m max with cutouts for lightening and passage of people, or the partial bulkhead with cutouts for lightening and passage of people shall be installed in plane of each web frame.

3.11 EMERGENCY EXIT

3.11.1 The spaces, the entrances or exits of which are likely to become partly or completely immersed in the damaged condition, shall have an emergency exit which is situated not less than 0.10 m above the damage water-line.

This requirement does not apply to forepeak and afterpeak.

3.12 FLOODABILITY

3.12.1 Dimensions of hull side damages in floodability calculations shall be taken as follows:
   .1 Damage length is 0.10L, but not less than 5.0 m;
   .2 Damage depth measured from the inner surface of the skin at right angle to the centre plane is 0.59 m;
   .3 vertical extent: from the base line upwards without limit;

3.12.2 Dimensions of bottom damages in floodability calculations shall be taken as follows:
.1 Damage length is $0.10L$, but not less than 5.0 m;
.2 Damage width is 3.0 m;
.3 Vertical damage size is from the baseline upwards to 0.49 m, exclusive of the drain well.

3.12.3 Floodability requirements shall be met when the following spaces are flooded:
.1 two adjacent side compartments
.2 two adjacent bottom compartments in transversal (longitudinal) direction
.3 machinery space.

3.12.4 At the final stage of flooding, the lower edges of all open openings (see 1.2.1.20 Part II of the Rules) shall be at least 0.10 m higher than the damaged waterline.

3.12.5 For all cases of unsymmetrical flooding, the heeling angle at the final stage of flooding shall not exceed 12°.

3.12.6 Area of damaged stability curve with positive arms shall not be less than 0.0065 m$^2$ rad to angle of 27° or to downflooding angle, whichever is less. In this case, the maximum arm of the damaged stability curve shall not be less than 0.05 m (Fig. 3.12.6).

3.12.7 Damaged stability of inland navigation ships carrying unfixed containers with dangerous goods shall meet the following requirements (see Fig. 3.12.7):

Fig. 3.12.6. Damaged stability curve:
$\theta_1$ is angle corresponding to equilibrium and final buoyancy position; $\theta_2$ is angle equal to 27° or to downflooding angle $\theta_{downflood}$, if $\theta_{downflood}$ < 27°

3.13 SCOPE OF REQUIREMENTS DEPENDING ON CLASS OF CARRIED DANGEROUS GOODS

3.13.1 Depending on degree of danger of carried dangerous goods defined by their class, the requirements stated in 3.1 to 3.12 may be relaxed.

Permissible relaxation in requirements depending on class of carried dangerous goods is as follows:

for carriage of dangerous goods in bulk, see Table 3.13.1-1;
for carriage of dangerous goods in containers, see Table 3.13.1-2.

Permissible relaxation in requirements as per Tables 3.13.1-1 and 3.13.1-2 irrespective of class and method of carriage of carried dangerous goods is exhaustive.

### Table 3.13.1-1

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Class or subclass of goods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.1</td>
</tr>
<tr>
<td>1. Immediate water supply with fire pump (see 2.1.1.2)</td>
<td>+</td>
</tr>
<tr>
<td>2. Non-adjacency to accommodation spaces (see 3.1.3)</td>
<td>—</td>
</tr>
<tr>
<td>3. Fire resistance of engine and boiler room bulkhead (see 3.1.4)</td>
<td>+</td>
</tr>
<tr>
<td>4. Determination of vapour concentration (see 3.1.6, 3.1.7)</td>
<td>—</td>
</tr>
</tbody>
</table>
### End of Table 3.13.1-1

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Class or subclass of goods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.1</td>
</tr>
<tr>
<td>5. Temperature monitoring (see 3.1.8)</td>
<td>—</td>
</tr>
<tr>
<td>6. Hatch covers (see 3.1.9)</td>
<td>+</td>
</tr>
<tr>
<td>7. Forced ventilation (see 3.2.1.1)</td>
<td>—</td>
</tr>
<tr>
<td>8. Flame-arresting fittings (see 3.2.1.5)</td>
<td>+</td>
</tr>
<tr>
<td>9. Spark extinguishers (see 3.3.4)</td>
<td>—</td>
</tr>
<tr>
<td>10. Electrical equipment (see 3.9)</td>
<td>+</td>
</tr>
<tr>
<td>11. Automatic hold fire alarm system</td>
<td>—</td>
</tr>
</tbody>
</table>

**Note:** 
1. Only for dangerous goods that evolve flammable vapours and gases.
2. Only for dangerous goods that evolve toxic vapours and gases.
3. Only for flammable dangerous goods.
4. Only for spontaneously inflammable and spontaneously decomposable dangerous goods.
5. Only for carriage of oil cake containing oil extracting solvents.
6. Only for carriage of ammonium nitrate and ammonium nitrate fertilizers.

### Table 3.13.1-2

<table>
<thead>
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<th>Requirements</th>
<th>Class or subclass of goods</th>
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</thead>
<tbody>
<tr>
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<td>1.1</td>
</tr>
<tr>
<td>1. Immediate water supply with fire pump (see 2.1.1.2)</td>
<td>+</td>
</tr>
<tr>
<td>2. Non-adjacency to accommodation spaces (see 3.1.3)</td>
<td>+</td>
</tr>
<tr>
<td>3. Fire resistance of machinery space bulkhead (see 3.1.4)</td>
<td>+</td>
</tr>
<tr>
<td>4. Determination of vapour concentration (see 3.1.6, 3.1.7)</td>
<td>+</td>
</tr>
<tr>
<td>5. Temperature monitoring (see 3.1.8)</td>
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</tr>
<tr>
<td>6. Hatch covers (see 3.1.9)</td>
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<tr>
<td>7. Forced ventilation (see 3.2.1.1)</td>
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<tr>
<td>8. Flame arresters (see 3.2.1.5)</td>
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<tr>
<td>9. Spark extinguishers (see 3.3.4)</td>
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<td>10. Drainage system (see 3.5.1)</td>
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<td>11. Portable fire extinguishers (see 3.6.6)</td>
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</tr>
<tr>
<td>12. Automatic fire detection system in cargo holds (see 3.7.1)</td>
<td>—</td>
</tr>
<tr>
<td>13. Electrical equipment (see 3.9)</td>
<td>+</td>
</tr>
</tbody>
</table>

**Note:**
1. Only for dangerous goods that evolve flammable vapours and gases.
2. Only for dangerous goods that evolve toxic vapours and gases.
3. In all cases, dangerous goods of class I shall be stowed at horizontal distance of 3 m from the machinery space limiting structures.
4. Only for spontaneously inflammable and spontaneously decomposable dangerous goods.
5. Only for flammable dangerous goods.
6. If this requirement is specified in the individual dangerous goods card.
7. Only for liquids (liquid dangerous goods).
8. Only for liquids with vapour flash point \(t \leq 23^\circ C\).
9. Dangerous goods are carried on deck only.

**Note:** "+" means required; "-" means not required.
4 INLAND NAVIGATION SHIPS CARRYING DANGEROUS GOODS IN BULK

4.1 GENERAL PROVISIONS

4.1.1 This section requirements apply to inland navigation ships carrying dangerous goods in bulk (including liquefied gases) listed in Table A1-1 in Appendix 1.

4.1.2 Necessity of implementing the general design requirements set in this Section as applied to tanker type is specified in Table 4.1.2, special requirements for carriage of specific dangerous goods are stated in Table A1-1 in Appendix 1.

4.1.3 The liquefied or pressurized gas installation elements on the ships carrying dangerous goods in bulk shall not be placed within the cargo spaces.

4.1.4 If this section does not contain any provisions required to make design solutions while an inland navigation liquefied gas tanker is designed or built, refer to the requirements of 6 of this Part.

4.2 MATERIALS

4.2.1 All ship structures and elements, including the equipment, which can contact with carried dangerous goods, shall be manufactured of materials which do not react when contact with carried dangerous goods or shall have insulating coating of material which does not react when contacts with carried dangerous goods.

Wood, aluminium alloys or plastic materials shall not be used in ship structures and elements, including equipment, mounted within the cargo area. These requirements do not apply to:

<table>
<thead>
<tr>
<th>Applicable requirements</th>
<th>G</th>
<th>C</th>
<th>Type of ship</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>N with cargo tanks</td>
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<tr>
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<td>4.2.1 to 4.2.3</td>
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### End of Table 4.1.2

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<tr>
<th>Applicable requirements</th>
<th>Type of ship</th>
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<tr>
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</tr>
<tr>
<td>4.23 – 4.24</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

**Note.** "+" means required; "—" means not required.

- gangways and external ladders
- moving parts of ship equipment
- fasteners of cargo tanks which are independent of ship’s hull and fasteners of ship’s machinery and equipment
- masts and similar mast timbers
- parts of ship’s machinery
- parts of electrical equipment
- lids of boxes located on the deck
- supports and stops (with regard to use of timber and plastics)
- gaskets (with regard to use of rubber and plastics)
- electric cables (with regard to use of rubber and plastics);
- loading and discharge hoses (with regard to use of rubber and plastics);
- insulation of cargo tanks and loading and discharge hoses (with regard to use of rubber and plastics).

#### 4.2.2 The paint used in the cargo area shall not be liable to produce sparks in case of impact.

#### 4.2.3 The ship’s boats may be made of plastics provided that these plastics are hardly inflammable (incapable of inflammation in air under long-time effect of low-energy fire source, for example, flame of a match at temperature of 750 to 800 °C or smoldering of a cigarette at temperature of 700 to 750 °C, also see 2.1.4.1 Part III of the Rules).

#### 4.3 PROTECTION AGAINST PENETRATION OF GASES

#### 4.3.1 The lower edges of the door openings in the sidewall of the superstructures and the coamings of the access hatches to the under-deck spaces shall be at height of not less than 0.50 m above the deck.

These requirements do not apply provided that the wall of the superstructures facing the cargo area extends from one side of the ship to the other and has the doors the coamings of which have a height of not less than 0.50 m. The height of this wall shall not be less than 2.00 m. The lower edges of the door openings in the sidewall of the superstructures and the coamings of the access hatches behind this wall shall be at a height of not less than 0.10 m above the deck. The coamings of the machinery space doors and access hatches shall always be at a height of not less than 0.50 m.

#### 4.3.2 The bulwark in its bottom part on the main deck shall have openings whose area in the cargo area shall be equal to that calculated by the following formula, m2:

with bulwark length \( l \) of 20 m and less
Inland Navigation Ships Carrying Dangerous Goods in Bulk

$F_{\text{min}} = 1 + 0.05l$; \hspace{1cm} (4.3.2-1)
with bulwark length $l$ exceeding 20 m

$F_{\text{min}} = 0.1l$. \hspace{1cm} (4.3.2-2)

The lower edges of the openings shall be located at the deck level.

4.3.3 For all spaces located within the cargo area, it shall be possible to monitor concentration of gas mixtures.

4.4 HOLD SPACES AND CARGO TANKS

4.4.1 The maximum permissible capacity of the cargo tanks shall not exceed values determined according to Table 4.4.1.

**Table 4.4.1**

<table>
<thead>
<tr>
<th>$L_{\text{max}}$, $B_{\text{max}}$, $H$, m$^3$</th>
<th>Maximum permissible capacity of the cargo tank, m$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 600</td>
<td>$0.3L_{\text{max}}B_{\text{max}}H$</td>
</tr>
<tr>
<td>600–3750</td>
<td>$180 + 0.0635(L_{\text{max}}B_{\text{max}}H - 600)$</td>
</tr>
<tr>
<td>over 3750</td>
<td>380</td>
</tr>
</tbody>
</table>

Note: $L_{\text{max}}$ is maximum ship’s hull length (m); $B_{\text{max}}$ is maximum ship’s hull breadth (m); $H$ is design side height within the cargo area (m).

For trunk ships, $H$ in product $L_{\text{max}}B_{\text{max}}H$ shall be replaced by $H'$ to be obtained from the following formula:

$H' = H + h_t b_t l_t / (B_{\text{max}} L_{\text{max}})$;

where $h_t$ — trunk height (m);

$b_t$ — trunk breadth (m);

$l_t$ — trunk length (m).

4.4.2 If the ship’s length is 50 m and less, the cargo tank length shall not exceed 10 m; if the ship’s length exceeds 50 m, the cargo tank length shall not exceed $0.20L_{\text{max}}$. This requirement does not apply to ships with cylindrical independent cargo tanks with length-to-diameter ratio $l/d$ less or equal 7.

High-pressure cargo tanks shall have ratio $l/d$ less than or equal to 7.

4.4.3 Trunks shall not be installed within the cargo area of type C tankers (except for cofferdams).

4.4.4 The cargo tanks that are not parts of the ship’s hull shall be fastened so that they cannot float.

4.4.5 The capacity of the cargo tank suction well shall not be more than 0.10 m$^3$.

4.4.6 The cargo tanks shall be separated from the accommodation spaces, machinery space and service spaces located outside the cargo area or, if such spaces are unavailable, from the ship ends by cofferdams of at least 0.60 m wide.

When the cargo tanks are placed in the hold space, a space of not less than 0.50 m shall be provided between these cargo tanks and the end bulkheads of the hold space. If the requirement is met, Class A-60 fire protection insulation may be installed on the transversal end bulkheads instead of cofferdams.

4.4.7 The holds, spaces, and cargo tanks shall be capable of being inspected and stripped.

4.4.8 The bulkheads limiting the cargo tanks, cofferdams, and hold spaces shall be watertight. The cargo tanks, cofferdams, and bulkheads limiting the cargo area shall have no openings or passages below the main deck. These requirements do not apply to passages intended for laying electric cables and pipelines of instrumentation and alarm systems, as well as passages of drive shafts of drain and ballast pumps through the bulkheads that separate a service space and a machinery space. These allowed passages shall be gastight.

4.4.9 Type G tankers within the cargo area may be designed as both double hull and single hull. If the double sides and the double bottom are available, the double side space breadth shall not be less than 0.8 m, and the double bottom space height shall not be less than 0.6 m. If the double sides are unavailable, the side stringer space shall not exceed 0.6 m, and the space between the web frames supporting the side stringers shall not exceed 2.0 m. The height of the side stringers and web frames shall not be less than 10% of the side height, but not less than 0.3 m. The free flange cross-section area for the side stringers and web frames shall not be less than 7.5 cm$^2$.
and 15 cm$^2$, respectively. The distance between the side plating of the ship and the cargo tanks shall not be less than 0.8 m, and that between the bottom plating and the cargo tanks shall not be less than 0.6 m. This distance below the cargo tank suction wells may be reduced to 0.5 m. The horizontal distance between the cargo tank suction wells and the bottom framing shall not be less than 0.1 m.

Other design solutions as applied to the ship hull in the cargo area may be used, if calculations confirm that in case of side collision with another ship having straight stem, energy of 22 MJ will be absorbed without rupturing the cargo tanks and the cargo piping connected to the cargo tanks.

4.4.10 The double side space width for type C tankers shall not be less than 1.0 m. This width may be reduced to 0.8 m provided that the hull is additionally reinforced as compared to the requirements of Part I of the Rules by:

1. increasing thickness of deck stringer by 25%;
2. increasing thickness of side plating by 15%;
3. decreasing distance between side stringers to 0.8 m (for transversal side framing system), here, stringer profile height shall not be less than 0.15 m, and free flange section area of shall not be less than 7 cm$^2$;
4. assigning profile height of longitudinal T-section stiffeners which shall not be less than 0.15 m with free flange section area of not less than 7 cm$^2$ (for longitudinal side framing system).

When longitudinal stiffeners with non-T section are used, equality of section moduli shall be provided between the used section and required tee section.

4.4.11 To provide access of the crew members wearing the protective clothes to the cofferdams, double side and double bottom compartments, cargo tanks and other hold spaces located within the cargo area, the cut-outs necessary to enter these cofferdams, compartments, tanks and spaces shall have the cross-section area of not be less than 0.36 m$^2$ and minimum side length of 0.5 m. Cutouts shall be arranged so as to allow injured or unconscious persons to be removed by means of fixed equipment. In these spaces the distance between the framing beams shall not be less than 0.5 m. In the double bottom space this distance may be reduced to 0.45 m. The round access hatches to the cargo tanks shall have clear diameter of at least 0.68 m.

4.4.12 The high pressure cargo tanks shall be rated at cargo temperature of +40 °C.

4.4.13 Separate wells of more than 0.1 m deep may be fitted in the deck of cargo tanks of type C tankers for installation of cargo pumps if the following conditions are satisfied:

1. The well depth shall not be more than 1 m;
2. The well shall be at least 6 m clear off the entrances and openings of the accommodation and service spaces located out of the cargo area and 0.25 of ship breadth clear off the sides;
3. If the well depth exceeds 0.5 m, it shall be provided with a fixed gas detection system which outputs light and sound signals when concentration of gases reaches 20% of lower explosive limit and automatically disconnects the ship cargo system;
4. If in the cargo area is provided with a water spraying system, the electrical equipment in the well shall be protected from flooding;
5. The well shall be drained by means of the drain system installed on the deck within the cargo area and independent of other systems;
6. The well shall be fitted with a device which measures its degree of filling, actuates its drain system and outputs light and sound signals when liquid accumulates on the well bottom.

4.5 VENTILATION

4.5.1 The double side and double bottom spaces and the cofferdams located within the cargo area shall be equipped with air pipes and ventilation system.

The air pipe outlet ends shall be equipped with permanent automatically operating clo-
sures which provide easy access of air and prevent ingress of air into the double side and double bottom spaces and cofferdams.

The air pipe outlet ends shall be provided with float-type closures capable of operating at any heel and trim. The closures and their fastenings shall be resistant to effect of dangerous goods and sea water.

Each service space within the cargo area below deck shall be fitted with forced ventilation system which provides at least 20-fold air exchange per hour based on the whole space volume.

Air for ventilation of double side and double bottom spaces and cofferdams shall be supplied through an air duct to the bottom part of a space 400 mm clear off the floor (bottom). Air shall exit through the air pipes.

The ventilation system inlet openings shall be located at a height of not less than 2 m above the deck and at a distance of not less than 2 m from the tank openings and 6 m from the safety valve openings.

4.5.2 The fans used to ventilate the spaces according to 4.5.1 shall have electrical equipment with type of explosion protection “i” (Exi).

4.5.3 Operating instructions, including information on conditions under which these openings are to be closed, shall be placed at the ventilation system inlet openings. All ventilation system inlet openings of the accommodation and service spaces facing the outside shall be equipped with fire dampers. These openings shall be located at a distance of not less than 2 m from the cargo area.

It is allowed to arrange the ventilation system inlet openings of the service spaces located in the cargo area below deck within this area.

4.5.4 The ventilation system inlet openings of the machinery space shall be at a distance of not less than 2 m from the cargo area.

4.5.5 Each hold space shall be ventilated in any part of it. To fulfil this requirement, each hold space shall have two closable deck openings to provide this ventilation. If such openings are unavailable, an inerting system for the hold spaces shall be provided.

4.5.6 The ventilation system shall be designed so as to exclude possibility of ingress of dangerous gases into the accommodation spaces, wheelhouse or machinery space.

4.5.7 The air pipe openings of each fuel oil tank shall be at a height of not less than 0.50 m above the deck. These openings and the openings of the overflow pipes connecting to the deck shall have a protection consisting of a wire mesh or a perforated plate.

4.6 SERVICE AND ACCOMMODATION SPACES

4.6.1 The service spaces may be located within the cargo area below deck provided that these spaces are enclosed with watertight walls extending from the deck to the bottom plating. Access to such service spaces shall be provided from the deck only. The cargo piping shall not be laid through these spaces.

4.6.2 The crew shall be enabled of accessing the service spaces mentioned in 4.6.1 and operating therein, and it shall be made possible to evacuate people in protective clothing therefrom.

4.6.3 The service spaces mentioned in 4.6.1 shall not be used as cargo pump rooms and shall not accommodate the loading and discharge systems unless the following conditions are satisfied:

.1 There is a cofferdam or a fire-insulated bulkhead of type A-60 or a service or hold space between the pump room and the machinery space or between the service spaces located out of the cargo area;

.2 No drive shafts of ballast or bilge pumps go through the bulkhead of type A-60 required in 4.6.3.1;

.3 The ventilation outlet openings are located at a distance of not less than 6 m from the entrances and openings of the accommodation and service spaces out of the cargo area;

.4 The access hatches and the ventilation inlet openings are provided with outer closures;
5 All loading and discharge pipelines and stripping pipelines are equipped with the shut-off devices on the suction inlet of the pump in the cargo pump room. Operating the controls located in the pump room, starting the pumps and monitoring the fluid flow shall take place from the main deck;

6 All loading and discharge pipelines (filling and supplying ones) shall be laid on the deck over the pump room;

7 The oily water space of the cargo pump room shall be equipped with an instrument for measuring the filling level in the oily water space which activates light and sound alarm in the wheelhouse when the upper filling level is reached;

8 The cargo pump room is equipped with a fixed gas detection system which automatically informs on presence of explosive gases or oxygen deficiency by means of direct measurement sensors and activates light and sound alarm when concentration of gases reaches 20% of the lower explosive limit;

9 The wheelhouse and the cargo pump room are equipped with sound and light alarm, and when alarm is signalled, the loading and discharge system is deactivated. If the gas detection system fails, the sound and light alarm shall operate in the wheelhouse and on the deck;

10 The ventilation system shall provide at least 30-fold air exchange per hour based on the total volume of the service space.

4.6.4 The accommodation spaces and the wheelhouse shall be located out of the cargo area.

4.6.5 The space entrances and the superstructure openings shall not face the cargo area. The hinges of the doors, which open outwards and are located out of the recesses the depth of which is equal to or exceeds the door breadth shall be located from the side of the cargo area.

4.6.6 The entrances and openable windows of the superstructures and accommodation spaces and other openings of these spaces shall be located at a distance of not less than 2 m from the cargo area. This requirement does not apply to the wheelhouse doors and windows, if there is no access from the wheelhouse to the accommodation spaces or if this access is provided through the gas-tight doors.

4.6.7 The seal assembly at the place where the bilge or ballast pump shaft penetrates the bulkhead separating the service space and the machinery space shall be gas-tight.

4.7 COFFERDAMS

4.7.1 Each cofferdam that adjoins the service spaces shall be provided with an access hatch. The access hatches and the ventilation outlet openings shall be arranged in accordance with the requirements of Part II of the Rules and shall be located at least 0.5 m above the deck.

4.7.2 It shall be possible to fill the cofferdams with water and drain them with the pumps. It shall take not more than 30 minutes to fully fill the cofferdams with water. The cofferdams shall have no inlet valves.

This requirement does not apply to the cofferdams that have common separating bulkhead with the machinery space if the bulkhead separating them has fire insulation of type A-60 and if the cofferdam is used as a service space.

4.7.3 It is not allowed to integrate the cofferdam systems with the other systems located out of the cargo area.

4.7.4 The cofferdam ventilation openings shall be equipped with flame arresters.

4.8 OPENINGS OF CARGO TANKS

4.8.1 The cargo tank openings with cross-sectional area of more than 0.10 m² shall be located above the deck at a height of not less than 0.5 m. This requirement also applies to the openings of the safety devices designed to prevent overpressure, on type C and N tankers with enclosed cargo tanks.

4.8.2 The cargo tank openings shall be equipped with the gas-tight closures which
can withstand test pressure equal to test pressure of cargo tanks

4.8.3 Each cargo tank or a group of cargo tanks which have common gas-freeing pipe-line shall have:

.1 a safety device for preventing overpressure or vacuum. This safety device shall be designed so as to prevent water ingress into the cargo tanks;

.2 a connection for safe return ashore of gases expelled from the cargo tanks during loading

.3 a device for safe depressurization in the cargo tanks, including a stop valve and a flame arrester. The stop valve position shall be marked.

4.8.4 The safety device mentioned in 4.8.3.1 shall have a vacuum valve with flame arrester and a pressure relief valve representing a quick-acting vent valve with flame arrester. The gas shall be returned upwards. The opening pressure for the quick-acting vent and vacuum valves shall comply with the values specified in col. 7 of Table A1-1 in Appendix 1 and shall be indicated on the respective valve.

4.8.5 The openings of the quick-acting vent valves (or overpressure valves for type G tankers) shall be located above the deck at a height of not less than 2 m and at a distance of not less than 6 m from the accommodation and service spaces located out of the cargo area. The above distance may be reduced provided that no equipment is placed and no work is performed within the radius of 1 m from the quick-acting vent valve (overpressure valve for type G tankers) opening. In this case, maximum permissible working pressure limits shall be marked on the vent valve. The quick-acting vent valves shall be adjusted so that they do not open during carriage until maximum permissible working pressure is reached in the cargo tanks.

4.8.6 When operated, the shut-off devices used during loading or discharge shall not cause sparking.

4.9 STABILITY AND FLOODABILITY

4.9.1 Intact stability of ships that have cargo tanks with total breadth in excess of 0.70B shall meet the following requirements:

The stability curve area with positive arms shall not be less than 0.024 m-rad to angle of 27° or to downflooding angle, whichever is less.

Here, the maximum arm of the stability curve shall not be less than 0.10 m.

The metacentric height shall not be less than 0.10 m.

These requirements shall be met with consideration of free surface effect in the cargo tanks under the most unfavourable loading condition.

4.9.2 Floodability requirements shall be met when the following spaces are flooded:

.1 two adjacent side compartments

.2 two adjacent bottom compartments in transversal direction

.3 machinery space.

4.9.3 For all cases of unsymmetrical flooding, the heeling angle at the final stage of flooding shall not exceed 12°.

4.9.4 The area of damaged stability curve with positive arms shall not be less than 0.0065 m-rad to angle of 27° or to downflooding angle, whichever is less. In this case, the maximum arm of the damaged stability curve shall not be less than 0.05 m (see Fig. 3.12.6).

4.9.5 Dimensions of hull side damages shall be taken as follows:

.1 Damage length is 10% of ship’s length L, but not less than 5 m;

.2 Damage depth measured from the inner surface of the skin at right angle to the centre plane is 0.79 m for type G and C tankers and 0.59 m for type N tankers;

.3 vertical extent: from the base line upwards without limit;

4.9.6 Dimensions of bottom damages shall be taken as follows:

.1 Damage length is 10% of ship’s length L, but not less than 5 m;
2. Damage width is 3 m;
3. Vertical damage size from the baseline upwards: to 0.59 m for type G and C tankers and to 0.49 m for type N tankers, exclusive of the drain well.

4.9.7 At the final stage of flooding the lower edges of all open openings shall be at least 0.10 m higher than the damaged waterline.

4.9.8 In checking calculations of floodability the design volume of flooded compartments shall be taken with due consideration of volume permeability factors of each room of the compartment which shall be taken as equal to:

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Permeability Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machinery spaces</td>
<td>0.85</td>
</tr>
<tr>
<td>Accommodation spaces</td>
<td>0.95</td>
</tr>
<tr>
<td>Double bottom, fuel oil tanks, ballast tanks</td>
<td>0.95 if considered empty, otherwise 0.85</td>
</tr>
</tbody>
</table>

4.10.1 The machinery space entrance shall not face the cargo area and shall be located at a distance of not less than 2 m from the cargo area. If the entrance doors are not located in the superstructure recess the depth of which is not less than the door breadth, they shall open towards the cargo area.

4.10.2 The piping from the machinery space may be laid through the adjacent service space located within the cargo area and through the cofferdams and hold spaces as well. In this case, the pipeline wall thickness shall not be less than 4 mm, and the pipeline shall have no detachable joints and branches in the spaces through which the pipeline passes. Besides, the pipelines going through the service spaces shall have shut-off devices at the wall from the side of the machinery space.

6.24.3 Ventilation of the closed machinery space shall provide temperature in the machinery space of max. 40 °C at ambient temperature of 20 °C.

4.11 TIGHTNESS TEST

4.11.1 The integral cargo tanks and the residual cargo tanks shall be tested for tightness in accordance with Appendix 10 to RTSC, and type C independent cargo tanks shall be tested with pressure equal to 1.1 of working pressure.

4.12 PUMPS AND PIPELINES

4.12.1 The cargo system (liquid cargo system) and all its elements shall be located within the cargo area.

4.12.2 In addition to capability of switching off the cargo pumps from the control station located within the cargo area, it shall be possible to remotely switch off the cargo pumps from the station located out of the cargo area.

4.12.3 The cargo pumps shall be located at a distance of not less than 6 m from the entrances or openings of the accommodation and service spaces located out of the cargo area.

4.12.4 The cargo piping shall not be placed under the deck, except for the cargo pumps located on the main deck.

4.12.5 The cargo system pipelines shall be designed so that it can be possible to drain residuals of dangerous goods (on completion of loading and discharge processes) from the system to the shore or ship tanks.

4.12.6 The cargo piping of type G tankers, gas-freeing manifolds, except for valves for shore connection, and stop, safety and other valves shall be located inside the zone limited in width to the outer boundaries of the cargo area.
tank domes and shall be clear off the ship’s side at least one quarter of the hull breadth. However, if there is only one dome across the breadth of the ship, these pipelines and valves shall be placed at a distance of not less than 2.7 m from the ship’s side. This requirement does not apply to the pipelines located behind the safety valves. The connections of the adjacent tanks shall be located on the line connecting the centres of the domes. The closing devices shall be located on the dome.

The shut-off system of the cargo piping shall consist of two devices, one of which shall be remotely operated quick-acting stop device.

4.12.7 The shore connections shall be located at a distance of not less than 6 m from the entrances to or openings of the accommodation and service spaces outside the cargo area.

4.12.8 The connections of the gas-freeing and cargo systems used during loading and discharge shall have the shut-off device. If these connections are not used during loading and discharge, they shall be blanked off.

4.12.9 The connections of the loading and discharge pipes used during loading or discharge shall be equipped with a device for removing residuals of dangerous goods.

4.12.10 The ship shall be provided with a fixed cargo tank stripping system. The stripping system shall provide the following maximum residual quantity of stripping solution (m³):

- for each cargo tank $5 \times 10^{-3}$
- for the entire stripping system $15 \times 10^{-3}$

4.12.11 When dangerous goods that can form substances aggressive to material of pipelines in contact with water (goods of class 8), flanges and stuffing boxes shall be protected from water splashes.

4.12.12 Distances mentioned in 4.12.3 and 4.12.7 may be reduced to 3 m if the cargo area is limited by a side-to-side cross wall as high as one tier of superstructure or more with no openings and entrances of accommodation spaces.

4.12.13 The cargo piping of type G tankers may not be used as ballast ones.

If washing water of type C and N tankers is supplied to the cargo tanks through the cargo piping system, inlet branches of these pipelines shall be within the cargo area, but out of the cargo tanks.

4.12.14 The cargo piping and gas-freeing manifolds shall have no flexible connections with swing joints.

4.13 RESIDUAL DANGEROUS GOODS TANKS AND SETTLING TANKS

4.13.1 The ship shall be provided with a tank for residual dangerous goods and a tank for settling with cannot be pumped out. These tanks shall be placed within the cargo area only. Independent tank containers may be used instead of stationary residual dangerous goods tanks. In this case, the ship shall be equipped with a device for collecting possible leakages of dangerous goods while the tank containers are being filled.

4.13.2 Maximum permissible capacity of dangerous goods residual tanks shall not exceed 30 m³.

4.13.3 The dangerous goods residual tanks shall be equipped with the following:

.1 for C type tankers:
  - quick-acting outlet pressure-relief valves
  - vacuum valves with flame arresters
  - closable opening for measurements
  - connections with stop valves for pipelines and hoses

.2 for type N tankers with open cargo tanks:
  - a pressure equalization device which shall have a flame arrester
  - opening for measurements
  - connections with stop valves for pipelines and hoses

.3 for type N tankers with enclosed cargo tanks:
  - pressure relief valves and vacuum valves with flame arrester
  - a device for measuring filling ratio
  - connections with stop valves for pipelines and hoses.
4.13.4 The residual dangerous goods tanks shall not be equipped with crossover pipes connecting them with the gas-freeing system of the cargo tanks.

4.13.5 The cargo containers, tank containers, and portable tanks used to take residues of dangerous goods or settlings shall be equipped with:
- a branch pipe for freeing gases expelled during loading
- a filling ratio indicator
- connections with shut-off devices for pipelines and hoses.

The residual dangerous goods tanks, cargo containers, tank containers or portable tanks shall not be connected with the gas-freeing manifold of the cargo tanks, except for connection to fill them.

The residual dangerous goods tanks, cargo containers, tank containers, and portable tanks located on the deck shall be removed from the side for a distance of not less than a quarter of the ship breadth.

4.14 WATER SPRAYING SYSTEM

4.14.1 To reduce volume of vapours expelled by dangerous goods, cool the tops of the cargo tanks and meet the requirements of Appendix 1, a water spraying system shall be provided on the deck within the cargo area (see 3.5 Part III of the Rules).

The water spraying system shall be activated from the ship wheelhouse.

4.14.2 It shall be possible to feed the water spraying system from shore.

4.14.3 The water spraying system pump shall provide water flow of at least $5 \times 10^{-2} \text{ m}^3/\text{h}$ per square meter of the deck area.

4.15 ENGINES AND GAS EXHAUST PIPING

4.15.1 Closed-cup vapour flash point of liquid fuel used for the main and auxiliary engines shall be higher than 60 °C, and for the emergency diesel generators, not less than 55 °C.

4.15.2 Temperature on the outside surfaces of the engines used during loading and discharge and that of their air intake and gas vent ducts shall not exceed the permissible values set in view of temperature class of carried dangerous goods as specified in the accompanying documentation for goods. This requirement does not apply to the engines installed in the service spaces which comply with the following requirements:

1. These spaces shall be equipped with a ventilation system providing positive pressure of 0.1 kPa. All windows (scuttles) of these spaces shall not be openable. The ventilation system inlet openings of the spaces considered shall be placed at a distance of 6 m min. from the cargo area and at a height of 2 m min. from the deck;

2. These spaces shall be equipped with a continuously operating gas detection system with sensors located as follows:
   - in ventilation system inlet openings at upper edge of coamings of doors of accommodation and service spaces;
   - when gas concentration in the spaces considered reaches 20% of lower explosive limit specified in the dangerous goods documentation, the fans shall be activated. In this case and when positive pressure is not maintained any more or the gas detection system fails, the electrical equipment not intended for operation in explosion-hazardous spaces of category 2 and above shall be deactivated.
   - Type of explosion protection of electrical equipment of ventilation system, gas detection system and alarm shall comply with working conditions in explosion-hazardous spaces of category 1.

4.15.3 The gas exhaust pipelines of the main and auxiliary engines shall not be laid through the cargo. The gas exhaust pipeline outlets shall be located at a distance of not less than 2 m from the cargo area.
4.16 BILGE AND BALLAST PUMPS

4.16.1 Bilge and ballast pumps for spaces located within the cargo area shall be installed within this area.

This requirement does not apply to the double side and double bottom spaces that have no common bulkhead with the cargo tanks, as well as to the cofferdams and hold spaces if ballasting is performed by means of the fire extinguishing system pipeline located in the cargo area, and unballasting, by means of ejectors.

4.16.2 If a ballast pump is installed in the cargo area, the delivery pipe and its side suction branch pipe for water ballasting shall be located within the cargo area, but out of the cargo tanks.

4.16.3 The cargo pump room located under the deck shall be drained by means of the autonomous system located within the cargo area and not connected with another system. Such a system shall be placed outside of the cargo pump room.

4.17 ADDITIONAL FIRE SAFETY REQUIREMENTS

4.17.1 The smoke funnel outlets shall be at a distance of not less than 2.00 m from the cargo area boundaries. Measures shall be taken to prevent flyout of sparks\(^1\) from the funnel outlets and ingress of water into the funnels.

4.17.2 The heating and cooking devices shall not use oil fuel, gas or solid fuel, except for the heating devices or boilers installed in the machinery space which are fired with oil fuel with vapour flash point of 60 °C and above.

The cooking or air cooling devices may be installed in the accommodation spaces only.

4.18 INERT GAS SYSTEM

4.18.1 The inert gas system shall maintain constant minimum pressure of 7 kPa in the spaces being protected. When operated, the inert gas injection installation shall not cause pressure increase in the cargo tank above pressure on which the overpressure valve is adjusted. The vacuum valve operation pressure shall be equal to 3.5 kPa.

4.18.2 If the ship is not provided with the inert gas generator, the inert gas storage shall be made available in amount required to inert the tanks during loading and discharge with consideration of possible loss of inert gas during carriage.

4.18.3 The inert gas pressure and concentration shall be monitored in the space being protected. In case of pressure drop and increase of concentration of inert gas, light and sound alarms shall be transmitted to the wheelhouse. The same signals shall be transmitted to the spaces wherein at least one crew member is present.

4.19 DANGEROUS GOODS HEATING SYSTEM

4.19.1 The boilers used to heat dangerous goods shall be fired with oil fuel with vapour flash point of above 60 °C. These boilers shall not be installed within the cargo area.

4.19.2 The dangerous goods heating system shall be designed so as to exclude ingress of dangerous goods into the boiler when the coils of this system become untight.

4.19.3 If the dangerous goods heating system is used during loading and discharge processes, the electrical equipment of the dangerous goods heating system located on the deck out of the cargo area shall be of explosion-proof design. The inlet openings of the ventilation system in the spaces, wherein the electrical equipment of the dangerous goods heating system is placed, shall be at a height of not less than 2 m from the deck.

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\(^1\) Here, sparks are understood as incandescent particles of fuel or its inclusions unburned in the engine cylinders and boiler furnaces and brought out by flow of gases into the gas exhaust system or smoke funnel.
level and shall be located at the following minimum distance (m):

- from the cargo area: 2
- from the openings of residual dangerous goods tanks, cargo pumps located on the deck, pressure relief valves and connections of cargo piping for reception from shore and the openings of the quick-acting outlet valves: 6

4.20 DANGEROUS GOODS COOLING SYSTEM

4.20.1 If the dangerous goods containment system is not rated for full positive pressure of dangerous goods vapours under conditions of maximum ambient temperature, pressure in the cargo tank shall be maintained below the maximum permissible set pressure of the safety valve by using one or several systems mentioned below:

- .1 Pressure control systems in the cargo tanks
- .2 Systems which use dangerous goods vapours as fuel for aboard ship or excessive heat recovery systems. If means are available for dissipating excessive energy (heat) produced by the above systems, these systems may be used when the ship is underway or at rest or in manoeuvring;
- .3 Systems which provide safety by preventing heating of dangerous goods and associated increase of cargo pressure. The insulation used in the cargo tanks shall make it possible to maintain temperature of dangerous goods in these tanks while the ship is being loaded and en route below the maximum temperature which corresponds to the maximum permissible activation pressure for the safety valves. In this case, the insulation design and strength properties of the cargo tank shall be rated for service life equal to at least three-fold specified service life of cargo tank at design pressure and temperature;
- .4 Other systems approved by the River Register.

4.20.2 Materials used to manufacture elements of systems mentioned in 4.20.1 shall not react and interact with goods to be carried or with their vapours. When the ship is in operation, the maximum design environmental temperature shall be taken equal to 20 °C for fresh water, 32 °C for sea water and 45 °C for air.

4.20.3 The cargo tanks of type G tankers shall withstand pressure of dangerous goods vapours at maximum design environmental temperature irrespective of a system provided for operating gas vapours.

4.20.4 The cooling system shall consist of one or several refrigerating units which make it possible to maintain design pressure and temperature of dangerous goods at maximum design environmental temperature. The heat-exchangers of these units (evaporators and condensers) shall have heat-exchange surface area which exceeds the required one by at least 25%.

In addition to the main refrigerating unit, the cooling system shall be equipped with a standby refrigerating unit (units) with refrigeration capacity equal to or exceeding the main refrigerating unit refrigeration capacity. The standby refrigerating unit shall include the control system and valves required for the autonomous operation of the refrigerating unit.

The cargo tanks, pipelines, and auxiliaries shall have heat insulation and sealing which can maintain a temperature which does not cause the safety valves to open for at least 52 h when all dangerous goods cooling systems go out of operation.

4.20.5 The safety devices and connecting pipelines of the cooling systems shall be connected to the cargo tanks above the liquid phase of dangerous goods when the cargo tanks are filled to their maximum permissible filling ratio. They shall remain in the gas phase at ship heel of up to 12°.

4.20.6 When two and more cooled dangerous goods which can chemically react are carried simultaneously, their cooling systems shall prevent these goods from mixing.

When these dangerous goods are carried simultaneously, the individual main and standby refrigerating units complying with the requirements of 4.20.4 shall be provided for
each dangerous goods. It is allowed not to install separate refrigerating units if dangerous goods are cooled by an indirect cooling system (see 4.20.9.2) or a combined cooling system (see 4.20.9.3), and leakage in the evaporator does not cause dangerous goods to mix.

4.20.7 If the ship simultaneously carries two and more cooled dangerous goods which under conditions of carriage do not dissolve in each other, but, when mixed, evolve vapours creating additional pressure, these cooling systems shall be designed so as to prevent these dangerous goods from mixing.

4.20.8 If sea water is used in the cooling system, a separate sea water pump intended to serve this system only shall be installed. This pump shall receive sea water from two kingston valves located on the different sides of the ship.

Besides, each cooling system shall be provide with a standby pump of the same capacity as the main one, and it shall receive sea water from two kingston valves located on the different sides of the ship too.

A pump intended for other purposes with capacity and head equal to those of the main pump may be used as a standby one, if its function of cooling dangerous goods does not interfere with its main function.

4.20.9 One of the following systems may be used to cool dangerous goods:

.1 direct cooling when vapouring dangerous goods are compressed, condensed and returned to the cargo tanks
.2 indirect cooling when dangerous goods (fluid fraction) or vapouring dangerous goods are cooled or condensed, carrying heat off to the cooling agent, without compression
.3 combined cooling when vapouring dangerous goods are compressed, condensed and cooled in the refrigerating unit evaporator and then cooled liquid dangerous goods are returned to the cargo tanks.

4.20.10 Specifications for delivery of cooling medium and cooling agent shall consider their compatibility with each other and with dangerous goods which they can contact with. Dangerous goods may be cooled in the heat exchanger located out of the cargo tank or by means of the condenser coils mounted inside or outside of the cargo tank.

4.20.11 If the cooling system is located in a separate service space, such service space shall meet the requirements of 4.6.1 and 4.6.3.

4.20.12 Heat flows to the environment shall be calculated for all cargo systems. Calculations shall be validated by results of heat-balance tests.

4.21 INSTRUMENTS

4.21.1 The cargo tanks shall be equipped with:

.1 level indicator
.2 alarm device operating when cargo tank filling ratio reaches 86% for type G tankers and 90% for type C and N tankers
.3 limit level sensor operating when filling ratio reaches 97.5%
.4 cargo tank gas pressure monitor
.5 cargo temperature monitor for C and N type tankers if dangerous goods require heating or limitations of maximum temperature of dangerous goods are present
.6 sampling device for closed type G tankers, for closed or partly closed C and N type tankers and/or sampling opening depending on requirements specified in Appendix 1 as applied to carried dangerous goods.

4.21.2 Permissible error for determination of filling ratio shall not exceed 0.5%.

4.21.3 The level indicator shall be located so that its indications can be seen from the respective tank shut-off device control station. In case of remote cargo control, it is allowed to transmit level indications over the loudspeaker communication or by means of hand radio.

4.21.4 The level indicator and the level alarm device shall be independent from each other.

When operated, the level alarm device shall give light and sound alarms to the cargo control station and to the wheelhouse. These sig-
nals shall differ from the high level sensor signals.

The light signal shall be visible from each cargo tank stop valves control station located on the deck. It shall be possible to check operability of sensors and electric circuits or these sensors and circuits shall be of safe type in view of operating principle.

4.21.5 When operated, the limit level sensor shall give light and sound alarms and simultaneously provide deactivation of the ship cargo pump or initiate deactivation of the shore pump.

4.21.6 The limit level sensor shall be independent of the alarm sensor (detector), but can be integrated with the level sensor.

4.21.7 The gas pressure and dangerous goods temperature monitor shall give light and sound alarms to the wheelhouse, continuous watchkeeping positions and cargo control station when the set pressure is exceeded or lowered. When the set pressure is exceeded during loading of dangerous goods, the transmitted alarms shall cause the cargo pump to be off and the shore pump to stop.

4.21.8 The pressure monitor shall operate when the quick-acting outlet valve operation pressure is exceeded by 1.15 times and the vacuum valve operation pressure is lowered by 1.1 times. The maximum permissible operation temperature of the temperature monitor shall be set for particular carried dangerous goods in accordance with the dangerous goods declaration. The above temperature value necessitates presence of dangerous goods cooling system or heating system onboard the ship (in addition to the requirements of Appendix 1).

4.21.9 The alarm devices mentioned in 4.21.7 may be integrated with high level sensor signalling device.

4.21.10 If pressure gauges are used to measure positive or negative pressure, their scale shall be at least 0.14 m in diameter, and positive or negative pressure limit values shall be marked on the scale with a red line.

4.21.11 Indications of pressure gauges or other indicators which perform the same function shall be visible from the cargo control position. If this requirement is not met, this information shall be transmitted to the cargo control position by means of loudspeaker or portable radio communication.

4.21.12 If cargo handling is controlled from the cargo control station, the light and sound signals mentioned in 4.21.7 shall be transmitted to the cargo control station in addition to the main deck. Here, the main deck shall receive the generalized signal which shall be detailed in the cargo control station. The cargo control station shall be designed so as all cargo area on the main deck can be visible.

4.21.13 The closed-type sampling device shall be designed so that possibility of leakages of cargo or its vapours can be eliminated during sampling.

4.21.14 The partly closed-type sampling device shall be designed so as to prevent leakage of cargo or its vapours during sampling, while leakage of dangerous goods or their vapours in amounts not endangering people is allowed.

4.21.15 Diameter of sampling openings shall not exceed 0.3 m. If the cargo is fire-hazardous, each sampling opening shall be provided with a closure with flame arrester which automatically closes the opening after sampling.

4.21.16 The sampling openings shall make it possible to measure filling ratio of cargo tanks with dipsticks. Openings for taking measurements shall be equipped with a self-closing cover.

4.21.17 It shall be possible to remotely close the quick-acting shut-off valve mounted on the flexible pipeline connecting the ship to the shore by means of switches. These switches shall be installed on the ship in two places (at bow and at stern).

4.22 ELECTRICAL EQUIPMENT

4.22.1 The onboard distributing networks shall not use the ship’s hull as a feedback, except for insulation resistance monitors pro-
vided that the leakage current does not exceed 30 mA.

4.22.2 The independent cargo tanks, tank containers, and all sealing flanges of connectors of cargo piping and hoses shall be grounded to the hull.

4.22.3 The technical documentation available on the ship shall contain the layout of explosion-hazardous zones and spaces agreed on with the River Register and the list of electrical equipment in these zones and spaces.

4.22.4 The cables laid in the explosion-hazardous spaces shall be connected to the electrical equipment installed in these spaces and areas only.

The transit cables may be laid through these spaces only if the requirements are met as specified in 2.10.9 to 2.10.11 Part VI of the Rules.

4.22.5 The movable cables intended for signal lights and gangway lighting fittings shall meet the requirements of 2.10.9 Part VI of the Rules, and the cable core cross-section shall not be less than 1.5 mm².

4.22.6 The cargo tanks, residual cargo tanks, and loading and discharge pipelines (zone 0) may accommodate only measuring, adjusting and signalling devices with type of explosion protection (Exia), and their cables shall meet the requirements of 2.10.13 Part VI of the Rules.

4.22.7 The cofferdams, double side spaces, double bottom spaces, and hold spaces (zone 1) may accommodate the following electrical equipment:

- measuring, adjusting and signalling devices with type of explosion protection (Exib)
- lighting fittings with type of explosion protection (Exd)
- sealed echo-sounder vibrators cables to which are laid in corrosion-resistant steel seamless tubes with gastight connections up to the main deck
- cables of active cathodic protection of hull plating which are laid in protective steel tubes.

4.22.8 The service spaces located within the cargo area below deck may accommodate the following electrical equipment:

- measuring, adjusting and signalling devices with type of explosion protection ‘ib’ (Exib)
- lighting fittings with type of explosion protection (Exd)
- main equipment driving motors (for example, for ballast pumps) with type of explosion protection (Exd) or (Exp).

4.22.9 Instruments and safety devices of electrical equipment mentioned in 4.22.6 through 4.22.8 shall be located out of the cargo area, unless they are explosion protected according to the Rules.

4.22.10 Electrical equipment located within the cargo area on the deck shall meet the requirements of 4.22.12 through 4.22.13.

4.22.11 Storage batteries shall be placed out of the cargo area.

4.22.12 The electrical equipment used during loading, discharge and degassing at the pier and located out of the cargo area depending on operation conditions shall be:

- with type of explosion protection (Exe) for apparatuses and devices which can spark or are exposed to heating up to 80 °C
- without explosion protection for apparatuses and devices which cannot spark or are not exposed to heating up to 80 °C. Enclosure shall have degree of protection depending on site of installation in accordance with 2.3.6 Part VI of the Rules.

4.22.13 The requirements of 4.22.12 do not apply to:

- lighting fittings located in accommodation spaces, except for switches located at entries of accommodation spaces
- communication facilities located in accommodation spaces or wheelhouse;
- electrical equipment installed in the accommodation spaces, wheelhouse or service spaces located out of the cargo area if the following conditions are satisfied:

These spaces shall be equipped with a ventilation system providing positive pressure of 0.1 kPa min.
All windows (scuttles) of these spaces shall not be openable.

Inlet openings of ventilation system of these spaces shall be placed at a distance of 6 m min. from the cargo area and at a height of 2 m min. from the deck.

4.22.14 The electrical equipment which do not conform to the requirements of 4.22.12 to 4.22.13 and its switches shall have red marking.

4.22.15 The sockets, which navigation lights and gangway lighting fittings are connected to/disconnected from, shall be designed so that connection to and disconnection from electric circuit are possible only if they are deenergized. These sockets shall be protected from mechanical damages.

4.22.16 When the electrical equipment located in the cargo area is deenergized, the respective light and sound signals informing on the fact shall be transmitted to the continuous watchkeeping position.

4.22.17 The cables to connect to the electrical equipment mentioned in 4.22.6 and 4.22.7 shall be laid in accordance with the requirements of 2.10.13 Part VI of the Rules.

4.23 SHOWER AND WASHBASIN

4.23.1 A shower and a washbasin shall be provided on the ship at a location which is directly accessible from the cargo area.

4.24 EMERGENCY EXIT

4.24.1 Spaces the entrances or exits of which are likely to become partly or completely immersed in the damaged condition shall have emergency exits with their lower edges situated not less than 0.10 m above the damaged waterline. This requirement does not apply to forepeak and afterpeak.
5.1 GENERAL PROVISIONS

5.1.1 This section requirements apply to river–sea navigation ships carrying in bulk liquid dangerous goods listed in Appendix 2.

5.1.2 This section sets general requirements for design of ships mentioned in 5.1.1. Additional special requirements stipulated by necessity of safety during carriage of particular dangerous goods are stated in Appendix 2.

5.1.3 The requirements of this section supplement the requirements stated in 4 of this Part. If the requirements stated in 4 and 5 of this Part with regard to the same object differ, the stricter requirements of the Rules shall be applied.

5.2 MATERIALS

5.2.1 If col. 13 “Structural materials” of Table A2-1 in Appendix 2 contains digits from 1 to 8, the following component metals and elements shall not be used to manufacture cargo tanks, pipelines, valves, fittings and other equipment which may contact with dangerous goods or their vapours:
- digit 1 — aluminium, copper, copper alloys, zinc, galvanized steel
- digit 2 — copper, copper alloys, zinc, and galvanized steel
- digit 3 — aluminium, magnesium, zinc, galvanized steel
- digit 4 — copper and copper alloys
- digit 5 — aluminium and aluminium alloys, copper and copper alloys
- digit 6 — copper, silver, magnesium, metal compound acetylides, and their alloys
- digit 7 — copper and alloys containing more than 1% of copper
- digit 8 — aluminium, zinc, and galvanized steel.

5.2.2 If col. 13 “Structural materials” of Table A2-1 in Appendix 2 contains digits from I to V, the following materials shall be used to manufacture cargo tanks, pipelines, valves, fittings and other equipment which may contact with dangerous goods or their vapours:
- digit I — steel with suitable protective lining or coating
- digit II — corrosion-resistant steel, if dangerous goods concentration is 98% or more
- digit III — special acid-resistant corrosion-resistant steel, if dangerous goods concentration is less than 98%
- digit IV — cryogenic austenitic corrosion-resistant steel (hardened)
- digit V — corrosion-resistant steel or steel with protective lining or coating.

5.2.3 If col. 13 “Structural materials” of Table A2-1 in Appendix 2 contains letter “Ý”, all materials used in the electrical equipment (copper, aluminium) and insulating materials require protection against contact with carried dangerous goods or their vapours.

5.2.4 Structural materials with melting temperature of less than 925 °C shall not be used to manufacture the outer pipelines used for handling dangerous goods on ships intended to carry dangerous goods with closed-cup vapour flash point of less than 60 °C.
5.3 SIDE DRAIN HOLES

5.3.1 The drain system pipelines for the spaces located below the watertight bulkheads deck or for the superstructures and houses provided with the weathertight doors shall be provided with a remotely operated non-return valve. The non-return valve shall be located at the side drain hole and shall be controlled from a position located above the watertight bulkheads deck.

5.3.2 If the vertical distance between the upper edge of the side drain system hole and the maximum load waterline exceeds 0.01L (where L is ship length along maximum load waterline, m), the drain system pipelines shall have two non-return valves located at a distance of 0.5 m max. from each other. Remote operation of these valves is not required, if access to them is provided under operation conditions.

5.4 CARGO TANKS

5.4.1 The cargo tanks of type 1 ships shall be removed:
   from the side plating to a distance of not less than B/5
   from the bottom plating along the centre plane to a distance of not less than B or 760 mm, whichever is less.

5.4.2 The cargo tanks of type 2 ships shall be removed from the bottom plating along the centre plane to a distance of not less than B or 760 mm, whichever is less.

5.4.3 The suction wells of cargo tanks, except for cargo tanks of type 1 ships, may be ignored in determination of damaged compartments if the suction well is located below the inner bottom plating at a distance of not more than 25% of the double bottom depth or not more than 350 mm, whichever is less.

5.4.4 If several types of dangerous goods capable of reacting with each other are carried, the cargo tanks with such goods shall be separated from each other with a cofferdam, empty space, cargo pump room of empty tank or of cargo tank with dangerous goods which do not react in contact with goods in the adjacent tank.

5.4.5 The volume of dangerous goods in one cargo tank of type 1 ship shall not exceed 1250 m³.

5.4.5 The volume of dangerous goods in one cargo tank of type 2 ship shall not exceed 3000 m³.

5.5 VENTILATION IN CARGO AREA

5.5.1 The cargo pump rooms and other enclosed spaces, wherein cargo handling equipment is installed, and the spaces wherein dangerous goods are handled, shall be equipped with the forced ventilation systems controlled from the outside.

5.5.2 These spaces shall be ventilated before people enter them and before the equipment located in them is started. A warning notice shall be placed at the entrances of these spaces to notify of necessity of such ventilation.

5.5.3 The ventilation system capacity shall not be less than 30 air changes per hour in the entire volume of the space. As applied to specific carried dangerous goods, other requirements for ventilation system capacity may be applied according to 5.18 and col. 15 of Table A2-1 in Appendix 2.

5.5.4 The ventilation system shall be of stationary and exhaust type, except for ventilation of the cargo pump drive motors space which shall be of plenum exhaust type.

5.5.5 Exhaust ventilation ducts from the cargo area spaces shall be removed to a distance of not less than 10 m horizontally from ventilation inlets and openings to accommodation, service and machinery spaces, control stations and other spaces located out of the cargo area.

5.5.6 The ventilation ducts shall not go through the accommodation, service and machinery spaces.

5.5.7 When flammable dangerous goods are carried, the fan drive motors shall be located
outside of the ventilation ducts. The fans shall be designed so as to eliminate sparking; for this purpose, fan parts and assemblies shall be made of the following materials:

1. Impellers or housing — nonmetallic materials incapable of static build-up
2. Impeller or housing — non-ferrous metals
3. Impeller or housing — austenic corrosion-resistant steel
4. Impeller or housing — carbon steel with design radial gap of 13 mm min. between them.

5.5.8 The outer openings of the ventilation ducts shall be provided with protective screens with at least 13 mm mesh width.

5.5.9 The pump rooms (compartments) and other enclosed spaces not mentioned in 5.5.1 shall be equipped with forced ventilation systems controlled from outside of these spaces. These systems shall provide at least 20 air changes per hour in the entire volume of the space. Such spaces shall be ventilated before people enter them.

5.6.2 The entrance doors, air intakes and openings in the accommodation, service and machinery spaces and control stations shall not face the cargo area. They shall be located on the wall facing the side which is opposite to the cargo area and/or on the side walls at a distance of not less than 4% of the ship length, but not less than 3 m from the outer walls of the superstructure or deck house facing the cargo area.

5.6.3 The doors leading to the spaces from which there is no access to the accommodation and service spaces and to the control stations may be installed on the outer walls of the superstructures and deck houses at a distance of less than 4% of the ship length or less than 3 m from the walls facing the cargo area, whichever is more. The fire resistance of the structures (bulkheads, partitions, and decks) which limit the spaces with such doors shall comply with type A-60.

5.6.4 The metallic removable plates for dismounting the ship equipment may be installed at a distance of less than 4% of the ship length or less than 3 m from the cargo area, whichever is more.

5.6.5 In the wheelhouse, the windows (scuttles) facing the cargo area and the windows and doors on the side walls of the wheelhouse may be installed at the distance specified in 5.6.3 if such windows and doors are designed so that they provide gas tightness of the wheelhouse.

5.6.6 The scuttles and windows facing the cargo area, for which the requirement of 5.6.2 regarding the permissible distance to the cargo area is not met, shall be of blind type (see GOST 19261 and GOST 21672). Such scuttles located on the main deck shall have the internal covers made of steel or another material equivalent to steel in fire resistance and strength.

5.7 ACCESS TO SPACES LOCATED IN CARGO AREA

5.7.1 Access to the cofferdams, ballast tanks, cargo tanks and other spaces located in
the cargo area shall be provided from the weather deck.

5.7.2 Access to the spaces located in the double bottom spaces may be provided through the cargo pump room, cofferdam or pipe gallery.

5.7.3 The horizontal openings and manholes through which access to spaces is provided shall not be less than 600×600 mm so as to enable people, who wear self-contained breathing apparatuses and protective gear, of climbing and descending and to enable lifting of a casualty from the bottom of a space.

5.7.4 To provide passage through the vertical openings and manholes, their dimensions shall not be less than 600×800 mm. If the lower edge of such openings and manholes is located at a height exceeding 600 mm from the bottom plating or floor plating, the intermediate foot gratings or other footholds shall be installed.

5.8 FLOODABILITY

5.8.1 For floodability calculations, the dimensions of the side and bottom damages shall be taken according to 5.8.2 and 5.8.3.

5.8.2 Side damage dimensions shall be taken as follows:

1. longitudinal dimension — \( L^{2/3}/3 \)
2. transversal dimension — \( B/5 \)
3. vertical dimension — upwards without limitation.

5.8.3 Bottom damage dimensions shall be taken as follows:

1. longitudinal dimension:
   - within 0.3\( L \) from the fore perpendicular — \( 1/3L^{2/3} \)
   - within the test of the ship — \( 1/3L^{2/3} \) or 5 m, whichever is less
2. transversal dimension:
   - within 0.3\( L \) from the fore perpendicular — \( B/6 \)
   - within the rest of the ship — \( B/6 \) or 5 m, whichever is less
3. vertical dimension — \( B/15 \).

5.8.4 If a liquid containing cargo tank is damaged, it shall be assumed that the tank contents completely escape and are replaced with water to the waterline level complying with the equilibrium position of the flooded ship.

5.8.5 If pipes, channels, trunks or tunnels are located within the estimated damage length, the design solutions shall be made to prevent flooding of other compartments, except for those which are to be flooded when the ship is damaged.

5.8.6 Depending on ship class and her length the following requirements shall be met:

1. Type 1 ship shall meet the requirements stated in 5.8.7 and 5.8.8, when the hull is damaged to the extent specified in 5.8.2 and 5.8.3 in any place lengthwise;
2. Type 2 ship of 150 m inclusive in length shall meet the requirements stated in 5.8.7 and 5.8.8, when the hull is damaged to the extent specified in 5.8.2 and 5.8.3 in any place lengthwise, except for the bulkheads that limit the aft machinery space;
3. Type 2 ship of more than 150 m in length shall meet the requirements stated in 5.8.7 and 5.8.8, when the hull is damaged to the extent specified in 5.8.2 and 5.8.3 in any place lengthwise;
4. Type 3 ship of less than 125 m in length shall meet the requirements stated in 5.8.7 and 5.8.8, when the hull is damaged to the extent specified in 5.8.2 and 5.8.3 in any place lengthwise, except for damage to the aft machinery space. At the same time, the designer shall verify the ship floodability when the machinery space is flooded, and the calculation results shall be recorded in the stability and floodability booklet;
5. Type 3 ship of 125 m or more in length shall meet the requirements stated in 5.8.7 and 5.8.8, when the hull is damaged to the extent specified in 5.8.2 and 5.8.3 in any place lengthwise, except for the bulkheads that limit the aft machinery space.

5.8.7 At any stage of flooding, the maximum heeling angle resulted from unsymmet-
tical flooding shall not exceed 25°. This angle may be increased to 30°, if the deck is not immersed in this case.

5.8.8 At the final stage of flooding, the following conditions shall be satisfied:

.1 The length of the positive arm section of the damage stability curve until the lower edges of the openings, through which water could be spread into the intact compartments, are immersed shall not be less than 20°;

.2 The maximum arm of the damage stability curve on the positive arm section mentioned in 5.8.8.1 shall not be less than 0.1 m;

.3 Area under the damage stability curve within this part shall be not less than 0.0175 m·rad.

5.9 DRAIN AND BALLAST SYSTEMS

5.9.1 The ballast pumps, pipelines, and equipment of ballast tanks shall be isolated from the cargo tank equipment and from the cargo tanks.

5.9.2 The drain devices of the ballast tanks, which are adjacent to the cargo tanks, shall be placed outside of the machinery and accommodation spaces.

5.9.3 The cargo tanks shall be ballasted from the deck level using the ballast pumps provided that the respective pipeline has no permanent connection with the cargo tanks and cargo piping and is equipped with a non-return valve.

5.10 CARGO SYSTEM

5.10.1 The cargo piping located below the main deck may not be laid out of the cargo tank, which is serviced by this piping, and passed through the adjacent tank if the shut-off valve operated from the weather deck is fitted on the piping at the bulkhead from the side of the serviced tank and if goods carried in these adjacent tanks are compatible.

5.10.2 The cargo piping may not be laid through the accommodation, service and machinery spaces, except for the spaces and rooms in which the pumps and the cargo pumps are installed.

5.10.3 The mentioned in 5.10.1 shut-off valve on the pipeline of the cargo tank adjoining the cargo pump room may be installed on the separating bulkhead from the side of the cargo pump room provided that an additional valve is installed between the valve on the bulkhead and the pump.

5.10.4 If one cargo pump serves several cargo tanks, an individual shut-off valve shall be mounted on each cargo piping.

5.10.5 The cargo systems for the tanks containing dangerous goods, which capable of reacting with each other, shall be independent and not connected to each other. The cargo system piping shall not be laid through the cargo tanks unless this piping is laid in the tunnel.

5.10.6 The cargo piping laid in the tunnel shall meet the requirements of 5.10.1 and 5.10.2. The tunnels for this piping shall meet the requirements of the Rules applied to the cargo tank design, location and ventilation.

5.10.7 The cargo piping wall thickness shall not be less than the value determined by the following formula, mm:

\[ t = \left( t_0 + b + c \right) / (1 - 0.01a) \]

(5.10.7-1)

where \( t_0 \) — theoretical thickness determined by the following formula, mm:

\[ t_0 = p d / \left[ 20 \left( [\sigma] + p \right) \right] \]

(5.10.7-2)

\( p \) — design pressure, MPa,

\( [\sigma] \) — permissible stress, MPa,

\( a \) — negative allowance for wall thickness deviation during pipe manufacture (%),

\( b \) — bend allowance which shall not be less than that determined by the following formula, mm:

\[ b = 0.4 d t_0 / r \]

(5.10.7-3)

\( c \) — corrosion allowance, mm,

\( d \) — outer diameter, mm,

\( r \) — mean pipe bend radius, mm.
5.10.8 The design pressure shall not be less than 1 MPa, except for open-end lines, for which the design pressure shall not be less than 0.5 MPa.

5.10.9 The permissible stress $[\sigma]$ shall be determined as the lesser of the following values:

$$[\sigma] = R_m/2.7 \quad \text{or} \quad [\sigma] = R_{st}/1.8,$$

where $R_m$ — tensile strength of material at ambient temperature (MPa),

$R_{st}$ — yield point of material at ambient temperature (MPa).

5.10.11 The cargo piping heat expansion shall be compensated by installing the expansion coils or by making the bends in the piping. The expansion glands shall not be used.

The cargo control system shall consist of:

.1 a manually-operated shut-off valve on each filling and discharge line at the cargo tank pipe input. It is allowed not to install the shut-off valve on the unloading line of such cargo tank if a separate submerged pump is used to discharge this tank;

.2 a shut-off valve before each connection joint of cargo hose

.3 remotely-operated devices to switch all cargo pumps off.

5.10.12 The controls used during pumping of dangerous goods, except for those placed in the cargo pump room, shall not be installed below the main deck.

5.11 GAS-FREEING SYSTEM

5.11.1 All cargo tanks shall be equipped with gas-freeing systems. These systems shall be independent of air ducts and gas-freeing systems installed in other compartments of the ship. The gas-freeing systems for the cargo tanks containing dangerous goods, which are capable of reacting with each other, shall be independent and not connected to each other.

5.11.2 The tank gas-freeing systems shall eliminate possibility of water ingress into the cargo tanks.

5.11.3 Depending on properties of carried dangerous goods, the following types of gas-freeing systems are used:

.1 pressureless vapour release system providing pressureless inflow of cargo vapours into the cargo tanks and release of the same from these tanks during cargo handling

.2 controlled vapour release system in which pressure/vacuum relief valves are installed to limit pressure increase or vacuum creation in the cargo tank.

5.11.4 The gas-freeing pipelines of the cargo tanks made of corrosion-resistant material or of the lined or coated cargo tanks for specific dangerous goods shall have the same lining or coating or shall be made of corrosion-resistant material too.

5.11.5 The gas-freeing systems shall be connected to the top of each cargo tank. The gas-freeing pipelines shall be self-draining at all operating ship roll and pitch values. If the gas-freeing pipeline is to be drained in points located above the pressure/vacuum relief valve in the cargo tank, provision shall be made to install a drain valve in these points.

5.11.6 Shut-off valves and any other stop valves shall not be installed on the gas-freeing pipelines of the pressureless vapour release system.

5.11.7 The controlled vapour release system outlets shall be located at a height of not less than 6 m over the upper deck or over the catwalk if they are placed within 4 m from the catwalk and at a distance of not less than 10 m horizontally from the nearest air intake or opening leading to the accommodation, service and machinery spaces and from the open flame sources.

5.11.8 The height of the outlets mentioned in 5.11.7 over the deck or over the catwalk may be decreased to 3 m if such outlets are provided with high-velocity valves in which upward vapour release velocity is not less than 30 m/s.

5.11.9 The controlled vapour release system on the tanks, which carry dangerous
goods with vapour flash point below 60 °C, shall be equipped with a device preventing ingress of flame into the cargo tanks.

5.11.10 When selecting the gas-freeing system type and considering the special requirements for carriage of dangerous goods, follow the requirements stated in Appendix 2.

5.12 DEGASSING OF CARGO TANKS

5.12.1 Degassing of cargo tanks carrying dangerous goods which require the controlled vapour release system to be used shall take place:

.1 through the outlets of the controlled vapour release system pipelines

.2 through the outlets located at least 2 m over the upper deck. Here, vapour shall be released vertically at velocity of not less than 30 m/s which shall be maintained throughout all process of degassing;

.3 through the outlets located at least 2 m over the upper deck. Here, vapour shall be released vertically at velocity of not less than 20 m/s, and the openings shall be provided with devices preventing ingress of flame.

5.12.2 If concentration of flammable vapours at the outlets decreases to 30% of the lower flammability limit, degassing may be continued at the level of the deck above the cargo tanks.

5.12.3 Vapour release mentioned in 5.12.1.2 and 5.12.1.3 can be carried out both through stationary and removable piping.

5.13 CARGO TEMPERATURE CONTROL SYSTEMS

5.13.1 If properties of carried dangerous goods require a cargo temperature control system (dangerous goods heating or cooling system) to be fitted on the ship, such system shall meet the following requirements:

.1 Materials used to manufacture this system shall be compatible with carried dangerous goods (see 5.2);

.2 Type of heat transfer medium or refrigerant shall comply with carried dangerous goods (see Appendices 1, 2);

.3 Surface temperature of heating coils or channels shall be such that possibility of local overheating or supercooling of dangerous goods will be eliminated;

.4 The system at any loading of the ship, except for light ship condition, shall keep inside higher pressure as compared to maximum hydrostatic pressure of dangerous goods which have effect on the system;

.5 The dangerous goods heating or cooling system shall be fitted with valves to shut the system off each cargo tank and to enable manual control of parameters.

5.13.2 To prevent dangerous goods from overheating or supercooling a dangerous goods temperature monitoring alarm system shall be provided.

5.13.3 Additional requirements to the temperature control systems for specific dangerous goods are set in 5.18.

5.14 CARGO TANK ATMOSPHERE CONTROL

5.14.1 The following methods (and systems corresponding to these methods) may be used to control the cargo tank atmosphere:

.1 Inerting — filling of cargo tank and piping connected to it and, if necessary, spaces which surround cargo tanks, with inert gas or vapours which do not sustain combustion and do not react with dangerous goods, and maintenance of such state

.2 creation of insulating layer — filling of cargo tank and piping connected to it with fluid, gas or vapour which separate dangerous goods from air and maintenance of such state

.3 draining — filling of cargo tank and piping connected to it with dry gas or vapours with dew point of –40 °C or lower at atmospheric pressure and maintenance of such state

.4 ventilation.

5.14.2 The inert gas and insulating layer systems shall continuously keep a positive pressure of at least 7 kPa within the cargo area. The pressure produced by these systems shall not exceed the cargo tank safety valve operation pressure.
5.14.3 If the inert gas or insulating layer systems are used, the ship shall have inert gas reserves or this gas shall be generated in amount sufficient for its intended use considering natural loss during carriage.

5.14.4 In order to maintain the required atmosphere, the aids shall be provided for monitoring the underdeck hold area which is not filled with dangerous goods and contains gas surface layer.

5.14.5 The inerting and insulating layer systems shall exclude possibility of static charge generation during inflow of inert (insulating) substance.

5.14.6 If the dehumidified nitrogen dehydrating system is used as atmosphere control system, dehydrator amount calculation shall allow for diurnal air temperature and humidity fluctuations.

5.15 ELECTRICAL EQUIPMENT

5.15.1 When selecting electrical equipment to be used in explosion-hazardous areas, follow chemical activity characteristics of carried dangerous goods regarding explosion hazard of mixtures evolved by them as specified in columns 7 to 9 of Table A2-1 in Appendix 2.

5.15.2 The autonomous cargo tanks shall be grounded to the hull. All sealing gaskets of cargo piping and hose connectors shall be grounded to the hull. Piping and hose connections that have gaskets and sealing flanges of cargo piping and hose connectors shall be grounded to the hull.

5.16 FIRE EXTINGUISHING SYSTEM

5.16.1 The cargo pump room shall be equipped with a fixed fire extinguishing system, including the carbon dioxide fire extinguishing system conforming to the requirements of the Rules for carbon dioxide fire extinguishing systems of machinery spaces or the halogenated hydrocarbon fire extinguishing system.

5.16.2 The carbon dioxide fire extinguishing system and the halogenated hydrocarbon fire extinguishing system shall not be used for inerting.

5.16.3 Amount of carbon dioxide in the carbon dioxide fire extinguishing system shall be sufficient to completely fill a space equal in volume to 45% of the total cargo pump room volume with gas.

5.16.4 Amount of halon in the halogenated hydrocarbon fire extinguishing system shall not be less than the following values:

- For halon 1301: 7% of the cargo pump room volume
- For halon 1211: 7% of the cargo pump room volume
- For halon 2402: 0.3 kg/m³

5.16.5 If the ship is intended to carry goods, which cannot be extinguished by the fire extinguishing systems mentioned in 5.16.1, the cargo pump room may be provided with a fixed water spraying system or high-expansion foam fire extinguishing system.

5.16.6 To extinguish fire in the cargo area, each ship shall be provided with a fixed deck foam extinguishing systems complying with the requirements of 5.16.7 to 5.16.17.

5.16.7 The foam fire extinguishing system shall use one type of foaming agent only. If the foaming agent cannot extinguish whole spectrum of the carried dangerous goods, and/or it is incompatible with carried dangerous goods, additional fire extinguishing means shall be provided for such dangerous goods.

5.16.8 The foam generators shall be capable of supplying foam to all the deck area and to any cargo tank.

5.16.9 The main control panel of the foam fire extinguishing system shall be placed outside of the cargo area and be easily accessed to operate it in case of fire in a zone protected with the fire extinguishing system.

5.16.10 The foam solution supply rate shall not be less than the greatest of the following values:
2 L/min per square meter of the deck area above the cargo tanks. The deck area is determined by the following formula, m²:

$$S_d = B_{\text{max}} \cdot l,$$

where $B_{\text{max}}$ — maximum ship breadth (m),

$l$ — length of area occupied by the cargo tanks (m).

20 L/min per square meter of plan area of a cargo tank having maximum value of this area.

10 L/min per square meter of an area protected by the highest power foam supply monitor and completely located in front of it, but not less than 1250 L/min.

5.16.11 Quantity of foaming agent shall provide foam supply for at least 30 min with the maximum rate specified in 5.16.10.

5.16.12 Foam shall be supplied with monitors and foam-supply fire hose nozzles. Each monitor shall supply foam solution at a rate of not less than 50% of that required in 5.16.10.1 and 5.16.10.2. Capacity of any monitor shall not be less than that required in 5.16.10.3.

5.16.13 The distance from the foam-supply monitor location to the most distant boundary of the protected area located in front of it shall not be more than 75% of length of jet from the monitor under no wind conditions.

5.16.14 A foam-supply monitor and a foam-supply fire hose nozzle connector shall be installed at each side at the forward poop bulkhead or accommodation spaces that have entrances facing the cargo area.

5.16.15 The foam-supply fire hose nozzle capacity shall not be less than 400 L/min, and its jet length under no wind conditions shall not be less than 15 m. At least four fire hose nozzles shall be installed. The number and location of fire hydrants shall provide foam supply to any place of the deck above the cargo tanks from at least two foam-supply fire hose nozzles.

5.16.16 Valves shall be installed on the foam supply main and on the fire main, if it is an integral part of the deck foam fire extinguishing system, before each monitor to cut off the damaged sections of these mains.

5.16.17 Two portable powder-type fire extinguishers located within the cargo area with capacity of at least 12 kg of powder shall be provided in addition to others available on the ship.

5.17 PERSONNEL PROTECTION

5.17.1 A ship carrying toxic dangerous goods shall have not less than two complete sets of personnel safety equipment.

5.17.2 Each complete set of safety equipment mentioned in 5.17.1 shall consist of:

- one self-contained air-breathing apparatus (use of compressed oxygen is not allowed)
- protective clothing, shoes, gloves and goggles
- fire-resistant rescue line with belt
- portable explosion-proof lamp.

5.17.3 An adequate supply of compressed air shall be provided for equipment mentioned in 5.17.1 as follows:

- one set of fully charged air bottles for each breathing apparatus and air compressor suitable for supply of high-pressure air of required purity with a charging manifold capable of dealing with sufficient spare breathing apparatus air bottles, or
- fully charged spare air bottles with a total free air capacity of at least 6000 L for each breathing apparatus.

5.17.4 One set of equipment shall be kept in an accessible locker at the cargo pump room.

5.17.5 Respiratory protection and eye protection means shall be provided for evacuation of people onboard the ship; these means shall comply with the following requirements:

- Operating principle of respiratory protection means shall not be based on use of filter.
- Self-contained breathing apparatus shall operate for at least 15 min.
- Emergency escape respiratory protection means shall not be used for fire-fighting or cargo handling purposes.
This requirement applies to the ships carrying dangerous goods that have a respective mark in col. 14 of Table A2-1 in Appendix 2.

5.17.6 Medical first-aid equipment including oxygen resuscitation equipment and antidotes for goods carried shall be provided on board.

5.17.7 Decontamination showers and eye wash eye wash means shall be available on the ship deck.

5.18 SPECIAL REQUIREMENTS

5.18.1 Special requirements for ships carrying specific dangerous liquid goods, which are resulted from properties of these goods, are specified in 5.18.2 to 5.18.104. Necessity to comply with the respective requirement imposed to specific dangerous goods is indicated in col. 15 “Special requirements” of Table A2-1 in Appendix 2.

Ships carrying ammonium nitrate solution (concentration of 93% or less)

5.18.2 The tanks and equipment of these ships shall be independent from the cargo tanks and equipment containing other dangerous goods. Such tanks shall not be used to take sea water for ballast.

5.18.3 Before carriage of ammonium nitrate solutions, the cargo tanks and the equipment shall be cleaned to remove residuals of other dangerous goods.

5.18.4 When ammonium nitrate solutions are carried, the temperature of the heat transfer medium circulating in the cargo tank heating system shall not exceed 160 °C. The heating system shall be equipped with controls to keep bulk temperature of dangerous goods at 140 °C. The sensors (detectors) shall operate when the upper level of 145 °C and 150 °C and the lower level of 125 °C are reached. The signal shall also be given when the heat transfer medium temperature will exceed 160 °C. The signals shall be transmitted to the wheelhouse.

5.18.5 A fixed system shall be installed to inject gaseous ammonia into dangerous goods bulk. The system control panel shall be located in the wheelhouse. The ship shall have ammonia reserves in amount of 300 kg of ammonia per 1000 t of ammonium nitrate solution.

5.18.6 The gas exhaust piping shall be equipped with protective mushrooms which shall be accessible for visual inspection and cleaning.

Ships carrying carbon disulfide

5.18.7 During loading and unloading, the water blanket shall be created and maintained in the cargo tanks. During carriage, there shall be inert-gas blanket in the empty part of the cargo tank.

5.18.8 A closed opening for the instrument shall be provided to measure dangerous goods level in the emergency situation.

5.18.9 The cargo piping and gas exhaust pipes shall be independent from the piping and gas-freeing pipes used for other dangerous goods.

5.18.10 The submerged pumps used for unloading shall be installed in trunks or shall be hydraulically operated. The trunk-mounted pump drive shall be designed so as to eliminate sparking, and its elements shall not to be heated above 80 °C.

5.18.11 If the carbon disulfide cargo tanks are discharged by displacing it with water or with inert gas, the cargo system shall be rated for pressure and temperature which occur during discharging.

5.18.12 The safety valves shall be made of corrosion-resistant steel.

Ships carrying diethyl ether

5.18.13 The empty spaces located around the cargo tanks shall be inerted or shall have ventilation. The forced ventilation blowers shall be intrinsically safe. The forced ventilation equipment shall not be placed in the empty spaces located around the cargo tanks.
5.18.14 The safety valves mounted on the pressure cargo tanks shall be adjusted on pressure of not less than 20 kPa.

5.18.15 If inert gas displacement is used for discharging cargo, the cargo system shall be rated for the expected pressure.

5.18.16 Open flame and/or heat sources shall not be located in the cargo area.

5.18.17 The cargo pumps shall be designed so as to prevent transfer of fluid pressure to the shaft seal. If this requirement is not met, the hydraulically operated submerged pumps applicable to the specific dangerous goods according to their intended purpose shall be installed.

5.18.18 During loading, discharge and carriage of dangerous goods, the inert-gas blanket shall be maintained.

**Ships carrying hydrogen peroxide solutions (concentration of 60% to 70%)**

5.18.19 These hydrogen peroxide solutions shall be carried on the ships intended for these dangerous goods only, and other dangerous goods shall not be carried on these ships.

5.18.20 The cargo tanks and equipment connected to them shall be made of pure aluminium (99.5%) or corrosion-resistant steel, and their surfaces shall passivated. The pipelines located on the deck shall not be made of aluminium. All nonmetallic materials used to manufacture the cargo system shall not react with carried dangerous goods.

5.18.21 The pump rooms shall not be used for cargo handling.

5.18.22 The cargo tanks shall be separated with cofferdams from the fuel oil tanks and other spaces containing flammable and combustible materials.

5.18.23 The cargo tanks shall not be used for ballasting.

5.18.24 The temperature sensors shall be installed at the top and bottom parts of the cargo tank to provide continuous temperature monitoring for dangerous goods. If temperature exceeds 35 °C, sound and light alarm shall operate in the wheelhouse.

5.18.25 A fixed system of continuous oxygen monitoring (or gas sampling lines with periodic sampling) shall be installed in the empty spaces adjoining the cargo tanks. If oxygen concentration exceeds 30% by space volume, sound and light signals shall operate in the wheelhouse. In addition to the above fixed system, two portable instruments shall be provided to measure oxygen contents.

5.18.26 A system for emergency discharge of dangerous goods overboard shall be provided on the ship. The system shall be activated, if the cargo temperature increases by more than 2 °C per hour for five hours or if the cargo tank temperature exceeds 40 °C.

5.18.27 The cargo tank gas-freeing systems shall be equipped with pressure/vacuum relief valves and safety membranes for emergency discharge of gases.

5.18.28 The ship shall be fitted with a water spraying system to dilute and wash off hydrogen peroxide solution of any concentration spilled on the deck. The system shall cover the deck of those cargo tanks in which hydrogen peroxide solution is carried and connections of cargo manifold with hoses. The system capacity shall be determined from the following:

1. Within 5 min after spillage, dangerous goods shall be diluted to 35% mass concentration as related to their initial concentration;

2. The spillage intensity and the design parameters of a space occupied by spilled dangerous goods are determined considering the maximum expected intensity of loading and discharge, time required to stop dangerous goods flow in case of overfilling of cargo tank or damage to pipeline/hose, and time to be spent in the cargo control station or in the wheelhouse to prepare for water supply in order to dilute spilled dangerous goods.

5.18.29 The crew members participating in cargo handling shall be provided with protec-
Ships carrying hydrogen peroxide solutions
(concentration of 8% to 60% by mass)

5.18.30 The cargo tanks of these ships shall be separated from the ship hull plating.

5.18.31 The cargo tanks of these ships and the equipment connected to them shall be made of pure aluminium (95.5%) or corrosion-resistant steel which do not react with hydrogen peroxide. The pipelines located on the deck shall not be made of aluminium. All nonmetallic materials used to manufacture the cargo system shall not contribute to cargo decomposition.

5.18.32 These hydrogen peroxide solutions shall not be carried with any other dangerous goods. The cargo tanks in which these dangerous goods were carried may be used for carriage of other substances only after the tanks are stripped.

5.18.33 The cargo tanks shall be separated by the cofferdams from the fuel oil tanks or any other space containing materials which react with hydrogen peroxide.

5.18.34 The temperature sensors shall be installed at the top and bottom parts of the cargo tank to provide continuous temperature monitoring for dangerous goods. If temperature exceeds 35 °C, light and sound alarms shall operate in the wheelhouse.

5.18.35 In the empty spaces that have common bulkheads and decks with the cargo tanks, a fixed continuous oxygen monitoring system (or gas sampling lines with periodic sampling) shall be provided. If oxygen concentration exceeds 30% by space volume, light and sound alarms shall operate in the wheelhouse. In addition to the fixed system, the ship shall be provided with two portable instruments for measuring oxygen contents.

5.18.36 A system of emergency discharge of dangerous goods overboard shall be provided on the ship. The system shall be activated, if temperature of dangerous goods increases by more than 2 °C per hour for five hours or if the cargo tank temperature exceeds 40 °C.

5.18.37 The cargo tank gas-freeing systems shall be equipped with pressure/vacuum relief valves and safety membranes for emergency discharge of gases.

5.18.38 The ship shall be fitted with a water spraying system to dilute and wash off hydrogen peroxide solution of any concentration spilled on the deck. The system shall protect the cargo area of those tanks in which hydrogen peroxide solution is to be carried and the connections of cargo manifold with hoses. The system capacity shall be determined from the following:

1. Within 5 min after spillage, dangerous goods shall be diluted to 35% mass concentration as related to their initial concentration;
2. The spillage intensity and the design parameters of a space occupied by spilled dangerous goods are determined considering the maximum expected intensity of loading and discharge, time required to stop dangerous goods flow in case of overfilling of cargo tank or damage to pipeline/hose, and time to be spent in the cargo control station or in the wheelhouse to prepare for water supply in order to dilute spilled dangerous goods.

5.18.39 The crew members participating in cargo handling shall be provided with protective clothing capable of resisting effect of these hydrogen peroxide solutions.

5.18.40 The cargo piping used for pumping of hydrogen peroxide shall be insulated from all other systems.

Ships carrying engine fuel anti-knock additives that contain alkyl lead

5.18.41 The cargo tanks of these ships shall not be used to carry other cargo, except for substances used in production of engine fuel anti-knock additives containing alkyl lead.

Ships carrying yellow or white phosphorus

5.18.42 The cargo tanks of these ships shall be rated for pressure equal to or more than
water head of 2.4 m high over the top of the tank.

5.18.43 The ship shall have a system for filling the cargo tank space with water to create a water blanket over carried dangerous goods. When the ship is unloaded, the system shall be used to displace phosphorus from the space being emptied. All water pumped off the cargo tank shall be delivered to the shore.

5.18.44 When the cargo tanks are designed, the minimum interfacial area between phosphorus and water blanket shall be provided.

5.18.45 The cargo tank void space volume over the water blanket shall be filled with inert gas or naturally ventilated through two ventilating ducts with outlets located at different levels: at a height of not less than 6 m above the deck and not less than 2 m above the deck limiting the pump room from the top.

5.18.46 The dangerous goods heating system shall enable control of heat transfer medium temperature so that phosphorus temperature does not exceed 60°C.

5.18.47 A water sprinkling system which automatically operates in case of phosphorus leakage shall be provided in all empty spaces located around the cargo tanks.

5.18.48 The spaces mentioned in 5.18.47 shall be provided with forced ventilation, and it shall be possible to close inlet and outlet ventilation ducts in these spaces in emergency.

5.18.49 The cargo control system shall:
prevent overfill of tanks (for this purpose the system shall be provided with alarm which operates when the upper level of dangerous goods is reached in the cargo tank)
stop cargo handling in case of emergency on the ship or on the shore.

Ships carrying propylene oxide and mixtures of ethylene oxide with propylene oxide containing not more than 30% of ethylene oxide in mass

5.18.50 The cargo tanks of these ships shall be made of steel.

5.18.51 The cargo tanks of these ships may be used to carry other dangerous goods only after these tanks and the piping systems connected to them are cleaned by washing or blowing down.

5.18.52 All valves, flanges, fittings, and auxiliary equipment shall be made of steel. Disks or surfaces of disks and valve pockets shall be made of corrosion-resistant steel with chromium content of not less than 11%.

5.18.53 The insulating and sealing materials shall not react with propylene oxide and mixtures of ethylene oxide with propylene oxide containing not more than 30% of ethylene oxide in mass, dissolve in them and reduce their spontaneous ignition temperature.

5.18.54 The following materials shall not be used to make seals, cups and glands to be used in the cargo systems:
neoprene or natural rubber if they contact with such dangerous goods
asbestos or materials with asbestos
materials containing magnesium oxides, for example, mineral wool.

5.18.55 Thread joints shall not be used in the pipelines intended for pumping liquid dangerous goods mentioned in 5.18.53 and their vapours.

5.18.56 The filling and discharge pipelines shall be located at a distance of not more than 100 mm from the bottom of the cargo tank or any sump.

5.18.57 The cargo system of the tank in which dangerous goods specified in 5.18.53 are carried shall have a valved connection for returning cargo vapours.

5.18.58 The cargo and gas-freeing systems of the tank mentioned in 5.18.57 shall be designed so as to exclude possibility of vapour release from the tank into the atmosphere during cargo handling. The system used to return vapours of dangerous goods to the shore, which is connected with the cargo system of the cargo tank intended for dangerous goods, shall be independent of other cargo systems.
5.18.59 During discharge, positive pressure of more than 7 kPa shall be maintained in the cargo tank.

5.18.60 Dangerous goods mentioned in 5.18.53 are discharged by means of the trunk-mounted cargo pumps, hydraulically operated submerged cargo pumps or by displacing dangerous goods with inert gas. The cargo pump shall be designed so as to prevent heating of pumped cargo when the discharge pipeline of the pump is closed or blanked off by some means or other.

5.18.61 Gases from the tanks in which these dangerous goods are carried shall be exhausted independent of the cargo tanks in which other dangerous goods are carried. Cargo tank contents shall be mandatorily sampled by means of closed-type devices which prevent escape of dangerous goods or their vapours into the atmosphere during sampling.

5.18.62 The cargo tanks, empty spaces, and other spaces that have common bulkheads and decks with the integrated pressure cargo tank with propylene oxide shall contain dangerous goods compatible with propylene oxide or these spaces shall be inerted. Any hold space containing an autonomous cargo tank shall be inerted too. These spaces and cargo tanks shall be monitored for ingress of carried dangerous goods from other cargo tanks and for oxygen concentration in atmosphere which shall be less than 2%.

5.18.63 The cargo system shall be designed so as to prevent ingress of air into the system filled with cargo.

5.18.64 Propylene oxide shall be carried in pressure tanks, autonomous tanks or integrated tanks. Mixtures of ethylene oxide/propylene oxide shall be carried in autonomous tanks or pressure tanks. The tanks shall be designed with consideration of maximum pressure which can occur during loading, carriage or discharge of dangerous goods mentioned in 5.18.53.

5.18.65 The cargo tanks designed to carry propylene oxide with design positive pressure of less than 60 kPa and the cargo tanks designed to carry mixtures of ethylene oxide/propylene oxide with design positive pressure of less than 120 kPa shall be equipped with the dangerous goods cooling system.

5.18.66 The cooling system mentioned in 5.18.65 shall keep temperature of dangerous goods below their boiling temperature at the given pressure. For this purpose, at least two refrigerating units automatically controlled depending on temperature variation in the cargo tanks shall be used. The refrigerating units control system shall be capable of changing over to manual control. If the temperature controls become inoperable, the respective alarm shall operate. The refrigerating capacity of each refrigerating unit shall sufficient to keep temperature of dangerous goods at a level lower than the design one.

5.18.67 As an option, three refrigerating units may be used, any two of which have total refrigerating capacity sufficient for keeping temperature of dangerous goods at a level below the design one.

5.18.68 Refrigerating agent separated from carried dangerous goods by a single wall shall be inert to such dangerous goods.

5.18.69 The cooling systems that require compression of dangerous goods mentioned in 5.18.53 shall not be used.

5.18.70 The safety valves shall be adjusted to operate at overpressure of not less than 20 kPa, and if they are mounted on pressure cargo tanks, this pressure shall not exceed 700 kPa for carriage of propylene oxide and 530 kPa for carriage of mixtures of ethylene oxide with propylene oxide.

5.18.71 The piping system which serves the cargo tanks designed to carry dangerous goods mentioned in 5.18.53 shall be autonomous (isolated from other piping systems serving other cargo tanks). If this system is not autonomous, it shall be isolated as required by removing the removable spool pieces or valves of other pipeline sections and replacing them with the blank flanges.
Each joint between the blank flange and the respective pipeline flange shall be sealed with a safety seal.

5.18.72 An automatic nitrogen inflating system shall be provided to keep pressure in the cargo tank at least 7 kPa in order to form the insulating layer. Commercially pure nitrogen (99.9% by volume) reserves shall be available on the ship to automatically keep pressure and replenish possible losses.

5.18.73 The ship shall be provided with a water spraying system the sprayers of which shall protect the cargo manifold area, deck cargo piping and covers of cargo tanks used for carriage of dangerous goods mentioned in 5.18.53. The water spraying system shall provide water supply at rate of 10 l/(m²·min). The remote system control position shall be located outside of the cargo area and shall remotely start the pumps supplying water to the water spraying system and remotely control the valves in this system.

5.18.74 A remotely operated shut-off valve with adjustable closing speed shall be installed in each cargo hose connection point.

Ships carrying sulphur melt

5.18.75 The cargo tanks with these dangerous goods shall be ventilated so that concentration of hydrogen sulphide during carriage will be less than the value equal to half its explosive limit (1.85% by volume).

5.18.76 If the forced ventilation system is used, this system shall be provided with alarm which signals in case of inoperability of this system.

5.18.77 The ventilation system shall be designed so as to prevent deposition of sulphur inside the system itself.

5.18.78 A provision shall be made for sampling and analyzing vapours in the empty spaces adjoining the cargo tanks. The openings in these spaces shall prevent ingress of water, sulphur or dangerous goods vapours.

5.18.79 The dangerous goods heating system shall maintain their temperature at a level which does not exceed 155 °C.

Ships carrying acids

5.18.80 The walls of the cargo tanks which carry inorganic acids shall not be parts of the hull plating.

5.18.81 Screens to localize splashing of dangerous goods and trays to prevent spillage of dangerous goods to the deck shall be fitted at the flange joints of the loading and discharge manifold.

5.18.82 The electrical equipment to be installed in the cargo area shall meet the requirements of 2.10 Part VI of the Rules.

5.18.83 The cargo tanks shall not adjoin the fuel oil tanks, their location shall meet the requirements of 4.4.6.

5.18.84 Cargo leakage monitors shall be installed in the spaces adjoining the cargo tanks.

5.18.85 The drainage system equipment mounted in the cargo pump room shall be made of materials resistant to corrosion in an environment containing mixture of hydrogen with air.

Ships carrying toxic dangerous goods

5.18.86 The outlets of the cargo tank gas-freeing systems shall be located as follows:

1. at the height equal to B/3 or 6 m, whichever is more, above the upper deck level or above the raised passage, if any
2. at the height of not less than 6 m above the longitudinal catwalk level if the outlets are not removed from this catwalk by more than 6 m
3. at the distance of 15 m from any opening or air intake of any accommodation or service spaces.

5.18.87 The gas exhaust piping openings may be located at the height of 3 m above the deck or the longitudinal catwalk if the high-velocity gas exhaust valves are installed to release mixture of vapours upwards with mixture jet velocity of not less 30 m/s.
5.18.88 The gas-freeing systems of the cargo tanks shall be equipped with fittings to connect the dangerous goods vapour ashore return pipeline.

5.18.89 Toxic dangerous goods shall not be placed in the cargo tanks adjoining the fuel oil tanks. They shall be placed in the cargo tanks with separate piping systems and in the cargo tanks the gas-freeing systems of which are separated from other cargo tanks containing non-toxic dangerous goods.

5.18.90 The safety valves of the cargo tanks shall be adjusted on positive pressure which shall not be less than 20 kPa.

Ships carrying dangerous goods protected by additives

5.18.91 The cargo tanks and the dangerous goods pumping system on the ships carrying dangerous goods protected by additives shall not use structural materials or contaminants that can behave as a catalytic agent in relation to cargo.

5.18.92 The ships in which air is removed from the cargo tanks to prevent oxidation of dangerous goods shall meet the requirements of 5.14.2 to 5.14.5.

5.18.93 The gas-freeing systems shall be designed so as to eliminate their clogging with polymerization products. It shall be possible to check the overall performance of the gas exhaust equipment.

5.18.94 To prevent overheat of dangerous goods and their further polymerization in the dangerous goods heating system using vapour as heat transfer medium of pairs, a double-loop low-temperature heating system shall be used.

Ships carrying dangerous cargoes with vapour pressure above 101.3 kPa at 37.8 °C

5.18.95 To keep temperature of dangerous goods at a level below their boiling temperature at the rated pressure of the cargo tank, a cooling system with refrigerating unit shall be used.

5.18.96 It is allowed not to install the cooling system, if the cargo system is rated for pressure of dangerous goods vapours at temperature of 45 °C. At the same time, the cargo tank safety valve operation pressure shall be adjusted.

5.18.97 Provision shall be made to connect to the pipeline of the shore system used to return dangerous goods vapours during loading.

5.18.98 Each cargo tank shall be provided with a pressure gauge indicating pressure in the cargo area, and with thermometers installed in the top and bottom parts of the cargo tank if the cooling system is available.

Ships carrying dangerous goods which may not be watered

5.18.99 When dangerous goods which may not be watered are carried, the following requirements shall be met:

.1 Pressure/vacuum relief valves of cargo tanks shall be located at a height of not less than 2 m above the upper deck level;

.2 The dangerous goods temperature system shall not use water or vapour as heat transfer medium;

.3 The cargo tanks shall not adjoin the ballast tanks or other tanks containing water, except for emptied or drained tanks;

.4 The cargo tanks shall not adjoin the settling tanks or the cargo tanks with ballast, washings or other watered dangerous goods. The pumps and pipelines serving such cargo tanks shall be isolated from the similar equipment serving the cargo tanks with the same dangerous goods. The pipelines going out of the settling tanks or the ballast pipelines shall not pass through cargo the tanks with these dangerous goods, except for the pipelines laid in the tunnel.

High-intensity ventilation

5.18.100 The ventilation system mentioned in 5.5 shall have the minimum performance of not less than 45 air changes per hour based on all space volume. The ventilation system
exhaust duct outlets shall be located at a distance of at least 10 m from the openings of accommodation spaces and working areas and at least 4 m above the deck over the cargo tanks.

**Tank overflow prevention**

**5.18.101** The cargo tanks shall be equipped with the light and sound alarm according to the requirements of 5.18.102 and 5.18.103 to inform that dangerous goods reach the upper level and the cargo tank overflow prevention system complying with requirements of 5.18.104.

**5.18.102** The dangerous goods limit level alarm shall be independent of the overflow prevention system mentioned in 5.18.104 and from the measuring equipment.

**5.18.103** When the safety system is deenergized during loading, light and sound alarm signal shall be transmitted to the control station.

**5.18.104** The cargo tank overflow prevention system shall:

1. operate, if during tank loading, the dangerous goods level continues raising after the filling level is reached
2. transmit cargo tank overfilling light and sound signal to the control station
3. transmit signal informing on necessity of deactivating the shore pumps and/or closing the shore shut-off valves and necessity of closing the ship shut-off valves.
6 RIVER – SEA NAVIGATION SHIPS CARRYING LIQUEFIED GASES IN BULK

6.1 GENERAL PROVISIONS

6.1.1 This section requirements apply to river – sea navigation liquefied gas tankers. Gases which may be carried by these ships in liquefied state in bulk are listed in Appendix 3.

6.1.2 The requirements set in this section supplement the requirements stated in 4 and 5 of this Part. If the requirements stated in 4, 5 and 6 of this Part to the same object are not identical, the strictest requirements of the Rules shall be applied.

6.1.3 If a liquefied gas tanker is designed to carry several types of dangerous goods, the safety requirements shall be based on total of properties of most dangerous carried goods.

6.2 HULL DESIGN

6.2.1 The ships intended to carry dangerous goods with boiling temperature below –10 °C shall mandatorily have the double bottom. The inner bottom shall extend throughout the length of the cargo area.

6.2.2 The bottom grillages shall be designed so as to take up forces transmitted to them by the cargo tanks.

6.2.3 The liquefied gas tanker double bottom design shall consider the requirement to lower COG of cargo tanks, peculiarities of attachment of cylindrical skirts of cargo tanks to inner bottom and transmission of forces from them to bottom grillage.

6.2.4 The liquefied gas tankers intended to carry dangerous goods with boiling temperature of –55 °C and below shall be provided with double sides throughout the length of the cargo area.

6.2.5 If the liquefied gas tanker hull design within the cargo area differs from that mentioned in 6.2.1 and 6.2.4, calculation shall be made to confirm that in case of side collision with another ship having straight stem, energy of 22 MJ will be absorbed without rupturing the cargo tanks and the cargo piping connected to the cargo tanks.

6.3 CARGO TANKS

6.3.1 The midship cargo tanks may be used, if they are of the following shapes:
- spherical
- cylindrical
- spherocylindrical with conical bottom
- prismatic.

6.3.2 When the cylindrical independent cargo tanks of more than 12 m long are installed horizontally along the ship (Fig. 6.3.2), a swash bulkhead shall be provided in the middle of length of each cargo tank.

Fig. 6.3.2 Diagram of installation of cylindrical independent cargo tanks horizontally along ship

6.3.3 The cylindrical independent cargo tank plating may be supported with internal
framework. Transversal support of cargo tank only is allowed.

The connected cylindrical cargo tanks shall be provided with a longitudinal bulkhead which separates the tanks. In this case, the tank’s framing members shall be located in one plane with the stays of the longitudinal bulkhead which separates the connected cargo tanks.

6.3.4 The spherical cargo tanks may have no framing. In this case, the plating is formed by strakes (Fig. 6.3.4).

6.3.5 Permissible out-of-roundness of strake shall be calculated by the following formula, m:

$$
\Delta D = |D_1 - D_2| < 0.005D_{nom},
$$

where $D_{nom}$ — nominal strake diameter, m; $D_1$ — maximum strake diameter, m; $D_2$ — minimum strake diameter, m;

Dimension lines $D_1$ and $D_2$ shall be perpendicular to each other.

6.3.6 Permissible deviation $a$ for two strakes joined (Fig. 6.3.6) shall be calculated by the following formula, m:

$$
a = 0.1t,
$$

where $t$ — thickness $t_1$ or $t_2$ of the strakes, whichever is less.

6.3.7 Maximum deviation of strake curvature shall not exceed the value shown in Fig. 6.3.7. Radius of curvature mold shown in Fig. 6.3.7 is equal to theoretical radius of spherical cargo tank.

6.3.8 The prismatic independent cargo tank plating shall be supported by framing members. The framing members shall be placed inside the cargo tank plating. The prismatic cargo tank shall have a longitudinal bulkhead installed in plane of longitudinal axis of symmetry and a transversal bulkhead, including that of swash type, installed in the middle along the cargo tank.

6.3.9 Squared manholes shall be made in the bottom part of the transversal bulkhead. The manhole plan size shall not be less than $0.8 \times 0.8$ m. The manholes shall be located on either side from the longitudinal bulkhead and shall be edged with coamings.

6.3.10 The prismatic cargo tanks shall not rise above the upper deck.

6.3.11 The membrane cargo tanks shall be designed so as to provide tightness of their shell when exposed to deformations related to
6.3.12 The designs utilizing nonmetallic membranes or membranes built in insulation and connected to insulation is allowed if technical feasibility study and calculations confirming feasibility of such designs are submitted to the River Register. Thickness of such membranes shall not exceed 10 mm.

6.3.13 Dangerous goods vapour design pressure in the membrane cargo tanks shall not exceed 0.025 MPa. Design pressure may be increased to 0.07 MPa provided that the ship hull structure is reinforced and technical feasibility study and calculations confirming that heat insulation is capable of transmitting loads from the membrane cargo tank to the hull structures without break are submitted to the River Register.

6.3.14 If the design of the membrane cargo tank shell includes primary (in relation to dangerous goods) and secondary membranes, a layer of heat insulation shall be placed between these membranes. The space between the secondary membrane and the ship hull structure shall be filled with heat insulation.

6.3.15 The membrane cargo tank design are allowed for use only after models of shell structure components, including corner membrane structures, are tested. Results of model tests shall confirm that the cargo tank is capable of withstanding stresses caused by static and dynamic loads specified in 6.7.1 to 6.7.16 that occur in operation of liquefied gas tanker.

6.3.16 The space between the secondary barrier of the support-type semimembrane cargo tank and the hull structures shall be filled with heat insulation (Fig. 6.3.16).

6.3.17 Height of grillage bars of support-type semimembrane cargo tank shall be equal to insulation thickness which is selected in accordance with the requirements of 6.5. Material of bars (balsa wood or material close to balsa in hardness, strength, vibration resistance and resistance to low temperatures) shall withstand loads from adjacent structures. The bars shall be installed over the keelsons or over the supported double bottom beams, as well as at the side stringers or double side platforms.

6.3.18 In case of leakage through the support-type semimembrane cargo tank shell, the secondary barrier shall provide tightness for liquefied gas.

6.3.19 The suspension-type semimembrane tank shall be attached to the hull structures so that its shell can expand to the design dimensions.

6.3.20 Rigidity of cylindrical sections at corners of suspension-type semimembrane cargo tank, as well as that of spheroidal corners located in joins of three planar tank sections shall be selected in view of conditions of shape retention for the suspended unstressed tank.

6.3.21 Meeting the requirement of 6.3.20, the semimembrane suspension-type cargo tank design shall provide flexibility required to take up thermal deformations and ship hull bending deformations.

6.3.22 The cargo tank dome is designed to accommodate the pipelines of the ship systems and the cargo pumps and to provide access to the cargo tank.

6.3.23 The independent prismatic cargo tank dome shall be installed symmetrically in relation to the longitudinal tight bulkhead with the manhole offset from the intersection of longitudinal and transversal symmetry axes of the cargo tank along the longitudinal sym-
metry axis of the tank to the nearest bulkhead web.

6.3.24 The cargo tank dome shall have the same heat insulation as the cargo tank has.

6.3.25 Meeting the requirement of 6.3.24, the cargo tank dome heat insulation shall provide strength enough for transfer of loads capable of displacing the cargo tank to the hull structures.

6.3.26 The cargo tank dome shall be connected with the ship hull structures so as to provide compensation of thermal deformations of cargo tank confirmed by positive calculations for the tank and its dome which occur during cargo handling and preparation of cargo tanks for reception of liquefied gas.

6.3.27 Access of people to the cargo tank shall be provided through a manhole representing a hermetically closable opening in the cargo tank dome. Minimum permissible manhole dimensions are 380×460 mm. If the cargo tanks shall be accessible by people who wear protective gear with self-contained breathing apparatus, the manhole plan dimensions shall not be less than 800×800 mm.

6.3.28 The drain wells of the liquefied gas tankers with the independent prismatic, membrane or semimembrane cargo tanks of each hold space shall be displaced to their aft bulkhead.

6.3.29 On the liquefied gas tankers with the independent spherical cargo tanks the drain wells shall be located under the vertical axis of each cargo tank.

6.3.30 The drain wells of the independent prismatic cargo tanks shall be installed symmetrically relative to the internal longitudinal bulkhead of the cargo tank (see 6.3.8) on either side of this bulkhead.

6.3.31 The drain wells of the independent prismatic cargo tanks shall have curved joints to provide minimum thermal stresses.

6.3.32 The drain wells shall be separated from the hull structures with heat insulation.

6.3.33 A temperature sensor for draining dangerous goods shall be provided in the drain well.

6.3.34 The cargo tanks shall be supported in a manner which will prevent the cargo tanks from displacement relative to the ship’s hull under static and dynamic loads resulted from ship movement on waves.

6.3.35 When the cargo tank supports are designed, calculations shall be made to confirm possibility of thermal deformation of the cargo tank.

6.3.36 The cargo tank support structures shall operate at ship heel of up to 30°.

6.3.37 The cargo tank attachment structures shall include stops to take up horizontal forces that occur during collision of ships.

6.3.38 The horizontal force applied from stern to bow is taken equal to a half of gravity force of completely filled cargo tank. The horizontal force applied from bow to stern is taken equal to a fourth of gravity force of completely filled cargo tank.

6.3.39 When strength of cargo tank support structures is calculated, it may be assumed that forces caused by the greatest possible resultant acceleration imparted to the cargo tank and its supports while in use and forces caused by collision of ships have independent effect on the support structures.

6.3.40 The vertical plates of the independent cylindrical cargo tank support shall be installed in the same plane as the floors are installed and shall support on the web side frames (Fig. 6.3.40).

6.3.41 The independent cylindrical cargo tanks shall be installed on at least two supports throughout their length.

6.3.42 One of cargo tank bracing members shall lie in plane of vertical support plate (see Fig. 6.3.40).

6.3.43 The spherical cargo tank supports shall be located in the equatorial part of the tank (see Fig. 6.3.4).
6.3.44 The following types of supports shall be used for the spherical cargo tanks:

1. Pole-type supports which provide cargo tank support on hull structures through a system of poles (Fig. 6.3.44, a);

2. Suspension-type supports which provide suspension of cargo tank by means of hinged supports located around equatorial zone of tank (Fig. 6.3.44, b);

3. Shell-type supports which provide cargo tank support on cylindrical shell reinforced with framing members (Fig. 6.3.44, c).

6.3.45 If a pole-type support is used for the spherical cargo tank, the support strake shall be located in the equatorial part of the cargo tank and shall have movable connection with the pole system.
6.3.46 The pole system shall be arranged around the circumference of the cargo tank. The pole system shall be provided with support bars to transmit forces to the hull structures (see Fig. 6.3.44, a).

6.3.47 Forces from the support bars to the hull structures shall be transmitted through isolating spacers. The isolating spacers shall prevent the support bar from lateral movements but they shall enable the support bar to radially move as a result of thermal deformations of the cargo tank.

If a suspension-type support is used for the spherical cargo tank, this support shall provide freedom of movement of the cargo tank under effect of thermal deformations.

6.3.48 If a shell-type support is used for the spherical cargo tank, the equatorial strake shall have a cross-section shown in View C of Fig. 6.3.44, c.

6.3.49 The shell-type support plating shall be supported with a framing consisting of vertical stays and horizontal stiffeners.

6.3.50 Attachment of spherocylindrical cargo tank with conical bottom with constricting tapes shall provide compression of cargo tank and heat insulation support (Fig. 6.3.50).

6.3.51 The drain well shall restrain the spherocylindrical cargo tank from horizontal displacement. The drain well shall rest with its walls against the tray. The tray shall be located in the double bottom of the liquefied gas tanker (see Fig. 6.3.50).

6.3.52 The membrane and semimembrane cargo tanks shall be attached together with cargo tank heat insulation and plating.

6.3.53 The supports of the independent prismatic cargo tanks are divided into:

1. load-bearing supports, i.e. supports that support the cargo tank only and do not prevent it from displacement relative to the vertical axis

2. retaining and load-bearing supports, i.e. supports that support the cargo tank and retain it from lateral displacement (displacement relative to the vertical axis).

6.3.54 The retaining and load-bearing supports shall be installed along the ship centre plane and along the midsection of the prismatic cargo tank (Fig. 6.3.54).
The load-bearing supports shall be evenly distributed throughout the remaining part of the prismatic cargo tank supported by them.

6.3.55 The retaining and load-bearing supports only may be installed in the top part of the prismatic cargo tank (Fig. 6.3.55).

6.3.56 If the independent prismatic cargo tank design does not comply with strength conditions when forces originating under dynamic cargo effect on the side walls of these tanks, the lateral load-bearing supports may be installed. These supports shall be arranged depending on peculiarities of application of these dynamic forces which shall be transmitted to the liquefied gas tanker hull structures by means of lateral load-bearing supports.

6.3.57 The design of the independent cargo tanks shall provide for fixtures (wedges, stops and so on) which prevent them from floating-up under buoyancy force having effect on the empty tank when the hold is flooded to the full load draught. At the same time, stress in the ship hull structure elements shall not exceed yield point $R_{yH}$.

6.4 SECONDARY BARRIER

6.4.1 If the carried liquefied gas boiling temperature at the atmospheric pressure is equal to $-10^\circ C$ and below, a secondary barrier shall be installed on the liquefied gas tanker. If the dangerous goods boiling temperature at the atmospheric pressure is higher than $-10^\circ C$, it is allowed not to install the secondary barrier.

The hull structures may be used as a secondary barrier if the carried liquefied gas boiling temperature at the atmospheric pressure is within $-10^\circ C$ to $-55^\circ C$; if so, the hull material shall comply with the requirements of Part X of the Rules and may be used in the specified temperature range.

6.4.2 If the hull structures are used as a secondary barrier, availability and type of secondary barrier shall be determined in accordance with Table 6.4.2. The hull structures shall not be used as a secondary barrier for the integral cargo tanks.

Table 6.4.2

<table>
<thead>
<tr>
<th>Availability and type of secondary barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cargo tank type</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Independent:</td>
</tr>
<tr>
<td>type A</td>
</tr>
<tr>
<td>type B</td>
</tr>
<tr>
<td>type C</td>
</tr>
<tr>
<td>Membrane</td>
</tr>
<tr>
<td>Semi-membrane</td>
</tr>
<tr>
<td>Internal insulation</td>
</tr>
</tbody>
</table>

\[1\] In the case of semi-membrane tanks which comply with the requirements applicable to type B independent tanks, except for the structure of support, a partial secondary barrier may be installed.

6.4.3 The secondary barrier design shall meet the following requirements:

.1 The secondary barrier shall be capable of containing the liquefied gas;

.2 The secondary barrier shall be capable of protecting the ship’s hull structures from cooling to an unsafe level in case of leakage of dangerous goods through the primary barrier;

.3 A failure of the primary barrier shall not cause any failure of the secondary barrier and vice versa;

.4 The secondary barrier fulfil its functions at a heel angle of up to $30^\circ$.

6.4.4 Where a partial secondary barrier is required according to Table 6.4.2, its extent shall be determined on the basis of cargo leakage volume corresponding to the length of a crack in the cargo tank wall. The crack
length shall be determined on the basis of loading condition as specified in 6.7.1 to 6.7.14 with liquid dangerous goods evaporation rate, leakage rate, and pumping capacity taken into account.

It shall not be possible for liquid dangerous goods to penetrate into the double bottom space.

6.4.5 If the secondary barrier is not required for the entire cargo tank or for a part of it, spray shields shall be installed (Fig. 6.4.5) or another structural protection may be used to protect the double bottom from cooling to an unsafe temperature.

Fig. 6.4.5. Spray shield installation diagram:
1 — spherical cargo tank foundation, 2 — bilge tank, 3 — double bottom space, 4 — spray shield, 5 — cargo tank body

6.4.6 The secondary barrier shall be capable of being periodically checked for its impermeability while the ship is in use.

6.5 INSULATION OF CARGO TANKS

6.5.1 The design of the cargo tanks intended for carriage of liquefied gas at temperature of −10 °C and below shall provide for insulation to keep temperature of hull structures higher than minimum permissible design temperature specified in 5 Part X of the Rules.

6.5.2 The design temperature for selecting heat insulation parameters is temperature of hull structures at air temperature of 5 °C and water temperature of 0 °C.

6.5.3 If the liquefied gas tanker is operated in latitudinal zones with higher air and water temperatures as compared with those specified in 6.5.2, the design temperatures higher than those specified in 6.5.2 are allowed.

6.5.4 If the ship is operated in latitudinal zones with lower air and water temperatures as compared with those specified in 6.5.2, the design temperatures specified in 6.5.2 shall be decreased.

6.5.5 Heat insulation calculations shall be made for navigation at calm water (see 2.2.1 Part I of the Rules) under no wind conditions.

6.5.6 When the secondary barrier is installed, it shall be assumed that its temperature will be equal to the temperature of carried dangerous goods at the atmospheric pressure.

Heat insulation calculations with the secondary barrier available shall allow for cooling effect of evaporation of dangerous goods leakage.

6.5.7 Use of devices for heating the hull structures is not a ground to change the design characteristics.

6.5.8 When steel grade is selected for the structural elements connecting the secondary barrier with the ship hull, the design temperature shall be determined as arithmetic mean of temperatures of dangerous goods and environment.

6.5.9 In cases mentioned in 6.5.1 to 6.5.4, devices for heating the transversal hull framing members may be installed to prevent drop of their temperatures below the minimum permissible value.

6.5.10 The devices for heating the cargo tank hull structures shall meet the following requirements:
.1 Amount of heat input shall be enough to keep temperature of hull structures above the minimum permissible temperatures specified in 6.5.2;
.2 The heating system shall be designed so that its undamaged part can provide not less than 100% of design amount of heat if any its part fails;
3. The heating system shall be considered as critical auxiliary equipment.

6.5.11 Determination of insulation thickness depending on temperature of dangerous goods shall consider quantity of evaporated dangerous goods and operation of onboard dangerous goods reliquefaction unit, main engines using dangerous goods as fuel or other system that has effect on temperature of dangerous goods or controls this temperature.

6.5.12 Insulation shall withstand loads from the adjacent structures which it may be exposed to while the liquefied gas tanker is in operation.

6.5.13 Insulation shall provide protection from mechanical damages and ingress of water vapours.

6.5.14 If powder or granular insulation is used, measures shall be taken to prevent it from compaction under vibration.

6.5.15 Insulation shall keep its properties and shall not press on elements of cargo system and other ship systems.

6.6 FABRICATION AND TESTING OF CARGO TANKS

6.6.1 All weld joints of independent cargo tank plating shall be made with full penetration butt welds. Weld joints of dome with plating and those of nozzles, branch pipes and manholes shall be made with full penetration.

6.6.2 Weld joints of parts of type C independent cargo tanks shall meet the following requirements:

.1 All weld joints of tank walls shall be made with full penetration butt welds with X- or U-shaped edge preparation. Another shape of edge preparation is allowed on condition that positive results of tests performed for approval of welding process are submitted to the River Register;

.2 All welds in the cargo tank structure (connection of parts and welding of branch pipes, nozzles and manholes) shall be made with full penetration.

6.6.3 Tests of weld joints, including non-destructive inspection, for all types of cargo tanks, except for type C independent cargo tanks, shall be performed in accordance with the requirements of 8 Part X of the Rules.

6.6.4 The internal insulation of the cargo tanks shall be visually inspected to check condition of its surface after the third trip of the loaded ship, but not later than six months of operation of the ship after building or after major repair of internal insulation cargo tanks.

6.6.5 The semimembrane cargo tanks shall meet the requirements imposed on the independent cargo tanks or membrane cargo tanks depending on requirements considered.

6.6.6 The integral cargo tanks shall be subject to hydraulic or air tightness test. Stresses that occur during tests shall be close to the design stresses, and pressure at the top of the cargo tank shall comply with the maximum permissible set pressure of the safety valve.

6.6.7 On the ships with the membrane and semimembrane cargo tanks all spaces containing liquid dangerous goods and having common hull structures with membrane supporting hull structures shall be subject to hydraulic or air tightness testing.

The membrane supporting hull structures of the ship shall be subject to tightness testing.

Tunnels for pipes and other compartments, which do not contain liquids, do not require hydraulic tightness testing.

6.6.8 For this chapter, the internal insulation cargo tanks are divided into two types:

.1 Cargo tanks of type I1 — cargo tanks in which insulation or combination of insulation and one or several layers of internal liner performs the main barrier function. The inner hull or the independent reservoir structure shall perform the secondary barrier function;

.2 Cargo tanks of type I2 — cargo tanks in which insulation or combination of insulation and one or several layers of internal liner performs the main and secondary barrier functions.

The internal liner is a protective layer not exposed to loads and made of metallic or
composite materials, which forms a structural part of the internal insulation cargo tank. The internal liner is used to prevent cracking or improve mechanical properties of insulation. Tightness requirement does not apply to the internal liner.

6.6.9 If the double bottom and double sides of the liquefied gas tankers equipped with the internal insulation tanks of type I2, are structures which support this insulation, all the structure of double bottom and double sides shall be subject to hydraulic or air test considering the maximum permissible set pressure of the safety valve.

6.6.10 If the structure of double bottom and double sides of the liquefied gas tanker or the independent tank structure is used as a secondary barrier for internal insulation tanks of type I1, these structures shall be tested for impermeability.

Impermeability tests shall be performed before insulation is installed.

6.6.11 If the liquefied gas tankers equipped with the internal insulation cargo tanks of type I2 have the independent cargo tanks which structurally support this insulation, such independent tanks shall be tested in accordance with 6.6.14.

6.6.12 Type C independent cargo tanks shall be subject to visual and instrumental check and impermeability tests. Here, the following shall be considered:

1. Visual and instrumental check shall ascertain whether dimensions and shape of ready cargo tank structure comply with requirements of technical documentation and quality of structure assemblage;

2. Scope of impermeability tests shall be as follows:
   - non-destructive testing
   - radiographic testing for 100% of butt welds
   - surface crack testing for 100% of welds of manholes, branch pipes and nozzles and 10% of all remaining welds
   - ultrasonic testing for all welds of manholes, branch pipes and nozzles.

6.6.13 The heating systems provided in accordance with 6.5.9 to 6.5.10 shall be tested for required heat flow and heat transfer coefficient.

6.6.14 Each independent cargo tank shall be tested by pressure with consideration of the following:

1. When type A independent cargo tanks are tested, measured stresses in the structural elements shall close to the design stresses, and pressure at the top of the cargo tank shall comply with the maximum permissible set pressure of the safety valve;

2. Type B independent cargo tanks shall be tested in accordance with the requirements of 1., and the maximum stresses in the primary membrane or the maximum bending stress of the main framework elements shall not exceed 90% of material yield point at the test temperature.

If the design stresses during test exceed 75% of material yield point, structure model tests with measurement of stresses shall also be performed;

3. Each type C independent cargo tank shall be tested by pressure of not less than 1.5ρ0 measured in the tank top, and the primary membrane stress in any point of its structure shall not exceed 90% of material yield point. If the design stresses during test exceed 75% of material yield point, structure model tests with measurement of stresses shall also be performed;

4. Temperature of water used for testing of type C cargo tanks shall be at least 30 °C higher than the critical fracture transition temperature of cargo tank material;

5. Time of pressure test of type C independent cargo tanks shall be set at the rate of 2 h per every 25 mm of tank wall thickness.

6.6.15 The cargo tanks of all types shall be subject to impermeability test which may be performed together with the pressure test mentioned in 6.6.14.

6.6.16 When the cargo tanks and the residual cargo tanks are tested, the test pressure shall not be less than 1.3 of design pressure. When the cofferdams and the open cargo
tanks are tested, the test pressure shall not be less than 0.01 MPa.

**6.6.17** If engineering solutions taken during design and fabrication of liquefied gas tankers with type B independent cargo tanks have not been confirmed in full by results of trial operation of the ship of the same series, at least one tank and its supports shall be equipped with sensors and instruments capable of detecting level of actual stresses.

**6.6.18** The instruments mentioned in 6.6.17 may be installed on the structural elements of type C independent cargo tanks.

**6.6.19** During initial cooling, filling and unloading of cargo tanks, all performance parameters of the cargo system shall be checked to compare them with the design parameters. The documents substantiating that parameters determined in operation comply with design parameters shall be submitted to the River Register.

**6.7 STRENGTH CALCULATIONS**

**Design loads**

6.7.1 Strength of the cargo tank structural components shall be verified by calculations under loads and their combinations in operation including the following:

.1 Loads arising during the tests;
.2 Increase of design gas vapours pressure $p_0$ when in port;
.3 Loads arising at list of 30°.

6.7.2 Design pressure of gas vapours $p_0$ for all types of cargo tanks, except for independent cargo tanks of type C, shall not exceed 0.025 MPa. When increasing the scantlings of the hull structures compared to the calculated scantlings and considering thermal insulation strength, it is allowed to increase design pressure, but in any case it shall not exceed 0.070 MPa.

6.7.3 Maximum overpressure for the independent cargo tank of type C shall not exceed the value calculated by the formula, MPa:

$$p_0 = 0.2 + 0.1ACp^{1.5},$$

where $A = 0.0185\left(\frac{\sigma_m}{\Delta\sigma_A}\right)^2$;

$\sigma_m$ — design stresses in the tank wall, MPa

$\Delta\sigma_A$ — permissible dynamic stresses in the cargo tank wall (double amplitude of the stress cycle complying with wave load exceedence probability of $10^{-4}$), components for steel 55 MPa and for aluminum alloys — 25 MPa

$C$ — characteristic size in the vertical direction, m, taken as maximum of the following values: 0.75$b$ or 0.45$l$.

Here $b$, $l$ — breadth and length of the tank in the vertical, transverse and longitudinal directions respectively, m

$\rho$ — relative (i.e. related to fresh water density) cargo density at the design temperature.

6.7.4 Design load from internal pressure in the cargo tank $P_i$ shall be calculated by the formula, MPa:

$$P_i = p_0 + (p_{hp})_{max},$$

(6.7.4)

where $(p_{hp})_{max}$ — maximum internal excessive hydrostatic pressure determined by gravity force and inertia forces caused by acceleration of cargo liquid due to ship motions.

6.7.5 Internal excessive hydrostatic pressure of the completely filled cargo tank is calculated by the formula, MPa:

$$p_{hp} = 9.81 \times 10^{-6} a_{\beta} \zeta_{\beta} \rho,$$

(6.7.5)

where $a_{\beta}$ — dimensionless acceleration expressed in percentage of gravity which is the result of gravity and dynamic accelerations in the direction at angle $\beta$ (Fig. 6.7.5-1)

$\zeta_{\beta}$ — liquid column height, m, above the point on the cargo tank plating, for which internal pressure shall be found; it is measured from the cargo tank plating in the direction of acceleration vector $a_{\beta}$, whose angle of deflection $\beta$ from the vertical is selected in the interval of 0 to $\beta_{max}$ (Fig. 6.7.5-2)

$\rho$ — cargo density at the design temperature, kg/m³.
Accelerations acting on cargo tanks are determined based on the assumption that acceleration vectors are applied in the centres of gravity of the tanks and that they include the following components:

- Vertical acceleration — an acceleration caused by heave, pitch and roll and directed perpendicular to the baseline of the ship;
- Transverse acceleration — an acceleration caused by sway, yaw and roll, as well as gravitational component of roll;
- Longitudinal acceleration — an acceleration caused by surge and pitch, as well as gravitational component of pitch.

For constructions specified in 6.7.7, maximum dimensionless (i.e. related to gravity) accelerations are used in the respective directions (in calculations they are considered to be separate) $a_x$, $a_y$, $a_z$:

- $a_x$ — includes a component of static weight in the longitudinal direction because of pitch
- $a_y$ — includes a component of static weight in the transverse direction because of roll
- $a_z$ — does not include a component of static weight.

6.7.7 When plotting acceleration ellipse required to determine angle $\beta_{\text{max}}$ (see 6.7.5), a line shall be laid from the centre of gravity of the tank with length taken as 1 (the scale of relative accelerations). The bottom end of the line is the centre of acceleration ellipse.

From the centre of acceleration ellipse, dimensionless accelerations $a_y$ and $a_z$ are laid in the horizontal and vertical directions respectively, and are taken as ellipse radii.

Angle at which vector of dimensionless acceleration $a_\beta$ passes tangential to the plotted ellipse shall be taken as angle $\beta_{\text{max}}$.

6.7.8 In order to determine height $z_\beta$, from the point on cross-section outline of the tank plating where internal pressure shall be determined, a set of angle $\beta$ values shall be specified from interval 0 to $\beta_{\text{max}}$, and height $z_\beta$ shall be graphically determined for each angle value in the specified range (Fig. 6.7.5-2).

6.7.9 In the calculation (see 6.7.5) a pair of values $z_\beta$ and $a_\beta$ shall be taken with maximum multiplication.

6.7.10 When determining internal excessive hydrostatic pressure in cargo tanks, whose longitudinal dimensions exceed their breadth, it may be required to consider the longitudinal acceleration of the centre of gravity of the cargo tank. In this case, instead of ellipse shown in Fig. 6.7.5-1, an ellipsoid with radii $a_x$, $a_y$ and $a_z$ shall be used.

The procedure of determining the values of the resulting dimensionless acceleration $a_\beta$
and liquid height \( z \), described in 6.7.7 and 6.7.8 is applicable to the acceleration ellipsoid. The requirement of 6.7.9 shall be met.

6.7.11 The domes of cargo tanks shall be considered when determining \( \beta \), except for the cases when total volume \( V_d \) doesn’t exceed the value, \( m^3 \):

\[
V_d = V \left( 100 - \frac{V}{V'} \right), \quad (6.7.11)
\]

where \( V \) — volume of the cargo tank without dome, \( m^3 \); \( V' \) — limit of cargo tank filling according to 6.20.1 and 6.20.3, \( \% \).

6.7.12 Design load of external pressure shall be determined as a difference between simultaneous minimum internal pressure (maximum vacuum) and maximum external pressure that may occur in operation.

6.7.13 Design dynamic loads caused by roll of the gas tanker and acting on the elements of cargo tanks shall be determined from consideration of long-term distribution of all types of ship motion at irregular waves; here, design exceedence probability for the maximum wave loads shall be taken equal to \( 10^{-8} \).

6.7.14 If data on inertia forces acting on cargo tanks due to ship motion at waves are not available, the following formulae shall be used to determine the acceleration components:

For vertical acceleration

\[
a_v = \pm a_0 \left[ 1 + \left( \frac{5.3 - 45/L}{2} \right)^2 \times \left( \frac{x/L + 0.05}{0.6/\delta} \right)^{1.5/0.5} \right]; \quad (6.7.14-1)
\]

For transverse acceleration

\[
a_y = \pm a_0 \left[ 0.6 + 2.5 \left( \frac{x/L - 0.05}{2} \right)^2 + K \left( 1 + 0.6Kz/B \right)^{0.5} \right]; \quad (6.7.14-2)
\]

For longitudinal acceleration

\[
a_x = \pm a_0 \sqrt{0.6 + A^2 - 0.25A} \quad (6.7.14-3)
\]

if

\[
A = 0.6 \left( 0.7 - \frac{L}{1200 + 5z/L} \right)/\delta, \quad (6.7.14-4)
\]

where \( L \) — ship length between perpendiculars, \( m \)

\( \delta \) — block coefficient

\( B \) — ship breadth, \( m \)

\( x \) — distance between the centre of gravity of the cargo tank and midship (positive value is forward from midship), \( m \)

\( z \) — vertical distance between actual waterline and centre of gravity of the cargo tank with dangerous cargo (positive value is above waterline, negative is below waterline), \( m \)

\( v \) — operating speed of the ship, \( km/h \)

\( K \) — coefficient for specific loading conditions and hull lines is determined by the formula:

\[
K = 13h_0/B \geq 1, \quad (6.7.14-6)
\]

where \( h_0 \) — metacentric height corresponding to the loading condition, \( m \).

6.7.15 Strength of cargo tanks shall be checked for the cases of their partial filling at dynamic loads which arise due to free surfaces.

6.7.16 In strength calculations of cargo tanks at temperature of the carried dangerous cargo below \(-55^\circ C\), thermal loads arising during cooling period shall be considered.

**Strength of membrane tanks**

6.7.17 Simultaneously with strength calculation of membrane cargo tanks, the test results of the membrane structure models and their angle joints confirming reliability of the calculation results shall be submitted to the River Register. The test conditions shall comply with most unfavorable operating conditions of the cargo tank determined by the designer and approved by the River Register.

6.7.18 The test results of the membrane cargo tank materials, which prove that ageing of the materials does prevent from intended
strengthen the structures, shall be submitted to the River Register.

6.7.19 If data on external loads on cargo tanks is not confirmed in full scope by the results of operational trials for the ships of the same design, the tests shall be performed with types and values of test loads assigned compliant with all possible load combinations in operation.

It shall be substantiated that under over-pressure in interbarrier space, vacuum inside the membrane cargo tank, impacts in presence of free surfaces or vibration, membrane integrity will not be compromised.

6.7.20 Strength of the membrane cargo tank case shall be calculated considering internal pressure specified in 6.7.4. The specified calculation shall consider the possibility of deformation of the membrane and adjacent insulation jointly with hull members.

Strength of independent tanks

6.7.23 Strength of the independent cargo tanks of type A shall be calculated according to the requirements of Part I of the Rules considering internal pressure according to 6.7.4 and corrosion allowances according to 6.7.46 to 6.7.48.

6.7.24 For the structures in the place of supports, the design stresses shall be determined considering the loads specified in 6.7.1 and hull deformation.

6.7.25 Strength of the independent cargo tanks of type B shall be calculated considering all possible static and dynamic loads and their combinations in operation. The requirements on restricting plastic deformation, maintaining stability and fatigue endurance as well as prevention of cracks shall be met. The following shall be performed:

.1 Static estimation of wave loads (see 6.7.5 to 6.7.9);
.2 Strength calculations of structures;
.3 Calculation of crack rate in the structural components of the cargo tank cover;
.4 Calculation of the structure strength under load transferred to the cargo tank structures from its supports and fasteners using a 3D FEM model.

6.7.26 If data for the ships of the design in question are not available, then a complete calculation of ship accelerations and motions at irregular waves as well as ship and cargo tank reaction to inertial loads shall be made.

6.7.27 Stability calculation shall consider maximum fabrication tolerances of the structures.

6.7.28 Design values of stress concentration coefficients and parameters of fatigue life of the newly constructed independent cargo tank components shall be verified by the test results on the models of these components.

6.7.29 Action of load causing fatigue damage of the structure shall comply with the following inequality:

$$\sum \frac{n_i}{N_i} + 1000/N_j \leq C_w,$$  \hspace{1cm} (6.7.29)

where \(n_i\) — number of cycles of each stress level over whole service life of the ship

\(N_i\) — number of cycles until fracture for the respective stress level \(\sigma\) according to fatigue curve \(\sigma = f(N)\)

\(N_j\) — number of cycles until fracture for fatigue load caused by handling operations

\(C_w\) — parameter which is usually taken \(C_w \leq 0.5\) depending on the test method and data used to plot fatigue curve \(\sigma = f(N)\);

value \(C_w > 0.5\) not exceeding 1.0 may be used.

6.7.30 Strength of the independent cargo tanks of type C shall be calculated considering the following requirements:

.1 Wall thickness of the independent cargo tanks of type C shall be determined considering the shape of their parts according to the procedures developed by the designer and approved by the River Register;

.2 If visual inspection and non-destructive testing are provided, design weld strength factor shall be taken equal to 0.95. It may be increased to 1.0 depending on the properties of the material, connection type, welding
process and loading conditions. For process pressure vessels, it is allowed to decrease the scope of non-destructive testing; here, design weld strength factor shall be taken not more than 0.85;

.3 If the independent cargo tanks of type C are subject to load action causing compression stress in the tank walls in operation, a technical justification for wall thickness and cargo tank shape shall be provided. Strength of such tanks shall be calculated considering fabrication tolerances;

.4 Design load due to external pressure $P_{e}$ shall be determined by the formula, MPa:

$$P_{e} = p_{1} + p_{2} + P_{3} + P_{4},$$

(6.7.30)

where $p_{1}$ — safety valve setting, for cargo tanks without safety valves $p_{1}$ shall be taken equal to min. 0.025 MPa;

$p_{2}$ — safety valve setting for hull compartments with cargo tanks or their parts; otherwise $p_{2} = 0$;

$P_{3}$ — compression stress due to any forces (influence of weight and insulation shrinkage, plating weight including corrosion allowance, etc.) which the cargo tank is subject to. These forces may include weight of dome, raised parts and pipelines, cargo in partially filled tank, load of hull deformation and inertia forces. Besides, local action of external and/or internal pressure shall be considered;

$P_{4}$ — assumed external load due to water washing the tanks or parts thereof on the open deck; otherwise $P_{4} = 0$;

.5 Stress in the places of supports of the cargo tanks (in the tank wall and in the hull structures) shall be calculated at load action specified in 6.7.1 to 6.7.16. The results of structure fatigue strength evaluation and calculations considering secondary and thermal stress shall be submitted to the River Register;

.6 Wall thickness of the independent cargo tanks of type C shall be not less than that obtained by calculations considering corrosion allowance, but in any case not less than, mm:

- for carbon-manganese and nickel steels 5
- for austenitic steels 3
- for aluminum alloys 7

**Strength of cargo tanks with internal insulation**

6.7.31 Strength of cargo tanks with internal insulation shall be calculated considering all the static and dynamic loads and their combinations possible in operation. Structural components forming walls of the cargo tank shall be evaluated for fatigue strength, tendency to crack propagation, adhesion of insulation, strength under compression, tension and shear. Besides, the following shall be made:

.1 Statistic analysis of wave loads considering 6.7.5 to 6.7.9;

.2 Strength calculations of structures;

.3 Damage mechanism analysis.

6.7.32 Stress level and respective structural deformations of the inner hull or independent cargo tank using a 3D FEM model shall be calculated. Such calculations shall confirm that the specified deformations do not lead to peeling or breakdown of the insulation material. The calculation shall consider pressure load inside the cargo tank (see 6.7.5) and dynamic loads due to wave generation in ballast compartments, if those compartments are adjacent to the cargo tank walls.

6.7.33 Permissible stresses arising in the cargo tank walls and permissible combined structural deformations of the cargo tank walls jointly with insulation shall be verified by a technical justification to be prepared by the designer and approved by the River Register.

6.7.34 Results of the cargo tank structure model testing including tests under combined effect of static, dynamic and thermal loads shall be submitted to the River Register.

6.7.35 The test conditions shall comply with the design operating conditions including heat cycling. The minimum number in this case shall be 400 heat cycles on the basis of 19 voyages per year. The 400 heat cycles may be divided into 20 complete cycles (tank wall temperature of up to 45 °C) and 380 partial cycles (cargo tank wall temperature reaches the set value set for ballasted voyage).

6.7.36 The cargo tank structure models shall be geometrically similar to the tested
prototype structure, including angles, connections, pump mounts, passages of pipelines and other stress concentration points; different properties of the cargo tank materials, fabrication process and quality control shall be considered too.

**6.7.37** Tensile tests and fatigue strength tests shall be performed to evaluate insulation material behavior as regards crack propagation in case of through crack development in the inner hull or independent cargo tank. The structure in the place of crack shall be subject to maximum hydrostatic pressure of ballast water.

**6.7.38** Action of load causing fatigue damage is to be determined according to 6.7.29.

**6.7.39** For the cargo tanks with internal insulation, when preparing the test program for the prototype structure to be tested, designer shall develop a repair technique for the insulation material and inner hull or independent tank structure.

### Permissible stresses

**6.7.40** For built-in cargo tanks, permissible stresses are determined according to 2.2 Part I of the Rules.

**6.7.41** For designing, permissible stresses for the structures of the independent cargo tanks of type A formed by flat surfaces shall be taken out of two values, whichever is less, MPa:

\[
[\sigma_A] = \frac{R_m}{2.66} \quad \text{or} \quad [\sigma_A] = \frac{R_{eh}}{1.33}
\]

where \(R_{eh}\) — yield point of the material, MPa;

\(R_m\) — tensile strength of material, MPa;

**6.7.42** If calculations consider bending deformations, axial displacement of the cargo tank, shear and torsional deformations, as well as hull and cargo tank interaction forces caused by deformations of gas tanker's double bottom and cargo tank bottom, then, in case of technical justification submitted to the River Register, stress values exceeding those obtained from calculations as per 6.7.17 to 6.7.39 are allowed.

**6.7.43** For the independent cargo tanks of type B with revolutional shape, actual stresses shall not exceed the following values:

\[
\begin{align*}
[\sigma_m] & \leq f, \\
[\sigma_L] & \leq 1.5f, \\
[\sigma_B] & \leq 1.5F, \\
[\sigma_L] + [\sigma_B] & \leq 1.5F, \\
[\sigma_m] + [\sigma_B] & \leq 1.5F,
\end{align*}
\]

where \(\sigma_m\) — equivalent membrane total stresses, MPa (stresses in shells outside the stress concentration or support areas)

\(\sigma_L\) — equivalent membrane local stresses, MPa (stresses in shells caused by pressure or other mechanical loads, or in the shell elements which serve as the main structure reinforcement, or in other stress concentration areas)

\(\sigma_B\) — equivalent shell stresses at bending, MPa

\(f\) — the lower of \(R_m/n_A\) or \(R_{eh}/n_B\);

\(F\) — the lower of \(R_m/n_C\) or \(R_{eh}/n_D\);

\(n_A, n_B, n_C, n_D\) — coefficients taken from Table 6.7.43.

**Table 6.7.43**

<table>
<thead>
<tr>
<th>Safety factor</th>
<th>Steel</th>
<th>Austenitic</th>
<th>Aluminium alloys</th>
</tr>
</thead>
<tbody>
<tr>
<td>(n_A)</td>
<td>3</td>
<td>3.5</td>
<td>4</td>
</tr>
<tr>
<td>(n_B)</td>
<td>2</td>
<td>1.6</td>
<td>1.5</td>
</tr>
<tr>
<td>(n_C)</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>(n_D)</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

The \(R_{eh}\) or \(R_m\) in the annealed state shall be used for the welded joints of the structures made of aluminum alloys.

The said characteristics shall comply with minimum specified mechanical properties of the materials including deposited metal of the welds.

**6.7.44** Equivalent stresses shall be calculated by the formula, MPa:

\[
[\sigma_{eq}] = \sqrt{[\sigma_x]^2 + [\sigma_y]^2 - \sigma_x\sigma_y + 3\tau_{xy}^2},
\]

\(\sigma_{eq}\) — equivalent membrane stresses, MPa.
where $\sigma_x$ — total normal stresses in X-direction;
$\sigma_y$ — total normal stresses in Y-direction;
$\tau_{xy}$ — total tangent stresses in the XY plane.

If static and dynamic stresses are determined separately and use of other methods is not reasonable, total stresses shall be calculated by the formulae:

$$\sigma_x = \sigma_{x,s} + \sqrt{\sum \sigma_{x,dyn}^2};$$  \hspace{1cm} (6.7.44-2)

$$\sigma_y = \sigma_{y,s} + \sqrt{\sum \sigma_{y,dyn}^2};$$  \hspace{1cm} (6.7.44-3)

$$\tau_{xy} = \tau_{x,y,s} + \sqrt{\sum \tau_{x,y,dyn}^2},$$  \hspace{1cm} (6.7.44-4)

where $\sigma_{x,s}$, $\sigma_{y,s}$, $\tau_{x,y,s}$, $\sigma_{x,dyn}$, $\sigma_{y,dyn}$, $\tau_{x,y,dyn}$ — static and dynamic stress components respectively which are determined separately from the acceleration components and hull stress components caused by sagging and twisting.

6.7.45 For the independent cargo tanks of type C, permissible membrane stress in the strength calculations shall be taken equal to $f$ (see 6.7.43)

**Corrosion allowance**

6.7.46 If active materials are carried in the cargo tanks or cargo tank environmental is not controlled, it is required to make a corrosion allowance for the cargo tank wall thicknesses as obtained from calculations, performed by the designer and approved by the River Register.

6.7.47 It is not required to make corrosion allowance for the cargo tank walls, if their external surfaces are protected by inert gas or insulation is resistant to dangerous cargo vapours.

6.7.48 Use of paint or other thin coatings for the cargo tank walls may not be considered as corrosion protection of these walls.

**6.8 STRUCTURAL FIRE PROTECTION**

6.8.1 Depending on hazard degree of the carried dangerous cargo, the following types of structural protection shall be provided for the liquefied gas tankers:

- **Type 1G** — maximum degree of structural protection for carriage of dangerous cargo, for which respective requirement (1G) is specified in column 4 of Table A3-1 in Appendix 3.
- **Type 2G** — degree of structural protection for carriage of dangerous cargo, for which respective requirement (2G) is specified in column 4 of Table A3-1 in Appendix 3.
- **Type 2PG** — degree of structural protection for carriage of dangerous cargo, for which respective requirement (2PG) is specified in column 4 of Table A3-1 in Appendix 3.

On liquefied gas tankers with structural fire protection 2PG, dangerous cargo shall be carried in the independent cargo tanks of type C designed for maximum permissible safety valves setting not less than 0.7 MPa and design temperature in the dangerous cargo containment system equal to $-55 \degree C$ or above.

Liquefied gas tanker complying with these requirements and more than 120 m in length shall have structural protection 2G.

- **Type 3G** — degree of structural protection for carriage of dangerous cargo, for which respective requirement (3G) is specified in column 4 of Table A3-1 in Appendix 3.

6.8.2 Open flame sources are not allowed in the spaces with inflammable vapours.

6.8.3 Machinery, accommodation and service spaces, chain lockers, drinking water tanks, water for domestic needs and food stores shall be separated from the cargo area of the liquefied gas tanker depending on availability of an additional barrier. If separation of the cargo tank with a barrier is not prescribed by the Rules, these spaces shall be protected using cofferdams or gas-tight bulkheads of type A-60. If open flame sources are not available in the adjacent spaces, it is allowed to use bulkheads of type A-0.

6.8.4 If dangerous cargo is carried in the cargo tanks which require installation of an additional barrier according to the Rules, the spaces specified in 6.8.3 as well as spaces located below or outside the bilge space and containing an open flame source shall be
separated from the cargo spaces using cofferdams. If no open flame source is available, it is allowed to install one bulkhead of type A-0.

6.8.5 Air lock designed for communication between the gas-hazardous and gas-safe spaces shall include two steel gas-tight self-closing doors without arresters. Simultaneous opening of the doors (to be signalled by audible and visual alarm) is not allowed. Height of the door coaming in the locks shall be at least 300 mm, and distance between the doors shall be at least 1.5 and not more than 2.5 m from each other.

6.8.6 Entrances and other openings in accommodation spaces, service spaces and control stations shall not face the cargo spaces or bow or stern cargo handling equipment. Entrances are arranged in bulkheads of the superstructures and outer walls of the wheelhouses \( L/25 \) apart, where \( L \) — ship length, but not less than 3 m and not more than 5 m from the outer side of the wheelhouse with the passage opening facing the cargo spaces.

6.8.7 Scuttles in side bulkheads of the superstructure within the specified boundaries shall be of blind type (see GOST 19261 and GOST 21672). It is allowed to fit scuttles of flapper type in the wheelhouse, if such scuttles are gas-tight. Side scuttles below the main deck level and at the first tier of the superstructure shall be only of blind type.

6.8.8 Cargo tank openings with a cross-sectional area of more than 0.10 m\(^2\) and safety device openings designed to prevent overpressure shall be located at height of at least 0.60 m above the deck level.

6.8.9 The design and arrangement of cargo tanks, bilge spaces and compressor rooms shall enable access of people with self-contained breathing apparatuses and in protective equipment, lifting the injured, and access to and inspection of all valves. Access to cargo tanks shall be provided from the open deck. Minimum dimensions of the vertical cutouts for passage along the length and breadth of the space shall be 800 \( \times \) 800 mm, and if there are no gratings, they shall be at height no more than 600 mm from the bottom plating. Access from the service spaces free of gas to gas-hazardous spaces is allowed only through air locks. If an air lock is not available, entry from the open upper deck to a gas-safe space shall be located at a height of at least 2.4 m above the open deck.

6.9 FLOODABILITY

6.9.1 For floodability calculations, the dimensions of the side and bottom damages shall be taken according to 6.9.2 and 6.9.3.

6.9.2 Side damage dimensions shall be taken as follows:

1. longitudinal dimension — \( 1/3 L^{2/3} \);
2. transversal dimension — \( B/5 \);
3. vertical dimension — upwards without limitation.

6.9.3 Bottom damage dimensions shall be taken as follows:

1. longitudinal dimension:
   - within 0.3 \( L \) from the fore perpendicular — \( 1/3 L^{2/3} \);
   - within the rest of the ship — \( 1/3 L^{2/3} \) or 5 m, whichever is less;
2. transversal dimension:
   - within 0.3 \( L \) from the fore perpendicular — \( B/6 \);
   - within the rest of the ship — \( B/6 \) or 5 m, whichever is less;
3. vertical dimension — \( B/15 \).

6.9.4 If a tank containing liquid is damaged, it shall be assumed that the tank contents completely escape and are replaced with water to the waterline level complying with the equilibrium position of the flooded ship.

6.9.5 If pipes, channels, trunks or tunnels are located within the estimated damage length, the design solutions shall be made to prevent flooding of compartments, except for those which are to be flooded when the ship is damaged.

6.9.6 Depending on the type of structural fire protection of the liquefied gas tanker and its length, the following requirements shall be met:

1. a ship with structural fire protection of type 1G shall comply with the requirements
specified in 6.9.7 and 6.9.8 if the hull is damaged in any place along its length;

.2 a ship 150 m long or less with structural fire protection of type 2G shall comply with the requirements specified in 6.9.7 and 6.9.8 if the hull is damaged in any place along its length, except for damage of bulkheads enclosing the aft machinery space;

.3 a ship over 150 m long with structural fire protection of type 2G shall comply with the requirements specified in 6.9.7 and 6.9.8 if the hull is damaged in any place along its length;

.4 a ship with structural fire protection of type 2PG shall comply with the requirements specified in 6.9.7 and 6.9.8 if the hull is damaged in any place along its length, except for damage of bulkheads, the distance between which exceeds the longitudinal length of the damage specified in 6.9.2.1;

.5 a ship less than 125 m long with structural fire protection of type 3G shall comply with the requirements specified in 6.9.7 and 6.9.8 if the hull is damaged in any place along its length, except for damage of bulkheads, the distance between which exceeds the longitudinal length of the damage specified in 6.9.2.1 and except for damage of the aft machinery space. In floodability calculations, flooding of the machinery space shall be taken into account;

.6 a ship over 125 m long with structural fire protection of type 3G shall comply with the requirements specified in 6.9.7 and 6.9.8 if the hull is damaged in any place along its length, except for damage of bulkheads, the distance between which exceeds the longitudinal length of the damage specified in 6.9.2.1. In floodability calculations, flooding of the machinery space shall be taken into account.

6.9.7 At any stage of unsymmetrical flooding, a maximum angle of heel shall not exceed 30°.

6.9.8 At the final stage of flooding, the following conditions shall be met:

.1 the length of the positive arm section of the damage stability curve until the lower edges of the openings, through which water could be spread into the intact compartments, are immersed shall not be less than 20°;

.2 the maximum arm of the damage stability curve on the section mentioned in 6.9.8.1 shall not be less than 0.1 m;

.3 area under the damage stability curve within this section shall be not less than 0.0175 m rad.

6.9.9 In floodability calculations, the dimension of the possible vertical damage of the bottom in case of use of membrane and semi-membrane cargo tanks shall be measured to the double bottom plating, in other cases – to the cargo tank bottom. The transverse length of the possible side damage in case of use of membrane and semi-membrane cargo tanks shall be measured to the longitudinal bulkhead, in other cases – to side walls of cargo tanks. For cargo tanks with internal insulation, the dimension of the possible damage shall be measured to the supporting plating of cargo tanks.

6.9.10 Except for liquified gas tankers with structural fire protection of type 1G, suction wells in cargo tanks may be installed within the vertical length of the possible bottom damage if they extend beyond the inner bottom plating for a distance not exceeding 25% of the double bottom height or for a distance of 350 mm, whichever is less. For single-bottom ships, a drain well shall not extend beyond the upper limit of the damaged bottom section for more than 350 mm.

6.10 CONTROL STATIONS

6.10.1 Control stations shall not be located in the cargo area. In ships equipped with the dangerous cargo containment system which requires installation of a secondary barrier, the control station bulkheads facing the cargo area with their plane shall be located so that to prevent gas penetration into the control station from the bilge space in case of deck or bulkhead damage.

6.10.2 Air intakes and openings leading to control stations shall be located at a distance
of not less than 2 m from the cargo pipeline, cargo gas-freeing systems and exhaust pipes of gas burners in machinery spaces.

6.10.3 Doorways of entrances, air intakes and openings leading to machinery spaces and control stations shall not face the cargo area. They shall be located on the end bulkhead facing the side which is opposite to the cargo area and/or on the side wall of the wheelhouse at a distance of not less than 4% of the ship length \( L \), but not less than 3 m and not more than 5 m from the superstructure or wheelhouse end facing the cargo area.

6.10.4 All air intakes and openings leading to control stations shall be equipped with locking arrangements. In case of toxic gas emission, these arrangements shall be actuated from the place located inside the control station.

6.10.5 Any cargo loading/unloading control station which shall be located above the upper deck may be located in the cargo area. The cargo loading/unloading control station may be located within accommodation or service spaces or control stations if the following requirements are met:

1. the cargo loading/unloading control station is a gas-safe space;
2. if openings to enter accommodation or service spaces or control stations comply with the requirements in 6.10.3, access to these spaces or control stations is allowed from the cargo loading/unloading control station;
3. if openings to enter accommodation or service spaces or control stations do not comply with the requirements in 6.10.3, access to these spaces from the cargo loading/unloading control station shall be prohibited and the boundaries of such spaces shall be insulated to A-60 class standard.

6.10.6 If the cargo loading/unloading control station is a gas-safe space, the instruments shall be installed according to the requirements in 6.11.6.

6.10.7 If cargo operations are controlled from the cargo loading/unloading control station, all visual and audible alarms, except for the main deck shall be duplicated in the cargo loading/unloading control station. Alarm with interpretation of the signal shall be installed in the cargo loading/unloading control station on the main deck. The cargo control station shall be designed so as the entire cargo area on the main deck can be visible.

6.10.8 If in the ships carrying inflammable dangerous cargo, the cargo loading/unloading control station is gas-hazardous, arrangement of open flame sources is not allowed.

6.10.9 Communication aids shall be provided between the cargo loading/unloading control station and the place of cargo hose connection to the shore.

6.11 DETECTION OF DANGEROUS CARGO VAPOURS (GAS)

6.11.1 The ship shall be equipped with gas detection equipment complying with the requirements in 6.11.2 to 6.11.15, if such a requirement for the carried dangerous cargo is included in column 11 "Cargo vapour detection system" of Table A3-1 in Appendix 3.

6.11.2 For all the spaces located within the cargo area, it shall be possible to monitor gas concentration.

At fixed sampling device locations designed for dangerous cargo carriage it shall be possible to measure vapour density and decrease vapour concentration by purging or venting the spaces.

6.11.3 If the installation of a secondary barrier is required, at least two sets of fixed sensors (temperature or gas detectors) shall be available to indicate liquid leakage through any point of the primary barrier or contact of dangerous liquid cargo with the secondary barrier in any place.
6.11.4 The pipelines from sampling devices shall not pass through gas-safe spaces except for the cases specified in 6.11.6.

6.11.5 Gas detection systems (see 6.11.8) shall be equipped with audible and visual alarms transmitting signals to the wheelhouse, to the cargo loading/unloading control station and to the place of taking readings from the gas detection system equipment.

6.11.6 Gas detection equipment may be located in the cargo loading/unloading control station, in the wheelhouse or other gas-safe spaces, if the following requirements are met:

.1 the sampling pipelines shall have shut-off valves to avoid communication with gas-hazardous spaces;

.2 gas from the gas analyzer shall be released into the atmosphere at a distance of not less than 10 m from the nearest air intake or openings in the accommodation and service spaces and control stations or from other gas-safe spaces.

6.11.7 Gas detection equipment shall be designed to be tested and calibrated. For this purpose, respective equipment and gas samples shall be available on board.

6.11.8 A fixed gas detection system as well as audible and visual alarms shall be installed:

.1 in spaces containing cargo pumps;

.2 in spaces containing cargo compressors;

.3 in spaces containing electric drives of handling equipment;

.4 in the cargo loading/unloading control station;

.5 in other closed spaces in the cargo area where vapours accumulate, including bilge and interbarrier spaces for independent tanks, except for cargo tanks of type C;

.6 in the vent hoods and gas channels;

.7 in air locks.

6.11.9 Gas detection equipment shall provide sampling and atmospheric composition analysis in the location of each sampling device at intervals not exceeding 30 min, except for sampling for gas detection in vent hoods and gas channels, specified in 6.11.8.6, which shall be continuous. Common sampling pipelines shall not be connected to gas detection equipment installed in such hoods or channels.

6.11.10 Sensors/detectors for detection of dangerous cargo vapours in air locks (at least two in each air lock) shall actuate when vapour concentration reaches 30% of the lower flammable level of dangerous cargo vapours.

6.11.11 If tanks of the dangerous cargo containment system other than independent cargo tanks are used for inflammable dangerous cargo, the bilge and interbarrier spaces shall be equipped with a fixed gas detection system providing measurement of gas concentration in the range of 0 to 100% by volume. These bilge and interbarrier spaces shall be equipped with at least two low temperature sensors for detection of dangerous cargo leakage in the trays for liquefied gas collection.

6.11.12 Using gas detection equipment with audible and visual alarm, sampling and atmospheric composition analysis shall be performed at each sampling device location at intervals not exceeding 30 min. Signalling devices of such equipment shall actuate when vapour concentration reaches 30% of the lower flammable level in the air. Common sampling pipelines shall not be connected to gas detection equipment.

6.11.13 If gases are toxic, the bilge and interbarrier spaces shall be equipped with fixed pipeline system for gas sampling from these spaces. Gas samples from these spaces shall be taken for analysis at each sampling device location using fixed or portable equipment at intervals not exceeding 4 h before anyone enters the space and every 30 min when people stay in these spaces.

6.11.14 Each ship shall be equipped with at least two sets of portable gas detection equipment approved by the River Register. This equipment shall be designed so as to detect dangerous cargo subject to carriage.

6.11.15 A device for measuring oxygen content in inert gas environment shall be installed.
6.12 ARRANGEMENT OF POWER INSTALLATION UNITS AND SYSTEMS

Cargo compressor and cargo pump rooms

6.12.1 Cargo pump and compressor rooms/spaces in liquefied gas tankers shall be located within the cargo area above the upper deck, except for the specified spaces in liquefied gas tankers designed for carriage of liquefied mixtures of hydrocarbon gases, propane and butane. For fire safety, the requirements to cargo pump spaces of oil tankers apply to cargo pump and compressor rooms/spaces of liquefied gas tankers.

6.12.2 If cargo pump and compressor rooms/spaces are located above or below the upper deck in the aft of the bilge space closest to the aft or in the fore of the bilge space closest to the fore, the length of the cargo area shall be such as to accommodate the cargo pump and compressor rooms/spaces located throughout the entire breadth of the ship and its freeboard as well as deck areas above these spaces.

6.12.3 If the cargo area boundaries are extended according to 6.12.2, the bulkhead separating the cargo pump and compressor spaces from accommodation and service spaces, control stations and machinery spaces, shall be located so that to prevent possible gas penetration into these spaces in case of deck or bulkhead damage.

6.12.4 If pumps and compressors are shaft driven, gas-tight lubricated glands shall be installed at shaft penetrations through the bulkheads or decks.

6.12.5 The design and arrangement of cargo pump and compressor rooms/spaces shall provide access for people wearing self-contained breathing apparatuses and protective equipment and lift of the injured as well as access to and inspection of all the valves used for cargo operations. Drain arrangements for pump and compressor rooms/spaces shall be provided.

Bow and stern handling equipment

6.12.6 Cargo pipelines for loading and discharge from the bow or stern shall comply with the requirements in 6.12.7 to 6.12.13.

6.12.7 Bow or stern handling pipelines laid near accommodation or service spaces or control stations shall not be used for transfer of cargo carried by liquefied gas tankers with structural fire protection of type 1G.

6.12.8 Use of portable handling equipment is not allowed.

6.12.9 Cargo pipelines and its connected equipment shall comply with the requirements in 4.12. Except for the specified, cargo pipelines and its connected equipment shall meet the following requirements:

1. the cargo pipelines and its connected equipment located outside the cargo area shall have only welded joints. The pipelines located outside the cargo area, except for the pipeline connected to the shore-based system shall be laid on the open deck and at a distance of not less than 760 mm from the ship's side. Such pipelines shall be marked and the points of their connection to the cargo pipeline system within the cargo area shall be equipped with shut-off valves. Such points shall be equipped with devices for cutting off these pipelines if they are not used with the help of removable inserts and blind flanges;

2. cargo pipelines shall be butt welded on a step-by-step basis. Then welded joints shall undergo complete X-ray examination irrespective of the pipeline diameter and design temperature. Flange connections of pipelines and drip trays for dangerous liquid cargo may be installed only within the cargo area as well as at points of the pipeline connection to the shore;

3. measures shall be taken to ensure purging and degassing of such pipelines after their use and further dismantling of removable inserts and plugging off the pipeline ends with blind flanges. Gas-freeing pipes connected to the purging system shall be located in the cargo area.
6.12.10 Entrances, air intakes and openings leading to accommodation, service and machinery spaces as well as to control stations shall not face connection points to the shore-based system or bow or stern handling equipment. They shall be located on the superstructure or wheelhouse side at a distance of not less than 4% of the ship length \( L \), but not less than 3 m and not more than 5 m from the superstructure or wheelhouse end facing the connection point to the shore-based system of bow or stern handling equipment. Side scuttles with openings facing the side where the shore connection devices are located and on the superstructure or wheelhouse sides within the specified distance shall be of a blind type. Besides, during use of the bow or stern handling equipment, all the doors, ports and other openings located on the respective superstructure or wheelhouse side shall be closed.

6.12.11 Deck openings and air intakes in spaces located at a distance of 10 m from the connection point of bow or stern handling equipment to the shore shall be capable of closing all the time this equipment is in use.

6.12.12 Electric equipment located within 3 m from the specified equipment connection point to the shore-based system shall comply with the requirements of Part VI of the Rules.

6.12.13 Installation of communication aids is required between the cargo loading/unloading control station and the cargo hose connection point to the shore-based system.

**6.12.15** If a ballast pump is installed in the cargo area, the delivery pipe and its side suction branch pipe for water ballasting shall be located within the cargo area, but out of the cargo tanks.

6.13 **HULL STRUCTURE HEATING SYSTEM**

6.13.1 Boilers used to heat the hull structures shall be fired with oil fuel with vapour flash point of above 60 °C. These boilers shall not be installed within the cargo area.

6.13.2 The hull structure heating system shall be designed so as to exclude ingress of dangerous goods into the boiler when the coils of this system become untight.

6.13.3 If the hull structure heating system is used during cargo handling operations, the ventilation system openings in spaces accommodating the hull structure heating system components shall be located at a height of at least 2.4 m from the deck level and at a distance of at least 3 m from the cargo area, at least 6 m from the residual dangerous cargo tank openings, deck mounted cargo pumps, pressure relief valves and connections of cargo piping for reception from shore, and at least 10 m from the openings of the quick-acting outlet valves.

6.14 **PIPELINES, VALVES AND FITTINGS**

6.14.1 Pipelines, valves and fittings of the power installation and general ship systems in liquefied gas tankers shall comply with the requirements of 10, Part IV of the Rules. The requirements of this Chapter apply to pipelines of special systems of liquefied gas tankers.

6.14.2 Pumps, pipelines, valves and other fittings of systems in the cargo tanks area shall have identification marking.

6.14.3 It is not allowed to integrate the cofferdam systems with similar systems located out of the cargo area.

6.14.4 Pipelines and fittings for media with operating temperatures between 0 °C and
–165 °C shall be made of materials listed in Table 5.5, Part X of the Rules.

6.14.5 Materials with melting point below 925 °C shall not be used in pipelines outside the cargo tanks, except the pipes connected to cargo tanks with fire-resistant insulation.

6.14.6 When selecting materials for pipelines and components of systems designed for cargo with temperature less than –165 °C, technical justification confirming the possibility of their use shall be submitted to the River Register.

6.14.7 Wall thickness of pipes operating under internal pressure shall be not less than that determined by the formula (10.2.12-1) Part IV of the Rules, and parameters $p$ (design pressure) and $c$ (corrosion allowance) shall be taken considering the following:

.1 for pipelines or their parts, maximum of the following compared pressures shall be taken as design pressure $p$:

- for pipelines or their parts which contain dangerous cargo vapours or some amount of dangerous liquid cargo and may be disconnected from the safety valves — pressure of the dangerous cargo saturated vapours at a temperature of 45 °C;
- for pipelines or their parts which always contain only dangerous cargo vapours and may be disconnected from the safety valves — pressure of the overheated vapours at a temperature of 45 °C. It is assumed that saturated vapour is generated in the system at working pressure and temperature;

maximum permissible preset actuation pressure of safety valves fitted on cargo tanks and their service cargo systems;

preset actuation pressure of the bypass safety valve fitted on the pump or compressor;

total maximum head in the cargo pipeline at ship loading or discharge;

preset actuation pressure of the safety valve on the pipeline.

In any case, design pressure $p$ shall be taken not less than 1 MPa and for open end pipelines — not less than 0.5 MPa;

.2 wall thickness corrosion allowance increases as compared to that established in 10.2.12, Part IV of the Rules at intense corrosion or erosion of the pipeline exposed to dangerous cargo. In this case corrosion allowance shall be taken considering the declared period of the pipeline operation.

6.14.8 Minimum safety factors accepted for the cargo pipeline when determining permissible stresses and used design characteristics (yield point or tensile strength) shall be specified in the certificate of ship fitness for carriage of liquefied gases in bulk.

6.14.9 Minimum wall thickness shall be adopted Table 10.2.13, Part IV of the Rules.

6.14.10 If design ambient temperature is –110 °C and below, a complete strength calculation shall be made considering all the stresses which can occur under pipe weight (including acceleration loads), internal pressure, thermal contraction as well as loads arising due to ship bending for each piping system branch.

For temperatures above –110 °C, stress calculations considering the structure features, material selection or system stiffness shall be submitted to the River Register.

The specified calculations shall be made using the methods approved by the River Register.

Temperature stresses shall be taken into account.


6.14.12 Pipelines shall be welded in compliance with the requirements in 7.5.9 Part X of the Rules.

6.14.13 Flange connections of pipelines, valves and fittings shall comply with the requirements in 10.2.19 Part IV of the Rules.

Flange connections shall not be used for design temperatures below –10 °C and nominal pipe diameters above 100 mm.

Flange dimensions shall be determined at design pressure according to 6.14.7.1.

6.14.14 Sleeve welded joints may be used only for open end pipelines with an outside
diameter of 50 mm or less and at design temperature of not less than 

-55 °C.

6.14.15 No sleeve threaded joints are allowed.

6.14.16 If expansion joints are used in pipelines, their number shall be sufficient to protect the pipelines of the cargo system and cargo tanks from stresses, arising as a result of thermal expansion of cargo tanks, pipelines and hull deformation.

Only bellows expansion joints shall be installed outside the cargo tanks. Expansion joints of other types shall be installed only inside the cargo tanks.

Means are to be provided to prevent the formation of ice on bellows expansion joints.

6.14.17 Pipelines designed for low temperature applications shall be thermally insulated from adjacent hull structures to avoid hull structure temperature decrease below the design temperature.

If pipelines for dangerous liquid cargo are subject to regular disassembling or leakage of dangerous liquid cargo is possible (e.g. at connections with shore mains or at pump glands), the hull structures located below shall be protected against exposure to low temperature dangerous cargo at pipeline disassembling points or possible dangerous cargo leakage points.

6.14.18 Any piping system which may contain dangerous cargo or dangerous cargo vapours shall comply with the following requirements:

1. the system shall be isolated from other piping systems, except for connections required for cleaning, gas removal and inert gas supply. In this case measures preventing penetration of dangerous cargo or its vapours into other piping systems through these connections shall be taken;

2. pipelines shall not pass through accommodation and service spaces, control stations and machinery space. This requirement doesn't apply to cargo pump and compressor rooms/spaces.

Emergency arrangements for dangerous cargo removal may be located in the aft part of the ship in accommodation and service spaces, control stations and machinery spaces. The pipelines shall not pass through these spaces;

3. the piping system shall be located in the cargo area on the open deck, except for the cases of bow or stern load according to 6.12.7 to 6.12.9 and use of cargo as fuel.

6.14.19 The cargo system pipelines shall not be located under the deck, except for the pipelines of the cargo tanks and cargo pump room.

6.14.20 The cargo system pipelines shall be designed so that it can be possible to drain residuals of dangerous cargo (on completion of loading and discharge processes) from the system to the shore or ship tanks.

6.14.21 The cargo system pipelines located on the deck, except for shore connections, shall be at a distance of not less than one quarter of the hull breadth from the ship's side.

6.14.22 The shore connections shall be located at a distance of not less than 6 m from the entrances to or openings of the accommodation and service spaces outside the cargo area.

6.14.23 The connections of the gas-freeing and cargo systems used during loading and discharge shall have the shut-off device. If these connections are not used during loading and discharge, they shall be blanked off.

6.14.24 For pressure relief and removal of liquid residuals from loading and discharge headers and cargo hoses, devices for their purging and degassing shall be installed in the cargo tanks prior to disconnection of cargo hoses.

Gas-freeing pipes connected with devices for removing residuals of dangerous goods shall be arranged in the cargo area.


6.14.26 Pipelines for bow and stern loading and discharge shall be isolated from the main
cargo pipeline with shut-off valves, detachable branch pipes and blind flanges in the cargo area.

6.14.27 The design and actuators of valves installed on the overboard discharges of pipelines running from spaces located under the freeboard deck or from closed superstructures and wheelhouses on the freeboard deck shall comply with the requirements in 10.4 Part IV of the Rules.

6.14.28 The valves shall be selected with consideration of the following:

1. overboard discharges shall be equipped with one automatic non-return valve with forced means of closure above the freeboard deck;

2. if the vertical distance from the summer waterline to the upper edge of the side drain opening of the discharge pipeline inside the hull of the liquefied gas tanker exceeds 0.01 L m (where L is the ship length along the maximum load waterline, in m), overboard discharges shall be equipped with two automatic non-return valves without forced means of closure if access to the valve located inside the hull for valve inspection is provided.

6.14.29 The cargo system pipelines to every cargo tank shall be equipped with emergency shut-off valves.

6.14.30 For cargo tanks equipped with safety valves adjusted for maximum permissible preset pressure of 0.07 MPa or less, all the connections for liquids and gas, except safety valves and closed-type instruments to determine liquid level mounted in the cargo tank, shall have shut-off valves fitted at the cargo tanks. These valves shall be equipped with manual controls ensuring their complete closure.

Remotely controlled emergency shut-off valves shall be installed on board the ship to stop transfer of liquid or gas between the ship and shore corresponding to the requirements in 6.14.33 and 6.14.34.

6.14.31 For cargo tanks equipped with safety valves adjusted for maximum permissible preset pressure more than 0.07 MPa, all the connections for liquids and gas, except safety valves and closed-type instruments to determine liquid level mounted in the cargo tank, shall have a manual stop valve and automatic remotely controlled shut-off valve.

If the pipe diameter exceeds 50 mm, it is allowed to use bypass valves instead of stop valves. It is allowed to use one by-pass valve instead of two, if it complies with the requirements in 6.14.34, is manually controlled and provides complete closure of the pipeline.

6.14.32 Branch pipes of the cargo tank to fit the instruments may have no by-pass or emergency shut-off valves if flow from the cargo tank does not exceed the flow rate from the cargo tank through a circular hole with a diameter of 1.5 mm.

6.14.33 A remotely controlled emergency shut-off valve shall be installed at each cargo hose connection.

Connections not used during transfer shall be blanked off with the help of blank flanges.

6.14.34 All the emergency shut-off valves required by the Rules shall be controlled from separate stations located in at least two places on board the ship spaced from each other. The control station or cargo loading/unloading control station shall be one of these places.

Emergency shut-off valve control system shall be equipped with fuse elements designed for melting temperature of 98 to 104 °C for automatic closing of the emergency shut-off valves in the event of fire. Fuse elements shall be located in the domes of cargo tanks and at loading stations.

6.14.35 Emergency shut-off valves shall be designed so that to close in case of the actuator failure (power supply failure) and be manually controlled.

Emergency shut-off valves on the liquid cargo pipelines shall fully close at all operating conditions in 30 s after sending the cut-off signal.

6.14.36 In order to avoid pressure rise in the cargo main above the permissible value when closing the valve connected to the
structure of the high liquid level alarm and sensor for their automatic closing and full filling of the cargo tank, total time of valve closing (time from feeding a signal to start closing to total closing of the valve) shall not exceed, in s, $3600 \frac{V_{res}}{Q_{max}}$, where $V_{res}$ is residual volume of the cargo tank, in m$^3$, above the level at which the alarm actuates; $Q_{max}$ is the maximum flow rate at loading considering compliance of the ship and shore loading facilities, in m$^3$/h. Measures shall be taken to avoid water hammers when closing the valve.

6.14.37 Information on closing time of valves and their performance shall be stored on board the ship. Provision shall be made for checking and displaying the time of valve closing.

6.14.38 The pipeline with valves, fittings and other components protected by a bypass valve shall have a larger capacity than design flow rate at the moment of valve closing.

Bypass valves may be equipped with an equalizing line to equalize pressure after the valve stops; the diameter of the equalizing line shall not exceed 1.0 mm.

6.14.39 All the pipelines or their sections designed to be isolated from cargo systems and tanks when filled with dangerous liquid cargo shall be equipped with safety valves. Dangerous cargo shall be drained from safety valves installed on cargo pipelines to cargo tanks. It is allowed to drain to gas venting masthead riser (column) if means for detection and removal of dangerous liquid cargo which may penetrate into the ventilation system are installed.

Dangerous cargo shall be drained from safety valves installed on cargo pumps to the pump suction.

6.15 CARGO SYSTEM

6.15.1 Cargo pumps shall be designed so that pressure decrease of elastic saturated vapour of liquid dangerous cargo at maximum temperature minimally affects the pump suction.

6.15.2 If dangerous cargo is transferred by cargo pumps which has no access for repair from the cargo tank side in operation, at least two independent dangerous cargo transfer arrangements shall be provided for dangerous cargo transfer from each cargo tank. These cargo transfer arrangements shall be designed so that when one of the cargo pumps or one of the transfer arrangements fails, the other cargo pump (pumps) or other dangerous cargo transfer arrangements shall remain serviceable.

6.15.3 Safety valves shall be installed if discharge pressure of cargo pumps and compressors exceeds design pressure in the cargo system.

6.15.4 When transferring dangerous cargo by its displacement with compressed gases, the possibility of safety valve actuation shall be excluded.

6.15.5 Cargo pumps and compressors shall be equipped with automatic cut-off devices in the following cases:

1. if emergency shut-off valves installed on pressure pipelines according to the requirements in 6.14.29 are closed by emergency shut-off valve control system prescribed in 6.14.34;

2. when the dangerous cargo filling level in the cargo tank reaches the designed value;

3. when pressure in the cargo tank drops to the minimum permissible value.

Cargo pumps and compressors shall be stopped from the local control station and shall be additionally capable of being stopped remotely from the station outside the cargo area.

6.15.6 If part of dangerous cargo not pumped by the cargo pumps remains in the cargo tank, the means to remove residual dangerous cargo shall be installed during replacement of dangerous cargo or repair.

6.16 PRESSURE REDUCTION SYSTEM

6.16.1 All the cargo tanks shall be equipped with the pressure reduction system by releasing excessive evaporated dangerous cargo to the gas-freeing piping through pressure relief valves.
Hold spaces, interbarrier spaces and cargo pipelines which pressure can exceed the design value according to design, shall be equipped with pressure reduction systems by releasing evaporated dangerous cargo. Pressure reduction systems shall be connected to the gas-freeing pipings. Provision shall be made to prevent dangerous cargo vapour from accumulating on decks and penetrating into accommodation, machinery and other spaces as well as control stations.

The pressure reduction systems shall be independent from other pressure regulation systems specified in 6.22.

6.16.2 Each cargo tank with capacity over 20 m$^3$ shall be equipped with at least two pressure relief valves of equal flow rate.

Cargo tanks with capacity of 20 m$^3$ or less shall be equipped with one pressure relief valve.

6.16.3 Interbarrier spaces shall be equipped with pressure reduction devices approved by the River Register.

6.16.4 Pressure relief valves shall be adjusted for actuation pressure not exceeding the pressure for which the cargo tank is designed. If the tank is equipped with two pressure relief valves or more, the valves may be adjusted for actuation pressure exceeding the design pressure by 5% if these valves take max. 50% of the total load at pressure relief.

6.16.5 The pressure relief valves shall be connected to the highest part of the cargo tank above the deck level. The pressure relief valves fitted on cargo tanks with design temperature below 0 °C shall be designed so that they always operate even if iced in closed position. The valves shall be made of materials with melting temperature above 925 °C.

6.16.6 If pressure relief valves of cargo tanks may be adjusted for actuation at several values of the preset pressure according to the design documentation, it may be achieved by installation of:

1. two or more sealed pressure relief valves adjusted for actuation and capable of being isolated from the cargo tank if not used; 2. pressure relief valves which actuation mode can be changed by using orifices or springs or other means not requiring pressure test to verify proper selection of a new set pressure.

6.16.7 The procedures of adjusting the preset pressure according to 6.16.6 and resetting the emergency sensors/detectors to a new pressure value shall be described in the operating manual for the ship. The master shall supervise the specified procedures and record the preset pressure value changes in the ship log.

6.16.8 Shut-off valves and other means of isolating the pipelines between the cargo tanks and pressure relief valves designed for maintenance and repair of these pipelines, shall be installed only in case of using the following:

1. means to prevent simultaneous failure of more than one pressure relief valve;
2. automatic alarm indicating which pressure relief valve is faulty;
3. pressure relief valves with the flow rate which shall be such that if one of the valves fails, the total capacity of the remaining valves is not less than that specified in 6.19. The total capacity of all the pressure relief valves may be not less than that specified in 6.19 only if a spare valve completely ready for installation is available on board the ship.

6.16.9 Each pressure relief valve installed on the cargo tank shall be connected to the gas-freeing system.

6.16.10 In case of simultaneous carriage of dangerous cargo which may react with each other, an autonomous pressure reduction system shall be provided for each carried dangerous cargo.

6.16.11 Pressure relief valves and pipelines shall be designed so that no liquid accumulates in them.

6.16.12 Pressure relief valves shall be located on the cargo tank so that they remain under influence of gaseous phase of the dangerous cargo at heel of 15° and trim of 0.015$^\circ$. 
6.17 ADDITIONAL PRESSURE REDUCTION SYSTEM FOR LIQUID LEVEL ADJUSTMENT

6.17.1 If there is a risk of early full filling of the cargo tank at its loading (see 6.20.4.2), such a tank shall be equipped with the pressure reduction system comprising the following:

1. one or more pressure relief valves adjusted for actuation at excessive pressure of dangerous cargo vapours and design temperature (see 6.20.4.2);
2. shut-off device providing system stop in normal mode. This device shall include elements which fuse at a temperature of 98 to 104 °C to actuate the pressure relief valve (valves) specified in 6.17.1.1. Fuse elements shall be located near the pressure relief valve (valves).

The pressure reduction system shall remain serviceable in case of power supply failure.

The shut-off device shall be independent of any ship’s power source.

6.17.2 Total capacity of the additional pressure reduction system at vapour pressure specified in 6.17.1.1 at standard temperature of 0 °C and pressure of 0.1013 MPa shall be not less than the minimum required air release rate \( Q \) determined by the formula, m³/s:

\[
Q = F_k g A^{0.82},
\]  

(6.17.2-1)

where \( F \) — ignition susceptibility coefficient, which depends on the type of cargo tanks. Values of \( F \) are taken equal to:

- for non-insulated cargo tanks located on the deck
- for cargo tanks located above the deck, which are insulated with fire resistant material with low thermal conductivity approved by the River Register
- for non-insulated independent cargo tanks installed in the holds
- for insulated independent cargo tanks installed in isolated holds
- for insulated independent cargo tanks installed in the holds accommodating inert gas and for non-insulated independent cargo tanks installed in inertized isolated holds
- for membrane and semi-membrane cargo tanks

\[
k_g = 12.4 \sqrt{ZT/M} \left[ D \left( r + \overline{\rho}_{liq} \right) \right],
\]  

(6.17.2-2)

where \( Z \) — gas compressibility factor at pressure reduction, i.e. under pressure exceeding the actuation pressure for which the pressure relief valve of the additional pressure reduction system is adjusted by 20%. If \( Z \) is unknown, \( Z \) shall be taken equal to 1.0;

\( T \) — temperature under pressure drop, K;

\( M \) — molar weight of dangerous cargo, kg/kmol;

\( D \) — constant adopted from Table 6.17.2-1 depending on the value of specific heat capacity \( c_u \) or taken equal to 0.606. If specific heat capacity is unknown, it shall be calculated by the formula, kJ/(kg·K):

\[
c_u = 8.314/M,
\]  

(6.17.2-3)

<table>
<thead>
<tr>
<th>Constant</th>
<th>( c_u )</th>
<th>( D )</th>
<th>( c_u )</th>
<th>( D )</th>
<th>( c_u )</th>
<th>( D )</th>
</tr>
</thead>
<tbody>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.606</td>
<td>1.36</td>
<td>0.677</td>
<td>1.72</td>
<td>0.734</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.611</td>
<td>1.38</td>
<td>0.681</td>
<td>1.74</td>
<td>0.736</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.615</td>
<td>1.40</td>
<td>0.685</td>
<td>1.76</td>
<td>0.739</td>
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<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.620</td>
<td>1.42</td>
<td>0.688</td>
<td>1.78</td>
<td>0.742</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.624</td>
<td>1.44</td>
<td>0.691</td>
<td>1.80</td>
<td>0.745</td>
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<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.628</td>
<td>1.46</td>
<td>0.695</td>
<td>1.82</td>
<td>0.747</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.633</td>
<td>1.48</td>
<td>0.698</td>
<td>1.84</td>
<td>0.750</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.637</td>
<td>1.50</td>
<td>0.701</td>
<td>1.86</td>
<td>0.752</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.641</td>
<td>1.52</td>
<td>0.704</td>
<td>1.88</td>
<td>0.755</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.645</td>
<td>1.54</td>
<td>0.707</td>
<td>1.90</td>
<td>0.758</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.649</td>
<td>1.56</td>
<td>0.710</td>
<td>1.92</td>
<td>0.760</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.652</td>
<td>1.58</td>
<td>0.713</td>
<td>1.94</td>
<td>0.763</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.656</td>
<td>1.60</td>
<td>0.716</td>
<td>1.96</td>
<td>0.765</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.660</td>
<td>1.62</td>
<td>0.719</td>
<td>1.98</td>
<td>0.767</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.664</td>
<td>1.64</td>
<td>0.722</td>
<td>2.00</td>
<td>0.770</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.667</td>
<td>1.66</td>
<td>0.725</td>
<td>2.02</td>
<td>0.772</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.671</td>
<td>1.68</td>
<td>0.728</td>
<td>2.04</td>
<td>0.774</td>
<td></td>
</tr>
<tr>
<td>c_u, kJ/(kg·K)</td>
<td>0.674</td>
<td>1.70</td>
<td>0.731</td>
<td>2.06</td>
<td>0.776</td>
<td></td>
</tr>
</tbody>
</table>

\( r \) — latent heat of evaporation at unloading, kJ/kg;
\( \bar{\rho}_{\text{liq}} \) — ratio of liquid dangerous cargo density to fresh water density at pressure reduction \( (\bar{\rho}_{\text{liq}} = 1 \text{ for fresh water}) \);

\( m \) — gradient of liquid dangerous cargo enthalpy reduction depending on increase of liquid dangerous cargo density at pressure reduction, in kJ/kg,

\[
m = - \frac{d h}{(d \bar{\rho}_{\text{liq}})}.
\]

For installations with pressure not exceeding 0.206 MPa, the values specified in Table 6.17.2-2 shall be used. For dangerous cargo not specified in Table 6.17.2-2 and for installations with higher pressure, the value \( m \) shall be determined on the basis of thermodynamic characteristics of dangerous cargo;

Table 6.17.2-2

<table>
<thead>
<tr>
<th>Dangerous cargo type</th>
<th>( m )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>400</td>
</tr>
<tr>
<td>Anhydrous ammonia</td>
<td>3400</td>
</tr>
<tr>
<td>Butadiene</td>
<td>1800</td>
</tr>
<tr>
<td>Butane</td>
<td>2000</td>
</tr>
<tr>
<td>Butylene</td>
<td>1900</td>
</tr>
<tr>
<td>Methane</td>
<td>2300</td>
</tr>
<tr>
<td>Propylene oxide</td>
<td>1550</td>
</tr>
<tr>
<td>Propane</td>
<td>2000</td>
</tr>
<tr>
<td>Propylene</td>
<td>1600</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>900</td>
</tr>
<tr>
<td>Methyl chloride</td>
<td>816</td>
</tr>
<tr>
<td>Ethane</td>
<td>2100</td>
</tr>
<tr>
<td>Ethylene</td>
<td>1500</td>
</tr>
</tbody>
</table>

Note: The values \( m \) are given for pressure not exceeding 0.206 MPa.

\( h \) — dangerous cargo enthalpy, kJ/kg;

\( A \) — outer surface area of the cargo tank, \( \text{m}^2 \). For cargo tanks depending on their shape and type, the area \( A \) shall be taken equal to:

- outer surface area — for cargo tanks with revolutioned shape;
- outer surface area without projected area of its bottom — for cargo tanks without revolutioned shape.

For cargo tanks of pressure vessel type which are arranged in rows (Fig. 6.17.2), the area \( A \) is taken equal to:

outer surface area of the holds without projected area of its bottom, if the hull structure is insulated;

outer surface area of pressure vessels arranged in rows, excluding insulation, without projected area of their bottom (in Fig.6.17.2 the area \( A \) is dotted), if the pressure vessel structure is insulated.

6.17.3 If according to 6.17.1.1 it is required to change adjustment of pressure relief valves, it shall comply with the requirements in 6.16.6.

6.17.4 Pressure relief valves specified in 6.17.1.1 can be adjusted according to the requirements in 6.16 if their preset pressure and flow rate comply with the requirements in 6.17.

6.17.5 Gas released from pressure relief valves shall be discharged to the gas-freeing system.

6.18 VACUUM PROTECTION SYSTEM

6.18.1 The vacuum protection system shall be provided in the cases when cargo tanks are designed for difference between external and internal pressure of 0.025 MPa or less and cannot withstand maximum difference between external and internal pressure in the cargo tank which may occur at high unloading rates without vapour return to cargo tanks or at use of dangerous cargo cooling system.

6.18.2 Cargo tanks which are provided with the vacuum protection according to the design shall be equipped with the following:

two independent pressure sensors to transmit an alarm signal and to stop liquid and gas dangerous cargo suction from the cargo tank
6.18.3 Vacuum safety valves shall provide supply of inert gas, dangerous cargo vapours or air to the cargo tank. They shall be designed to exclude ingress of water or snow into the tank.

If at actuation of vacuum safety valves, dangerous cargo vapours are supplied to the cargo tank, their ingress from vapour outlet pipes shall be excluded.

6.18.4 Means shall be provided to test the operating vacuum protection system at design pressure.

6.19 SAFETY VALVE DIMENSIONS

6.19.1 The cargo tank safety valves shall have total flow rate required for discharging each cargo tank at the rate equal to one of the values given below. Pressure in the cargo tank shall not exceed the maximum permissible preset pressure of safety valve actuation by more than 20%:

1. maximum efficiency of the system for cargo tank filling with inert gas, if maximum working pressure in the cargo tank inerting system exceeds the maximum permissible preset pressure of the cargo tank safety valve actuation pressure;

2. vapour formation rate if the cargo tank is exposed to high temperatures in case of fire calculated by the formula (6.17.2-1).

The gas factor \(k_g\) in the formula is determined according to the formula:

\[k_g = 12.4 \sqrt{Z T / M (r D)}\]

where \(r, D, Z, T\) and \(M\) — see 6.17.2.

6.19.2 When determining the flow rate specified in 6.17.2, back-pressure in gas-freeing mains shall be taken into account. Pressure drop in the gas-freeing pipeline from the cargo tank to the safety valve outlet shall not exceed 3% of the preset valve actuation pressure. For uncontrolled safety valves, back-pressure in the exhaust pipeline shall not exceed 10% of overpressure in the safety valve inlet, connected to the pipes for releasing vapour resulted from cargo tank exposure to high temperature in case of fire as specified in 6.19.1.2.

6.20 CARGO TANK FILLING LIMITS

6.20.1 The cargo tank shall be filled with liquid cargo for not more than 91% of the volume at design temperature taken according to 6.20.4, except for the provisions specified in 6.20.3.

6.20.2 The maximum volume \(V_L\) of liquid cargo filled into the cargo tank shall be calculated by the formula, m³:

\[V_L = 0.01 z \rho_R / \rho_L\]

where \(z\) — accepted limit of liquid cargo filling according to 6.20.1 or 6.20.3, %;

\(\rho_R\) — dangerous cargo density at the design temperature, kg/m³;

\(\rho_L\) — dangerous cargo density at temperature and pressure in the tank during its filling, kg/m³;

\(V\) — volume of the cargo tank without dome, m³.

6.20.3 A cargo tank may be filled with dangerous liquid cargo for 91% to 98% of its volume at the design temperature specified in 6.20.4 if the design organization submits relevant technical justifications and calculations to the River Register. In this case, the following shall be considered: tank shape, location of safety valves, liquid level and temperature measurement accuracy as well as difference between dangerous cargo temperature during loading and temperature when dangerous cargo vapour pressure corresponds to the preset safety valve actuation pressure. The valves
shall be located according to the requirements in 6.16.12.

Tank filling for more than 98% of its volume is not allowed.

6.20.4 For the purposes of this chapter, design temperature means:

.1 temperature at which dangerous cargo vapour pressure corresponds to the pressure for which safety valves are adjusted, if the temperature and pressure regulation system for dangerous cargo vapours complying to the requirements specified in 6.22 is not installed;

.2 maximum dangerous cargo temperature upon completion of loading, during transportation or discharge, if the temperature and pressure regulation system for dangerous cargo vapours complying to the requirements specified in 6.22 is installed. If a cargo tank is completely filled at such a design temperature before dangerous cargo temperature raises to the value corresponding to the dangerous cargo vapour pressure for which the safety valves are adjusted according to the requirements in 6.16.2, additional pressure reduction system complying with the requirements in 6.17 shall be installed.

6.20.5 If technical justifications and calculations are submitted to the River Register by the design organization, it is allowed to load tanks of type C to the limit determined by the formula specified in 6.20.2, where \( \rho_R \) is dangerous cargo density at maximum temperature which the dangerous cargo may reach upon completion of loading, during transportation or discharge carried out at ambient temperature specified in 4.20.2. These requirements do not apply to dangerous cargo carried by liquefied gas tankers of type 1G.

6.20.6 Maximum permissible filling limits for each cargo tank and for each carried cargo at loading condition temperatures as well as for maximum possible temperature shall be specified in operating documentation. This documentation shall also specify the preset pressure of safety valves, including those required according to 6.17.

6.21 GAS-FREEING SYSTEM

6.21.1 The gas-freeing system shall be installed to remove excessive gas from the cargo tank safety valves.

6.21.2 The gas-freeing system shall be designed so as to direct the outgoing gas upwards and to prevent water or snow ingress into the system.

6.21.3 Exhaust openings of gas-freeing pipes shall be located above the open deck at a height of at least \( B/3 \), where \( B \) is ship breadth, or 6 m, whichever is greater, and 6 m above the operating area platform, bow and stern catwalks. If quick-release valves are used, they shall be located at a height of at least 2.4 m above the deck level and at a distance of at least 10 m from accommodation and service spaces located outside the cargo area.

6.21.4 Exhaust openings for gas outlet from the cargo tank safety valves shall be located at a distance equal to the ship breadth or 25 m, whichever is less, from the nearest air intake or openings of accommodation and service spaces or other gas-safe spaces.

All other exhaust openings of the gas-outlet pipes connected to the dangerous cargo containment system shall be located at a distance of at least 10 m from the air intake or openings of accommodation and service spaces and control stations or other gas-safe spaces.

6.21.5 In case of simultaneous carriage of dangerous cargo which may react with each other, autonomous gas-freeing piping shall be laid from safety valves for each carried dangerous cargo.

6.21.6 Means providing liquid removal from places of its accumulation shall be installed in gas-freeing systems.

6.21.7 Protective screens shall be installed at gas-freeing piping outlets.

6.21.8 All the gas-freeing pipes and their fasteners shall be designed so that to prevent pipe damage at temperature variation or under loads occurring at ship motion.
6.22 CARGO PRESSURE AND TEMPERATURE REGULATION SYSTEM

6.22.1 If the dangerous cargo containment system is not rated for full positive pressure of dangerous cargo vapours under conditions of maximum ambient temperature, pressure in the cargo tank shall be maintained below the maximum permissible set pressure of the safety valve by using one or several systems mentioned in 4.20.1.

6.22.2 For dangerous cargo which is to meet special requirements specified in Appendix 3, cargo tanks shall withstand total dangerous cargo vapour pressure at the maximum design ambient temperature irrespective of the system installed for operations with gas vapours.

6.22.3 The requirements of 4.20.2, 4.20.4, 4.20.6 to 4.20.10 shall be met.

6.23 BILGE SYSTEM FOR EVACUATING CARGO LEAKS AND BALLAST SYSTEM

6.23.1 If dangerous cargo is carried in cargo tanks not requiring a secondary barrier, bilge spaces shall be equipped with independent bilge systems not connected to machinery spaces and designed for pumping dangerous cargo which leaked through the primary barrier, e.g. in case of cargo tank leakage or primary barrier damage.

Installation of means for dangerous cargo leakage detection is required in the specified bilge spaces.

6.23.2 If a secondary barrier is used, a bilge system is required to evacuate cargo leaked into bilge spaces or isolated spaces through the ship structures.

The suction pipeline of such systems shall not be connected to the pumps located in the machinery space.

6.23.3 Bilge or interbarrier spaces in the ships with autonomous cargo tanks of type A shall be equipped with a bilge system providing pumping of liquid dangerous cargo in case of its leakage into the cargo tank or cargo tank damage. Such systems shall provide return of the dangerous cargo which leaked from the cargo tank into the cargo pipeline. Removable spool pieces shall be installed.

6.23.4 Independent bilge systems for pump and compressor rooms/spaces shall be installed.

6.23.5 The cargo pump room located under the deck shall be drained by means of the autonomous system located within the cargo area and not connected with another system. Such a system shall be placed outside of the cargo pump room.

6.23.6 Internally insulated cargo tanks do not require leakage detection means and bilge system for the interbarrier space and spaces between the secondary barrier and double sides and double bottom or structure of the independent cargo tank which are totally filled with insulation material.

6.23.7 Ballast tanks, fuel oil tanks and gas-safe spaces may be served by ballast pumps located in the machinery space.

Bottom tunnels accommodating ballast pipelines may be connected to the machinery space containing ballast pumps if the pipes are connected directly to the pumps and discharged overboard.

Gas exhaust pipes of the pumps shall have no open ends entering machinery space.

6.24 VENTILATION SYSTEM

Ventilation of spaces manned during cargo operations

6.24.1 Spaces accommodating electric motors of cargo pumps and compressors as well as other enclosed spaces containing equipment for dangerous cargo transfer and spaces from which cargo operations are controlled shall be equipped with artificial ventilation independent from other ventilation systems and controlled outside these spaces. Measures shall be provided to start the ventilation system of these spaces before personnel enters them. The warning sign to start the ventilation system shall be placed at the entry of these spaces.
6.24.2 Inlet and outlet openings of artificial ventilation shall be located so that to provide air supply to the space to avoid accumulation of inflammable or toxic vapours of dangerous cargo and provide safe atmosphere.

The ventilation system shall provide at least 30 air changes per hour based on the total volume of the space. As an exception, for gas-safe cargo loading/unloading control stations, 8 air changes per hour are allowed.

6.24.3 Ventilation systems of spaces shall be fixed. Exhaust ventilation systems shall provide air intake from upper and lower parts of the space depending on the density of the carried dangerous cargo vapours.

6.24.4 Supply ventilation shall be provided in spaces containing electric motors of cargo compressors and pumps, in spaces accommodating inert gas generators, in cargo loading/unloading control stations if they are gas-safe as well as in other gas-safe spaces within the cargo area.

6.24.5 Exhaust ventilation shall be provided in cargo compressor and pump spaces/rooms and in cargo loading/unloading control stations if they are gas-hazardous.

6.24.6 Exhaust ventilation ducts shall provide air removal upwards from gas-hazardous spaces. Outlet openings shall be located above the cargo deck at a height of at least 4 m and at a distance of at least 10 m in the horizontal direction from inlet ventilation ducts and openings in accommodation and service spaces, control stations and other gas-safe spaces.

6.24.7 Inlet openings of the ventilation system shall be located so that to prevent return of dangerous vapours from outlet ventilation openings.

6.24.8 Ventilation ducts of gas-hazardous spaces shall not pass through machinery, accommodation and service spaces and control stations.

6.24.9 Electric motors of fans shall be located outside ventilation ducts in case of inflammable dangerous cargo carriage.

Fans shall not be the source of ignition of dangerous cargo vapours in the ventilated space and in the ventilation system serving this space.

Fans and ventilation ducts for gas-hazardous spaces at fan locations shall be designed so as to exclude sparking.

6.24.10 Fans of each type used in cargo areas shall be provided with a set of spare parts: impellers with a shaft, bearings and electric motors.

6.24.11 For protection of ventilation ducts, their outer openings shall be equipped with tight covers and protective strainers with cells the sides of which do not exceed 13 mm.

6.24.12 If engines suck air from the machinery space, the inlet ventilation openings of the machinery space shall be located at a distance of not less than 2 m from the cargo area. This requirement also applies to the location of engine air intakes.

6.24.13 Ventilation of the closed machinery space shall provide temperature in the machinery space of max. 40 °C at ambient temperature of 20 °C.

Ventilation of occasionally manned spaces

6.24.14 Bilge spaces, interbarrier spaces, cofferdams, cargo piping spaces and other spaces where dangerous cargo vapours may accumulate, shall have ventilation providing safe atmosphere if these spaces are to be manned. If such spaces are not equipped with a fixed ventilation system, portable means of artificial ventilation approved by the River Register shall be provided.

Fans shall comply with the requirements in 6.24.9 and shall not prevent access of the personnel to this space.

6.24.15 The space and cofferdam purging shall be ensured with portable or fixed fans providing at least 20 air changes per hour based on the total volume of the space.

Air for space and cofferdam purging shall be supplied through an air duct to the bottom part of a space 400 mm clear off the floor (bottom). Air shall exit through the air pipes.
The purging system inlet openings shall be located at a height of not less than 2.4 m above the deck and at a distance of not less than 5 m from the tank openings and 10 m from the safety valve openings.

6.24.16 Fans used for purging of spaces according to 6.24.15 shall be explosion-proof.

6.24.17 The cofferdam ventilation openings shall be equipped with flame arresters.

**Ventilation of other spaces**

6.24.18 Inlet ventilation openings of accommodation and service spaces as well as control stations shall be located on the outer walls of superstructures or wheelhouses not facing the cargo area, bow or stern handling equipment or on the side walls of the superstructure or wheelhouse at a distance equal to at least 4% of the ship length but not less than 3 m and not exceeding 5 m from the wall of the superstructure or the wheelhouse facing the cargo area or bow or stern handling equipment.

Location of ventilation system inlet openings as related to cargo pipelines, gas-freeing piping as well as exhaust piping of devices running with liquefied gas shall be also taken into account.

The specified requirements do not apply to liquefied gas tankers designed for carriage of dangerous cargo posing no toxic or fire hazards or small liquefied gas tankers which are not technically capable of meeting the specified requirements.

6.24.19 All the inlet openings of the ventilation system and openings in accommodation and service spaces and control stations shall be equipped with devices locking from inside the space and providing gas tightness.

When carrying dangerous cargo emitting toxic gases, all the inlet openings of the ventilation system shall open and close from inside the spaces.

6.24.20 The air lock space shall have artificial supply ventilation from gas-safe space to maintain overpressure with respect to the gas-hazardous zone on the open deck.

Air circulation rate shall not be less than 30 air changes per hour.

6.24.21 An independent ventilation system to exclude dead air and stagnation shall be provided in machinery spaces of type A where liquefied gas is used as fuel.

**6.25 FIRE-FIGHTING SYSTEMS**

**Fire smothering systems**

6.25.1 Requirements in 6.25.2 to 6.25.4 complement the requirements in 2.1 to 2.4.

6.25.2 Cargo compressor and pump spaces/rooms shall be equipped with one of the fire smothering systems (aerosol, water mist, chemical smothering). If the carbon dioxide fire extinguishing system according to 3.8 Part III of the Rules is used, the coefficient $\phi$ in the formula (3.8.9) in Part III of the Rules shall be taken equal to 0.45.

Starting arrangements of the fire smothering system shall have marking specifying that the system is to be used only for fire extinguishing, not for inerting.

6.25.3 Cargo compressor and pump spaces/rooms in the ships designed for carriage of dangerous cargo which cannot use the carbon dioxide fire extinguishing system shall be equipped with a fire smothering system.

6.25.4 Audible alarm devices which warn of the carbon dioxide fire extinguishing system start in the cargo compressor and pump spaces/rooms shall have protection required for use in the spaces which contain inflammable vapours of dangerous cargo in their air area.

**Fire water mains system**

6.25.5 In addition to the requirements in 2.1.1 the fire water mains system shall comply with the following requirements:

1. water pressure at any fire hydrant shall be at least 0.5 MPa;
2. shut-off valves shall be installed on bypass pipelines and on the fire main at the point where it exits from the quarter deck superstructure and every 40 m on the deck in the cargo area;
.3 Fire pump capacity and head as well as diameter of the fire main shall be such that water jets supplied from at least two fire nozzles reach any deck part in the cargo area as well as areas of the dangerous cargo containment system and covers of cargo tanks located above the deck. The length of fire hoses on open decks shall not exceed 33 m;

.4 At least three doubled fire nozzles shall be installed within the cargo area. A return spring valve shall be installed on the fire main to avoid gas penetration into accommodation or service spaces.

**Water sprinkling system**

6.25.6 In ships carrying inflammable or toxic dangerous cargo, a water sprinkling system to cool the structures, restrict fire spread and protect people shall be installed. This system shall protect the following areas:

.1 Domes and other projections of cargo tanks having no fire protection;

.2 Deck cargo tanks for storage of inflammable or toxic gases having no fire protection;

.3 Cargo manifolds for liquid and vapours as well as valve control stations and other areas accommodating control valves. The area of these locations shall be not less than the area of available water drip trays;

.4 Outer walls of superstructures and wheelhouses facing the cargo area as well as cargo pump and compressor rooms/spaces, cargo loading/unloading control station, storerooms for highly inflammable materials and substances.

6.25.7 The water sprinkling system shall protect all the areas specified in 6.25.6 by uniformly sprayed water at water flow rate of at least 10 l/m² per minute for horizontal surfaces and 4 l/m² per minute for vertical surfaces. For structures having no horizontal or vertical surfaces, capacity of the water sprinkling system shall be taken equal to the greatest of the following values determined as:

.1 Horizontal surface area multiplied by 10 l/m² per minute;

.2 Actual surface area multiplied by 4 l/m² per minute.

If sprayers located on vertical surfaces spray only the lower parts, the estimated drain from the upper parts may be considered. The water sprinkling line shall be equipped with shut-off valves which are to be adequately spaced to cut off the damaged sections. The water sprinkling system may be divided into two or more sections which are to operate independently provided that control devices are installed at the same location abaft the cargo area. The sprinkling system section protecting the areas specified in 6.25.6.1 and 6.25.6.2 shall protect the entire group of the cargo tanks related to this section in transverse direction relative to the centreline.

6.25.8 Capacity of the water sprinkling system pumps shall be sufficient for simultaneous distribution of the required amount of water to all sections. If the water sprinkling system is divided into sections, its devices and pump capacity shall provide simultaneous water supply to one of its sections and to the surfaces specified in 6.25.6.3 and 6.25.6.4. If it is impossible to comply with the specified requirements, fire pumps of the fire water main system may be used for water sprinkling if their total capacity is increased taking into account the water flow rate required for the water sprinkling system operation. The fire main of the fire water main system and the water sprinkling system line shall be interconnected outside the cargo area. A shut-off valve shall be installed at their connection point.

6.25.9 It is allowed to use sanitary service, ballast, bilge and other sea water pumps for the water sprinkling system, if their capacity and head comply with the requirements for the water sprinkling system.

6.25.10 The pumps serving the water sprinkling system as well as manually closed valves shall be remotely controlled from fire-safe places outside the cargo area.

**Dry powder fire extinguishing system**

6.25.11 Ships designed for carriage of inflammable dangerous cargo shall be equipped with a dry powder fire extinguishing system to protect the cargo area, bow and stern areas.
used for cargo handling operations and cargo manifolds.

6.25.12 The dry powder fire extinguishing system shall provide supply of the dry powder approved by the River Register from at least two hoses with hand fire nozzles or from a fire monitor/hose with a hand fire nozzle to any part of the cargo area above the deck subject to fire risk and including an above-deck cargo pipeline. The system shall be actuated using nitrogen or other inert carrier gas of the powder used solely for this purpose and stored in high-pressure vessels located near the containers for powder.

6.25.13 The dry powder fire extinguishing system in the cargo area shall consist of at least two independent dry powder stations with respective controls, fixed pipeline for the media maintaining the pressure, fire monitors or hoses with hand fire nozzles. It is allowed to install only one such station for ships with cargo carrying capacity less than 1000 m³. A fire monitor shall be provided for protection of the cargo manifold location. The fire monitor shall be actuated from the local dry powder station or remotely controlled. Remote control of the fire monitor is not required, if it supplies powder to all the parts of the serviced zone from one position. All the fire hoses with hand fire nozzles and fire monitors shall be actuated from the place at reels for the fire hose or monitor. One fire hose with hand fire nozzle or fire monitor shall be located in the stern cargo area.

6.25.14 Additional dry powder station equipped with at least one fire monitor and one fire hose shall be installed in the ships equipped with bow or stern handling equipment. This additional station shall be located so that to protect bow or stern handling equipment. The cargo pipeline forward or abaft the cargo area shall be protected with fire hoses with hand fire nozzles.

6.25.15 The dry powder station with two or more fire monitors, fire hoses with hand fire nozzles or both shall be equipped with independent pipes with a manifold at the container for powder.

6.25.16 The system shall be remotely started from any dry powder station. The dry powder fire extinguishing system shall be ready for operation not later than 30 s after opening the starting bottle at the most distant fire station operating from this station.

6.25.17 Each container at the dry powder station shall contain the design quantity of powder which is to ensure continuous operation of all hand fire nozzles and fire monitors served by this station with rated consumption for at least 45 s.

Fire hoses shall be equipped with fire nozzles operating in a two-position mode at powder consumption of at least 3.5 kg/s providing a powder jet min. 8 m long. Fire hoses shall not twist. A maximum operation zone for each hand fire nozzle shall be determined depending on the length of its fire hose. The maximum efficiency of the fire nozzle shall be such that the one person can use the nozzle. The fire hose length with a hand fire nozzle shall not exceed 33 m.

Powder consumption through each fire monitor shall be at least 10 kg/s, maximum range of fire monitors with supply of 10, 25 and 45 kg/s shall be taken equal to 10, 30 and 40 m respectively.

6.25.18 Quantity of powder for protection of emergency power source rooms and store-rooms for highly inflammable materials and substances shall be determined for operation of the dry powder station with powder supply rate of 0.1 (kg/s)/m³ for 10 s.

6.25.19 Quantity of carrier gas shall provide single release of all powder from the container.

6.25.20 If two or more dry powder installations are connected to the dry powder station, the powder shall be supplied to each installation from the manifold of the dry powder station via a separate pipeline equipped with a starting valve.

The dry powder station shall provide both separate and simultaneous operation of all the dry powder installations.

6.25.21 If a stationary pipeline is installed between the powder container and fire hose
with a hand fire nozzle or fire monitor, the length of such a pipe shall not exceed the length of the pipeline when powder is maintained in the free flowing condition during continuous or periodic operation and when it can be removed by purging if the dry powder fire extinguishing system is switched off. The material of fire hoses and nozzles shall be weather resistant, otherwise they shall be stored in accessible places in weather resistant lockers or boxes.

6.25.22 A hand fire nozzle shall be equipped with a device for switching on/off powder supply.

6.25.23 The cross-sectional area of the fire nozzle shall be equal to the cross-sectional area of the fire hose or less by max. 50%.

6.25.24 Starting bottles shall be equipped with pressure gauges.

6.25.25 The operating instruction containing a guidance for starting the system shall be available at each dry powder fire extinguishing station.

6.25.26 A flow tube not reaching the container bottom by 100 mm shall be fitted in the powder container.

6.25.27 A device for gas passage into the container preventing powder penetration into the gas main shall be installed in the lower part of the powder container.

6.25.28 The powder filling ratio of the container shall not exceed 0.95.

6.25.29 The system pipelines and fittings shall not have cross-sectional contractions or extensions.

6.25.30 The cross-sectional area of the manifold in the dry powder station shall be not less than the total cross-sectional area of pipelines connected to it for simultaneous powder supply or exceed it more than twice.

6.25.31 A device for purging the pipelines after switching off the system shall be installed on the distribution manifold of the dry powder station.

6.25.32 The bending radius of the powder pipeline shall be at least 10 pipeline diameters.

6.25.33 Powder shall be supplied to the emergency power source rooms and store-rooms for highly inflammable materials and substances through sprayers. Their design, location and quantity shall provide even spraying of the powder in the total volume of the space. The pressure at the most distant sprayer shall be taken equal to a minimum pressure at which even spraying of the powder is provided in all directions from the sprayer.

6.26 INERT GAS SYSTEM

Bilge space inerting

6.26.1 If a ship is designed for carriage of inflammable dangerous cargo, interbarrier spaces and bilge spaces which are adjacent to the dangerous cargo containment system which require complete or partial barrier shall be inerted with dry inert gas. Inert atmosphere shall be maintained using the ship gas plant or inert gas storage facilities designed to provide the required gas consumption for at least 30 days.

6.26.2 It is allowed to fill the spaces and bilge spaces specified in 6.26.1 with dry air if the inert gas system or inert gas storage facility is available on board the ship and their efficiency or volume provide inerting of the maximum of these spaces provided that their configuration, gas detection system and efficiency of the inert gas system detect leakage from the cargo tanks or their inerting before unsafe atmosphere may occur.

Equipment providing generation of dry air sufficient for inerting shall be installed.

6.26.3 Spaces adjacent to the cooled independent cargo tanks of type C shall be inerted with dry inert gas or filled with dry air. This condition shall be maintained using the ship facilities specified in 6.26.1 or using equipment providing dry air supply.

6.26.4 Interbarrier spaces of internally insulated cargo tanks as well as spaces between the secondary barrier and double bottom and
double sides or independent tank structures completely filled with insulation do not require inerting.

Cargo tank and system inerting

6.26.5 A ship shall be equipped with a piping system to degas each cargo tank and purge the pipelines of this system with gas cargo after degassing. This system shall be designed so as to exclude formation of gas or air pockets which will remain after degassing or purging.

6.26.6 The required amount of places shall be provided for each cargo tank. Branch pipes for gas sampling shall be equipped with valves and located under the hoods above the main deck.

6.26.7 For flammable gases, the piping system specified in 6.26.5 shall be designed so as to exclude the presence of flammable mixture in the cargo tank at any stage of degassing by using inert gas at intermediate stage of degassing. In addition, this system shall provide purging of the cargo tank with inert gas prior to its filling with vapourous or liquid fraction of cargo. The presence of flammable mixture shall be avoided throughout purging of this tank.

6.26.8 Piping systems carrying dangerous cargo shall provide their degassing and purging as specified in 6.26.5 and 6.26.7.

6.26.9 Inert gas used for degassing and purging may be supplied from shore or generated/stored on board the ship.

Inert gas generator

6.26.10 An inert gas generator shall generate inert gas with oxygen content not exceeding 5% by volume.

According to the requirements specified in Appendix 3, devices for permanent monitoring of oxygen content with a sensor/detector giving a signal if oxygen content exceeds 5% by volume shall be installed on the inert gas supply pipeline from the generator.

If inert gas is generated on board the ship by air fractionation which requires storage of low-temperature liquefied nitrogen on board for its further use, liquefied nitrogen shall be checked for presence of oxygen traces before being placed in storage on board the ship to avoid enrichment of inerting gas with oxygen.

6.26.11 The inert gas supply system shall be equipped with pressure regulators and instruments which correspond to the cargo containment system. A device preventing cargo penetration into the inert gas system shall be installed in the cargo area.

6.26.12 Spaces containing inert gas generators shall not be connected to accommodation and service spaces as well as control stations. The specified generators may be installed in machinery spaces. If such inert gas generators are located in the machinery or other space located outside the cargo tanks, two return valves shall be located on the inert gas main within the cargo area. It is not allowed to lay the inert gas pipeline though accommodation/service spaces or control stations. If the inert gas system is not used, it may be switched off or disconnected from the cargo system in the cargo area. This requirement does not apply to connection joints of the inert gas system with bilge or interbarrier spaces.

6.26.13 It is allowed not to locate equipment to receive inert gas using open flame in the cargo area.

6.27 TESTS OF SYSTEMS

6.27.1 Tests of fittings shall comply with the requirements of 6.2.55, 6.2.56 and 6.2.58 RTSC. Besides, the valves of each type and size used at working temperature below –55 °C shall be leak tested at or below the minimum design temperature and at pressure not less than the design pressure of valves. During the tests, the serviceability of valves shall be checked.

6.27.2 Bellows used in cargo pipeline located outside and inside the cargo tank shall undergo the following type tests:

.1 the bellows element not pre-compressed shall be tested by pressure exceeding the design one at least five times for
not less than 5 min; the wall of such element shall not break;

.2 a typical compensating connection of all fittings (flanges, links, articulated joints) shall be tested by pressure exceeding the design one two times in the extreme displacement positions causing no residual deformation and recommended by the manufacturer;

.3 cyclic test, including those for thermal fatigue, shall be carried out on the fully assembled connection that shall withstand, without breaking, so many cycles of pressure, temperature, axial displacement, rotational displacement and lateral displacement as it will occur in operation.

It is allowed to run the tests at a room temperature if the test conditions are the same as the test conditions at working temperature;

.4 cyclic fatigue tests shall be carried out on completely assembled connection without internal pressure by simulating bellows displacement over a length corresponding to the length of expansion pipe for not less than 2·10⁶ cycles at a frequency not more than 5 cycles per second. Such tests are required only when the pipelines are exposed to loads due to ship deformation.

It is allowed not to perform the above mentioned tests if the technical documentation and calculations confirming that the compensating connections can withstand the specified operating loads is submitted to the River Register.

If the maximum internal pressure exceeds 0.1 MPa, the technical documentation and calculations shall contain the test results data justifying the calculation method used and comparing the results of calculations and tests.

6.27.3 Safety valves installed on cargo tanks according to 6.16.2 shall be tested to verify that the throughput capacity corresponds to that required in 6.19.

Besides, each valve shall be tested for opening at the set pressure with maximum tolerance (%) for pressure (MPa):

<table>
<thead>
<tr>
<th>Pressure range (MPa)</th>
<th>Tolerance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 0.15</td>
<td>±10</td>
</tr>
<tr>
<td>0.15 to 0.3</td>
<td>±6</td>
</tr>
<tr>
<td>0.3</td>
<td>±3</td>
</tr>
</tbody>
</table>

Safety valves shall be tested and lead-sealed. The appropriate record shall be made in the report issued to the ship. Maximum permissible set pressure of safety valves shall also be specified in the report.

6.27.4 All pipeline systems, including fittings, valves and equipment for operation with dangerous cargo and dangerous cargo vapours, shall undergo the tests to verify their operation under operating conditions during the first reception of dangerous cargo.

6.28 PERSONNEL PROTECTION

6.28.1 Liquefied gas tanker shall have firefighting outfit complying with Table 6.28.1.

<table>
<thead>
<tr>
<th>Ship cargo capacity, m³</th>
<th>Number of firefighting outfit sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤5000</td>
<td>4</td>
</tr>
<tr>
<td>&gt;5000</td>
<td>5</td>
</tr>
</tbody>
</table>

6.28.2 Any breathing apparatus included in firefighting outfit shall be a self-contained breathing apparatus with at least 1200 litres of atmosphere air.

6.28.3 The crew members participating in cargo handling shall have protection outfit, including eye protection, appropriate for the particular dangerous cargo.

6.28.4 In addition to the firefighting outfit required according to 6.28.1, the ship shall be also fitted with at least two whole outfits providing safety of personnel working in a room filled with gas.

6.28.5 One whole safety outfit shall comprise the following:

.1 one self-contained breathing apparatus in which compressed oxygen cannot be used and whose capacity is not less than 1200 litres of atmosphere air;

.2 protective clothing, shoes, gloves, head ware and tightly fitting mask to protect face and eyes;

.3 life line with steel core and belt;

.4 lamp of explosion-proof design.
6.28.6 The ship shall have compressed air supply from one of the following compressed air sources:

.1 one set of bottles completely filled with air for each breathing apparatus required according to 6.28.4, a dedicated air compressor capable of delivery of high-pressure air of the required purity, and a pipe header to fill the spare bottles of breathing apparatuses with air according to 6.28.4;

.2 spare bottles completely filled with air with total capacity of not less than 6000 litres for each breathing apparatus required according to 6.28.4.

6.28.7 It is allowed to install low pressure air pipes with an assembly for connection of hose suitable for use with breathing apparatus required according to 6.28.4. Such a system shall be capable of supplying high pressure air through reducers to obtain a low pressure sufficient for work of two persons in a gas hazardous space within at least one hour without use of air bottles of breathing apparatuses. It is necessary to provide the means for recharge of stationary air bottles and bottles of breathing apparatuses with the help of an air compressor capable of supplying high pressure air.

6.28.8 Protection equipment stated in 6.28.3 and safety outfit according to 6.28.4 shall be stored in the marked cabinets installed in accessible places.

6.28.9 Equipment of compressed air system shall be inspected and tested at least once a year.

6.28.10 Each person onboard the ship shall have means for protection of breathing organs and eyes in case of emergency evacuation. The following conditions shall be met:

.1 do not use breathing organs protection means of filtering type;

.2 emergency breathing apparatus (self-rescuer) shall operate as stated in the technical documentation but not less than 15 min;

.3 breathing organs protection means designed for emergency evacuation shall not be used in case of fire extinguishing or dangerous cargo transfer and they shall have appropriate warning inscription;

.4 two additional sets of the above mentioned protection means for breathing organs and eyes shall always be available in the wheelhouse. The rooms where the crew get together, for example, the mess room, shall be equipped with a training self-rescuer;

.5 it shall be possible to arrange additional (at least two sets) protection means for breathing organs and eyes in extremities (forecastle and aft superstructure) of a ship subdivided by cargo area, if it is impossible to evacuate people to the aft superstructure without protection means.

6.28.11 On the deck, there shall be showers for decontamination and arrangements for eye washing with appropriate inscriptions. Showers and eye washing arrangements shall remain operational at any ambient conditions.

6.28.12 Ships with cargo carrying capacity of 2000 m³ and more shall be provided with two whole outfit sets in addition to the equipment according to 6.28.1 and 6.28.4. For each self-contained breathing apparatus, there shall be at least three spare bottles filled with air with total capacity of at least 3600 litres or there shall be at least three spare self-contained breathing apparatuses if the bottles are not replaceable. The spare bottles (apparatuses) shall not be stored in one place.

6.28.13 To protect the ship’s personnel from the consequences of dangerous cargo leakages, a special enclosed space (collective protection space) shall be provided onboard the ship near the superstructure. The area of this space shall be sufficient to accommodate the entire crew of the ship and it shall be provided with air source with capacity sufficient for the crew to stay in this space for at least 4 hours.

This space can be accesses from the deck and other accommodation spaces through an air lock. Near the air lock to such space, there shall be a shower for decontamination.

6.28.14 It is necessary to provide access to enclosed space of collective protection from the open deck and from accommodation
spaces and possibility of tight closing this space.

6.29 ELECTRIC EQUIPMENT

6.29.1 In addition to the electrical equipment specified in Part VI of the Rules, the following electrical equipment is subject to technical supervision:

.1 dangerous cargo containment system;
.2 reliquefaction units;
.3 inert gas systems;
.4 dangerous cargo pressure and temperature regulation systems;
.5 drives and controls of liquefied gases cooling systems;
.6 cargo pumps and compressors;
.7 ventilation systems of explosion-hazardous spaces and air locks;
.8 measurement, alarm and indication systems for:
   cargo level in cargo tanks;
   temperatures in cargo pipelines;
   pressure in cargo tanks and pipelines;
   pressure in ventilation systems that produce overpressure in air locks, spaces and enclosures of explosion-proof electrical equipment;
.9 systems of automatic and remote cutoff of drives;
.10 systems for remote control of valves for hull structure heating arrangements.

6.29.2 Requirements of Part VI of the Rules to electrical equipment of explosion-hazardous zones, areas and spaces apply to gas-hazardous areas of liquefied gas tankers.

6.29.3 Electrical equipment installed in the spaces with gas detection devices and spaces for handling the boil-off gas used as a fuel is not considered an electrical equipment of gas-hazardous spaces.

6.29.4 Electrical equipment or cables shall not be installed in gas-hazardous spaces or areas, except for the equipment for operation in these areas, provided the requirements of 6.29.5 to 6.29.38 are met.

6.29.5 A space, which accommodates dangerous cargo heating system, shall have electrical equipment of explosion-proof design.

6.29.6 Cables to be laid in explosion-hazardous rooms and spaces shall remain serviceable at temperatures maintained in these spaces in operation.

6.29.7 All gas-hazardous spaces and areas with constant explosion-hazardous gas-and-air mixture shall be fitted only with explosion-proof electrical equipment.

6.29.8 The spaces of dangerous cargo containment system may be fitted with submersible cargo pumps and their power supply cables. Protection devices shall be provided to automatically cut off electric motors when the liquid gas level reduces below the permissible one. These protective devices shall be made based on sensitive elements responding to:

.1 pressure reduction when the pump is being unloaded;
.2 reduction of electric motor load current;
.3 reaching dangerous low level of liquefied gas.

As the protection operates, the alarm signal shall be fed to the cargo loading/unloading control station.

6.29.9 Electric motors of cargo pumps shall be provided with devices for electrical disconnection from supply systems (including power lines) during degassing operations. It shall be possible to operate these devices prior to degassing.

6.29.10 In cargo areas equipped with dangerous cargo containment system with additional barrier, it is allowed to lay electric power cables of electric motors of submersible cargo pumps.

6.29.11 In cargo areas with dangerous cargo containment system, which does not require additional barrier, and in the spaces separated from dangerous cargo areas with
one gastight bulkhead, it is allowed to install the following electrical equipment:
- transit cables;
- lighting equipment with protection type (Exp) or (Exd);
- electric level sensors, speed log components and anodes (electrodes) of impressed current cathodic protection system. These instruments and devices shall have gastight enclosure.

In the areas separated from cargo areas by means of gastight bulkheads the following may be installed:
- electric motors of explosion-proof design for remote control of cargo valves or ballast system;
- acoustic devices of explosion-proof design, general alarm system.

6.29.12 Electric motors of cargo pumps or compressors of reliquefaction units shall be separated from pump (compressor) compartments (spaces) by means of a gastight bulkhead or deck.

Flexible couplings shall be used for alignment of shafts of electric motors and machinery driven from them. Glands shall be installed in places where the shafts go through the gastight bulkheads and decks. Electric motors of cargo pumps and compressors and their control systems shall be arranged in explosion-hazardous spaces.

6.29.13 If operational or design limitations make it impossible to fulfill the requirements of 6.29.12, the following shall be used to drive the cargo pumps or cargo compressors:
- 1 electric motors of enhanced reliability in explosion-proof case with type of explosion protection (Exe) or (Exd);
- 2 electric motors in pressurized enclosure with type of explosion protection (Exp).

6.29.14 Acoustic devices of general alarm shall be of explosion-proof design with type of explosion protection (Exd).

6.29.15 In areas or semi-closed spaces on the open deck at a distance of up to 3 m from any opening of the cargo tank, gas exhaust equipment, flanged joints of cargo pipes, valves of cargo system or inlets or ventilation holes leading to compartments (space) of cargo pumps and cargo compressors, in areas on the open deck above the cargo area and 3 m back and forth from the cargo area on the open deck and upwards to the altitude of 2.4 m above the deck, in the areas at a distance of 2.4 m from external surface of dangerous cargo retention system in which such surface is exposed to weather conditions and atmospheric precipitations, the following is allowed:
- installation of explosion-proof equipment;
- laying of transit cables.

6.29.16 In closed or semi-closed spaces through which pass the pipelines of dangerous cargo and in cargo hoses store rooms, the following is allowed:
- 1 installation of lighting equipment with type of explosion protection (Exp) or (Exd);
- 2 laying of transit cables.

6.29.17 In closed of semi-closed spaces with opening leading to any gas-hazardous space/area, it is allowed to install electrical equipment that complies with requirements to electrical equipment to be fitted in the spaces/area to which those openings lead.

6.29.18 Electrical equipment arranged in spaces protected by means of air locks shall be of explosion-proof design. It is allowed to use electrical equipment without protection type if it is de-energized with the help of automatic cutoff devices in case of air over-pressure loss in the room and is not started until the pressure returns to the preset value.

Electrical equipment without protection type used for maneuvering, anchoring and mooring, as well as emergency fire pumps shall not be arranged in spaces to be protected with air locks.

6.29.19 Electrical equipment arranged in double pipes or ducts shall be intrinsically safe.

6.29.20 Grounding of electrical equipment and pipelines of liquefied gas tanker shall comply with the requirements of 2.6, 12.6.5, 16.2.23 to 16.2.29 Part VI of the Rules.
6.29.21 Metal mechanical protections for cables laid on the upper deck and passing through the explosion-hazardous areas shall be grounded at both ends of each protection (casing, steel pipe, armouring braid).

6.29.22 Metallic cargo tanks, including independent tanks, container tanks, pipelines separated from hull structures with use of heat insulation, joints of pipelines and hoses with gaskets, sealing flanges of connecting parts of cargo pipelines and hoses, shall be grounded to the hull.

6.29.23 Electric drive of cargo pumps, booster pumps and compressors shall be fitted with automatic cutoff devices to be cut off in case of closing of quick closing valves on pipelines.

6.29.24 Electric drives of submersible cargo pumps shall be fitted with automatic cutoff devices operating at low level of liquid in the cargo tank.

6.29.25 Electric motors of booster pumps and gas/air blowers shall be arranged in the spaces separated from explosion-hazardous spaces by means of a gastight bulkhead and they shall comply with the requirements of 6.29.12.

6.29.26 Electric drives of fans providing overpressure in air locks, spaces protected by air locks and cases of electrical explosion-proof equipment shall not be used for other purposes.

6.29.27 Electric motors of fans shall not be installed in ventilation ducts of supply or exhaust ventilation of explosion-hazardous spaces.

6.29.28 Opening doors and switching-on of electrical equipment installed in explosion-hazardous spaces shall be interlocked with fan drive to make it possible to enter the spaces and switch on the electrical equipment only after start of fans and their operation within a time period sufficient for 3 to 4 air changes in this space.

6.29.29 Electric drives of ship machinery stated in 6.29.23 to 6.29.26 shall have cutoff devices, one of which shall be outside the spaces in which the drives are installed, but in the immediate proximity from the exits of these spaces, and the second remote cutoff device shall be arranged in the wheelhouse or in the cargo loading/unloading control station.

6.29.30 Lighting network of explosion-hazardous rooms and spaces, including compartments (spaces) of cargo pumps, cargo compressors, closed or semi-closed spaces accommodating pipelines with dangerous cargo, spaces for cargo hoses, cargo areas equipped with dangerous cargo containment system which does not require additional barrier and spaces separated from spaces with dangerous cargo with the help of one gastight bulkhead, shall be divided into at least two lines and shall receive power supply from different switchboards.

6.29.31 Cutoff switches and protective devices of lighting network of rooms and spaces specified in 6.29.29 shall be double-pole switches and shall be installed outside these rooms and spaces.

6.29.32 Lighting system of rooms and spaces specified in 6.29.29 shall be made with use of explosion-proof devices (lanterns) with type of explosion protection (Exp) or (Exd).

It is allowed to illuminate these rooms and spaces from adjacent spaces through gastight glass holes. However, the lights of such adjacent spaces shall be explosion-proof as well.

6.29.33 The rooms and spaces specified in 6.11.8 shall be equipped with stationary alarm system for detection of dangerous cargo vapours.

6.29.34 Light and sound signals about dangerous concentration of dangerous cargo vapours shall be fed to gas sampling places (space), to the wheelhouse and cargo loading/unloading control station.

Generalized alarm on gas concentration above the preset limits shall be fed to the places of permanent watch keeping.
6.29.35 Two independent power supply sources shall be provided for the alarm system.

6.29.36 The alarm on automatic cutoff of submersible cargo pumps, closing of quick closing valves of cargo pipelines, water in interbarrier spaces, dangerous cargo leakages in condensate of dangerous cargo heaters and operation of inert gas system shall be fed to the cargo loading/unloading control station.

The alarm on water in interbarrier spaces shall also be fed to the wheelhouse.

6.29.37 When dangerous cargo is used as a fuel, the alarm on pressure drop in the fuel oil pipeline or stop of gas fuel supply to machinery space equipment shall be provided in the central to control position.

6.29.38 The alarm on reduction/loss of excessive pressure in air locks and electrical equipment with type of explosion protection (Exp) shall be provided in central control station and in places of permanent watch keeping.

6.30 SPECIAL REQUIREMENTS

6.30.1 Special requirements to ships carrying dangerous liquid loads depending on the properties of such dangerous cargo are specified in 6.30.2 to 6.30.77. The need of fulfillment of this or that requirement as pertaining to the particular dangerous cargo is specified in column 10 “Special requirements” of Table A3-1 in Appendix 3.

Construction materials

6.30.2 Materials which during normal operation of the ship are exposed to dangerous cargo, shall be resistant to corrosive action of gases. Besides, for transportation of some dangerous cargoes, the following materials shall not be used for fabrication of cargo tanks and their pipelines, valves, fittings and other components:

.1 mercury, copper, copper alloys and zinc;

.2 copper, silver, mercury, magnesium and other metals which form acetylides;

.3 aluminium and aluminium alloys;

.4 copper, copper alloys, zinc or galvanized steel;

.5 aluminium, copper and their alloys;

.6 copper and alloys containing more than 1% of copper

Independent cargo tanks

6.30.3 Dangerous cargo shall be transported only in independent cargo tanks.

6.30.4 Dangerous cargo shall be transported in independent cargo tanks of type C considering the requirements of 6.22.2. For calculating pressure in cargo tank, it is necessary to take into account supercharge pressure or pressure of vapours during unloading.

Cooling systems

6.30.5 Is allowed to use only indirect cooling system (see 4.20.9.2).

6.30.6 Onboard the ship which transports dangerous cargoes producing dangerous peroxides, it shall be ensured that the repeatedly condensed dangerous cargo has no stagnation zones with non-inhibited fluid. This may be reached through one of the following ways:

.1 use of an indirect cooling system with condenser inside the cargo tank;

.2 use of a direct cooling system or combined cooling system (see 4.20.9.1 and 4.20.9.3) or a indirect cooling system with condenser outside the cargo tank, or designing the cooling system in such a way as to prevent from condensate accumulation and retention areas.

6.30.7 If the ship is engaged on voyages with any of the dangerous cargoes specified in 6.30.6 and there are ballast transits between these voyages, then, prior to the ballast transit, all the non-inhibited fluid shall be removed. If after voyage with one of the dangerous cargoes it is required to transport another dangerous cargo, the reliquefaction system shall be dried and blown prior to loading such a dangerous cargo. Inert gas or dangerous cargo vapours or another compatible dangerous cargo vapours shall be used for this blowing.
Deck cargo pipelines

6.30.8 All butt welds in cargo pipelines, whose diameter exceeds 75 mm, shall undergo 100% X-ray testing.

Air release from vapour spaces

6.30.9 Prior to loading, air shall be released from cargo tanks and pipelines connected to them in a way to prevent from its return by one of the following methods:

.1 introduction of inert gas to maintain overpressure. Inert gas reserve or inert gas system capacity shall be sufficient for standard operation needs and compensation of leakages through the safety valve. Oxygen content in the inert gas at any time shall not exceed 0.2% by volume;

.2 adjustment of dangerous cargo temperature to continuously maintain overpressure.

Gas moisture content control

6.30.10 It is necessary to control the moisture content of non-flammable gases which can become corrosive or dangerous in case of contact with water. To meet this requirement, the cargo tanks shall be kept dry before loading and filled with dry air with dew point of – 45 °C or less at the atmospheric pressure, or with dangerous cargo vapours during unloading to prevent excessive vacuum.

Inhibition

6.30.11 Measures shall be taken to inhibit dangerous cargoes throughout the entire voyage to prevent them from polymerization. The ships shall have a certificate issued by the shipper. The certificate shall include the following:

.1 name and amount of the used inhibitor;

.2 date of inhibitor introduction and expected duration of its action under normal conditions;

.3 temperature limits for efficiency of the inhibitor;

.4 measures to be taken if the duration of voyage exceeds the inhibitor expiry date.

Sampling pipelines

6.30.12 Gas sampling pipelines shall not be brought to or laid through gas-safe spaces.

Transducers/sensors specified in 6.11.3 shall operate when concentration of vapours reaches the permissible limits.

6.30.13 The use of portable equipment specified in 6.11.14 is not allowed.

Flame retention shields on gas release holes

6.30.14 For transportation of dangerous cargoes specified in Appendix 3, the gas release holes of cargo tanks shall be fitted with flame retention shields or safety mouthpieces. The design of flame retention shields and mouthpieces of gas-freeing pipes shall prevent them from closing due to freezing of dangerous cargo vapours or icing.

Maximum permissible amount of cargo in cargo tank

6.30.15 When a dangerous cargo specified in Appendix 3 is transported, its amount in any cargo tank shall not exceed 380 m3.

Submersible electrical cargo pumps

6.30.16 Prior to loading inflammable liquids and during their transportation and unloading, the vapour spaces of cargo tanks fitted with submersible electrical cargo pumps shall be inerted and overpressure shall be maintained in them.

Ships carrying ammonia

6.30.17 Cargo tanks, high pressure process vessels and cargo pipelines shall be manufactured of a fine-grained carbon-manganese steel with certified minimum yield point not exceeding 355 MPa and actual yield point not exceeding 440 MPa. One of the following design or operational measures shall be taken:

.1 it is necessary to use material with lower yield point, whose certified minimum breaking strength does not exceed 410 MPa; or
cargo tanks, high pressure process vessels and cargo pipelines shall undergo thermal treatment to relief post-welding stresses; or

measures shall be taken to keep the ammonia temperature during transportation close to its closed-vessel boiling point (–33 °C), but in any case the temperature shall not exceed 20 °C; or

ammonia shall contain at least 0.1% of water by mass.

If carbon-manganese steels with higher yield properties as compared to those specified in 6.30.17 are used, the complete cargo tanks and pipelines shall undergo thermal treatment to relief post-welding stresses.

If high pressure process vessels and pipelines from the condensing part of the cooling system are manufactured of carbon-manganese steel or nickel steel, they shall undergo thermal treatment to relief post-welding stresses.

The yield point and ultimate tensile strength of the weld built-up metal shall exceed the same characteristics of the materials used for manufacture of cargo tank or pipeline.

Nickel steel with more than 5% of nickel and carbon-manganese steel which does not meet the requirements of 6.30.17 and 6.30.18 are susceptible cracking due to corrosive action of ammonia. Such steels may not be used in dangerous cargo containment system and pipeline systems designed for transportation of this dangerous cargo.

Nickel steel with more than 5% of nickel may be used if the temperature of ammonia during transportation meets the requirements of 6.30.17.3.

To prevent from cracking due to corrosive action of ammonia, the dissolved oxygen level in the tank atmosphere shall be below 2.5 ppm by mass, also by reducing the mean content of oxygen in the tanks prior to loading of liquid ammonia as compared to the following values by volume (%) depending on ammonia transportation temperature \( t \), °C:

<table>
<thead>
<tr>
<th>Temperature ( t )</th>
<th>Oxygen Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+30</td>
<td>0.03</td>
</tr>
<tr>
<td>+20</td>
<td>0.05</td>
</tr>
<tr>
<td>+10</td>
<td>0.10</td>
</tr>
<tr>
<td>0</td>
<td>0.16</td>
</tr>
<tr>
<td>–10</td>
<td>0.28</td>
</tr>
<tr>
<td>–20</td>
<td>0.50</td>
</tr>
<tr>
<td>–30 and less</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Oxygen content for intermediate temperatures of ammonia may be obtained by linear interpolation.

**Ships carrying chlorine**

Dangerous cargo containment system shall comply with the following requirements:

1. capacity of each tank shall not exceed 380 m³, and total capacity of all cargo tanks shall not exceed 760 m³;
2. design pressure of vapours in the tank shall be not less than 1.35 MPa;
3. parts of tanks protruding above the upper deck shall have protection against heat radiation from adjacent tanks if on fire;
4. each cargo tank shall have two safety valves. A safety diaphragm shall be installed between the tank and the safety valves. Bursting pressure of the diaphragm shall be 0.1 MPa less than the safety valve opening pressure which is to be set equal to design pressure of vapours in the tank, but not less than 1.35 MPa. The space between the diaphragm and the safety valve shall be connected to a pressure gauge and gas detection system through a bypass valve. During operation of the tank, measures shall be taken to keep the pressure in this space equal to the atmospheric pressure within ±5%;
5. exhaust outlets of safety valves shall exclude the possibility of creating hazard to the ship and the environment.

The gas coming out from the safety valves shall go through an absorption unit to reduce its concentration. On the pipeline section near the fore extremity of the ship, it is necessary to install a device able to release the vapours overboard at the deck level from any side, as well as a mechanical interlocking device to keep one of the pipelines always open.
6.30.25 Cargo pipeline system shall comply with the following requirements:

1. liquefied gas tanker shall be unloaded with the help of compressed vapours of chlorine received from the shore, dry air or with the help of submersible pumps. Pressure in vapour space of the cargo tank during unloading shall not exceed 1.05 MPa. Compressors installed on the ship may not be used for unloading of liquefied gas tankers;

2. design pressure in cargo pipeline system shall be not less than 2.1 MPa. Inner diameter of cargo pipes shall not exceed 100 mm. It is allowed to use pipe bends only as a mean of thermal expansion compensation. If flange connections are used, the flanges shall be welded to pipe end, and the edges shall be prepared for welding as a tongue-and-groove joint;

3. gases from safety valves of cargo pipeline system shall be released to an absorption unit; the backpressure in the gas-freeing pipelines as specified in 6.19.2 shall be taken into consideration.

6.30.26 Materials shall comply with the following requirements:

1. cargo tanks and pipelines of cargo pipeline system shall be manufactured of steel suitable for safe transportation of dangerous cargo at temperature of –40 °C even if higher temperatures in transportation are expected;

2. cargo tanks shall undergo thermal treatment to relief internal thermal stresses. Mechanical relief of internal stresses is not allowed.

6.30.27 Safety devices shall comply with the following requirements:

1. an absorption unit connected to pipelines of cargo pipeline system and cargo tanks shall be installed onboard the ship for chlorine absorption. The absorption unit shall neutralize the chlorine with absorption intensity of not less than 2% of dangerous cargo of total cargo capacity of the ship;

2. during degassing of cargo tanks, the chlorine vapours shall not be released to atmosphere;

3. a gas detection system shall be installed to monitor concentration of chlorine vapours, it shall be capable of detecting at least 1 ppm by volume. Sampling points shall be arranged in the following places:

   - at the bottom of hold spaces;
   - in the pipes going from safety valves;
   - at the outlet hole of absorption unit;
   - at the inlet hole of ventilation systems of accommodation, service and machinery spaces and control stations;
   - on the deck at the fore boundary of, in the middle part of, and at the aft boundary of, the cargo area (to be used only in the course of cargo handling and degassing).

   Gas detection system shall be provided with sound and light alarm actuating in case of gas concentration of 5 ppm;

4. each cargo tank shall be provided with emergency pressure transducer/sensor which generates sound signal when overpressure reaches 1.05 MPa.

6.30.28 In addition to the requirements to protection stated in 6.28, it is necessary to provide an air compressor and equipment for filling air bottles.

6.30.29 The following requirements to cargo tank filling limits shall be met:

1. requirements 6.20.4.2 are not applied for transportation of chlorine;

2. the content of gas chlorine in vapour space of cargo tank after loading shall exceed 80% by volume.

6.30.30 The dangerous cargo shall be unloaded only with the help of submersible pumps installed in trunks or hydraulically driven pumps. The design of such pumps shall exclude the possibility of liquid pressure transfer to shaft seal.

6.30.31 Independent tanks of C type may be unloaded by displacing the dangerous cargo by means of inert gas, provided the cargo pipeline system is designed to withstand such inert gas pressure.

Ships carrying diethyl ether and vinyl ethyl ether

6.30.32 For transportation of ethylene oxide, requirements of 6.30.50 shall be taken
into consideration along with requirements of 6.30.33 to 6.30.42.

6.30.33 Deck tanks shall not be used for transportation of ethylene oxide.

6.30.34 Stainless steels and cast iron may not be used for manufacture of dangerous cargo containment system tanks and cargo pipeline system pipelines used for ethylene oxide.

6.30.35 Prior to loading, the cargo tanks and pipelines connected to them shall be cleaned from all remains of earlier transported dangerous cargoes, except for the remains of ethylene oxide, propylene oxide or mixtures of these products. Tanks used for ammonia transportation shall be cleaned as well.

6.30.36 Ethylene oxide shall be unloaded only with the help of pumps installed in trunks or by its displacement by inert gas. The design of pumps shall comply with the requirements of 6.30.62.

6.30.37 Ethylene oxide shall be transported refrigerated and its temperature during transportation shall be less than 30 °C.

6.30.38 Safety valves shall operate at pressure of not less than 0.55 MPa.

6.30.39 Protective layer of gaseous nitrogen specified in 6.30.74 shall be sufficient to ensure nitrogen concentration in vapour spaces of cargo tanks of not less than 45% by volume at any time.

6.30.40 Before loading liquid or vaporous ethylene oxide and as long as it remains in the cargo tank, the latter shall be inerted with nitrogen.

6.30.41 In case of fire spread over the dangerous cargo containment system, the waterspraying system according to 6.30.76 shall operate automatically.

6.30.42 Equipment for emergency discharge of ethylene oxide shall be provided.

Ships carrying isopropylamine and monoethylamine

6.30.43 A system of separate pipelines not connected to pipelines of other cargo or gas-freeing systems shall be provided.

Ships carrying methyl acetylene and propadiene mixtures

6.30.44 Mixtures of methyl acetylene and propadiene shall be stabilized to be transported. Besides, it is necessary to prescribe the maximum temperatures and pressures permissible for cooling such mixtures.

6.30.45 Possible compositions of stabilized mixtures admitted to transportation:

   option 1:
   - maximum molar ratio of methyl acetylene to propadiene: 3:1;
   - maximum concentration of methyl acetylene and propadiene in mixture: 65 mole %;
   - minimum concentration of propane, butane and isobutane in mixture: 24 mole %;
   - the mixture shall contain at least 1/3 of butanes (from total number of moles in the mixture) and 1/3 of propane; and
   - maximum concentration of propylene and butadiene in the mixture: 10 mole %.

   option 2:
   - maximum concentration of methyl acetylene and propadiene in mixture: 30 mole %;
   - maximum concentration of methyl acetylene: 20 mole %;
   - maximum concentration of propadiene: 20 mole %;
   - maximum concentration of propylene: 45 mole %;
   - maximum concentration of butadiene and butylene in the mixture: 2 mole %;
   - minimum concentration of saturated hydrocarbon C₄: 4 mole %;
   - minimum concentration of propane: 25 mole %.

6.30.46 Ships carrying mixtures of methyl acetylene and propadiene shall be equipped with an indirect cooling system specified in 4.20.9.2 or a cooling system with direct compression of mixture vapours. For mixtures
with composition specified in 6.30.45 the following is required:

.1 vapour compressor operating under conditions excluding the possibility of increase of vapour temperatures and pressures over 60 °C and 1.75 MPa, respectively, and the possibility of compressor clogging by the vapour;

.2 pipelines for gas removal from compressor at each compression stage or from each cylinder of piston compressor after compression equivalent to compression at the corresponding stage; these pipelines shall be fitted with the following:

- two temperature switches set to 60 °C or less;
- pressure switches set to 1.75 MPa or less;
- safety valve set to 1.8 MPa or less;

.3 safety valve set to 1.8 MPa or less that shall remove vapours to mast uprise according to requirements of 6.16.9, 6.16.10, 6.21.4 and 6.21.7. Removal of vapours from safety valve to compressor suction is not allowed;

.4 transducer/sensor that feeds a sound signal to the cargo loading/unloading control station and the wheelhouse on the switch actuation in case of pressure or temperature increase.

6.30.47 Pipelines, including dangerous cargo cooling system pipelines, servicing the cargo tanks for methyl acetylene and propadiene mixture, shall be independent or shall be isolated from pipeline systems and cooling systems servicing other tanks. This requirement applies to all pipelines for transfer of liquids and vapours and to other joints.

**Ships carrying nitrogen**

6.30.48 Structural materials and coatings of cargo system components shall be resistant to high concentration of oxygen in nitrogen appearing in case of nitrogen condensation or enrichment at low temperatures. Possible places of nitrogen condensation shall be ventilated.

Ships carrying propylene oxide and mixtures of ethylene oxide with propylene oxide containing not more than 30% of ethylene oxide in mass

6.30.49 Transported dangerous cargo shall not contain acetylene.

6.30.50 Prior to loading, the cargo tanks and pipelines connected to them shall be cleaned from all remains of earlier transported dangerous cargoes, except for the cases when the tanks are loaded immediately after unloading of propylene oxide or ethylene oxide / propylene oxide mixture.

6.30.51 Efficiency of washing of cargo tanks and pipelines connected to them shall be determined by tests or inspections to make sure that there are no traces of any acid or alkaline materials.

6.30.52 Prior to each first loading of propylene oxide and its mixtures, the cargo tanks shall be inspected to make sure that they are free of dirt, including rust deposits, and visible damages of the shell. If cargo tanks are continuously used for transportation of the specified dangerous cargoes, such inspections shall be carried out at least once in two years.

6.30.53 Tanks for transportation of propylene oxide and its mixtures shall be made of steel.

6.30.54 Tanks containing propylene oxide and its mixtures may be used for transportation of other dangerous cargoes after cleaning these tanks and pipeline systems connected to them by washing or blowing.

6.30.55 All valves, flanges, fittings and auxiliary equipment shall be made of steel suitable for their safe operation in the medium of propylene oxide and its mixtures. Disks or surfaces of disks, seats and other valve surfaces subject to wear shall be made of corrosion resistant steel with chromium content of not less than 11%.

6.30.56 Gaskets shall be made of materials, which do not react with propylene oxide and its mixtures, do not dissolve in them, do not contribute to reduction of their self-ignition temperature, and are fireproof. The surface of
gaskets contacting with dangerous cargo shall be made of teflon or other materials that ensure the similar degree of safety due to their inactivity. For manufacture of gaskets with teflon or similar fluorinated polymer filler, it is allowed to use reinforcing coils of stainless steel.

6.30.57 Insulating and sealing materials, if used, shall not react with propylene oxide and its mixtures, dissolve in them or reduce self-ignition temperature.

6.30.58 The following materials are considered unsuitable for manufacture of gaskets, seals and similar purposes in keeping systems of propylene oxide and its mixtures:
   .1 neoprene or natural rubber if they contact with propylene oxide and its mixtures mentioned above;
   .2 asbestos or bonding agents comprising asbestos;
   .3 materials comprising magnesium oxides, such as mineral wool.

6.30.59 Intake and discharge pipelines shall be up to 100 mm above the tank bottom or any bilge well bottom.

6.30.60 Propylene oxide and its mixtures shall be loaded and unloaded so as to prevent release of gases from cargo tank to atmosphere. If simultaneously with loading of tanks the vapours are returned to shore, the vapour return system connected to the dangerous cargo retention system designed for the given dangerous cargo shall be independent from the retention systems of other dangerous cargoes.

6.30.61 During unloading, the pressure in the cargo tank shall be kept above 0.007 MPa.

6.30.62 Discharging shall be carried out by means of the trunk-mounted cargo pumps, hydraulically operated submerged cargo pumps or by displacing dangerous goods with inert gas. It is necessary to prevent heating of dangerous cargo if the outlet pipeline of the pump is closed or blocked.

6.30.63 The gas from tanks used for transportation of propylene oxide and its aforementioned mixtures shall be released independently from gas release from tanks used for transportation of other dangerous cargoes. There shall be fitted sampling devices for cargo tank sampling that prevent communication of the dangerous cargo with atmosphere.

6.30.64 The “ONLY FOR ALKYLENE OXIDE” inscription shall be applied on the cargo hoses used for transfer of propylene oxide and mixtures of ethylene oxide and propylene oxide with not more than 30% of ethylene oxide by mass.

6.30.65 It is necessary to check the content of vapours of propylene oxide and its mixtures in bilge spaces. Bilge spaces surrounding standalone tanks of type A and B shall be inerted with measuring the content of oxygen in their atmosphere. Oxygen content in these spaces shall be less than 2%. It is allowed to use portable sampling equipment.

6.30.66 Prior to disconnection of shore pipelines, the pressure in pipelines for transfer of liquid and vapours shall be reduced with the help of the appropriate valves installed on cargo manifold. Release of liquid and vapours from these pipelines to atmosphere is not allowed.

6.30.67 Cargo tanks shall be designed with consideration of maximum pressure of dangerous cargo, which can appear during loading, transportation or unloading.

6.30.68 Cargo tanks for transportation of propylene oxide with design vapour pressure less than 0.06 MPa and cargo tanks for transportation of ethylene oxide and propylene oxide mixtures with design vapour pressure less than 0.12 MPa shall be equipped with a cooling system to keep the temperature of the given dangerous cargo below the design temperature.

6.30.69 The safety valve installed on independent cargo tanks of type C shall be set to overpressure varying within 0.02 MPa to 0.7 MPa for transportation of propylene oxide and up to 0.53 MPa for transportation of ethylene oxide and propylene oxide mixtures.
6.30.70 The pipeline system servicing the cargo tanks intended for loading of propylene oxide and its mixtures shall be independent (isolated from cargo compressors and pipeline systems servicing other cargo tanks, including empty ones). If the pipeline system for cargo tanks loaded with the specified dangerous cargoes is not independent, such pipelines shall be isolated by removing demountable spool pieces, valves or other pipeline sections and installing blind flanges in their place. All pipelines for transfer and discharge of liquid and vapours and other pipelines, for example, common pipelines for inert gas supply shall be isolated as specified above.

6.30.71 Propylene oxide and its mixture shall be transported only in accordance with the cargo handling plans. Each loading equipment to be used shall be specified in the separate cargo handling plan. Cargo handling plan shall outline the entire system of cargo pipelines and blind flanges installed to comply with the requirements to isolation of pipelines in accordance with 6.30.70.

6.30.72 Prior to every first loading of propylene oxide and its mixtures and prior to each further unloading, an organization having the River Register recognition certificate for accomplishment of isolation operations shall issue the certificate to certify that the pipelines have been isolated according to the requirements. This certificate shall be kept onboard the ship. The representative of this organization shall lockwire every blind flange to pipeline flange connection and lead-seal it to prevent inadvertent removal of this blind flange.

6.30.73 Maximum permissible loading levels of each cargo tank for each possible loading temperature and the specific maximum design temperature shall be specified in the list. The copy of this list shall always be kept by the master on board the ship.

6.30.74 Dangerous cargo shall be transported under protective layer of nitrogen, the requirements to which are specified in 6.30.39. An automatic nitrogen pumping system shall be installed to prevent pressure drop in the tank below 0.007 MPa in case of dangerous cargo temperature reduction under environment conditions or as a result of cooling system failure. A reserve of nitrogen for automatic control of pressure shall be available onboard the ship. Commercially pure nitrogen (99.9% by volume) shall be used to form protective layer of nitrogen.

6.30.75 Prior to loading and after unloading, the composition of cargo tank vapour space shall be checked. Oxygen content in it shall not exceed 2% by volume.

6.30.76 It is necessary to provide a water spraying system, whose capacity and arrangement shall enable treatment of the area around the loading manifold and the deck pipeline, which is not protected from fire hazard and is used for transfer of dangerous cargo, and the tank domes. The arrangement of pipelines and trunks shall ensure treatment of the entire area with the same intensity of 10 L/m² per minute. Manual control of water spraying system shall be both local and remote. The arrangement of water spraying system shall ensure outwash of any amount of spilled dangerous cargo. Operation of water spraying system with manual remote control shall be organized in a way so that the remote start of pumps for water supply to this system and manual control of any closed valves of this system is carried out from a place outside the cargo area near the accommodation spaces, accessible and fit for control of the equipment arranged in it in case of fire on the sections serviced by this system. Moreover, fire hose with nozzle shall be connected to the water spraying system to supply for water delivery under pressure during loading and unloading.

Ships carrying vinyl chloride

6.30.77 When polymerization of vinyl chloride is prevented by an inhibitor, the requirements of 6.30.11 shall be followed. If the inhibitor was not added or its amount is insufficient, any inert gas used according to the requirements of 6.30.9 shall contain not more than 0.1% of oxygen. Prior to the beginning of loading, samples of the inert gas shall be
taken from the cargo tanks and pipelines for the analysis. During transportation of vinyl chloride and during ballast passages between successive voyages with this dangerous cargo, an overpressure shall be continuously maintained in the tanks.
## DANGEROUS LIQUID CARGOES AND SPECIAL TECHNICAL REQUIREMENTS TO INLAND NAVIGATION SHIPS CARRYING SUCH CARGOES

### Table AI-1

<table>
<thead>
<tr>
<th>Cargo type</th>
<th>UN number</th>
<th>Tanker type</th>
<th>Cargo tank design</th>
<th>Cargo tank type</th>
<th>Ship cargo tank's equipment</th>
<th>Actuation pressure of quick-action breathing valve (kPa)</th>
<th>Maximum cargo tank filling ratio, %</th>
<th>Vapour relative density at 20°C</th>
<th>Type of sampling device</th>
<th>Explosion protection*</th>
<th>Combustible gas indicator*</th>
<th>Toxicometer*</th>
<th>Mixture group</th>
<th>Mixture class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adiponitrile, water solution</td>
<td>2205</td>
<td>C 2 2</td>
<td>—</td>
<td>25</td>
<td>95</td>
<td>0.96</td>
<td>2</td>
<td>—</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T4 IIB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acrylamide, water solution</td>
<td>2074</td>
<td>C 2 2</td>
<td>—</td>
<td>30</td>
<td>95</td>
<td>1.03</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>—</td>
<td>+ T4 IIB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acraldehyde</td>
<td>1092</td>
<td>C 1 1 3</td>
<td>50</td>
<td>95</td>
<td>0.84</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T3 IIB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stabilized acrylonitrile</td>
<td>1093</td>
<td>C 1 1 3</td>
<td>50</td>
<td>95</td>
<td>0.80</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T1 IIB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid alkyl sulphonic acids with not more than 5% of free sulphuric acid by mass</td>
<td>2586</td>
<td>N 4 3</td>
<td>97</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allyl acetate</td>
<td>2333</td>
<td>C 2 2</td>
<td>—</td>
<td>35</td>
<td>95</td>
<td>0.93</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T2 IIA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allyl isothiocyanate, inhibited</td>
<td>1545</td>
<td>C 2 2</td>
<td>—</td>
<td>30</td>
<td>95</td>
<td>1.02</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T4 IIB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allyl chloride</td>
<td>1100</td>
<td>C 1 1</td>
<td>—</td>
<td>95</td>
<td>0.94</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T2 IIA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Octyl aldehydes (N-octaldehyde)</td>
<td>1191</td>
<td>N 3 2</td>
<td>—</td>
<td>97</td>
<td>0.82</td>
<td>3</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T3 IIB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Octyl aldehydes (2-ethylcapronaldehyde)</td>
<td>1191</td>
<td>C 2 2</td>
<td>—</td>
<td>30</td>
<td>95</td>
<td>0.82</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T4 IIA</td>
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<td></td>
</tr>
<tr>
<td>Amyllamine (n-amylamine)</td>
<td>1106</td>
<td>C 2 2</td>
<td>—</td>
<td>40</td>
<td>95</td>
<td>0.76</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T4 IIA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyl chlorides (1-chloropentane)</td>
<td>1107</td>
<td>C 2 2</td>
<td>—</td>
<td>40</td>
<td>95</td>
<td>0.88</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T3 IIA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyl chlorides (1-chloro-3-methylbutane)</td>
<td>1107</td>
<td>C 2 2</td>
<td>—</td>
<td>45</td>
<td>95</td>
<td>0.89</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T3 IIA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyl chlorides (2-chloro-2-methyl-butane)</td>
<td>1107</td>
<td>C 2 2</td>
<td>3</td>
<td>50</td>
<td>95</td>
<td>0.87</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T2 IIA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyl chlorides (1-chloro-2,2-dimethyl-propane)</td>
<td>1107</td>
<td>C 2 2</td>
<td>—</td>
<td>50</td>
<td>95</td>
<td>0.87</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T3 IIA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amyl chlorides (...)</td>
<td>1107</td>
<td>C 1 1</td>
<td>—</td>
<td>95</td>
<td>0.9</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T4 IIA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N-aminoethylpiperezine</td>
<td>2815</td>
<td>N 4 2</td>
<td>—</td>
<td>97</td>
<td>0.98</td>
<td>3</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anhydrous ammonia</td>
<td>1005</td>
<td>G 1 1 3</td>
<td>91</td>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>T1 IIA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anhydrous ammonia, deeply refrigerated</td>
<td>9000</td>
<td>G 1 1 1;3</td>
<td>95</td>
<td>1</td>
<td>+</td>
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## Appendix 1

Continuation of Table Al-1

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<td>—</td>
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<td>IIB</td>
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<td>2</td>
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<td>T2</td>
<td>IIB*</td>
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<td>T4</td>
<td>IIA*</td>
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<td>T4</td>
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<td>45</td>
<td>95</td>
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<td>T1</td>
<td>IIA</td>
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<td>2</td>
<td>2</td>
<td>—</td>
<td>45</td>
<td>95</td>
<td>1.23</td>
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<td>+</td>
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<td>—</td>
<td>T2</td>
<td>IIA</td>
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<td>IIA*</td>
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<td>T1</td>
<td>IIA</td>
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Appendix 1
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Appendix 1

Continuation of Table A1-1

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<td>1127</td>
<td>C</td>
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<td>2</td>
<td>3</td>
<td>50</td>
<td>95</td>
<td>0.89</td>
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<td>95</td>
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<td>—</td>
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<td>2</td>
<td>—</td>
<td>30</td>
<td>95</td>
<td>1.08</td>
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<td>IIA</td>
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<td>25</td>
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<td>(2-chlorophenol)</td>
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<td>Epichlorohydrin</td>
<td>2023</td>
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<td>2</td>
<td>—</td>
<td>35</td>
<td>95</td>
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<td>+</td>
<td>T2</td>
<td>IIB</td>
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<tr>
<td>Alcohol (ethyl alcohol)</td>
<td>1170</td>
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<td>2</td>
<td>—</td>
<td>10</td>
<td>97</td>
<td>0.79</td>
<td>3</td>
<td>+</td>
<td>+</td>
<td>T2</td>
<td>IIB</td>
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<td>Ethanol solution (ethyl alcohol solution) with alcohol concentration more than 24%, but not more than 70% by volume</td>
<td>1170</td>
<td>N</td>
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<td>2</td>
<td>—</td>
<td>10</td>
<td>97</td>
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<td>+</td>
<td>+</td>
<td>T2</td>
<td>IIB</td>
<td></td>
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<td>Ethanol solution (ethyl alcohol solution) with alcohol concentration more than 70% by volume</td>
<td>2491</td>
<td>N</td>
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<td>—</td>
<td>—</td>
<td>97</td>
<td>1.02</td>
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<td>+</td>
<td>+</td>
<td>T2</td>
<td>IIB</td>
<td></td>
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<tr>
<td>Ethanolamine or ethanolamine solution</td>
<td>1917</td>
<td>C</td>
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<td>2</td>
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<td>40</td>
<td>95</td>
<td>0.92</td>
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<td>+</td>
<td>T2</td>
<td>IIB</td>
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<td>1173</td>
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<td>10</td>
<td>97</td>
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<td>T2</td>
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<td>—</td>
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<td>T3</td>
<td>IIA</td>
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<td>2-ethylexylamine</td>
<td>2276</td>
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<td>—</td>
<td>—</td>
<td>97</td>
<td>0.79</td>
<td>3</td>
<td>+</td>
<td>+</td>
<td>T3</td>
<td>IIA</td>
<td></td>
</tr>
<tr>
<td>Ethylene, refrigerated liquid</td>
<td>1038</td>
<td>G</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>95</td>
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<td>T1</td>
<td>IIB</td>
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<tr>
<td>Ethylene oxide and propylene oxide mixture with not more than 30% of ethylene oxide by mass</td>
<td>2983</td>
<td>C</td>
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<td>3</td>
<td>—</td>
<td>95</td>
<td>0.85</td>
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<td>T2</td>
<td>IIB</td>
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<tr>
<td>Ethylene oxide with nitrogen, total pressure of up to 1 MPa (10 bar) at 50 °C</td>
<td>1040</td>
<td>G</td>
<td>91</td>
<td>+</td>
<td>+</td>
<td>T2</td>
<td>IIB</td>
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<td>Ethylenediamine</td>
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<td>T2</td>
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<td>1605</td>
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<td>T2</td>
<td>IIA</td>
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<td>Ethylene dichloride (1,2-dichloroethane)</td>
<td>1184</td>
<td>C</td>
<td>2</td>
<td>2</td>
<td>—</td>
<td>50</td>
<td>95</td>
<td>1.25</td>
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<td>+</td>
<td>+</td>
<td>T2</td>
<td>IIA</td>
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<tr>
<td>Ethylene chlorohydrid (2-chloroethanol)</td>
<td>1135</td>
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<td>2</td>
<td>—</td>
<td>30</td>
<td>95</td>
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<td>+</td>
<td>T2</td>
<td>IIA</td>
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<tr>
<td>Ethyl methyl ketone (methyl ethyl ketone)</td>
<td>1193</td>
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<td>2</td>
<td>—</td>
<td>10</td>
<td>97</td>
<td>0.80</td>
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<td>T1</td>
<td>IIA</td>
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<tr>
<td>N-ethyltoluidines (N-ethyl-o-toluidine, N-ethyl-m-toluidine) with vapours flash point from 23 °C to 61 °C</td>
<td>2754</td>
<td>C</td>
<td>2</td>
<td>2</td>
<td>25</td>
<td>95</td>
<td>0.94</td>
<td>2</td>
<td>+</td>
<td></td>
<td>T2</td>
<td>IIB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>over 61 °C</td>
<td>C</td>
<td>2</td>
<td>2</td>
<td>25</td>
<td>95</td>
<td>0.94</td>
<td>2</td>
<td>+</td>
<td></td>
<td>T2</td>
<td>IIB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N-ethyltoluidines (N-ethyl-m-toluidine) with vapours flash point from 23 °C to 61 °C</td>
<td>2754</td>
<td>C</td>
<td>2</td>
<td>2</td>
<td>25</td>
<td>95</td>
<td>0.94</td>
<td>2</td>
<td>+</td>
<td>—</td>
<td>T2</td>
<td>IIB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>over 61 °C</td>
<td>C</td>
<td>2</td>
<td>2</td>
<td>25</td>
<td>95</td>
<td>0.94</td>
<td>2</td>
<td>+</td>
<td>—</td>
<td>T2</td>
<td>IIB</td>
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<tr>
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</tr>
<tr>
<td><strong>N-ethyltoluidines (N-ethyl-o-toluidine and N-ethyl-m-toluidine mixtures) with vapours flash point</strong> from 23 °C to 61 °C</td>
<td>2754</td>
<td>C</td>
<td>2</td>
<td>2</td>
<td>25</td>
<td>95</td>
<td>0.94</td>
<td>2</td>
<td>+</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>over 61 °C</strong></td>
<td>2754</td>
<td>C</td>
<td>2</td>
<td>2</td>
<td>25</td>
<td>95</td>
<td>0.94</td>
<td>2</td>
<td>—</td>
<td>+</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>N-ethyltoluidines (N-ethyl-p-toluidine) with vapours flash point</strong> from 23 °C to 61 °C</td>
<td>2395</td>
<td>C</td>
<td>2</td>
<td>2</td>
<td>—</td>
<td>30</td>
<td>95</td>
<td>1.08</td>
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<td>+</td>
<td>+</td>
<td>T4</td>
<td>IIA</td>
<td></td>
</tr>
<tr>
<td><strong>over 61 °C</strong></td>
<td>2350</td>
<td>N</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td>97</td>
<td>0.74</td>
<td>3</td>
<td>+</td>
<td>+</td>
<td>T4</td>
<td>IIB</td>
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<tr>
<td><strong>Divinyl ether, stabilized</strong></td>
<td>1167</td>
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<td>1</td>
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<td>—</td>
<td>—</td>
<td>95</td>
<td>0.77</td>
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<td>0.72</td>
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<td>+</td>
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<td>T2</td>
<td>IIA</td>
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<tr>
<td><strong>Dimethyl ether</strong></td>
<td>1033</td>
<td>G</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>91</td>
<td>—</td>
<td>+</td>
<td>—</td>
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<td>IIB</td>
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<tr>
<td><strong>Ethyl-2-chloro-propionate</strong></td>
<td>2935</td>
<td>C</td>
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<td>—</td>
<td>35</td>
<td>95</td>
<td>1.18</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>T4</td>
<td>IIA</td>
<td></td>
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<tr>
<td><strong>Ethylchlorohydrin</strong></td>
<td>2023</td>
<td>C</td>
<td>2</td>
<td>2</td>
<td>—</td>
<td>35</td>
<td>95</td>
<td>1.18</td>
<td>2</td>
<td>+</td>
<td>+</td>
<td>T4</td>
<td>IIA</td>
<td></td>
</tr>
<tr>
<td><strong>Butyl methy ether</strong></td>
<td>2350</td>
<td>N</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td>97</td>
<td>0.74</td>
<td>3</td>
<td>+</td>
<td>+</td>
<td>T4</td>
<td>IIB</td>
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<td></td>
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<tr>
<td><strong>Ethylene glycol diethyl ether</strong></td>
<td>1188</td>
<td>N</td>
<td>3</td>
<td>2</td>
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<td>0.74</td>
<td>3</td>
<td>+</td>
<td>+</td>
<td>T3</td>
<td>IIB</td>
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<td><strong>Ethylene glycol monoethyl ether acetate</strong></td>
<td>1171</td>
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<td>—</td>
<td>—</td>
<td>97</td>
<td>0.93</td>
<td>3</td>
<td>+</td>
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<td>T3</td>
<td>IIB</td>
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<td><strong>Ethylene glycol monoethyl ether</strong></td>
<td>1172</td>
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<td>3</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>97</td>
<td>0.98</td>
<td>3</td>
<td>+</td>
<td>+</td>
<td>T2</td>
<td>IIA</td>
<td></td>
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<tr>
<td><strong>Methyl tert-butyl ether with vapours flash point</strong> Below –18 °C</td>
<td>2398</td>
<td></td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>91</td>
<td>—</td>
<td>+</td>
<td>—</td>
<td>T3</td>
<td>IIB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>from –18 °C to +23 °C</td>
<td>1153</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>97</td>
<td>0.84</td>
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<td>+</td>
<td>T4</td>
<td>IIB</td>
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<tr>
<td><strong>Ethyl propyl ether</strong></td>
<td>2615</td>
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<td>97</td>
<td>0.73</td>
<td>3</td>
<td>+</td>
<td>+</td>
<td>T4</td>
<td>IIA</td>
<td></td>
<td></td>
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</table>

**Notes.**

1. The ignition temperature has not been determined in accordance with IEC 60079-4; therefore, provisional assignment has been made to temperature class T3 which is considered safe.

2. The ignition temperature has not been determined in accordance with IEC 60079-4; therefore, provisional assignment has been made to temperature class T2 which is considered safe.

3. The ignition temperature has not been determined in accordance with IEC 60079-4; therefore, provisional assignment has been made to temperature class T4 which is considered safe.

4. No maximum safe gap has been measured in accordance with IEC 60079-1A; therefore, provisional assignment has been made to explosion group IIA.

5. No maximum safe gap has been measured in accordance with IEC 60079-1A; therefore, provisional assignment has been made to explosion group IIB.

6. Maximum safe gap is between explosion groups IIA and IIB.

7. No maximum safe gap has been measured in accordance with IEC 60079-1A; therefore, provisional assignment has been made to explosion group IIC.

---

*:**+ — required.

1. Number in “Cargo tank design” column means: 1 — high pressure cargo tank; 2 — closed cargo tank; 3 — open cargo tank with flame arrester; 4 — open cargo tank.

2. Number in “Cargo tank type” column means: 1 — independent cargo tank; 2 — integral cargo tank; 3 — cargo tank with walls disconnected from the hull.

3. Number in “Ship cargo tank equipment” column means: 1 — cargo cooling system; 2 — cargo heating system; 3 — water spray system.

4. Number in “Type of sampling device” column means: 1 — closed; 2 — semi-closed; 3 — sampling hole.
### Table A2-1

<table>
<thead>
<tr>
<th>Production description</th>
<th>UN number</th>
<th>Type of ship</th>
<th>Tank type</th>
<th>Release of vapours from tank</th>
<th>Tank atmosphere control</th>
<th>Electrical equipment</th>
<th>Vapours detection</th>
<th>Fire protection</th>
<th>Construction materials</th>
<th>Eye and respiratory protection</th>
<th>Special requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic acid</td>
<td>9760</td>
<td>2</td>
<td>2</td>
<td>T1</td>
<td>IIA</td>
<td>-</td>
<td>2</td>
<td>B</td>
<td>1</td>
<td>1, 3 I</td>
<td>5.18.81, 5.18.83 – 5.18.85, 5.18.101</td>
</tr>
<tr>
<td>Acetic anhydride</td>
<td>1715</td>
<td>2</td>
<td>2</td>
<td>T2</td>
<td>IIA</td>
<td>-</td>
<td>2</td>
<td>B-T</td>
<td>1</td>
<td>1 I</td>
<td>5.18.81, 5.18.83 – 5.18.85, 5.18.101</td>
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<tr>
<td>Acetone cyanohydrin</td>
<td>1541</td>
<td>2</td>
<td>2</td>
<td>T1</td>
<td>IIA</td>
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<td>T</td>
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<td>Acetonitrile</td>
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<td>IIA</td>
<td>-</td>
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<td>1 I</td>
<td>5.18.86 – 5.18.90, 5.18.101</td>
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<td>Acrylamide solution</td>
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<td>G</td>
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<td>1</td>
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<td>1</td>
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<td>IIA</td>
<td>-</td>
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<td>B-T</td>
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<td>1 I</td>
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<td>IIB</td>
<td>-</td>
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<td>B-T</td>
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<td>3, 1 I</td>
<td>5.18.86 – 5.18.90, 5.18.91 – 5.18.104</td>
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<td>Adiponitrile</td>
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<td>+</td>
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<td>T</td>
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<td>1</td>
<td>1 I</td>
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<tr>
<td>Alachlor, industrial</td>
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<td>1 I</td>
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<td>1701</td>
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<td>2</td>
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<td>+</td>
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<td>1</td>
<td>1 I</td>
<td>5.18.101</td>
</tr>
<tr>
<td>Alcoholic (C12-C15)</td>
<td>1701</td>
<td>2</td>
<td>2</td>
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<td>+</td>
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<td>1</td>
<td>1 I</td>
<td>5.18.101</td>
</tr>
<tr>
<td>Alcoholic (C12-C15)</td>
<td>1701</td>
<td>2</td>
<td>2</td>
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<td>+</td>
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<td>1</td>
<td>1</td>
<td>1 I</td>
<td>5.18.101</td>
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<td>Alcoholic (C6-C17)</td>
<td>2106</td>
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<td>2</td>
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<td>+</td>
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<td>1</td>
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<td>1</td>
<td>1 I</td>
<td>5.18.101</td>
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<tr>
<td>Alcoholic (C6-C17) (secondary) poly (7-12) ethoxylates</td>
<td>3</td>
<td>2G</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>1</td>
<td>—</td>
<td>1</td>
<td>—</td>
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</tr>
<tr>
<td>Sodium salt of 60-65% alkane (C14-C17) sulphonic acids, in water</td>
<td>3</td>
<td>2G</td>
<td>—</td>
<td>—</td>
<td>HP</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Alkanes (C6-C9)</td>
<td>3</td>
<td>2G</td>
<td>2</td>
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<td>—</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>B</td>
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<td>Simple alkaryl polyethers (C9-C20)</td>
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<td>—</td>
<td>—</td>
<td>+</td>
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<td>—</td>
<td>1</td>
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<td>Alkyl acrylate-vinylpyridine copolymer in toluene</td>
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<td>2G</td>
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<td>3</td>
<td>B</td>
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<td>Alkyl (C3-C4) benzenes</td>
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<td>—</td>
<td>2</td>
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<td>5.18.101</td>
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<td>Alkylbenzene sulphonic acid</td>
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<td>Sodium alkyl benzene sulfonate</td>
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<td>HP</td>
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<td>Alkyl (C7-C9) nitrates</td>
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<td>+</td>
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<td>Allyl alcohol</td>
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<td>T2</td>
<td>11B</td>
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<td>B-T</td>
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<td>Allyl chloride</td>
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<td>T2</td>
<td>11A</td>
<td>—</td>
<td>3</td>
<td>B-T</td>
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<td>Aluminium chloride solution (30% or less) / salt acid (20% or less)</td>
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<td>1G</td>
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<tr>
<td>2-(2-Aminoethoxy) ethanol</td>
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<td>2G</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Aminoethylethanolamine N-</td>
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<td>3</td>
<td>2G</td>
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<tr>
<td>Aminoethylpiperazine 2-Amino-2-methyl-1-propanol (90% or less)</td>
<td>3</td>
<td>2G</td>
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<td>Ammonia water solution (28% or less)</td>
<td>2672</td>
<td>(m)</td>
<td>3</td>
<td>2G</td>
<td>2</td>
<td>—</td>
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<td>Ammonium nitrate solution (93% or less)</td>
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<td>—</td>
<td>—</td>
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<tr>
<td>Ammonium sulphide solution (45% or less)</td>
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<td>2683</td>
<td>2</td>
<td>2G</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>3</td>
<td>B-T</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Ammonium thiocyanate solution (25% or less) / ammonium thiosulphate (20% or less)</td>
<td></td>
<td>3</td>
<td>2G</td>
<td>1</td>
<td>—</td>
<td>HP</td>
<td>1</td>
<td>—</td>
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<tr>
<td>Ammonium thiosulphate solution (60% or less)</td>
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<td>2G</td>
<td>1</td>
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<td>Amyl acetate (all isomers)</td>
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<td>1104</td>
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<td>2G</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>2</td>
<td>B</td>
<td>1</td>
</tr>
<tr>
<td>Aniline</td>
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<td></td>
<td>1549</td>
<td>2</td>
<td>2G</td>
<td>2</td>
<td>—</td>
<td>T1</td>
<td>IIA</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>Aviation alkylates (paraffins 8 and iso-paraffins BPT 95 – 120o C) (bb)</td>
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<td>Benzene and mixtures with 10% of benzene or more*</td>
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<td>5.18.7 – 5.18.12, 5.18.86 – 5.18.90, 5.18.101 – 5.18.104</td>
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<td>5.18.86 – 5.18.90, 5.18.101 – 5.18.104</td>
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<td>5.18.91 – 5.18.94</td>
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<td>Cashew nut shell oil (untreated)</td>
<td>1750</td>
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<td>+</td>
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<td>5.18.81, 5.18.83 – 5.18.85, 5.18.89, 5.18.101 – 5.18.104</td>
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<td>Chloracetic acid (80% or less)</td>
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<td>5.18.101 – 5.18.104</td>
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<td>5.18.86 – 5.18.90, 5.18.101</td>
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<td>Column 2</td>
<td>Column 3</td>
<td>Column 4</td>
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<td>Column 7</td>
<td>Column 8</td>
<td>Column 9</td>
<td>Column 10</td>
<td>Column 11</td>
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<td>Chlorohydrin (crude)</td>
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<td>B-T</td>
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<td>Dimethylamine salt of 4-chloro-2-</td>
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<td>methylphenoxyacetic acid</td>
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<td>(amine isomers)</td>
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<td>1, 4</td>
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<td>p-Cymene (bb)</td>
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<td>Decanoic acid</td>
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<td>Decyl acetate</td>
<td>3 G 1</td>
<td>---</td>
<td>+ 1</td>
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<td>Decyl acrylate</td>
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<td>T3 IIA</td>
<td>+ 1</td>
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<tr>
<td>Decyl alcohol (all isomers)</td>
<td>3 G 1</td>
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<td>+ 1</td>
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<td>Decyloxytetrahydrothiophene dioxide</td>
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<td>+ 2 T 1</td>
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<td>T2 IIA</td>
<td>2 B-T 1, 3, 4</td>
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<td>+ 1</td>
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<td>Dibutyl phthalate</td>
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<td>---</td>
<td>+ 1</td>
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<td>T1 IIA</td>
<td>+ 2 T 1, 2, 5</td>
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<td>T2 IIA</td>
<td>2 B-T 1</td>
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<td>+ 2 T 1, 3, 5</td>
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<td>T1 IIA</td>
<td>+ 2 T</td>
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<td>---</td>
<td>HP 1</td>
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<td>HP 1</td>
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<td>---</td>
<td>HP 1</td>
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<td>2 B-T 1, 2</td>
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<td>2 B-T 1, 2</td>
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<td>3 B-T 1, 2</td>
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<td>---</td>
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<td>Diethanol amine</td>
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<td>T2 IIA</td>
<td>—</td>
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<td>B-T</td>
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<td>1</td>
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<td>5.18.86 – 5.18.90, 5.18.101</td>
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<td>B-T</td>
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<td>5.18.13 – 5.18.18, 5.18.95 – 5.18.98, 5.18.101 – 5.18.104</td>
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<tr>
<td>Diethyl phthalate</td>
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<td>1594</td>
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<td>5.18.101</td>
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<td>N1</td>
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<td>5.18.86 – 5.18.90, 5.18.100, 5.18.101 – 5.18.104</td>
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<td>Dimethylbenzene (all isomers)</td>
<td>2051</td>
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<td>N, N-Dimethylcyclohexylamine solution (40% or less)</td>
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<td>T</td>
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<td>5.18.86, 5.18.87, 5.18.100</td>
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<td>T2 IIA</td>
<td>—</td>
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<td>B-T</td>
<td>1, 3, 4</td>
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<td>+</td>
<td>5.18.101</td>
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<td>Dimethylamine, solution (45% or less)</td>
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<td>T2 IIA</td>
<td>—</td>
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<td>B-T</td>
<td>1, 3, 4</td>
<td>1</td>
<td>+</td>
<td>5.18.86 – 5.18.90, 5.18.101</td>
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<tr>
<td>Dimethylamine, solution (more than 45%, but not more than 55%)</td>
<td>1160</td>
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<td>—</td>
<td>3</td>
<td>B-T</td>
<td>1, 3, 4</td>
<td>2</td>
<td>1</td>
<td>+</td>
<td>5.18.86 – 5.18.90, 5.18.95 – 5.18.98, 5.18.100, 5.18.101 – 5.18.104</td>
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<td>B-T</td>
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<td>1</td>
<td>+</td>
<td>5.18.86 – 5.18.90, 5.18.95 – 5.18.98, 5.18.100, 5.18.101 – 5.18.104</td>
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<td>N, N-Dimethylcyclohexylamine</td>
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<td>2</td>
<td>B-T</td>
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<td>5.18.86 – 5.18.90, 5.18.100, 5.18.101</td>
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<td>Dimethylbenzene</td>
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<td>T3 IIA</td>
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<td>B-T</td>
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<td>+</td>
<td>1</td>
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<td>5.18.86, 5.18.90, 5.18.100, 5.18.101 — 5.18.104</td>
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<td>5.18.86 — 5.18.90, 5.18.100, 5.18.101 — 5.18.104</td>
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### Appendix 2

#### Continuation of Table A2-1

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**Continuation of Table A2-1**
### Appendix 2

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<td>Petroleum sodium sulfonate</td>
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<td>1, 2</td>
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<td>+</td>
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<td><strong>Triisopropylated phenyl phosphates</strong></td>
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<td><strong>Trimethylamine, solution (30% or less)</strong></td>
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<td>5.18.101</td>
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<tr>
<td><strong>Urea / ammonium nitrate (containing ammonia water)</strong></td>
<td>2618</td>
<td>3</td>
<td>2G</td>
<td>2</td>
<td>—</td>
<td>—</td>
<td>HP</td>
<td>2</td>
<td>T</td>
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<td>4</td>
<td>—</td>
<td>5.18.101</td>
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<td><strong>Valeraldehyde (all isomers)</strong></td>
<td>2058</td>
<td>3</td>
<td>2G</td>
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<td>1</td>
<td>T3</td>
<td>IIB</td>
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<td>2</td>
<td>B-T</td>
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<td>—</td>
<td>5.18.18, 5.18.101</td>
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<td><strong>Vinyl acetate</strong></td>
<td>1301</td>
<td>3</td>
<td>2G</td>
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<td>T2</td>
<td>IIA</td>
<td>—</td>
<td>2</td>
<td>B</td>
<td>1</td>
<td>—</td>
<td>5.18.91 – 5.18.94, 5.18.101</td>
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<tr>
<td><strong>Vinyl ethyl ether</strong></td>
<td>1302</td>
<td>2</td>
<td>1G</td>
<td>2</td>
<td>1</td>
<td>T3</td>
<td>IIB</td>
<td>—</td>
<td>3</td>
<td>B-T</td>
<td>1</td>
<td>6</td>
<td>+</td>
<td>5.18.13 – 5.18.18, 5.18.91 – 5.18.94, 5.18.95 – 5.18.98, 5.18.101 – 5.18.104</td>
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<td><strong>Vinylidene chloride</strong></td>
<td>1303</td>
<td>2</td>
<td>2G</td>
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<td>1</td>
<td>T2</td>
<td>IIA</td>
<td>—</td>
<td>2</td>
<td>B-T</td>
<td>2</td>
<td>5</td>
<td>+</td>
<td>5.18.91 – 5.18.94, 5.18.95, 5.18.98, 5.18.101</td>
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<td><strong>Vinyl neodecanoate</strong></td>
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<td>—</td>
<td>1</td>
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<td>1, 2</td>
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<td>5.18.91 – 5.18.94, 5.18.101</td>
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<td><strong>Vinyltoluene</strong></td>
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<td>2G</td>
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<td>IIA</td>
<td>—</td>
<td>2</td>
<td>B</td>
<td>1, 2</td>
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<td><strong>White spirit, low aromatic (15-20%)</strong></td>
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<td>—</td>
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<td><strong>Xylenes (bb)</strong></td>
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<td><strong>Xylenol</strong></td>
<td>2261</td>
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<td>2G</td>
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<td>IIA</td>
<td>+</td>
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<td>1, 2</td>
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<td>5.18.101</td>
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<tr>
<td><strong>Zinc alkaryl dithiophosphate (C7-C16)</strong></td>
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<td>2G</td>
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<td>—</td>
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<td>1</td>
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<td>1, 2</td>
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<tr>
<td><strong>Zinc alkaryl dithiophosphate (C3-C14)</strong></td>
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<td>1, 2</td>
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<td>5.18.101</td>
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</table>

*For mixtures free of other components and representing perils to safety and in case of contaminant class C or lower.*

**Notes.**
1. Numbers in the “Type of ship” column mean: 1 — ship of type 1; 2 — ship of type 2; 3 — ship of type 3.
2. Numbers in the “Type of tank” column mean: 1 — independent tank; 2 — integral tank; G — gravity tank; P — pressure tank.
3. Numbers in the “Release of vapours from tank” column mean: 1 — free release of vapours; 2 — controlled release of vapours.

4. Numbers in the “Tank atmosphere control” column mean: 1 — by inerting; 2 — by isolating layer of liquid or gas; 3 — by drying; 4 — by natural or forced ventilation.

5. Characters and symbols in the “Vapours flash point over 60 °C” column mean: HP — non-flammable product; ++ — vapour flash point over 60°C; ” — vapour flash point of 60°C and less.

6. Numbers in the “Taking measurements” column mean: 1 — with the help of open type device; 2 — with the help of semi-closed device; 3 — with the help of close type device.

7. Characters in the “Vapours detection” column mean: Â — flammable vapours; Ò — toxic vapours.

8. Numbers in the “Fire protection” column mean: 1 — alcohol-type or universal-type foam; 2 — ordinary foam (all non-alcohol foams); 3 — water-spraying; 4 — dry chemical.


10. The “+” sign in the "Eye and respiratory protection" means "required".
### LIQUEFIED GASES AND SPECIAL TECHNICAL REQUIREMENTS
### RIVER – SEA NAVIGATION SHIPS CARRYING SUCH CARGOES

<table>
<thead>
<tr>
<th>Name of substance, its formula</th>
<th>UN number</th>
<th>Density, kg/m³ at temperature, °C as indicated in parenthesis</th>
<th>Type of liquefied gas tank</th>
<th>Independent tanks of type C are required</th>
<th>Tank atmosphere control</th>
<th>Cargo vapour detection system</th>
<th>Type of instrumentation</th>
<th>Number as per MFAG Table</th>
<th>Special requirements</th>
</tr>
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<tbody>
<tr>
<td>Acetaldehyde, CH₃CHO</td>
<td>1089</td>
<td>780 (20.8)</td>
<td>2G/2PG</td>
<td>—</td>
<td>1 B+T</td>
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<td>6.30.5, 6.30.9, 6.28.13, 6.28.14</td>
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<tr>
<td>Ammonia anhydrous, NH₃</td>
<td>1005</td>
<td>771 (–33.4)</td>
<td>2G/2PG</td>
<td>—</td>
<td>— T</td>
<td>2</td>
<td>725</td>
<td>6.30.2.1, 6.28.11–6.28.13</td>
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<tr>
<td>Butadiene, CH₂CHCHCH₂</td>
<td>1010</td>
<td>646 (0)</td>
<td>2G/2PG</td>
<td>—</td>
<td>— B+T</td>
<td>1</td>
<td>310</td>
<td>6.30.2.2, 6.30.6, 6.30.7, 6.30.9, 6.30.11</td>
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<tr>
<td>Butane, C₅H₁₀</td>
<td>1011</td>
<td>600 (0)</td>
<td>2G/2PG</td>
<td>—</td>
<td>— B</td>
<td>1</td>
<td>310</td>
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<tr>
<td>Butane/Propane mixture (LPG)</td>
<td>1011/1978</td>
<td>2G/2PG</td>
<td>—</td>
<td>—</td>
<td>— B</td>
<td>1</td>
<td>310</td>
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<tr>
<td>Butylenes, CH₃CH₂CHCH₂</td>
<td>1012</td>
<td>670 (0)</td>
<td>2G/2PG</td>
<td>—</td>
<td>— B</td>
<td>1</td>
<td>310</td>
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<tr>
<td>Chlorine, Cl₂</td>
<td>1017</td>
<td>1560 (–34)</td>
<td>1G</td>
<td>Yes</td>
<td>2 T</td>
<td>3</td>
<td>740</td>
<td>6.30.4, 6.30.5, 6.30.8, 6.30.9, 6.30.10, 6.30.12, 6.30.13, 6.30.24.1–6.30.24.5, 6.28.10–6.28.14</td>
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<tr>
<td>Diethyl Ether*, (C₂H₅)₂O</td>
<td>1155</td>
<td>640 (34.6)</td>
<td>2G/2PG</td>
<td>—</td>
<td>1 B+T</td>
<td>2</td>
<td>330</td>
<td>6.30.3, 6.30.9, 6.30.13, 6.30.14, 6.30.15, 6.30.30, 6.30.31, 6.28.11, 6.28.12</td>
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<tr>
<td>Dimethylamine, (CH₃)₂NH</td>
<td>1032</td>
<td>680 (0)</td>
<td>2G/2PG</td>
<td>—</td>
<td>— B+T</td>
<td>2</td>
<td>320</td>
<td>6.30.2.1, 6.28.11–6.28.13</td>
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<tr>
<td>Ethane, CH₃CH₃</td>
<td>1961</td>
<td>550 (–88)</td>
<td>2G/2PG</td>
<td>—</td>
<td>— B</td>
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<td>310</td>
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<tr>
<td>Ethyl Chloride, CH₃CH₂Cl</td>
<td>1037</td>
<td>921 (0)</td>
<td>2G/2PG</td>
<td>—</td>
<td>— B+T</td>
<td>1</td>
<td>340</td>
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<tr>
<td>Ethylene, C₂H₄</td>
<td>1038</td>
<td>550 (–88)</td>
<td>2G/2PG</td>
<td>—</td>
<td>— B</td>
<td>1</td>
<td>310</td>
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<td>1</td>
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<tr>
<td>Ethylene Oxide, ( \text{CH}_2\text{CH}_2\text{O} )</td>
<td>1040</td>
<td>882</td>
<td>2G</td>
<td>Yes</td>
<td>1</td>
<td>B+T</td>
<td>2</td>
<td>365</td>
<td>6.30.2.2, 6.30.4.2, 6.30.5, 6.30.8, 6.30.9, 6.30.32–6.30.42, 6.28.11–6.28.13, 6.28.14</td>
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<tr>
<td>Ethylene Oxide/Propylene Oxide mixture with Ethylene Oxide content of not more than 30% by weight*</td>
<td>2983</td>
<td>2G/2PG</td>
<td>—</td>
<td>1</td>
<td>B+T</td>
<td>2</td>
<td>365</td>
<td>6.30.3, 6.30.5, 6.30.9, 6.30.14, 6.30.15, 6.30.49–6.30.52, 6.30.76–6.30.78, 6.28.12</td>
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<tr>
<td>Isoprene*, ( \text{CH}_3\text{C}(\text{CH}_3)\text{CH}_2 )</td>
<td>1218</td>
<td>680</td>
<td>2G/2PG</td>
<td>—</td>
<td>1</td>
<td>B</td>
<td>1</td>
<td>310</td>
<td>6.30.11, 6.30.14, 6.30.16, 6.28.12</td>
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<tr>
<td>Isopropylamine*, ( \text{CH}_3\text{CH}_2\text{NH}_2 )</td>
<td>1221</td>
<td>710</td>
<td>2G/2PG</td>
<td>—</td>
<td>1</td>
<td>B+T</td>
<td>2</td>
<td>320</td>
<td>6.30.2.4, 6.30.14, 6.30.15, 6.30.49–6.30.52, 6.30.76, 6.28.11, 6.28.12</td>
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<td>Methyl acetylene/propadiene mixtures</td>
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<td>B</td>
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<td>6.30.44, 6.30.45, 6.30.46</td>
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<td>Methyl Bromide, ( \text{CH}_2\text{Br} )</td>
<td>1062</td>
<td>1730</td>
<td>1G</td>
<td>Yes</td>
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<td>B+T</td>
<td>2</td>
<td>345</td>
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<td>Methyl Chloride, ( \text{CH}_2\text{C}1 )</td>
<td>1063</td>
<td>920</td>
<td>2G/2PG</td>
<td>—</td>
<td>1</td>
<td>B+T</td>
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<td>Monoethylamine* (Ethylamine), ( \text{C}_2\text{H}_5\text{NH}_2 )</td>
<td>1036</td>
<td>706</td>
<td>2G/2PG</td>
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<td>B+T</td>
<td>2</td>
<td>320</td>
<td>6.30.2.1, 6.30.3, 6.30.14, 6.30.15, 6.30.49–6.30.52, 6.30.76, 6.28.11, 6.28.12</td>
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<td>Nitrogen, ( \text{N}_2 )</td>
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<td>808</td>
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<td>620</td>
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<td>1265</td>
<td>626</td>
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<td>Pentene (all isomers)*</td>
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<td>Propane, ( \text{CH}_3\text{C}_2\text{H}_3 )</td>
<td>1978</td>
<td>590</td>
<td>2G/2PG</td>
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<td>Propylene, ( \text{CH}_2\text{CHCH}_3 )</td>
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<td>860</td>
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<td>Propylene Oxide*, ( \text{CH}_2\text{CHOCH}_3 )</td>
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<td>830</td>
<td>2G/2PG</td>
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<td>B+T</td>
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<td>Dichlorodifluoromethane, ( \text{CC}_1\text{F}_2 )</td>
<td>1028</td>
<td>1490</td>
<td>3G</td>
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<td>1</td>
<td>350</td>
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<td>Dichlorotetrafluoroethane, ( \text{CF}_2\text{CCF}_2 )</td>
<td>1958</td>
<td>1510</td>
<td>3G</td>
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<td>350</td>
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<td>1480</td>
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<td>Monochlorodifluoromethane, ( \text{CHC}_1\text{F}_2 )</td>
<td>1018</td>
<td>1420</td>
<td>(–42)</td>
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<td>Column 7</td>
<td>Column 8</td>
<td>Column 9</td>
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<td>2</td>
<td>Monoclorotrifluoromethane, CF₃Cl</td>
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<td>1520</td>
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<td>T</td>
<td>2 635</td>
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<td>3</td>
<td>Sulphur Dioxide, SO₂</td>
<td>1079</td>
<td>1460</td>
<td>1G</td>
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<td>2</td>
<td>T</td>
<td>2 635</td>
<td>6.30.4, 6.30.5, 6.30.8, 6.30.10, 6.30.12, 6.30.13, 6.28.10 – 6.28.14</td>
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<td>4</td>
<td>Vinyl Chloride*, CH₂CHCl</td>
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<td>970</td>
<td>2G/2PG</td>
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<td>—</td>
<td>B+T</td>
<td>2 340</td>
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<td>5</td>
<td>Vinyl Ethyl Ether, CH₂CHO₂H₂</td>
<td>1302</td>
<td>755</td>
<td>2G/2PG</td>
<td>—</td>
<td>1</td>
<td>B+T</td>
<td>2 330</td>
<td>6.30.2.2, 6.30.3, 6.30.9, 6.30.14, 6.30.15, 6.30.30, 6.30.31, 6.28.11, 6.28.12</td>
</tr>
<tr>
<td>6</td>
<td>Vinylidene Chloride*, C₂H₂CCL₂</td>
<td>1303</td>
<td>1250</td>
<td>2G/2PG</td>
<td>—</td>
<td>1</td>
<td>B+T</td>
<td>2 340</td>
<td>6.30.2.3, 6.30.3, 6.30.9, 6.30.14, 6.30.15, 6.28.11, 6.28.12</td>
</tr>
</tbody>
</table>

**Notes.** 1. Chemical formula (column 1) is only informative.
2. Density (column 3) is only informative and to be ascertained by the shipper’s data.
3. Numbers in the “Tank atmosphere control” column 6 mean: 1 — by inerting; 2 — by drying.
4. Characters in the “Cargo vapour detection system” column 7 mean: B — detection of flammable vapours; T — detection of toxic vapours; O — detection of oxygen (dissolved oxygen meter); B+T — detection of flammable and toxic vapours.
5. Numbers in the “Type of instrumentation” column 8 mean: 1 — semi-closed devices; 2 — close type devices; 3 — indirect measurement devices.
6. Numbers as per MFAG (Medical First Aid Guide) Table of the International Maritime Organization (IMO) (column 9) are given to inform about actions to be taken in case of accidents linked to substances to which the requirements of this Part of the Rules apply.
7. If any of the specified substances is transported at negative temperature which can cause freezing injury, No. 620 as per MFAG Table shall be used as well.
8. Requirements of Section 5 of this Part of the Rules also apply to the substances marked with asterisk “*”.

End of Table A3-1
Part X

MATERIALS AND WELDING
1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION

1.1.1 Requirements of the present part of the Rules apply to:
- Materials (including welding consumables) subject to the supervision by the River Register;
- Engineering procedures of welding and welded joints examination.

1.1.2 In addition to compliance with the requirements of the present part, materials shall meet the requirements of other parts of the Rules relevant to the application of materials.

1.1.3 Manufacture of materials shall be carried out in compliance with the technical documentation agreed by the River Register.

1.1.4 Methods of materials testing are stated in Appendices 1 – 12.

1.2 TERMS AND DEFINITIONS

1.2.1 The following terms are used in this Part of the Rules:
- **High temperature brazing** is a brazing method at which the melting temperature of the solder is above 450 °C;
- **Quality control documents** is a document issued by a manufacturer which includes results of materials testing and results of materials acceptance by the manufacturer’s technical control service;
- **Heat-affected zone (HZ)** is the layer of the base metal adjacent to a weld (or to the deposited metal) where structural changes were caused by the welding heat;
- **Weld metal** is the metal obtained by the merging of the fused base metal and the deposited metal or by fusion of the base metal only;
- **Deposited metal** is the metal obtained by the melting of an electrode or a wire and not containing inclusions of the base metal;
- **Specimen** is a test piece of specified shape and size prepared from a sample and used for determination of mechanical, technological and other properties of the material by testing;
- **Base metal** is the metal of items being welded;
- **Semi-finished product** is a consumable made by casting, forging, rolling, drawing or other similar methods and intended for machining or technological treatment during its proper use;
- **Sample** is a portion of a semi-finished product or a specially fabricated blank of which test specimens shall be machined;
- **Penetration** is the merging of the base metal with the deposited one or the merging of the metal of both components being welded;
- **Welding consumable** is an electrode, welding wire, flux and shielding gas used in welding;
- **Lamellar tearing** is breaking of welded construction elements made of rolled plates or tubes due to considerable welding stresses and/or external loads applied in the direction perpendicular to the plate surface.

1.3 MARKING

1.3.1 Marking shall be carried out according to the national standards taking into consideration the following requirements:

1 GOST 52927, GOST 5520, GOST 26358, GOST 1060.
1. In the case of semi-manufactured products delivered in single pieces each one of them shall be marked. For semi-finished products delivered in bundles two weather-resistant labels containing the marking shall be provided and firmly fastened to the opposite ends of the bundle.

Marking shall be legible and framed with a light paint resistant to atmosphere.

2. In the general case, the stamp shall include the following information:
   - name of material or semi-finished product;
   - name and address of the manufacturer and/or manufacturer's brand mark;
   - material category and/or trademark;
   - serial number (no. of the semi-manufactured product, cast no., etc.);
   - the date of manufacturing;
   - weight;
   - disposal method;
   - lifting points;
   - stamp of the manufacturer's technical control service;
   - the River Register brand (in cases described by Appendix 1 to RTSC);
   - other information to describe marked material or semi-manufactured product;

3. If the semi-manufactured product does not withstand the tests required by the Rules or defects are revealed which make its use in accordance with the purpose impossible, the River Register brand and the material grade designation shall be removed or cancelled.

4. The label attached to the packing shall be marked with the inscription: Approved by Russian River Register.
2 STEEL AND CAST IRON

2.1 GENERAL REQUIREMENTS

2.1.1 The present requirements are applied to hull structural steel, steel for boilers and pressure vessels, steel pipes and tubes, steel for cable chains, steel forgings and casting, high strength steel in accordance with GOST R 52927, reinforcing-bar steel in accordance with GOST R 5781 and iron castings.

2.1.2 Semi-manufactured products may be used if manufactured in compliance with national standards or in compliance with the technical documentation agreed by the River Register.

2.2 HULL STRUCTURAL STEEL

General requirements

2.2.1 The requirements of the present Chapter are applied to weldable hot-rolled plates, strip and sections up to 50-mm thick as well as steel shapes.

Steel differing by its chemical composition, the method of deoxidation, heat treatment or mechanical properties including clad steel shall have a special identification mark: S added to the grade symbol.

Chemical composition

2.2.2 The chemical composition of normal strength steel shall comply with the requirements of Table 2.2.2-1 and that of higher strength steel — Table 2.2.2-2.

\[\text{T a b l e 2.2.2-1}\]

<table>
<thead>
<tr>
<th>Chemical element</th>
<th>Chemical composition (ladle analysis), %, steel grade</th>
<th>A</th>
<th>B</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>By the method of deoxidation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Killed or semi-killed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Killed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Killed, fine-grained, aluminum treated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C_{\text{max}}</td>
<td>0.21;</td>
<td>0.21;</td>
<td>0.21;</td>
<td>0.18;</td>
<td></td>
</tr>
<tr>
<td>Mn_{\text{max}}</td>
<td>2.5;</td>
<td>2.5;</td>
<td>2.5;</td>
<td>2.5;</td>
<td></td>
</tr>
<tr>
<td>Si_{\text{max}}</td>
<td>0.50;</td>
<td>0.50;</td>
<td>0.50;</td>
<td>0.50;</td>
<td></td>
</tr>
<tr>
<td>P_{\text{max}}</td>
<td>0.040;</td>
<td>0.040;</td>
<td>0.040;</td>
<td>0.040;</td>
<td></td>
</tr>
<tr>
<td>S_{\text{max}}</td>
<td>0.040;</td>
<td>0.040;</td>
<td>0.040;</td>
<td>0.040;</td>
<td></td>
</tr>
<tr>
<td>Al_{\text{min}}</td>
<td>—</td>
<td>—</td>
<td>0.015</td>
<td>0.015</td>
<td></td>
</tr>
</tbody>
</table>

Notes. 1. Grade A steel sections up to a thickness of 12.5 mm may be accepted in rimmed steel.
2. Carbon content for Grade A steel sections is permitted up to 0.23%.
3. The minimum manganese content in Grade B being impact tested may be reduced to 0.60 %.

\[\text{T a b l e 2.2.2-2}\]

<table>
<thead>
<tr>
<th>Chemical composition (ladle analysis) of killed steel, %</th>
<th>Chemical composition (ladle analysis) of killed steel, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_{\text{max}}</td>
<td>0.18</td>
</tr>
<tr>
<td>Mn_{\text{max}}</td>
<td>0.90 – 1.60</td>
</tr>
<tr>
<td>Si_{\text{max}}</td>
<td>0.50</td>
</tr>
<tr>
<td>P_{\text{max}}</td>
<td>0.035</td>
</tr>
<tr>
<td>S_{\text{max}}</td>
<td>0.035</td>
</tr>
<tr>
<td>Cu_{\text{max}}</td>
<td>0.35</td>
</tr>
<tr>
<td>Cr_{\text{max}}</td>
<td>0.20</td>
</tr>
<tr>
<td>Ni_{\text{max}}</td>
<td>0.40</td>
</tr>
<tr>
<td>Mo_{\text{max}}</td>
<td>0.08</td>
</tr>
<tr>
<td>Al_{\text{max}}</td>
<td>0.015</td>
</tr>
<tr>
<td>Nb</td>
<td>0.02 – 0.05</td>
</tr>
<tr>
<td>V</td>
<td>0.05 – 0.10</td>
</tr>
<tr>
<td>Ti_{\text{max}}</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Notes. 1. Up to a thickness of 12.5 mm and less the manganese content may be reduced to 0.70 %.
2. Where steel is thermomechanically treated, the chemical composition shall be determined in accordance with GOST R 52927.

1 GOST R 52927, GOST 5520, GOST 26358, GOST 1050, GOST 1060.
Tables 2.2.2-1 and 2.2.2-2 give data on the content of acid soluble aluminum. If the total aluminum content is determined, it shall be at least 0.020 %.

In case if the content of elements in normal strength steel is other than specified in Tables 2.2.2-1 and 2.2.2-2, then chromium, nickel and copper content shall not exceed 0.30 % for each element.

For normal strength carbon steel the total carbon content and 1/6 of the manganese content is not to exceed 0.40 %.

The carbon equivalent, in per cent, for higher strength steel is determined during type approval testing using the data of the ladle analysis and is calculated by the formula:

$$C_{eq} = C + \frac{Mn}{6} + (Cr + Mo + V)/5 + (Ni + Cu)/15.$$ (2.2.2);

The arsenic content in steel of all grades shall not to exceed 0.08 %.

If normal and high strength hull structural steel is treated by one grain refining element, for example niobium, vanadium or aluminum, its content shall comply with that specified in Tables 2.2.2-1 and 2.2.2-2. When a combination of the elements is used, the content of one or several elements in the steel shall comply with that specified in the Tables 2.2.2-1 and 2.2.2-2.

Where the content of aluminum or other grain refining elements is lower than required by Tables 2.2.2-1 and 2.2.2-2., the austenite grain size to be determined in accordance with GOST 5639 and not exceed grain size 5. Grade D steel of thickness exceeding 25 mm shall be killed, fine-grained and shall contain Al ≥ 0.015 %.

**Mechanical properties**

2.2.3 The mechanical properties of normal strength steel shall comply with the requirements of Table 2.2.3-1 and those of higher strength steel – with the requirements of Table 2.2.3-2.

The impact energy at impact testing may be determined either on longitudinal ($KV_L$) or on transverse ($KV_T$) specimens (see Appendix 10).

### Table 2.2.3-1

**Normal strength hull structural steels — Mechanical properties**

<table>
<thead>
<tr>
<th>Grade of steel</th>
<th>Tensile test</th>
<th>Impact testing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R_p$ (MPa)</td>
<td>$R_m$ (MPa)</td>
</tr>
<tr>
<td></td>
<td>not less than</td>
<td>not less than</td>
</tr>
<tr>
<td>A</td>
<td>400–520</td>
<td>235</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>-20</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>-40</td>
</tr>
</tbody>
</table>

**Note.** When full thickness $t$ (mm) standard specimens with a gauge length of 200 mm are tensile tested, the minimum elongation (%) shall meet the following values: $t \leq 5$: 14, $20 < t \leq 25$: 19, $5 < t \leq 10$: 16, $25 < t \leq 30$: 20, $10 < t \leq 15$: 17, $30 < t \leq 40$: 21, $15 < t \leq 20$: 18, $40 < t \leq 50$: 22.

### Table 2.2.3-2

**Higher strength hull structural steels — Mechanical properties**

<table>
<thead>
<tr>
<th>Grade of steel</th>
<th>Tensile testing</th>
<th>Impact testing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R_p$ (MPa)</td>
<td>$R_m$ (MPa)</td>
</tr>
<tr>
<td></td>
<td>not less than</td>
<td>not less than</td>
</tr>
<tr>
<td>A32, D32, E32</td>
<td>440–590</td>
<td>315</td>
</tr>
<tr>
<td>A36, D36, E36</td>
<td>490–620</td>
<td>355</td>
</tr>
<tr>
<td>A40, D40, E40</td>
<td>510–650</td>
<td>390</td>
</tr>
</tbody>
</table>

* Testing for Grade A steel shall be carried out at temperature 0 $^\circ$C, D — at –20 $^\circ$C, E — at –40 $^\circ$C.

**Note.** When full thickness $t$ (mm) standard specimens are tensile tested, the minimum elongation (%) shall meet the following values (%) for grades of steel:

<table>
<thead>
<tr>
<th>Grade of steel</th>
<th>Tensile testing</th>
<th>Impact testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>A32, D32, E32</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>A36, D36, E36</td>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>A40, D40, E40</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>t ≤ 5</td>
<td>19</td>
<td>18</td>
</tr>
<tr>
<td>5 &lt; t ≤ 10</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>10 &lt; t ≤ 15</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>15 &lt; t ≤ 20</td>
<td>22</td>
<td>21</td>
</tr>
</tbody>
</table>
Supply condition

2.2.4 The condition of steel shall comply with Tables 2.2.4-1 and 2.2.4-2 and shall be specified in a manufacturer’s quality control document. Rolling with controlled temperature or thermomechanically controlled rolling may be used instead of normalizing heat treatment (N) provided that the required steel properties.

Table 2.2.4-1
Condition of supply of normal strength steel

<table>
<thead>
<tr>
<th>Grade</th>
<th>Thickness (mm)</th>
<th>Supply condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B</td>
<td>any</td>
<td>Not specified (any)</td>
</tr>
<tr>
<td>D</td>
<td>≤ 35</td>
<td>Normalizing heat treatment (N), rolling with controlled temperature (CR), thermomechanical controlled rolling (TMCP)</td>
</tr>
<tr>
<td></td>
<td>&gt; 35</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>any</td>
<td>N or TMCP</td>
</tr>
</tbody>
</table>

Note. Grade D sections may be supplied in as rolled condition provided that the impact tests results (see Appendix 10) are in compliance with the requirements of Table 2.2.3-1. Similarly grade E sections may be supplied in as rolled condition or after CR.

Table 2.2.4-2
Condition of supply of higher strength steel

<table>
<thead>
<tr>
<th>Grade of steel</th>
<th>Grain refining elements</th>
<th>Thickness t (mm)</th>
<th>Supply condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A32, A36, Nb, V</td>
<td>t ≤ 12.5</td>
<td>Not specified (any)</td>
<td></td>
</tr>
<tr>
<td>A40</td>
<td>t &gt; 12.5</td>
<td>N, CR or TMCP</td>
<td></td>
</tr>
<tr>
<td>D32</td>
<td>t ≤ 20</td>
<td>Not specified (any)</td>
<td></td>
</tr>
<tr>
<td>D36, D40, Al+Ti</td>
<td>20 &lt; t ≤ 35</td>
<td>Same or rolled when agreed with the River Register</td>
<td></td>
</tr>
<tr>
<td>E32, E36, E40</td>
<td>Any</td>
<td>N, TMCP or quenching and tempering (QT) at manufacturer's discretion</td>
<td></td>
</tr>
</tbody>
</table>

Notes. 1. The scope of impact testing is determined according to 2.1.3 of Appendix 11.
2. Steel sections in Grades A32, A36, A40, D32, D36, D40 may be supplied in as rolled condition provided that the results of impact tests are in compliance with requirements of Table 2.2.3-2. Similarly grades E32, E36, E40 sections may be supplied in as rolled condition or after CR. The scope of impact testing is determined according to 2.1.4 of Appendix 11.

2.2.5 Maximum permissible under-thickness tolerances of hull structural steel plates and strips shall not exceed 0.3 mm.

Maximum permissible under-thickness tolerances of steel plates and bars intended for marine engineering shall correspond to those specified in Table 2.2.5.

Table 2.2.5
Maximum permissible under-thickness tolerances of hull structural steel plates and strips

<table>
<thead>
<tr>
<th>Thickness t (mm)</th>
<th>Maximum permissible tolerances (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 ≤ t &lt; 8</td>
<td>-0.4</td>
</tr>
<tr>
<td>8 ≤ t &lt; 15</td>
<td>-0.5</td>
</tr>
<tr>
<td>15 ≤ t &lt; 25</td>
<td>-0.6</td>
</tr>
<tr>
<td>25 ≤ t &lt; 40</td>
<td>-0.8</td>
</tr>
<tr>
<td>40 ≤ t</td>
<td>-1.0</td>
</tr>
</tbody>
</table>

Notes. 1. For the plate thickness less than 5 mm maximum under-thickness tolerances are adopted according to GOST R 52927.
2. Thickness shall be measured at the distance of not less than 25 mm from the plate edge.

The semi-manufactured articles shall be free from cracks, slag inclusions or other defects prejudicial to the use of the material for its intended application.

The surface of semi-manufactured articles shall be clean and not be subject to impact flattening.

Total removal of pipes shall be proved by check tests. The test procedure shall be developed with regard to requirements of GOST 22727, GOST 12503 and agreed with the River Register.

Removal of the surface defects by local grinding is allowed only for the depth not exceeding 7% the nominal thickness but in all cases not exceeding 3 mm. The total area of grinding shall not exceed 2% of the product surface.

The surface defects which cannot be removed by local grinding may be removed by chipping or grinding followed by welding provided that:

1. The product thickness before welding is not reduced by more than 20% after removal of the defects;
2. Welding is carried out in accordance with the procedure developed according to re-
requirements of Section 7 of the present Part of the Rules and agreed with the River Register;

The welded area is ground to the nominal thickness of the product;

The area of single weldings shall not exceed $25 \cdot 10^{-4}$ m$^2$;

The total welded area shall not exceed 1% of the product surface;

Heat treatment shall be carried out after welding of the surface defects. Method and necessity of heat treatment shall be determined by the manufacturer proceeding from the chemical composition, purpose and shape of the casting.

Marking

2.2.6 The steel manufacturer shall have a system for identification of ingots, slabs and semi-manufactured articles which enables the material to be traced to its original cast.

Each semi-manufactured article shall have the brand of the River Register and the marking according to requirements of 1.3.

When the steel is supplied after thermomechanically controlled processing, the index TM shall be added after identification of the grade (e.g. E36TM).

2.3 STEEL FOR BOILERS AND PRESSURE VESSELS

General provisions

2.3.1 Requirements of the present Chapter are applied to rolled steel intended for marine boilers, heat exchangers and pressure vessels.

2.3.2 Rolled steel manufactured and tested in accordance with requirements of the present Chapter is intended for operation at room (20±10) °C or elevated temperature.

2.3.3 The rolled steel shall be free from defects prejudicial to the application of the material. The soundness shall be proved by non-destructive testing.

Surface defects due to the specific method of manufacture may be allowed when their depth does not exceed the permissible limits of values normalized by GOST 5520.

Chemical composition

2.3.4 The chemical composition of steel is determined in accordance with GOST 5520 depending on the required mechanical properties at room or elevated design temperatures; the content of base elements in per cent shall not exceed:

For carbon and carbon-manganese steel (ladle analysis):

- Carbon ............... 0.20
- Phosphorus .......... 0.040
- Silicon .............. 0.50
- Nickel .............. 0.30
- Manganese ......... 1.6
- Chromium .......... 0.30
- Sulphur ........... 0.040
- Copper ............ 0.30

The use of steel with carbon content more than 0.2% is permitted, if the proper weldability was preliminarily tested (see 4 of Appendix 10);

For low-alloy steel (ladle analysis), %:

- Carbon ............... 0.18
- Phosphorus .......... 0.040
- Silicon .............. 0.50
- Chromium .......... 2.50
- Manganese ......... 0.80
- Nickel .............. 1.10
- Sulphur ........... 0.040
- Vanadium .......... 0.35

2.3.5 Using of rimming steel is not permitted.

The steel may be treated with grain-refining elements.

Carbon and carbon-manganese steel intended to operate at temperatures over 400 °C shall not contain aluminium.

Mechanical properties

2.3.6 Mechanical properties of steel at the room and rated elevated temperature are specified by GOST 5520.

The properties of steel shall be confirmed by the following tests to be carried out in accordance with the requirements of Appendix 10:

- Tensile test (with tensile strength, yield stress and percentage elongation to be determined);
- Bend test;
- Impact test ($KCU$ or $KV$).

Strength characteristics

2.3.7 Strength characteristics of steel for boilers are stated in Tables 2.3.7-1 and 2.3.7-2.
### Table 2.3.7-1

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>$R_m$ (MPa)</th>
<th>Lower yield point (MPa) according to the rated temperature ($^\circ$C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon steels</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>330</td>
<td>195</td>
</tr>
<tr>
<td>12K and 15K</td>
<td>350</td>
<td>205</td>
</tr>
<tr>
<td>Cr3</td>
<td>370</td>
<td>205</td>
</tr>
<tr>
<td>16K, 20 and 20K</td>
<td>400</td>
<td>235</td>
</tr>
<tr>
<td>18K</td>
<td>430</td>
<td>255</td>
</tr>
<tr>
<td>Alloyed steels</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>15XM</td>
<td>440</td>
<td>225</td>
</tr>
<tr>
<td>12X1MΦ</td>
<td>440</td>
<td>255</td>
</tr>
<tr>
<td>16ΓC and 09Γ2C</td>
<td></td>
<td>450</td>
</tr>
<tr>
<td>with increased content of manganese 22ΓK</td>
<td>530</td>
<td>335</td>
</tr>
</tbody>
</table>

### Table 2.3.7-2

<table>
<thead>
<tr>
<th>Steel grade</th>
<th>$R_m$ (MPa)</th>
<th>$R_{eh}$ (MPa)</th>
<th>Long-term strength (MPa) according to the rated temperature ($^\circ$C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon steels</td>
<td></td>
<td></td>
<td>370</td>
</tr>
<tr>
<td>10, 12K and 15K</td>
<td>330</td>
<td>195</td>
<td>195</td>
</tr>
<tr>
<td>16K, 18K, 20 and 20K</td>
<td>350</td>
<td>205</td>
<td>205</td>
</tr>
<tr>
<td>15XM</td>
<td>440</td>
<td>225</td>
<td>226</td>
</tr>
<tr>
<td>12X1MΦ</td>
<td>440</td>
<td>255</td>
<td>255</td>
</tr>
<tr>
<td>16ΓC and 09Γ2C</td>
<td></td>
<td>450</td>
<td>265</td>
</tr>
<tr>
<td>with increased content of manganese 22ΓK</td>
<td>530</td>
<td>335</td>
<td>324</td>
</tr>
</tbody>
</table>

### Marking

**2.3.8** Marking shall be provided in accordance with the requirements of 1.3.

### 2.4 STEEL PIPES AND TUBES

#### General requirements

**2.4.1** Requirements of the present Chapter apply to hot and cold-formed steel pipes and tubes as well as welded pipes and tubes which are intended for manufacturing of boilers, heat exchangers, pressure vessels, shipborne systems and piping.

**2.4.2** The pipes and tubes manufactured and tested in accordance with the present requirements are intended for operation both at room and elevated temperatures.

**2.4.3** The welded pipes and tubes may be manufactured by means of electric induction welding, pressure contact welding or fusion welding.

**2.4.4** The surface of the pipes and tubes shall be free from cracks, skins, fissures and laps.

A certain number of minor nicks and dents, marks, thin layer of scale, traces of defects grinding and small skins are permitted if they do not decrease the wall thickness below the allowable under-thickness tolerances.

Hydraulic tests may be omitted if all the pipes and tubes undergo non-destructive ultrasonic or other testing (see 8.1.2).

The welds in welded pipes and tubes are to undergo the ultrasonic testing.
Chemical composition

2.4.5 The chemical composition of steel is determined in accordance with national standards\(^1\) depending on the required mechanical properties at room or elevated design temperatures; the content of base elements in per cent shall not exceed:

for carbon and carbon-manganese steel (ladle analysis), %:
- Sulphur .............. 0.04
- Phosphorus........ 0.04
- Manganese......... 1.50
- Chromium......... 0.30
- Silicon................ 0.50
- Nickel................ 0.30
- Carbon............... 0.23
- Copper............... 0.30

for low-alloy steel (ladle analysis), %:
- Sulphur ............ 0.035
- Phosphorus...... 0.035
- Manganese.......... 1.0
- Chromium......... 2.50
- Silicon................ 0.50
- Molybdenum ..... 1.20
- Carbon............... 0.20
- Vanadium.......... 0.35

2.4.6 The steel shall be killed. Unkilled steel is not permitted for manufacturing pipes and tubes. Semi-killed and fine-grained steel is permitted on condition that values of mechanical properties are provided according to the Rules.

Carbon and carbon-manganese steel intended for working temperatures above 400 °C shall not contain aluminum.

Mechanical and technological properties

2.4.7 The mechanical and technological properties of steel intended for pipes and tubes at room and elevated design temperature are set by national standards\(^2\).  

2.4.8 In the process of manufacture the pipes and tubes shall undergo the following tests:

- Tensile test (determination of tensile strength, yield stress and elongation) according to 2.2 of Appendix 10;
- Tensile test at elevated temperature (determination of proof stress) according to 2.2 of Appendix 10;
- Flattening test according to 2.15 of Appendix 10 or tensile test of rings according to 2.17 of Appendix 10;
- Expanding test according to 2.16 of Appendix 10.

Tensile test at elevated temperature, flattening test, tensile test of rings and expanding test shall be carried out when required by national standards\(^2\) or by technical documentation approved by the River Register on the basis of which the test results are estimated. The results of long-term stress tests of steel for pipes and tubes at elevated temperature shall be submitted to the River Register, when such tests are stipulated by the relevant parts of the Rules or by national standards mentioned above.

Heat treatment

2.4.9 The pipes and tubes shall be heat treated, when stipulated by the relevant parts of the Rules, by national standards mentioned in 2.4.8 or technical design documentation approved by the River Register. The cold-formed and electrically welded pipes and tubes shall in any case be heat-treated: normalized, normalized and tempered or quenched and tempered. The method and conditions of heat treatment chosen by the manufacturer shall be stated in the quality control document.

All steel alloy pipes as well as the following carbon steel pipes require heat treatment after bending and prior to hydraulic test:

1. For steam with a working pressure exceeding 1.6 MPa;
2. For fuel oil with a working pressure exceeding 1 MPa;
3. For other media with a working pressure exceeding 3 MPa.

Heat treatment of carbon steel pipes is not required at cold bending of pipes with a radius of \(4d\) \((d \text{ — outside diameter of the pipe})\) and over, and at hot bending at 850 – 950 °C.

Heat treatment is required after cold bending of carbon and alloyed steel pipes with a radius of \(4d\) and below.

\(^1\) GOST 380, GOST 1050, GOST 4543.
\(^2\) GOST 8731, GOST 8733, GOST 1060.
Heat treatment with stress relief for 0.3% carbon-molybdenum pipes with wall thickness exceeding 15 mm shall be carried out at temperature 580–640 °C in all cases, for 1 Cr – 0.5 Mo chromium-molybdenum pipes with wall thickness exceeding 8 at temperature 620–680 °C. Heat treatment with stress relief for 2.25 Cr – 1 Mo chromium-molybdenum and 0.5 Cr – 0.5 Mo – 0.25 V chromium-molybdenum-vanadium pipes with wall thickness exceeding 8 mm, diameter above 100 mm and working temperature above 450 °C shall be carried out at 650–720 °C.

Pipes made of copper and copper alloys, except for pipes of monitoring and control devices, require annealing prior to hydraulic test.

For carbon-manganese, and carbon-molybdenum steel pipes subsequent heat treatment after hot bending is not required.

Marking

2.4.10 The marking shall be in accordance with 1.3.

2.5 STEEL FOR CHAIN CABLES AND ACCESSORIES

General requirements

2.5.1 The requirements of the present Chapter apply to rolled steel used for the manufacture of chain cables.

2.5.2 Technical documentation for rolled steel, which confirms that the steel is in compliance with requirements of this Chapter, shall be submitted to the River Register for the approval together with the test reports. The documents shall contain the data on the melting and deoxidation procedures, required chemical composition, condition of supply and mechanical properties of the steel.

2.5.3 Depending on the value of tensile strength of the steel used stud chain cables are divided into grades 1, 2 and 3, and studless chain cables — into grades 1 and 2.

2.5.4 The rolled bars are supplied in a rolled condition.

2.5.5 The admissible tolerances of rolled bars diameter are set down in compliance with 3.7.6, Part V of the Rules and shall be stated in the manufacturer’s quality control document.

2.5.6 The rolled bars shall be free from inner and surface defects that might impair proper workability and use. The surface defects may be removed by grinding within the limits of admissible diameter tolerances, specified by GOST 228.

Chemical composition

2.5.7 The chemical composition of steel based on ladle analysis shall comply with Table 2.5.7.

Table 2.5.7

<table>
<thead>
<tr>
<th>Chemical composition of rolled steel bars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chain cable grade</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

¹ Aluminium may be replaced partly by other fine graining elements.

² Additional alloying elements may be added.

The rolled bars shall be manufactured of killed steel: the steel for chain cables of grades 2 and 3 steel shall be fine grain treated.

Mechanical properties

2.5.8 The mechanical properties of rolled steel bars shall ensure the properties of finished chain according to Table 3.7.8. of Part V of the Rules.

Marking

2.5.9 The marking of the rolled bars shall be made on each product in accordance with 1.3.

2.6 STEEL FORGINGS

General requirements

2.6.1 The present requirements are applicable to forgings intended for hull and machinery applications.
2.6.2 The requirements are applied also to rolled billets used instead of forgings and to rolled sections of a diameter not exceeding 250 mm used for manufacturing (only by machining) of shafts, bolts and similar items of simple shape. For rolled bars used as a substitute for forgings the reduction ratio shall be not less than 6:1.

2.6.3 The technical documentation for forgings intended for service at low or elevated temperature, as well as forgings of alloy steel with special properties (corrosion resistance, heat resistance, high temperature oxidation resistance, etc.) shall be submitted to the River Register for agreement and contain detailed information on the chemical composition, mechanical and special properties, heat treatment, methods and scope of testing.

2.6.4 The plastic deformation ratio shall be such as to ensure soundness, structure uniformity and the required mechanical properties. The plastic deformation ratio shall comply with the requirements of Table 2.6.4.

<table>
<thead>
<tr>
<th>Table 2.6.4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forgings plastic deformation ratio</strong></td>
</tr>
<tr>
<td>Manufacturing method</td>
</tr>
<tr>
<td>From ingot or forged billet</td>
</tr>
<tr>
<td>From ingot or forged billet</td>
</tr>
<tr>
<td>From rolled billet</td>
</tr>
<tr>
<td>From rolled billet</td>
</tr>
</tbody>
</table>

Notes:
1. \( L \) and \( D \) — the length and diameter of a forging or its part respectively.
2. The forging ratio shall be calculated with reference to the average cross-sectional area of the ingot. The initial upsetting of the ingot may be also taken into consideration.

The thickness of any part of a disc-type forging, e.g., gear wheel forging, shall not exceed one-half the length of the billet from which it was formed by upsetting, provided that the initial forging reduction is not less than 1.5:1. Where the piece used has been cut directly from ingot or the initial reduction is less than 1.5:1, the thickness of any part of the disk-type forging shall not exceed one-third the length of the original piece.

Rings and other types of hollow forgings shall be made from hollow billets by expanding or drawing on a suitable mandrel. Hollow cast billets may be used as well. The wall thickness of the forging shall not exceed one-half the wall thickness of the hollow billet; otherwise the adequate pre-processing shall be given to the billet with reduction 2:1.

2.6.5 Surface imperfections are permitted within machining allowances only. Small surface imperfections revealed through visual examination or by non-destructive testing may be removed by local grinding or by chipping and grinding. Complete rectification of imperfections shall be proved by magnetic particle or dye penetrant testing.

2.6.6 Defect repairs by welding shall be restricted to the rectification of defects of the minor nature and in areas not subject to considerable working stresses. After welding all locations of welded-up defects and the results of inspection shall be shown in a drawing or sketch of the forging.

Chemical composition

2.6.7 The chemical composition of steel for forgings shall be appropriate for the particular type of steel and the required mechanical and special properties.

The forgings are to be made from killed steel.

2.6.8 For carbon and carbon-manganese steel forgings the chemical composition of ladle samples shall comply with the following overall limits in %:

- Carbon................. 0.60
- Silicon ............... 0.45
- Copper............... 0.30
- Manganese 0.30–1.50
- Chromium........... 0.30
- Sulphur.............. 0.040
- Molybdenum..... 0.15
- Phosphorus...... 0.040
- Nickel ............... 0.40

2.6.9 For alloyed steel forgings the chemical composition of ladle samples shall comply with the following overall limits in %:

- Carbon................. 0.45
- Sulphur .............. 0.035
- Silicon ............... 0.45
- Phosphorus...... 0.035

2.6.10 The content of grain refining components is to be reported in the ladle analysis.
### Mechanical properties

**2.6.11** Proceeding from the required minimum tensile strength the values of yield stress, percentage elongation, percentage area reduction and results of impact tests for carbon and carbon-manganese forgings shall comply with the values specified in Table 2.6.11-1, forgings of alloyed steels after quenching and tempering — Table 2.6.11-2, forgings from of alloyed carburizing steel — Table 2.6.11-3.

When using the data in Tables 2.6.11-1 – 2.6.11-3, the following shall be considered:

1. The tensile strength values obtained at tensile testing at required $R_m$ (MPa) shall not exceed the specified values by more than (MPa):

<table>
<thead>
<tr>
<th>$R_m$</th>
<th>600 &gt; 900</th>
<th>900 &gt; 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&lt; 600$</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>$600$-900</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>$&gt; 900$</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carbon and carbon-manganese steel forgings mechanical properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength $R_m$ (MPa)</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>360</td>
</tr>
<tr>
<td>400</td>
</tr>
<tr>
<td>440</td>
</tr>
<tr>
<td>480</td>
</tr>
<tr>
<td>520</td>
</tr>
<tr>
<td>560</td>
</tr>
<tr>
<td>600</td>
</tr>
<tr>
<td>640</td>
</tr>
<tr>
<td>680</td>
</tr>
<tr>
<td>720</td>
</tr>
<tr>
<td>760</td>
</tr>
</tbody>
</table>

**Notes.** 1. Requirements for testing longitudinal specimens are adduced in the numerator, in the denominator — for testing transverse specimens.

2. For intermediate tensile strength values the minimum values of yield stress, elongation reduction of area and impact energy $KV$ or impact toughness $KCU$ may be obtained by linear interpolation.

3. The requirements given in these Tables relate to the specimens taken with their axes at a distance up to 10 % of the diameter or thickness from the surface.

### Mechanical properties of alloyed steels forgings after quenching and tempering

<table>
<thead>
<tr>
<th>Tensile strength $R_m$ (MPa)</th>
<th>Upper yield stress $R_{0.2}$ or $R_{0.5}$ (MPa)</th>
<th>Elongation $A_5$ (%)</th>
<th>Reduction $Z$ (%)</th>
<th>Impact energy $KU$ (J)</th>
<th>Impact toughness $KCU$ (J/cm²)</th>
<th>Brinell hardness HB</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>420</td>
<td>18 / 14</td>
<td>50 / 35</td>
<td>41 / 24</td>
<td>35 / 24</td>
<td>70 / 48</td>
</tr>
<tr>
<td>650</td>
<td>450</td>
<td>17 / 13</td>
<td>50 / 35</td>
<td>32 / 22</td>
<td>30 / 23</td>
<td>60 / 46</td>
</tr>
<tr>
<td>700</td>
<td>480</td>
<td>16 / 12</td>
<td>45 / 30</td>
<td>32 / 22</td>
<td>30 / 23</td>
<td>60 / 46</td>
</tr>
<tr>
<td>750</td>
<td>530</td>
<td>15 / 11</td>
<td>45 / 30</td>
<td>32 / 20</td>
<td>30 / 22</td>
<td>60 / 44</td>
</tr>
<tr>
<td>800</td>
<td>590</td>
<td>14 / 10</td>
<td>40 / 27</td>
<td>32 / 20</td>
<td>30 / 22</td>
<td>60 / 44</td>
</tr>
<tr>
<td>850</td>
<td>640</td>
<td>13 / 9</td>
<td>40 / 27</td>
<td>27 / 18</td>
<td>26 / 20</td>
<td>52 / 40</td>
</tr>
<tr>
<td>900</td>
<td>690</td>
<td>13 / 9</td>
<td>40 / 27</td>
<td>27 / 18</td>
<td>26 / 20</td>
<td>52 / 40</td>
</tr>
<tr>
<td>950</td>
<td>750</td>
<td>12 / 8</td>
<td>35 / 24</td>
<td>25 / 16</td>
<td>25 / 18</td>
<td>50 / 36</td>
</tr>
<tr>
<td>1000</td>
<td>810</td>
<td>12 / 8</td>
<td>35 / 24</td>
<td>25 / 16</td>
<td>25 / 18</td>
<td>50 / 36</td>
</tr>
<tr>
<td>1050</td>
<td>870</td>
<td>11 / 7</td>
<td>35 / 24</td>
<td>21 / 13</td>
<td>23 / 15</td>
<td>46 / 30</td>
</tr>
<tr>
<td>1100</td>
<td>930</td>
<td>11 / 7</td>
<td>35 / 24</td>
<td>21 / 13</td>
<td>23 / 15</td>
<td>46 / 30</td>
</tr>
</tbody>
</table>

Note. See notes to Table 2.6.11-1.
### Mechanical properties of forgings of alloyed carburizing steel

<table>
<thead>
<tr>
<th>Diameter or thickness of sample (mm)</th>
<th>Tensile strength $R_{m}$ (MPa)</th>
<th>Upper yield stress $R_{0.2}$ (MPa)</th>
<th>Elongation $A_{5}$ (%)</th>
<th>Reduction $Z$ (%)</th>
<th>Impact energy $K_{V}$ (J)</th>
<th>Impact energy $K_{U}$ (J)</th>
<th>Impact toughness $K_{C U}$ (J/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>800-1100</td>
<td>600</td>
<td>10 / 8</td>
<td>35 / 25</td>
<td>22 / 16</td>
<td>24 / 18</td>
<td>48 / 36</td>
</tr>
<tr>
<td></td>
<td>1000-1300</td>
<td>680</td>
<td>8 / 6</td>
<td>35 / 25</td>
<td>18 / 14</td>
<td>20 / 15</td>
<td>40 / 30</td>
</tr>
<tr>
<td></td>
<td>1050-1350</td>
<td>780</td>
<td>8 / 6</td>
<td>35 / 25</td>
<td>18 / 14</td>
<td>20 / 15</td>
<td>40 / 30</td>
</tr>
<tr>
<td>60</td>
<td>650-950</td>
<td>450</td>
<td>11 / 9</td>
<td>40 / 27</td>
<td>22 / 16</td>
<td>24 / 18</td>
<td>48 / 36</td>
</tr>
<tr>
<td></td>
<td>800-1100</td>
<td>550</td>
<td>10 / 8</td>
<td>35 / 27</td>
<td>22 / 16</td>
<td>24 / 18</td>
<td>48 / 36</td>
</tr>
<tr>
<td></td>
<td>950-1250</td>
<td>680</td>
<td>8 / 6</td>
<td>35 / 27</td>
<td>18 / 14</td>
<td>20 / 15</td>
<td>40 / 30</td>
</tr>
</tbody>
</table>

**Note.** See notes to Table 2.6.11-1.

If not specially specified by the River Register, the impact energy $K_{V}$ and $K_{U}$ or impact toughness ($K_{C U}$) shall be determined via impact testing at the manufacturer’s discretion. These are determined on specimens according to Figs. A10.2.8-2 and A10.2.8-1 of Appendix 10.

3. Where more than two or more tensile test specimens are taken from a forging, the variation in tensile strength $R_{m}$ (MPa) shall not exceed:

- **required $R_{m}$**: 70
  - $<600$
  - $600-900$: 100
  - $>900$: 120

4. The variation in hardness for an individual forging or in a batch of forgings at required $R_{m}$ (MPa) shall not exceed (HB):

- **required $R_{m}$**:
  - $<600$: 25
  - $600-900$: 35
  - $>900$: 42

### Heat treatment

2.6.12 All the forgings shall be suitably heat treated to obtain the required metal structure and mechanical properties as well as grain refining. The heat treatment procedure shall be chosen by the manufacturer proceeding from the chemical composition of steel, the purpose and dimensions of the forging. The following conditions shall be also observed:

The tempering temperature shall not be less than 550°C;

If a forging after being heat treated is subject to further heating during hot processing, it shall be reheat treated;

Where induction hardening, carburising or nitriding shall be carried out after machining, the forging shall be heat treated (either by full annealing or by normalizing and tempering) to a condition appropriate for this subsequent surface treatment;

If any straightening operation is performed after the final heat treatment, the forging shall be subject to subsequent stress relieving;

The method of heat treatment shall be stated in the quality control document.

#### Ultrasonic testing

2.6.13 Ultrasonic testing shall be carried out in accordance with 2.21 of Appendix 10.

#### Marking

2.6.14 The marking of steel forgings shall meet the requirements of 1.3.

### 2.7 STEEL CASTINGS

#### General requirements

2.7.1 Steel castings shall be manufactured and tested in accordance with the requirements of 2.7.2 – 2.7.11.

2.7.2 The requirements of the present Chapter are applicable to carbon and carbon-manganese steel castings used in hull and machine construction, the purpose of which is
established proceeding from their properties determined at room temperature.

2.7.3 The technical documentation for castings intended for service at low or elevated temperature, as well as castings of alloy steel with special properties (corrosion resistance, heat resistance, high temperature oxidation resistance, etc.) shall be submitted to the River Register for agreement and shall contain detailed information on the chemical composition, mechanical and special properties, heat treatment, methods and scope of testing.

2.7.4 Surface defects lying within machining allowances may be removed by machining.

2.7.5 Defects may be eliminated by welding in accordance with 7.6.3. Prior to carrying out weld repairs of large-sized defects alloy steel castings, castings for crankshafts and other essential components shall be heat treated in accordance with the requirements of 2.7.10. The welded spots are subjected to non-destructive testing.

Chemical composition

2.7.6 The chemical composition of steel for castings is established proceeding from the required mechanical and special properties. The castings shall be made from killed steel.

2.7.7 For carbon and carbon-manganese steel castings the chemical composition of ladle samples shall comply with the following overall limits in %:

<table>
<thead>
<tr>
<th>Element</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>0.40</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.60</td>
</tr>
<tr>
<td>Copper</td>
<td>0.30</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.50-1.60</td>
</tr>
<tr>
<td>Chromium</td>
<td>0.30</td>
</tr>
<tr>
<td>Sulphur</td>
<td>0.040</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.40</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.040</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.15</td>
</tr>
</tbody>
</table>

It is permitted to use castings provided that the chemical composition and mechanical properties are in compliance with GOST 977.

2.7.8 The content of grain refining components is to be reported in the ladle analysis.

Mechanical properties

2.7.9 Proceeding from the required minimum tensile strength $R_m$ the values of yield stress, percentage elongation, percentage area reduction and results of impact tests for carbon and carbon-manganese castings shall comply with the values specified in Table 2.7.9.

The tensile strength values obtained at tensile testing shall not exceed the required minimal values specified by Table 2.7.9 by more than 150 MPa and for castings mentioned in Note 1 for Table 2.7.9 – by more than 120 MPa.

<table>
<thead>
<tr>
<th>Tensile strength $R_m$ (MPa)</th>
<th>Upper yield stress $R_{p0.2}$ or $R_{p0.25}$ (MPa)</th>
<th>Elongation $A_5$ (%)</th>
<th>Reduction $Z$ (%)</th>
<th>Impact energy $K_U$ (J)</th>
<th>Impact toughness $K_CU$ (J/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400</td>
<td>200</td>
<td>25 / 28</td>
<td>40 / 45</td>
<td>25 / 32</td>
<td>25 / 30</td>
</tr>
<tr>
<td>440</td>
<td>220</td>
<td>22 / 26</td>
<td>30 / 45</td>
<td>20 / 28</td>
<td>22 / 27</td>
</tr>
<tr>
<td>480</td>
<td>240</td>
<td>20 / 24</td>
<td>27 / 40</td>
<td>18 / 25</td>
<td>20 / 25</td>
</tr>
<tr>
<td>520</td>
<td>260</td>
<td>18 / 22</td>
<td>25 / 40</td>
<td>15 / 20</td>
<td>17 / 22</td>
</tr>
<tr>
<td>560</td>
<td>300</td>
<td>15 / 20</td>
<td>20 / 35</td>
<td>12 / 18</td>
<td>15 / 20</td>
</tr>
<tr>
<td>600</td>
<td>320</td>
<td>13 / 18</td>
<td>20 / 35</td>
<td>10 / 18</td>
<td>12 / 17</td>
</tr>
</tbody>
</table>

Notes. 1. The elongation, reduction of area, impact energy and impact toughness mentioned in the denominator are established for castings of main (responsible) components (crankshafts, turbine parts, propellers).

2. The impact energy KV and KU or impact toughness (KCU) shall be determined via impact testing at the manufacturer’s discretion. These are determined on specimens according to Figs. A10.2.8-2 and A10.2.8-1 of Appendix 10.

3. For intermediate tensile strength values the minimal values of yield stress, elongation, reduction of area and impact energy or impact toughness may be determined by linear interpolation.
2.7.10 Heat treatment

To ensure the structure and mechanical properties required by Table 2.7.9, the castings shall undergo heat treatment. The heat treatment procedure shall be chosen by the manufacturer proceeding from the chemical composition, the purpose and shape of castings when meeting the following conditions:

The tempering temperature shall be not less than 500 °C;

The stress relief heat treatment of castings for components where dimensional stability and absence of internal stresses are of great importance, e.g. crankshafts, engine bedplates etc., shall be carried out at a temperature of not less than 550 °C followed by furnace cooling to 300 °C or lower;

2.7.11 Marking

The marking of steel castings shall meet the requirements of 1.3.

2.8 STEEL PROPELLER CASTINGS

General requirements

2.8.1 The requirements of the present Chapter apply to castings of solid-cast propellers, propeller blades and hubs of propellers with detachable blades made of carbon, low alloyed and alloyed steels. Requirements of 2.7 shall be met as applicable.

Alloy steel with chemical composition or mechanical properties not in compliance with requirements of 2.8.3 and 2.8.4 may be used. In this case steel corrosion fatigue tests results shall be submitted. Fatigue strength which is determined on the base of 10 cycles shall be not less than 75 MPa.

2.8.2 The surface of the castings shall undergo dye penetrant or magnetic particle testing. The pressure and suction surfaces of the blade as well as the transition zone between the blade and the hub or between the blade and the flange shall undergo testing by one of the above methods.

The scope and procedure of testing as well as the norms of permissible defects shall be in accordance with technical documentation agreed with the River Register.

The revealed defects may be rectified by machining or welding.

The places of defect rectification or welding spots shall undergo non-destructive testing. The dimensions and location of the welded defects shall be indicated in the drawing attached to the propeller casting quality control document.

Chemical composition

2.8.3 The chemical composition of steel castings for propellers shall comply with Table 2.8.3.

For all steel grades S and P content shall not exceed 0.035 % for each element.

Mechanical properties

2.8.4 The mechanical properties of steel for propellers are determined during the testing of specimens machined from samples cast either separately or integrally to the hub or the flange portion of the blade; they shall be in accordance with Table 2.8.4.

Heat treatment

2.8.5 Propeller castings shall be heat treated in conformity with Table 2.8.4. Stress relieving heat treatment shall not adversely affect the mechanical properties of the casting metal and its corrosion resistance. The heat treatment procedure is set by the manufacturer.

### Table 2.8.3

<table>
<thead>
<tr>
<th>Casting grade</th>
<th>Material</th>
<th>Maximum contents of elements (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Carbon steel</td>
<td>As per 2.7</td>
</tr>
<tr>
<td>2</td>
<td>Low-alloy steel</td>
<td>C 0.22  Si 0.5  Mn 2.0  Cr 0.9  Ni 2.0  Mo —  Cu 1.5</td>
</tr>
<tr>
<td>3</td>
<td>Alloy steel (martensite-ferrite class)</td>
<td>C 0.12  Si 0.6  Mn 1.0  Cr 13.0-17.0  Ni 2.0  Mo 0.2  Cu 1.5</td>
</tr>
<tr>
<td>4</td>
<td>Alloy steel (martensite-austenite class)</td>
<td>C 0.8  Si 0.6  Mn 2.0  Cr 13.5-17.0  Ni 3.0-5.0  Mo 1.0  Cu 1.5</td>
</tr>
<tr>
<td>5</td>
<td>Alloy steel (austenite class)</td>
<td>C 0.12  Si 2.0  Mn 1.6  Cr 16.0-20.0  Ni 8.0-11.0  Mo 0.5 —</td>
</tr>
</tbody>
</table>
### Mechanical properties for propeller steel

<table>
<thead>
<tr>
<th>Casting grade</th>
<th>Tensile test</th>
<th>Impact test</th>
<th>Supply conditions (heat treatment)</th>
<th>Temp. of test (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R_m$ (MPa)</td>
<td>$R_p0.2$ (MPa)</td>
<td>$A_5$ (%)</td>
<td>$Z$ (%)</td>
</tr>
<tr>
<td>1</td>
<td>As per 2.7</td>
<td>Normalization and tempering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>450</td>
<td>350</td>
<td>20</td>
<td>45</td>
</tr>
<tr>
<td>3</td>
<td>550</td>
<td>380</td>
<td>19</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>750</td>
<td>600</td>
<td>17</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>450</td>
<td>175</td>
<td>30</td>
<td>50</td>
</tr>
</tbody>
</table>

#### Chemical composition

2.9.2 The chemical composition of steel shall be determined by the manufacturer from each cast or ladle and shall comply with the requirements of technical specification agreed with the River Register. The maximum content of alloying and grain refining elements are stated in Table 2.9.2.

<table>
<thead>
<tr>
<th>Grade of steel</th>
<th>Content of elements (%), max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td>D, E</td>
<td>0.20</td>
</tr>
<tr>
<td>F</td>
<td>0.18</td>
</tr>
</tbody>
</table>

The chemical composition of steel shall be determined by the manufacturer from each cast or ladle and shall comply with the requirements of technical specification agreed with the River Register. Steel shall be fully killed and fine grain treated.

#### Heat treatment

2.9.3 The steel shall be quenched and tempered. This requirement does not apply to precipitation-hardening steel.

#### Mechanical properties

2.9.4 The mechanical properties of steel at tensile and impact testing shall conform to those stated in Table 2.9.4.

2.9.5 The marking shall meet the requirements of 1.3 and 2.2.6.

2.10 STEEL REINFORCEMENT

2.10.1 Requirements of the present Chapter apply to the following types of reinforcement for hulls of reinforced-concrete ships:

- Plain reinforcement of carbon steel of grades BCr3CN2 and BCr3nC2 GOST 5781, class A-I (A240);
- Die-rolled section of carbon steel of grades Cr5cn2 and Cr5nC2 GOST 5781, class A-II (A-300);
The mechanical properties of steel at tensile and impact testing

<table>
<thead>
<tr>
<th>Grade of steel</th>
<th>Mechanical properties at testing</th>
<th>To tension</th>
<th>To impact</th>
<th>( R_m ) or ( R_{p_0.2} ) (MPa)</th>
<th>( A_r ) (%)</th>
<th>Impact energy ( K_V ) (J)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D420, E420, F420</td>
<td>530 to 680</td>
<td>620</td>
<td>420</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D460, E460, F460</td>
<td>570 to 720</td>
<td>720</td>
<td>460</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D500, E500, F500</td>
<td>610 to 770</td>
<td>770</td>
<td>500</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D550, E550, F550</td>
<td>670 to 830</td>
<td>830</td>
<td>550</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D620, E620, F620</td>
<td>720 to 890</td>
<td>890</td>
<td>620</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D690, E690, F690</td>
<td>770 to 940</td>
<td>940</td>
<td>690</td>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Testing for Grade D steel shall be carried out at temperature –20 °C, E — at –40 °C, F — at –60 °C.

Note. \( L \) — for longitudinal specimen, \( T \) — for transverse specimen.


2.10.2 Reinforcing-bar steel that has undergone hardening and profiling by means of cold treatment as well as thermo-strengthening is not allowed for ordinary (non-pre-tensioned) reinforced-concrete.

2.10.3 For ships operating in extra inclement conditions (month average temperature of the most cold month below –20 °C) the use of semi-killed steel reinforcement is not allowed.

2.10.4 The use of grade 35ГС GOST 5781 steel reinforcement is forbidden for structures subject to variable or alternating loads (shipborne machinery foundations etc.).

2.10.5 Steel reinforcement of different grades may be used in the same cross-section of reinforced-concrete product provided that yield points differ by not more than 30 %.

2.10.6 Embedded items shall be made of killed and semi-killed steel which comply with the requirements of 2.2 related to welding hull structural steel; anchors of embedded items shall be made of steel which comply with the requirements of 2.10.1 – 2.10.5.

2.10.7 For pre-tensioned steel reinforcement of the ship structures the following shall be used:

1 High-tensile reinforcement wire of types B, Bp GOST 7348 and reinforcement ropes K-7 GOST 13840;

2 Thermo-strengthened reinforcement steel bars of classes Ar 800 and Ar 1000 GOST 10884;

3 Hot-rolled and thermo-strengthened reinforcement steel bars of class A-IV (A600) GOST 5781;

4 Hot-rolled reinforcement steel bars of classes (A300) and (A400) GOST 5781.

2.11 NODULAR GRAPHITE IRON CASTINGS

General requirements

2.11.1 The requirements of the present Chapter apply to nodular graphite iron castings used in hull and ship machinery construction, which purpose is established proceeding from their properties determined at room temperature.

2.11.2 The technical documentation for castings intended for service at low or elevated temperature shall be submitted to the River Register for agreement and shall contain detailed information on the chemical composition, mechanical and special properties, heat treatment, methods and scope of testing.

2.11.3 The castings shall be free from defects which would be prejudicial to their application in service. Repairing of defects by welding is not permitted. The surface defects may be removed by grinding.

Chemical composition

2.11.4 The chemical composition is set proceeding from the required mechanical properties of the castings. The chemical composition of ladle samples shall be reported in technical documents for the castings.
Mechanical properties

2.11.5 The mechanical properties of the castings shall conform to Table 2.11.5.

Table 2.11.5

<table>
<thead>
<tr>
<th>Composition of wire</th>
<th>Tensile strength $R_m$ (MPa)</th>
<th>Yield point $R_{e5}$ or $R_{p0.2}$ (MPa)</th>
<th>Elongation $A_5$ (%)</th>
<th>Brinell hardness HB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrite</td>
<td>370</td>
<td>230</td>
<td>17</td>
<td>120-180</td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>250</td>
<td>12</td>
<td>140-200</td>
</tr>
<tr>
<td>Ferrite / perlite</td>
<td>500</td>
<td>320</td>
<td>7</td>
<td>170-240</td>
</tr>
<tr>
<td></td>
<td>600</td>
<td>370</td>
<td>7</td>
<td>190-270</td>
</tr>
<tr>
<td>Perlite or post-tempering structure</td>
<td>800</td>
<td>480</td>
<td>2</td>
<td>250-350</td>
</tr>
</tbody>
</table>

While performing the tensile test of the casting material the tensile strength and percentage elongation shall be determined.

The minimum tensile strength shall conform to the norms stated in Table 2.11.5.

In order to determine intermediate tensile strength values minimum elongation and yield limit values may be obtained using the linear interpolation of the data stated in Table 2.11.5.

2.11.6 Where impact testing is required, the dimensions and type of specimen shall be in compliance with GOST 7293 or the technical documents agreed with the River Register.

2.11.7 The microstructure of the castings shall include not less than 90 % of nodular graphite. No flaked graphite is permitted.

Heat treatment

2.11.8 The castings shall be supplied in either as the cast or heat treated condition.

The necessity of heat treatment and the relevant procedure are determined by the manufacturer proceeding from the chemical composition, purpose and shape of the casting.

The stress relieving heat treatment shall follow the structure refining heat treatment prior to its machining.

2.11.9 If the local surface hardening is required, its procedure shall be agreed by the River Register.

Marking

2.11.10 The marking of nodular iron castings shall comply with the requirements of 1.3.

2.12 GREY IRON CASTINGS

General requirements

2.12.1 The requirements of the present Chapter apply to grey iron castings used in hull and machinery construction.

2.12.2 The castings shall be free from defects which would be prejudicial to their application in service. The surface defects may be removed by local grinding. The soundness of the casting shall be proved by non-destructive testing.

Chemical composition

2.12.3 The chemical composition is set by the manufacturer proceeding from the required mechanical properties of the castings. The chemical composition of ladle samples shall be reported in technical documents for the castings.

Mechanical properties

2.12.4 The required minimum tensile strength shall be in compliance with the technical documentation for the casting, but in any case it shall be not less than 200 MPa.

Heat treatment

2.12.5 Castings may be supplied in the cast or heat treated condition.

The necessity of heat treatment and the relevant procedure are determined by the manufacturer proceeding from the chemical composition, purpose and shape of the casting.

The stress relieving heat treatment shall follow the structure refining heat treatment prior to its machining.
Marking

2.12.6 The marking of grey iron castings shall comply with the requirements of 1.3.

2.13 MALLEABLE CAST IRON

General requirements

2.13.1 Malleable cast iron may be used for the manufacture of products for hull and machinery construction which are intended to operate at a temperature not exceeding 300 °C and the working pressure not exceeding 2 MPa.

2.13.2 The chemical composition, mechanical properties and scope of testing of items made of malleable cast iron shall comply with the technical documents agreed by the River Register and proceeding from the intended use of castings.
3 COPPER AND COPPER-BASE ALLOYS

3.1 SEMI-MANUFACTURED PRODUCTS OF COPPER AND COPPER-BASE ALLOYS

General requirements

3.1.1 The requirements of the present Chapter apply to semi-manufactured products of copper and copper-base alloys (rolled, forged, drawn, press-formed etc.) and castings which are used in hull and machinery construction.

3.1.2 The chemical composition and mechanical properties of copper and copper-base alloy products such as pipes, plates, bars, rolled sections, forgings and castings shall comply with the requirements of appropriate national standards1 and technical documents approved by the River Register.

For each batch the following shall be determined:

- Chemical composition (heat analysis);
- Mechanical properties ($R_m$, $R_{0.2}$, $A$);
- Technological tests.

Heat exchanger tubes made of CuZn alloy shall undergo mercury nitrate or ammonium nitrate testing, flattening and expanding testings, microstructure investigation and hydraulic testing.

The average grain size shall be 0.01 to 0.05 mm.

Test pressure shall be set according to the technical documents. The test pressure for heat exchanger tubes shall be 5 MPa and for tubes (bushes) on propeller shaft platting — 2 MPa.

When choosing copper-base alloys, the required level of mechanical properties at room or elevated temperatures, corrosion resistance and other properties determined by their application shall be considered.

Supply condition

3.1.3 The heat treatment procedure shall be determined by the manufacturer proceeding from the required mechanical properties of copper and copper-base alloys semi-manufactured products. The method of heat treatment shall be stated in the quality control document.

Rolled semi-manufactured products made of CuZn alloys (brass) shall be annealed for stress relieving.

Products in solid and semi-solid condition may be used only if in compliance with the technical documents approved by the River Register and on condition that the justified data is submitted.

3.1.4 The semi-finished products and the castings shall be free from defects prejudicial to their proper operation as per their application.

Marking

3.1.5 The marking of semi-manufactured products and castings of copper and copper-base alloys shall comply with the requirements of 1.3.

3.2 PROPELLER CASTINGS

General requirements

3.2.1 The requirements of the present Chapter apply to castings of solid-cast propell-
3 Copper and Copper-Base Alloys

3.2.2 Casting surfaces shall undergo dye penetrant and visual inspection. Non-destructive testing to be conducted on castings for checking the absence of internal defects.

The revealed defects may be rectified by machining or welding.

The places of defect rectification and/or welding spots shall undergo non-destructive testing.

Stresses arisen due to welding of defects shall be relieved.

Welding of defects shall be performed by welders who has got the admission Certificate.

The dimensions and location of the welded defects shall be indicated in the drawing attached to the propeller casting quality control document.

Chemical composition

3.2.3 The chemical composition shall meet the requirements of Table 3.2.3.

Table 3.2.3
Typical chemical composition of steel alloys used for propeller castings

<table>
<thead>
<tr>
<th>Chemical element</th>
<th>Components content (%) in alloy of grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Cu</td>
<td>55-62</td>
</tr>
<tr>
<td>Al</td>
<td>0.5-3.0</td>
</tr>
<tr>
<td>Mn</td>
<td>0.5-4.0</td>
</tr>
<tr>
<td>Ni</td>
<td>≤1.0</td>
</tr>
<tr>
<td>Fe</td>
<td>0.5-2.5</td>
</tr>
<tr>
<td>Zn</td>
<td>Residue</td>
</tr>
<tr>
<td>Sn</td>
<td>max 1.5</td>
</tr>
<tr>
<td>Pb</td>
<td>max 0.5</td>
</tr>
</tbody>
</table>

Note. The total content of admixtures of any grade to be agreed by the River Register.

Unless otherwise specified the present Chapter, zinc content in alloys of grades 1 and 2 calculated according to the formula in per cent

\[ C_{Zn} = 100 - 100 Cu / (100 + A) \]  

shall not exceed 45%.

In formula (3.2.3):

- \( Cu \) — copper content in the alloy, %;
- \( A \) — parameter of the alloy:
  \[ A = 1Sn + 5Al - 0,5Mn - 2,3Ni - 0,1Fe; \]
- \( Sn, Al, Mn, Ni, Fe \) — content of tin, aluminium, manganese, nickel and iron content in the alloy, %.

The content of Alpha phase in alloys of grades 1 and 2 shall be not less than 25%. Alpha phase content is determined by the manufacturer.

Alloys with the base elements content exceeding the specified limits, as well as alloys with different chemical composition compared to specified above, may be used provided that their properties in expected operating conditions are as good as the properties of alloys with chemical composition specified above.

Mechanical properties

3.2.4 The mechanical properties of alloys for propellers are determined during the testing of specimens machined from samples cast separately; they shall be in accordance with Table 3.2.4.

Table 3.2.4
Mechanical properties for propeller alloys

<table>
<thead>
<tr>
<th>Alloy grade</th>
<th>Yield point ( Rm ) or ( R_{p0.2} ) (MPa)</th>
<th>Tensile strength ( Rm ) (MPa)</th>
<th>Elongation ( A_5 ) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>175</td>
<td>440</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>175</td>
<td>440</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>245</td>
<td>590</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>275</td>
<td>630</td>
<td>18</td>
</tr>
</tbody>
</table>

When testing specimens machined from samples integrally cast or taken directly from the casting, mechanical properties may be up to 30% lower than those specified in Table 3.2.4.

Marking

3.2.5 The marking of propeller castings shall comply with the requirements of 1.3.
4 ALUMINIUM ALLOYS

4.1 WROUGHT ALUMINIUM ALLOYS

General requirements

4.1.1 The requirements of the present Chapter apply to aluminium alloy forgings, punchings, rods, sections, pressed panels and plates of thickness exceeding 1.5 mm which are intended for hull and machinery construction.

4.1.2 Plates, sections, forgings, punchings and panels shall be free from defects prejudicial to their proper application.

All semi-manufactured products of the batch shall undergo visual examination.

The manufacturing process is to ensure that the products are free from internal or surface defects.

Metallographic examination and non-destructive testing of semi-manufactured products for soundness shall be performed according to the technical documentation approved by the River Register.

Mechanical properties

4.1.3 Determined during the testing of specimens mechanical properties of wrought aluminium alloy semi-manufactured products shall comply with the requirements of Table 4.1.3.

Chemical composition

4.1.4 The chemical composition of wrought aluminium alloys shall comply with the Table 4.1.4.

The total content of admixtures not indicated in the Table is not to exceed 0.1 %.

Titanium and zirconium may be partially or totally substituted by other grain refining elements.

<table>
<thead>
<tr>
<th>Alloy grade</th>
<th>Type of semi-finished product</th>
<th>Tensile strength $R_m$ (MPa)</th>
<th>Yield point $R_p$ (MPa)</th>
<th>Elongation $A_5$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Plates</td>
<td>200</td>
<td>80</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Sections</td>
<td>180</td>
<td>80</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>2 Plates thickness $t$ (mm) ≤ 10</td>
<td>270</td>
<td>120</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>&gt; 10</td>
<td>260</td>
<td>110</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Sections</td>
<td>260</td>
<td>110</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>3 Plates thickness $t$ (mm) ≤ 10</td>
<td>270</td>
<td>125</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>&gt; 10</td>
<td>260</td>
<td>120</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Sections, bars</td>
<td>250</td>
<td>120</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>4 Plates thickness $t$ (mm) ≤ 5</td>
<td>310</td>
<td>155</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>&gt; 5</td>
<td>330</td>
<td>175</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Sections, bars, panels</td>
<td>330</td>
<td>205</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Forgings, stampings</td>
<td>280</td>
<td>125</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>6 Plates, stampings (cold hardened)</td>
<td>200</td>
<td>100</td>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

Heat treatment

4.1.5 Proceeding from the required mechanical properties aluminum alloy semi-manufactured products shall be supplied in hot-rolled, hot-pressed or annealed condition.

The supply condition shall be indicated in the quality control document for product.

Application of products in semi-hardened and hardened condition in welded structures is subject to is allowed on condition that the required properties of these structures are provided.

Performing of process operations accompanied with local heating, cold hardening and deformation of structures shall not bring to change of properties being prejudicial to proper application of the products.
4 Aluminium Alloys

Table 4.1.4

Chemical composition of wrought aluminium alloys

| Alloy grade | Chemical composition % | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | Basic elements | Other elements | | | | |
| | Mg | Mn | Ti | Zr | Si | Fe max. | Cr max. |
| 1 | 2.7-3.8 | ≤0.6 | ≤0.2 | — | ≤0.80 | 0.50 | 0.35 |
| 2 | 4.0-4.9 | 0.3-1.0 | ≤0.2 | — | ≤0.40 | 0.40 | 0.25 |
| 3 | 4.3-5.8 | 0.2-0.8 | 0.02-0.2 | — | ≤0.50 | 0.50 | 0.35 |
| 4 | 5.5-6.5 | 0.8-1.1 | — | 0.02-0.2 | ≤0.40 | 0.40 | — |
| 5 | 5.8-6.8 | 0.5-0.8 | 0.02-0.1 | — | ≤0.40 | 0.40 | — |
| 6 | 0.4-1.5 | 0.2-1.0 | ≤0.2 | — | 0.6-1.6 | 0.50 | — |

1 For all grades aluminium content shall not exceed the residual values.
2 For all grades copper content — max 0.10 %, zinc — max 0.20 %.

Marking

4.1.6 The marking of plates, sections, rods, forgings, punchings, stampings and panels made of wrought aluminium alloys shall be made according to 1.3.

The manufacturer shall have the marking system which allows to trace back the whole manufacturing procedure of the material and to determine the origin of the relevant batch.

4.2 CAST ALUMINIUM ALLOYS

General requirements

4.2.1 The requirements of the present Chapter apply to parts and structures of cast aluminium alloys for hull and machinery construction.

4.2.2 The castings shall be free from defects which would be prejudicial to their strength and application in service.

Surface defects may be removed by grinding or machining if they are within the dimensional tolerances specified by the technical documentation approved by the River Register.

Casting defects may be rectified by welding in accordance with the procedure developed according to requirements of Section 7 of the present Part of the Rules and agreed with the River Register.

Where the material of the castings shall undergo hydraulic tightness pressure tests, the working pressure in the tested chamber and the test pressure values shall be stated in the casting drawing.

Non-destructive testing shall be conducted on castings intended for items subject to high loads for checking the absence of internal defects.

Chemical composition and mechanical properties

4.2.3 The chemical composition and mechanical properties of products cast of aluminium alloys are to meet the requirements of Table 4.2.3.

In case of die or chill casting the mechanical properties required and the sampling procedure shall comply with the technical documents agreed by the River Register.

Corrosion resistance check shall be performed for alloys differing in chemical composition from those given in Table 4.2.3. according to applicable national standards.

Heat treatment

4.2.4 If aluminium alloy castings are heat treated, the type of heat treatment is stated by the manufacturer and recorded in quality control document.

Marking

4.2.5 The marking of the castings shall comply with the requirements of 1.3.

1 GOST 9.908, GOST 9.913
### Table 4.2.3

<table>
<thead>
<tr>
<th>Casting grade</th>
<th>Chemical composition %</th>
<th>Mechanical Properties</th>
<th>Condition of supply</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic elements¹</td>
<td>Allowable residual elements² (max)</td>
<td>Tensile strength $R_m$ (MPa)</td>
</tr>
<tr>
<td>1</td>
<td>2.0-4.5</td>
<td>0.05-0.3 0.05-0.6 0.50 0.20 0.20</td>
<td>140 210</td>
</tr>
<tr>
<td>2</td>
<td>4-6</td>
<td>0.5-0.3 0.05-0.5 0.50 0.10 0.20</td>
<td>150</td>
</tr>
<tr>
<td>3</td>
<td>9-11.5</td>
<td>≤1.3 ≤0.4 0.50 0.10 0.15</td>
<td>270</td>
</tr>
<tr>
<td>4</td>
<td>≤0.5</td>
<td>7-11 0.15-0.5 0.60 0.30 0.15</td>
<td>150</td>
</tr>
<tr>
<td>5</td>
<td>10-13.5</td>
<td>≤0.5 ≤0.5 0.60 0.30 0.15</td>
<td>150</td>
</tr>
</tbody>
</table>

¹For all grades aluminium content shall not exceed the residual values.
²For all grades copper content — max 0.10 %. 
5 MATERIALS USED FOR LNG CARRIERS

5.1 GENERAL REQUIREMENTS

5.1.1 The requirements of this Section apply to rolled plates and sections, pipes, forgings and castings intended for:

.1 Cargo tanks and process pressure vessels operated at the design temperature of 0 °C and above;

.2 Hull structures providing an additional barrier, cargo tanks, process pressure vessels operated at the design temperature of 0 to –55 °C;

.3 Hull structures providing an additional barrier, cargo tanks, process pressure vessels operated at the design temperature of –5 to –165 °C;

.4 Cargo and process pipelines operated at the design temperature of –165 to 0 °C;

.5 Hull structures not providing an additional barrier and not specified in 5.1.1.1 – 5.1.1.3, that can be exposed to negative temperature due to cargo carried at such temperatures.

Materials specified in 5.1.1.3 – 5.1.1.4 may be used at the design temperature below –165 °C on condition that values of structure properties are provided according to the Rules. Detailed information on the chemical composition, mechanical and special properties, heat treatment, scope and methods of castings testing shall be submitted to the River Register.

5.1.2 If the design temperature of hull structures is below –5 °C, steel grade and maximum thickness shall be determined from Table 5.1.2.

If minimum design temperature of hull structures is below –30 °C, the temperature of impact bending test as specified in 5.3.3 shall be lower than the design temperature for 5 °C.

<table>
<thead>
<tr>
<th>Minimum design temperature of hull structures (°C)</th>
<th>Maximum thickness if steel plates (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>–5</td>
<td>15</td>
</tr>
<tr>
<td>–10</td>
<td>*</td>
</tr>
<tr>
<td>–20</td>
<td>*</td>
</tr>
<tr>
<td>–30</td>
<td>*</td>
</tr>
</tbody>
</table>

* This grade of steel is not permitted.

5.1.3 Design temperature of full or partial additional barrier is taken to be equal to the cargo temperature at atmospheric pressure.

Main barrier design temperature for cargo tanks not having additional barrier is taken to be equal to the cargo temperature.

5.1.4 If hull structures provide additional barrier, materials used for manufacture of hull structures shall be selected taking into account requirements of 5.3.1 – 5.3.2.

If the additional barrier is not integral to a hull structure, a material used for manufacture of the additional barrier shall be selected taking into account requirements of 5.3.1 – 5.3.2 and 5.4.1 – 5.4.2 in accordance with the temperature of the cargo carried.

If the additional barrier is provided by a deck plating section or the outer shell plating, a material used for manufacture of the additional barrier shall be selected taking into account requirements of 5.3.1 – 5.3.2.

5.1.5 If materials heat treatment is carried out after welding, properties of heat-treated...
base metal shall comply with requirements of 5.2.3, 5.2.4, 5.3.3, Table 5.4.1, and Table 5.5.1, properties of welded joint after treatment shall comply with requirements of section 7 and 8 of this Part of the Rules.

5.2 MATERIALS TO BE USED AT DESIGN TEMPERATURES OF 0 °C AND ABOVE

Chemical composition

5.2.1 Rolled plates and sections, forgings used for cargo tanks, process pressure vessels, for design temperature of 0 °C and above shall be made from carbon manganese killed steel. Fine grained steel shall be used for materials with wall thickness exceeding 20 mm.

Heat treatment

5.2.2 Steel shall be heat treated i.e. normalized or quenched and tempered. Rolling with controlled temperature may be used instead of normalization or quenching and tempering.

Tests

5.2.3 Each plate shall undergo tensile and impact testing. Rolled sections and forgings are submitted for testing in batches. Designed minimum yield stress shall not exceed 410 MPa.

5.2.4 Impact tests for steel plates are conducted on transverse specimens and impact tests for steel sections and forgings are conducted on longitudinal specimens. Minimum average value of the impact energy $KV$ for steel plates is $27 \, \text{J}$, for steel sections and forgings — $41 \, \text{J}$. Test temperature is dependent on the material thickness as per Table 5.2.4;

<table>
<thead>
<tr>
<th>Thickness of the material S (mm)</th>
<th>Test temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 20</td>
<td>0</td>
</tr>
<tr>
<td>Over 20 to 40</td>
<td>−20</td>
</tr>
</tbody>
</table>

5.2.5 Seamless pipes and fittings shall comply with the requirements of 2.4. Welded pipes with longitudinal and spiral welds may be used on condition that required properties of pipes are provided.

5.3 MATERIALS TO BE USED AT DESIGN TEMPERATURES OF 0 TO MINUS 55 °C

Chemical composition

5.3.1 Rolled plates and sections, forgings used for hull structures providing an additional barrier, cargo tanks, process pressure vessels, for design temperature of 0 to minus 55 °C shall be made from fine-grained, aluminum treated carbon manganese killed steel.

The chemical composition of steel based on ladle analysis shall comply with the following maximum values in per cent:

- Carbon.............. 0.16
- Chromium.......... 0.25
- Silicon .......... 0.10–0.50
- Molybdenum..... 0.08
- Manganese 0.70–1.60
- Copper ............. 0.35
- Sulphur.......... 0.035
- Columbium....... 0.05
- Nickel.............. 0.80
- Vanadium......... 0.10

The carbon content may be increased to 0.18 provided that the design temperature is not below minus 40 °C.

Heat treatment

5.3.2 Steel shall be heat treated i.e. normalized or quenched and tempered.

Rolling with controlled temperature may be used instead of normalization or quenching and tempering. Specially treated steel or steel which complies with the requirements of 5.4.1 – 5.4.2 shall be used for materials more than 25 mm thick tested at temperatures of minus 60 °C and below.

Tests

5.3.3 Each plate shall undergo tensile and impact testing. Rolled sections and forgings are submitted for testing in batches.

Impact tests for steel plates are conducted on transverse specimens and impact tests for steel sections and forgings are conducted on longitudinal specimens. Minimum average value of the impact energy $KV$ for steel plates is $27 \, \text{J}$, for steel sections and forgings — $41 \, \text{J}$. Test temperature is dependent on the material thickness as per Table 5.3.3;
Impact energy values for materials more than 40 mm thick shall be agreed with the River Register.

### Table 5.3.3

<table>
<thead>
<tr>
<th>Thickness of the material S (mm)</th>
<th>Test temperature (°C) lower than the design value for or*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 25</td>
<td>5</td>
</tr>
<tr>
<td>Over 25 to 30</td>
<td>10</td>
</tr>
<tr>
<td>30 to 35</td>
<td>15</td>
</tr>
<tr>
<td>35 to 40</td>
<td>20</td>
</tr>
</tbody>
</table>

* Whichever is lower.

Materials for cargo tanks and their components subjected to stress relief heat treatment after welding, may be tested at temperature lower than the design temperature for 5 °C or at temperature of minus 20 °C, whichever is lower.

### 5.4 MATERIALS TO BE USED AT DESIGN TEMPERATURES OF MINUS 55 TO MINUS 165 °C

#### 5.4.1

The chemical composition, heat treatment procedure, impact test temperature and minimum average value of the impact energy for hull structures materials providing additional barrier, cargo tanks, process pressure vessels for the design temperature below minus 55 and to minus 165 °C are specified in Table 5.4.1.

#### 5.4.2

The impact test temperature for steels with thickness of 25 mm or less is taken from Table 5.4.1, for steels of thickness exceeding 25 mm — from Table 5.4.2. Thickness exceeding 25 mm is not permitted for steels with 9% of Ni, austenitic stainless steels and aluminium alloys.

Each plate shall undergo tensile and impact testing. Rolled sections and forgings are submitted for testing in batches. Impact tests for steel plates are conducted on transverse specimens and impact tests for steel sections and forgings are conducted on longitudinal specimens.

Test temperature shall not exceed the values specified in Tables 5.4.1 – 5.4.2.

### Table 5.4.2

<table>
<thead>
<tr>
<th>Thickness of the material S (mm)</th>
<th>Test temperature lower than the design values for (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 25 to 30</td>
<td>10</td>
</tr>
<tr>
<td>30 to 35</td>
<td>15</td>
</tr>
<tr>
<td>35 to 40</td>
<td>20</td>
</tr>
</tbody>
</table>

### Table 5.4.1

<table>
<thead>
<tr>
<th>Minimum rated temperature (°C)</th>
<th>Chemical composition and heat treatment</th>
<th>Impact testing impact energy (°C)</th>
<th>Plates</th>
<th>Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>−60</td>
<td>Steel with Ni content of 1.5 %, normalized.</td>
<td>−65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>−65</td>
<td>Steel with Ni content of 2.25 %, normalized or normalized and tempered(^1)</td>
<td>−70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>−90</td>
<td>Steel with Ni content of 3.5 %, normalized or normalized and tempered(^1)</td>
<td>−95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>−105</td>
<td>Steel with Ni content of 5 %, normalized or normalized and tempered(^1),(^2)</td>
<td>−110</td>
<td>27</td>
<td>41</td>
</tr>
<tr>
<td>−165</td>
<td>Steel with Ni content of 9 %, two-fold normalized and tempered or quenched and tempered Austenitic steel 08X18H10, 03X19H10, 08X17H12M2, 08X18H10T and 08X18H11B, solution treated(^1)</td>
<td>−196</td>
<td>No test required</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Lower minimum design temperature may be permitted for quenched and tempered steel.

\(^2\) Steel after threefold heat treatment may be used at temperature down to −165 °C on condition that the impact tests are conducted at temperature of −196 °C.

\(^3\) Impact tests may be omitted.
5.5 MATERIALS INTENDED FOR PIPES TO BE USED AT THE DESIGN TEMPERATURE OF 0 TO MINUS 165 °C

5.5.1 The chemical composition, heat treatment procedure, impact test temperature and minimum average value of the impact energy for materials of cargo and process pipelines operated at the design temperature of 0 to minus 165 °C, are specified in Table 5.5.1.

5.5.2 Each batch of pipes, forgings and castings shall undergo tensile and impact testing. The test shall be carried out on the longitudinal samples.

5.5.3 Welded pipes with longitudinal and spiral welds may be used on condition that required operational properties of pipes are provided.

Test temperature for valves and fittings of pipelines undergone stress relieving heat treatment shall be equal to the temperature required for testing of adjacent tank plating considering the plating thickness.

5.6 TESTING OF INSULATION MATERIALS

5.6.1 Insulation materials shall be tested to determine their properties and mechanical characteristics with respect to:
- Compatibility with the cargo;
- Solvability in the cargo;
- Absorption of the cargo;
- Shrinkage;
- Ageing;
- Porosity;
- Density;
- Mechanical properties;
- Thermal expansion;
- Wear;
- Adhesion properties;
- Thermal conductivity;
- Vibration resistance;
- Non-combustibility and flame spreading.

In addition, the following properties of insulation materials for cargo tanks with inner insulation shall be tested:
- Adhesion properties;
- Resistance to compression caused by cargo pressure;
- Resistance to fatigue crack propagation;

---

<table>
<thead>
<tr>
<th>Minimum rated temperature (°C)</th>
<th>Chemical composition and heat treatment</th>
<th>Test temperature (°C)</th>
<th>Minimum average value of the impact energy (J)</th>
</tr>
</thead>
<tbody>
<tr>
<td>−55</td>
<td>Fine-grained, aluminum treated carbon manganese killed steel. Normalization or other heat treatment(^2) upon agreement with the River Register</td>
<td>T(^1)</td>
<td>27</td>
</tr>
<tr>
<td>−65</td>
<td>Steel with Ni content of 2.25 %, normalized or normalized and tempered(^2)</td>
<td>−70</td>
<td>34</td>
</tr>
<tr>
<td>−90</td>
<td>Steel with Ni content of 3.5 %, normalized or normalized and tempered(^2)</td>
<td>−95</td>
<td></td>
</tr>
<tr>
<td>−165</td>
<td>Steel with Ni(^3) content of 9 %, two-fold normalized and tempered or quenched and tempered Austenitic steel 08X18H10, 03X19H10, 08X17H12M2, 08X18H10T and 08X18H11B, solution treated(^4) Aluminium alloy AMr4,5, annealed</td>
<td>−196</td>
<td>41</td>
</tr>
</tbody>
</table>

\(^1\) Test temperature T shall be −20 °C or 5 °C lower than the minimum design temperature, whichever is lower.

\(^2\) Lower minimum design temperature may be permitted for quenched and tempered steel.

\(^3\) This steel is not used for castings.

\(^4\) Impact tests may be omitted.
Compatibility with cargo components and any other agents which can contact with the insulation in process of the ship operation;
Influence of the zone and of the water pressure on the insulation;
Gas de-absorption.
Testing of specified insulation materials shall be conducted at temperatures from maximum to 5 °C lower than minimum design temperature, but not less than –196 °C.

5.6.2 Insulation materials technical documents shall include the manufacture process, storage and assembly conditions, quality control methods and determination of the degree of solar radiation harmful effect.
6 NON-METALLIC MATERIALS

6.1 GENERAL REQUIREMENTS

6.1.1 Requirements of the present Section apply to non-metallic materials used in hull and machinery construction for the manufacture of structures and parts.

6.1.2 Unless otherwise specified, all plastics and materials of organic origin as well as structures and items incorporating them shall meet the following requirements:

1. Be assessed for combustibility, flame propagation, combustibility and fire resistance according to Appendices 1 – 5;

2. Not to release explosive gases at temperature exceeding their operation temperature;

3. To ensure reliable operation of structures and items on the open deck at temperatures from –40 to +70 °C and in the inside spaces of the ship at temperatures from –10 to +70 °C, unless service conditions provide for lower or higher operating temperatures;

4. To resist embrittlement in service and to prevent a decrease of mechanical properties by more than 30 % in comparison with the original values;

5. To resist decay and destruction by fungi as well as not to affect adversely the materials with which they come into contact.

6.1.3 Inside spaces finishes shall undergo tests for combustibility, flame spreading, inflammability and fire resistance according to Appendices 1 – 5 and nontoxicity test according to GOST 12.1.044.

6.2 REINFORCED CONCRETE

General requirements

6.2.1 The ship compartments used for the storage of oil products shall be manufactured of oil-tight reinforced concrete.

6.2.2 Reinforcement for reinforced-concrete ships hulls shall be chosen according to the requirements of 2.10.1 – 2.10.5.

Concrete

6.2.3 For hulls of floating cranes and carriers hull structural concrete of at least B40 class as per GOST 26633 shall be used, for other ships — of B30 class as per GOST 26633.

A concrete class means a concrete grade with regard to compression strength.

6.2.4 A concrete class with regard to frost-resistance for hull elements subject to moistening (bottom, sides, open parts of deck, watertight bulkhead, ballast compartments etc.) shall be assigned according to Table 6.2.4 depending on climate conditions of an area where a ship is supposed to operate. A concrete grade for non-moistened hull elements and superstructures shall be at least F50 as per GOST 26633.

6.2.5 Tests of hull structural concrete for the determination of the strength parameters, tightness, frost-resistance are carried out in accordance with national standards.

For ships with a prolonged period of construction concrete strength parameters may be

1 GOST 10180, GOST 12730.5, GOST 10060.0
### Table 6.2.4

<table>
<thead>
<tr>
<th>Climate conditions</th>
<th>Frost-resistance grade at a number of frost and thaw cycles during winter period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>up to 50</td>
</tr>
<tr>
<td>Temperate</td>
<td>F50</td>
</tr>
<tr>
<td>Inclement</td>
<td>F100</td>
</tr>
<tr>
<td>Extra inclement</td>
<td>F150</td>
</tr>
</tbody>
</table>

**Note.** Temperate climate conditions are determined by a month average temperature of the most cold month from 0 to –10°C, inclement conditions — from –10 to –20°C, extra inclement — bellow –20°C.

determined at the age of 60 and 90 days (GOST 10180).

6.2.6 If concrete of the same mix has been normally cured and steam-cured, tightness and frost-resistance tests may be carried out only for steam-cured concrete.

6.2.7 At construction of a series of ships using concrete of the same mix, curing conditions and strength parameters, one test of frost-resistance for several ships may be carried out.

6.2.8 Where a project provides checking of concrete strength on various terms differing from 28 days period, samples of each batch of concrete shall be taken and tested for each term.

6.2.9 Cement content both in heavy-weight and light-weight concrete according to GOST 25192 shall be at least 450 kg/m³.

In concrete for closed decks and bulkheads cement content may be reduced by 15 % from the above value provided that the resulting concrete meets the requirements of 6.2.3 – 6.2.5.

6.2.10 Hull structural concrete shall fill the mould (decking) and not to laminate at a chosen method of laying as well as shall not produce shrinkage cracks in the assigned process of curing.

6.2.11 For concreting of intersectional joints fine-grain (sand) concrete may be used.

### Concrete mix components

6.2.12 For making hull structural concrete Portland shall be used (ordinary, high-early-strength, sulfate-resistant) of at least grade 400 according to GOST 10178.

For concreting butts and sealing of reach-through holes gypsum-alumina concrete of at least grade 400 may be used as well.

For ships intended for operation in seawater concrete shall be made using sulphate-resistant Portland only of grade not less than 400.

6.2.13 Cement properties shall ensure the manufacture of hull structural concrete of the required grade provided that content of the cement is according to 6.2.9.

6.2.14 Cement shall be used only after checking of its physical and mechanical properties in accordance with national standards1. The period between the mentioned check and the utilization of cement shall not exceed 2 months for ordinary cement and 1 month for high-early-strength one.

6.2.15 As a coarse concrete aggregate for hull structural heavy-weight concrete graded breakstone from crushed hard rock or graded gravel of natural origin shall be used which meet the requirements of GOST 8267 related to materials for hull structural concrete.

6.2.16 As a coarse concrete aggregate for hull structural light-weight (claydite) concrete claydite gravel with a density of 600 – 800 kg/m³ in freely bulked condition and water absorption of not more than 15 % for 2 hours shall be used.

6.2.17 The size of concrete aggregate grains shall not exceed 20 mm or 0.25 of the smallest size of an element to be concreted, it shall also be less than minimum distance between parallel reinforcement bars.

6.2.18 As a fine concrete aggregate for hull structural concrete coarse or medium natural quartz or feldspar sands and crushed-stone or

---

1 GOST 310.1, GOST 310.2, GOST 310.3
gravel screenings shall be used which comply with requirements of GOST 26633.

6.2.19 Water for preparing hull structural concrete shall comply with requirements of GOST 23732.

6.2.20 In order to increase frost-resistance, tightness, improve technical qualities of a concrete mix, reduction the cement consumption, as well as to allow concreting at negative ambient temperatures, special additives may be added into the concrete mix.

6.2.21 For the rectification of minor defects the use of glass-reinforced plastics and epoxy-based plastic concrete as well as cement colloid glues.

Pre-tensioned reinforced concrete

6.2.22 Pre-tensioned structures shall be made of heavy-weight concrete of at least class B40 and light-weight concrete of at least class B30.

Concrete for filling of ducts shall be of at least class B30.

To the moment of transition of tension force to the concrete the latter shall have a strength not less than 70% of that corresponding to the grade as per GOST 26633.

6.2.23 Pre-tensioned reinforcement of the ship structures shall be assigned in accordance with requirements of 2.10.7.

6.3 GLASS-REINFORCED PLASTICS

6.3.1 Items made of glass-reinforced plastic shall not have delaminations, cavities, extraneous impurities and other defects which can be detected by means of non-destructive tests and would be prejudicial to their proper application in service.

Glass-reinforced plastic quality may be verified by destructive method.

When performing tests the following parameters shall be determined: tensile strength at tension and compression, Young’s modulus of elasticity at tension, compression and bending and relative mass glass content.

The value of mechanic properties is determined as arithmetic mean of test results of five specimens taken from one sample in warp and weft shoot directions.

In case of standard approval of glass-reinforced plastic in accordance with requirements of Appendix 10 the following parameters shall be determined: ageing degree, resistance to oil and sea water. Each of the tests specified shall be carried out on three specimens.

Requirements for hull material

6.3.2 As a binder for the manufacture of glass reinforced plastics and joining the hull structures cold-cured resins shall be used, e. g. polyester resins, epoxy resins, etc.

6.3.3 The resin type and binder preparation procedure shall be stated in engineering process for manufactured structures.

6.3.4 The resins used shall be self-extinguishing, i.e. not sustaining combustion when removed from fire. Self-extinguishing resins may be used only for outer layers, or surfaces may be coated with non-inflammable paints.

6.3.5 When additives or extenders are added to the resin during manufacture, its properties such as inflammability degree, corrosion resistance etc. shall be kept; strength and elasticity characteristics shall not be reduced by more than 10% of the designed values.

6.3.6 For the manufacture of glass-reinforced plastics as reinforcement materials may be used glass-fibre materials of different types as well as their combinations — cloths, plaits, mats etc.

6.3.7 Glass-fibre materials shall be made of alkali-free glass and treated with hydrophobic adhesive compounds. Application of glass-fibre materials non-treated with hydrophobic adhesive compounds shall be well-grounded.

For ships up to 15 m long alkali glass may be used when it is impregnated with hydrophobic adhesive compounds.

Glass-fibre materials are to be free from glass fibre sizers (paraffin, oil etc.).
6.3.8 Glass reinforced plastics based on cold-hardened resins with different reinforcement materials shall have physical and mechanical properties that provide the hull strength and rigidity specified in the design technical documentation.

6.3.9 After a glass reinforced material specimen has been kept in fresh water for at least 6 months in unloaded condition, the lower tensile or compression strength of the material shall be reduced by more than 20%. Prolonged exposure of glass-reinforced material to water may be replaced by immersing the specimen in boiling fresh water for 2 hours.

Fatigue strength which is determined according to test results on non-notched specimens on the base of $10^7$ cycles at symmetric loading, shall be not less than 25% of the lower limits of the tensile strength of the material.

6.3.10 If glass content in glass reinforced plastics differs from the design value, then tensile strength and modulus of elasticity values shall be re-calculated. Variation of glass mass content shall not exceed $\pm 10\%$.

6.3.11 Light fillers such as rigid foams or honeycomb plastics, used for sandwich structures, shall be non-sustaining combustion, be resistant to water, oil and liquid fuel, not subject to damage when being coated by polyester or epoxy resin as well as not subject to destruction by rodents.

6.3.12 Plastics based on hot-hardened resin may be used for ships up to 15 m long as well as for bulkheads, partitions, deckhouses and similar structures of any dimensions.

6.4 LAMINATED TEXTILES

Scope of application

6.4.1 The requirements of the present Chapter apply to textiles which have a rubber or plastic watertight coating and are intended for structures being under pressure in service conditions.

Properties

6.4.2 Laminated textiles shall be air-tight; their properties shall comply with Table 6.4.2.

Table 6.4.2

<table>
<thead>
<tr>
<th>Laminated textiles properties</th>
<th>Warp and weft properties</th>
<th>Coating adhesion (N/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength (kN/5cm), min</td>
<td>Breaking tensile elongation (%), max</td>
<td>Tear propagation on strength (N)</td>
</tr>
<tr>
<td>2.0</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

Note: The tensile strength may be reduced down to value considered sufficient for shells of particular structures according to the calculation agreed by the River Register, but not more than to four times the hoop stress developed in gas-filled pipes under the safety valve opening pressure.

For shells of inflatable liferafts when the material is air-tight, tensile strength in warp and weft directions may be taken not less than calculated by the formulae:

- for one-deck liferaft structure
  
  \[ T = 0.15D_r \]

- for two-deck liferaft structure
  
  \[ T = 0.095D_r \]

where \( T \) is warp and weft tensile strength of the liferaft laminated textiles (kN/5cm);

\( D_r \) is weight displacement of the liferaft with the rated number of people and provision onboard (kN).

Breaking tensile elongation of material for shells of inflatable liferafts in warp and weft directions shall not exceed 40%.

6.4.3 After ageing and bend test, the tensile strength in laminated textiles shall not differ by more than 10% of the initial value, and the shrinkage in warp and weft directions after ageing shall not exceed 2% from the initial dimensions.

When performing tensile tests of the adhesive joints of laminated textiles before and after ageing, the tear shall occur in the base material.

6.4.4 Type approval of laminated textiles in accordance with Appendix 10 requires the following tests:

- Tensile tests with the determination of break elongation on ten specimens each (five along the warp and five along the weft);
Tear propagation tests on ten specimens each (five along the warp and five along the weft);
- Delamination test on three specimens;
- Air tightness test on two specimens;
- Post-ageing tensile test;
- Bend test;
- Test of adhesive bond joints of laminated textiles before and after ageing on ten specimens each (five along the warp and five along the weft);
- Folding and shape stability tests after aging;
- Oil resistance test;
- Sea water resistance test;
- Cold resistance test;
- Ozone resistance test;
- The material mass shall be determined in accordance with GOST 32649.

Each batch of laminated textiles shall undergo the following tests:
- Tensile tests with the determination of break elongation on ten specimens each (five along the warp and five along the weft);
- Tear propagation tests on ten specimens each (five along the warp and five along the weft);
- Delamination test on three specimens;
- Air tightness test on two specimens;
- After tests for bending, ageing, post-aging folding and dimensional stability, oil resistance, cold resistance, ozone and sea water resistance the surface of laminated textiles shall be free from cracks, delaminations, colour changes, it shall not become stick.

6.4.5 The used colouring agents shall not adversely affect the properties of the base material.

6.4.6 On the surface of laminated textiles neither damages, recesses, dead folds, textile flaw marks, delaminations, spots, blisters, porosity nor other defects which may preclude their application in accordance with the purpose are acceptable.

Marking

6.4.7 Marking of laminated textiles shall be made in accordance with 1.3. In addition, the mass of material per unit of area shall be stated.

6.5 FOAM PLASTICS

General requirements

6.5.1 The requirements of the present Chapter apply to foam plastics used for the manufacture of items.

6.5.2 Type approval of foam plastics in accordance with Appendix 10 requires tests carried out to determine the following:
- Compression strength of foam plastic on three specimens in order to determine the maximum load resulting in abrupt destruction of the foam plastics structure, which shall be reached within 1 min approximately;
- Bend strength of foam plastic on three specimens;
- Apparent density of foam plastic on three specimens;
- Besides, the following tests are required:
  - Water absorption test on five specimens;
  - Oil product resistance test on three specimens;
  - Sea water resistance test on three specimens;
  - Ageing test on three specimens.

Each batch of foam plastics shall undergo tests, which determine compression strength, apparent density and water absorption of foam plastics.

Properties

6.5.3 The mechanical properties of foam plastics shall meet Table 6.5.3.

The mechanical properties of foam plastics affected by sea water and oil products shall not worse than stated in 6.5.3. The structure of foam plastics shall be of closed-cell type and shall not have shrinkage deformations in time which exceed admitted tolerances for linear dimensions specified by the technical documentation approved by the River Register.

Shrinkage of foam plastics used for filling-up cavities shall not break adhesion to boundary surfaces.
6.5.3 Mechanical properties of foam plastics

<table>
<thead>
<tr>
<th>Foam plastics grade</th>
<th>Foam plastics</th>
<th>Density (kg/m³)</th>
<th>Compression strength at bending (MPa) min.</th>
<th>Compressive modulus (MPa)</th>
<th>Water absorption in 24 h (kg/m²) max.</th>
<th>Limit temperature of application (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Polystyrene rigid foam</td>
<td>20; 60; 100</td>
<td>0.3; 0.8; 1.0</td>
<td>0.1; 0.4; 0.7</td>
<td>20; 34; 49</td>
<td>0.06; 0.03; 0.02</td>
</tr>
<tr>
<td>2</td>
<td>Polyvinylchloride rigid foam</td>
<td>120; 250</td>
<td>1.0; 3.3</td>
<td>0.7; 2.9</td>
<td>49; 145</td>
<td>0.25; 0.15</td>
</tr>
<tr>
<td>3</td>
<td>Polyurethane rigid foam</td>
<td>50; 250</td>
<td>0.2; 4.0</td>
<td>0.2; 2.9</td>
<td>29; 145</td>
<td>0.50; 0.03</td>
</tr>
</tbody>
</table>

6.5.4 Foam plastics shall have fine-cellular structure (cell dimension 0.1–0.5 mm) with closed cells in the cut foam plastics.

6.6 DECK PLATING

6.6.1 Deck plating shall comply with the requirements of 6.1.2.

6.6.2 Deck plating shall be manufactured and tested in compliance with the technical documentation approved by the River Register.

6.7 PLASTIC PIPING AND FITTINGS

6.7.1 The type of plastic, mechanical and electrical properties, testing scope and methods for plastic piping and fittings shall comply with the technical documentation agreed by the River Register.

6.8 ADHESIVES

6.8.1 Adhesive compounds for joining parts of structures and details subject to loading, shall have the manufacturer's documents which confirm properties of these compounds.

6.9 RETRO-REFLECTING MATERIALS FOR LIFE-SAVING APPLIANCES

6.9.1 Type approval of retro-reflecting materials for life-saving appliances in accordance with Appendix 10 requires the following tests:

- Tensile test;
- Test to determine the strength of adhesion of materials with an adhesive layer to different surfaces;
- Test to determine retro-reflection factor;
- Test to determine retro-reflection factor under a water film;
- Ageing test;
- Abrasion-resistance test;
- Sea water resistance test;
- Salt fog resistance test;
- Fungus resistance test;
- Bend test;
- Test for adhesion and resistance to contaminants.

For retro-reflective materials with an adhesive layer the strength of adhesion to different surfaces shall be determined after exposure to the ultraviolet irradiation and to distilled and sea water.

Each of the tests shall be made on three specimens only at approval tests of the type of material.

Each batch of material shall undergo tensile test, test to determine the strength of adhesion to different surfaces and test to determine the retro-reflection factor in accordance with Appendix 10.

Properties

6.9.2 The tensile strength of retro-reflective materials with an adhesive layer shall not be less than 0.6 MPa and of those with a warp for mechanical attachment — 13 MPa in the longitudinal direction and 9 MPa in the transverse direction.

6.9.3 Proceeding from the entrance angle and observation angle the values of the retro-
reflection factor \( R \) in \( \text{cd/}(\text{lx-m}^2) \) shall not be less than those specified in Table 6.9.3.

<table>
<thead>
<tr>
<th>Entrance value</th>
<th>Retro-reflection factor ( R ) (( \text{cd/}(\text{lx-m}^2) )) at observation angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>5°</td>
<td>180 175 72 14</td>
</tr>
<tr>
<td>30°</td>
<td>140 135 70 12</td>
</tr>
<tr>
<td>45°</td>
<td>85  85  48  9.4</td>
</tr>
</tbody>
</table>

**Table 6.9.3**

6.9.4 When the material is under a water film and after ageing (see 3.19 – 3.21 of Appendix 10), the retro-reflection factor may be lowered by not more than 20% as compared to table Table 6.9.3, and after the abrasion test it may be lowered by not more than 50%.

6.9.5 Exposure to sea water, mildew, salt fog and ultimate temperatures shall not lower the retro-reflection factor of the material.

6.9.6 For retro-reflective materials with an adhesive layer the strength of adhesion to different surfaces shall not be less than 0.6 MPa.

6.9.7 Exposure to ultraviolet radiation, sea water and fresh water shall not lower the adhesion properties of retro-reflective materials with an adhesive layer.

6.9.8 After the effects of sea water during 10 min, salt fog during 4 hours, limiting temperatures in process of ageing and after the bend and adhesion tests, no cracks, delamination, bulging, stickiness, change of colour and size shall be observed.

6.9.9 The surface of retro-reflective materials shall be free from damages, recesses, creases, delaminations, stains or other defects prejudicial to the use of the material for the intended application.

**Marking**

6.9.10 The marking of retro-reflective materials shall comply with 1.3; the mass of material per unit area shall be specified.
### 7 WELDING PROCEDURE REQUIREMENTS

#### 7.1 GENERAL REQUIREMENTS

**7.1.1** The requirements of this Section cover welding of structures and elements subject to the technical supervision of the River Register in process of manufacturing.

Welding procedures and survey of welded joints of the structures shall be performed on the equipment which provides the quality required by Section 8 of the present Part of the Rules.

**7.1.2** Welding of structures and components shall be performed by certified welders (operators) who has got the Approval Certificate and using welding consumables and welding procedures in accordance with the requirements of the present Part of the Rules.

The welding site shall be protected from wind and precipitation.

**7.1.3** Welding conditions at negative air temperatures shall provide the possibility to produce welded joints in compliance with the requirements of the present Part of the Rules.

**7.1.4** Welding operations may be performed at any negative temperature of ambient air, provided that the conditions of 7.1.2 are complied with and the welding consumables have been tested in conformity with 9.2.8 at air temperature –25 °C. Otherwise the minimum permissible air temperature for non-preheated welding shall be established by the manufacturer of welding consumables and fixed at approving the welding consumables after appropriate testing has been performed.

At temperatures indicated in Table 7.1.4, the edges of connecting parts shall be preheated before welding to temperature not less than 20 °C over a width of 75 mm.

| Ambient temperature requiring heating of weldments edges |  
|---|---|
| Air temperature (°C), below | Items for welding |
| –25 | Plates over 20 mm thick |
| –15 | Forgings and castings of the ship’s hull |
| –10 | Structures of semi-killed and unkillled steel |
| –5 | Structures of low-alloy boiler steel; Boilers and pressure vessels (manufacturing and repair) |

**7.1.5** Low-alloy steel piping, piping of the steam main as well as piping which shall operate at temperatures above 350 °C shall be welded at temperatures of 0 °C and above.

**7.1.6** The structural requirements for welds aimed at ensuring their strength shall be found in the relevant Parts of the Rules.

**7.1.7** The edge preparation for welding shall comply with national standards\(^1\) or technical documents approved by the River Register.

**7.1.8** The edges of parts to be welded shall be prepared by methods, which comply with the requirements of the Rules for welded joints.

**7.1.9** The edges of the parts to be welded are to be free from oil, moisture, scale, rust, paint and other contaminating substances.

It is permitted to weld primed steel parts without removing the primer, provided that the primer is approved by result of tests (see 4 of Appendix 8).

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\(^1\) GOST 5264, GOST 14771, GOST 8713.
7.1.10 When structures are welded at temperatures below 0 °C, the edges being welded shall be free from snow, hoar-frost, ice and shall be dry.

7.1.11 Welding operations shall be performed in such a sequence that to prevent impermissible (see Appendix 11 of RTSC) residual stresses or strains.

7.1.12 When it is necessary to preheat the parts before welding, the preheating temperature shall be determined taking into account the chemical composition of the metal, welding procedure, thickness of parts to be welded.

7.1.13 Underwater welding and cutting operations, as well as welding on structures having water on the reverse side shall be carried out according to the procedure approved by the River Register.

7.1.14 When plates or sheets shall be welded into a rigid contour, technological measures shall be taken to reduce the post-welding stresses.

Note. Rigid contour is an opening of closed perimeter with one of dimensions being less than 60 time the thickness of the plate in the given area. In complex structures a contour may be regarded rigid even at greater ratios of opening dimensions.

7.1.15 It is permitted to perform hot dressing both with mechanical effect and without it. No damages of the weld or plate surfaces are admissible. The heating temperature for hot dressing shall not exceed 650 °C, but in any case the heating shall not involve changes in the metal structure.

7.1.16 Post-weld heat treatment is required for elimination of residual stresses.

The type of heat treatment shall be determined by the manufacturer depending on the properties of material and shall be agreed with the River Register.

7.1.17 Components made of hull structural steel by cold bending may be welded as non-heat-treated, if the inner radius of bending complies with national standards indicated in 7.1.7. If there are no such standards, the radius shall be equal to at least the three times the thickness of the plate.

7.1.18 Welding consumables with controllable hydrogen content in the deposited metal shall be stored as well as annealed before use in accordance with the manufacturer’s recommendations.

7.1.19 Dimensions of fillet welds for structures shall be taken according to requirements of respective parts of the Rules; if the weld dimensions are not stated there, they shall be determined by national standards given in 7.1.17.

Throat thickness (design throat) shall be: at hand welding $a_h = a$; at machine welding (for the first pass) $a_m \geq 1.4 a$, where $a$ — the altitude of the isosceles triangle inscribed into the bead section (Fig. 7.1.19).

The relation between the leg of the fillet weld and the altitude of the isosceles triangle, inscribed into the bead section is: $k = 1.4a$ or $a = 0.7k$.

When replacing hand welding stipulated by the design by a machine one, the throat thickness or the weld leg (depending on what the calculation is based on) may be reduced, but by no more than 30% for single-pass welds.

![Fig. 7.1.19. For determination of design throat](image)

7.2 WELDING OF SHIP HULL AND EQUIPMENT

7.2.1 Welding of the parts to be assembled shall be performed using a technology which
provides the minimal post-welding stresses. Tack weld operations shall be performed by persons of the necessary qualification. Track welding shall be carried out using welding consumables of the grade required for welding of the given structure or of one grade higher. Tack welds shall be free from defects which could impair the quality of welded joints.

Cracks found in way of tack welds shall be eliminated by dressing and patch welding. Temporary fittings for assembling may be applied as less as possible, and it is necessary to dress and weld them without undercuts, cracks and other inadmissible defects (see 8.3).

Excessive cut-outs and other damages of the base metal occurred while removing temporary fittings shall be re-welded with after-grinding ensuring smooth transition to the base metal. When grinding, the base metal shall not be thinned to more than the plate thickness limit tolerances prescribed by national standards1.

Prominent remains of temporary fitting welds shall be removed with subsequent grinding from the following hull structures:

1. The strength deck (plates and longitudinal framing including continuous longitudinal coamings of cargo holds);
2. Hull bottom (plates and longitudinal framing);
3. Shipboards;
4. The sheerstrake and the bilge strake (plates and longitudinal framing);
5. Tank bulkheads;
6. Tank web framing;
7. Structures located in places subject to intensive vibration.

Thickenings are permitted if they do not exceed admissible tolerances for weld strengthening stated by the national standards. The necessity of grinding protruding weld residuals of temporary mounting fittings on other structures shall be stated by the designer.

7.2.2 When assembling butt joints, the admissible mutual relative displacement of plates is up to 0.1 plate thickness but not exceeding 3 mm.

7.2.3 Straightening of edges by deposit welding due to incorrect machining of the assembling parts or inaccurate assembling shall be performed according to the procedure approved by the River Register.

7.2.4 Welding consumables shall be chosen proceeding from the grade of steel to be welded in accordance with Table 7.2.4. Welding consumables intended for welding of steel grades A40, D40, E40 shall provide the mechanical properties \(R_{m}, R_{eH}, A_{5}\) in the deposited metal of not less than those required for these steel grades.

| Grades of welding consumables depending on the grade of steel to be welded |
|-----------------------------|-----------------------------|
| Grades of hull structural steel |
| normal strength | higher strength |
| A | B | D | E | A32, D32 | A36, D36 | A40, D40 | E32, D32 | E36, D36 | E40 |
| 1, 1S, 1T, 1M, 1TM | + | − | − | − | − | − |
| 2, 2S, 2T, 2M, 2TM | + | + | + | + | + | − | − | − |
| 3, 3S, 3T, 3M, 3TM | + | + | + | + | − | − | − | − |
| 1Y, 1YS, 1YT, 1YM, 1YTM | + | − | − | + | − | − | − | − |
| 2Y, 2YS, 2YT, 2YM, 2YTM | + | + | + | + | − | − | − | − |
| 3Y, 3YS, 3YT, 3YM, 3YTM | + | + | + | + | + | + | + | + |

The following shall also be considered:

1. For welded joints where normal strength steel is welded to higher strength steel, it is permitted to use welding consumables of lower grade from those permitted by Table 7.2.4 and the present paragraph for each particular grade of steel (e.g., in weldment of steels D32 and E32 grades welding consumables of grade 2 may be used);

2. For joints welded of steels of the same strength but differing by testing temperature at impact test it is permitted to use welding consumables of lower grade from those permitted by Table 9.2.4 for each particular grade of steel (e.g., in weldment of steels D32 and E32 grades welding consumables of grade 2Y may be used);

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1 GOST 5521, GOST R 52927.
3 For welded joints where higher strength steels are welded or higher strength steel is welded to normal strength steel, welding consumables with controllable diffusible hydrogen content shall be used according to Table 9.2.4. Application of welding consumables with non-controllable diffusible hydrogen content is allowed only for steels with the carbon equivalent $C_{eq} \leq 0.41$ (see 2.2.2 of the present Part) after testing according to the program agreed with the River Register;

4 For weldments of higher strength steels welding consumables of grade 1Y may be used only for joints with the metal thickness up to 25 mm inclusive;

5 Welding consumables chosen according to Table 7.2.4, may be assigned also for welding steel other than prescribed by the Table if it is equivalent by the mechanical properties and chemical composition to the steel for which that welding consumable is approved;

6 Rutile-coated electrodes shall not be used for welding of the following joints:
   Intersectional field butts;
   All butts and seams of the ice strake of the outer plating;
   Butt joints of the longitudinal framing and butt joints of the hull with thickness over 20 mm;
   Stern-post, stem or butt joints welded in rigid contour conditions;

7 Acid-coated electrodes shall not be used for welding structures mentioned by Part 1 of the present Rules;

8 Welding consumables used for welding hull structures M-CTI (ice) class ships and icebreakers directly affected by ice, shall meet the requirements of 9.2.6. For this case the ratio of corrosion rates of welded joint elements shall be within 0.9 – 1.1.

Welding consumables shall be chosen proceeding from the grade of steel to be welded in accordance with Table 7.2.4.

7.2.5 Cut-outs exceeding those stated in 8.3.2 may be removed by patch welding or grinding.

7.3 WELDING OF SHIP MACHINERY CONSTRUCTION ITEMS

7.3.1 Welding consumables for ship machinery shall be chosen on the basis of particular steel grades used for their manufacturing taking the requirements of 7.2.4 into account.

7.3.2 If welded parts are intended for operation at high temperatures (above 60 °C) or in a chemically aggressive medium, those conditions shall be taken into account when selecting welding consumables.

7.3.3 Steel parts 30 mm thick or more shall be welded using welding consumables which would guarantee the cold cracking resistance of the weld; or the manufacturer shall take technological precautions (preheating, heat treatment, limiting of the minimal ambient air temperature during welding, etc) against cold cracking.

7.3.4 The welds in structures subject to dynamic loads shall be made with full penetration. The transition from the base metal to the weld shall be smooth.

7.3.5 Welding of ship shafting and crankshafts is permitted on condition that shaft properties are provided as required by the Rules. Non-destructive testing of all welds shall be carried out and the fatigue strength of welded joints shall be provided.

Before welding is commenced, the scope of the necessary experimental welding and the test program required by the Rules shall be agreed with the River Register.

7.3.6 Methods of welding, deposition welding, metal pulverization and other similar methods applied at the manufacture and repair of the ship machinery construction items shall be specified in the manufacturer's technical documents agreed with the River Register.

Ship shafts of carbon steel (hydrogen content up to 0.45 %), which are worn or have corrosive vapors, gases, liquids which can damage insulation and surfaces of parts or produce deteriorative deposits.
surface cracks may be restored by deposit welding provided that the wear or the depth cracks do not exceed 5% of the shaft diameter, but in all cases it shall not be more than 15 mm.

The whole shaft surface shall be checked for cracks prior to deposit welding. Furthermore, both places prepared for deposit welding and already welded places shall be checked for cracks. Detected cracks shall be rectified mechanically.

Prior to deposit welding the shaft shall be preheated over the entire thickness up to 350 – 650 °C.

The indicated temperature shall be maintained and monitored during the entire welding process. After welding the shaft shall be cooled at room temperature avoiding forced cooling.

Automatic single-pass or two-pass submerged arc deposit welding of the ship shafts made of carbon steel with hydrogen content of not more than 0.4% and magnesium content of not more than 0.8% may be performed without preheating.

After being mechanically treated the deposited metal shall be subject to surface cold rolling.

7.4 WELDING OF STEAM BOILERS AND PRESSURE VESSELS

7.4.1 Boiler welds shall be marked as to make it possible to identify the operator who performed the welding.

The longitudinal and circumferential welds of boiler shells shall be made with a back-sealing run with the exception of cases when the weld strength factor is to be taken 0.7 or less.

Cuts and openings in the boiler shell shall not cross circumferential or longitudinal welds of the boiler shell.

Welding of fastenings, catches and the like parts shall be prevented.

The longitudinal and circumferential welds of headers, boiler shells and pressure vessels shall be butt-welded.

7.4.2 Welding consumables for boilers and pressure vessels shall be chosen on the basis of specific steel grades used for their manufacturing taking in account the requirements of 7.2.4.

7.4.3 Rutile and oxide-coated electrodes are not permitted for the welding of boilers and pressure vessels of Class I (see 8.2.1 of Part IV of the Rules); these electrodes are permitted for boilers and pressure vessels of Class II and Class III, provided that those items are manufactured of carbon steel and the thickness of weldments does not exceed 20 mm.

7.4.4 Boilers and pressure vessels shall be heat treated according to recommendations of steel manufacturers.

The welded joints in parts which cannot be heat treated as a whole for stress relieving due to their dimensions or inappropriate structure may be subjected to local heat treatment. Such a heat treatment shall be performed by uniform warming-up of a sufficiently wide area along the weld (for a distance about 6 times the plate thickness on both sides of the weld) so as to prevent the spread of thermal stresses to other areas of the parts involved. Local treatment by means of a welding torch is prohibited.

7.4.5 Worn-out shell plates of boilers and pressure vessels may be repaired by deposit welding, in such a case the welded area shall not be larger than 500 cm², and the depth shall not exceed 30% of the plate thickness. If these conditions cannot be met, the faulty area shall be replaced by a new plate.

7.4.6 When manufacturing boilers, heat-exchangers and pressure vessels of Class I or Class II (see 8.2.1 of Part IV of the Rules), mechanical properties of welded joints shall be tested and for this purpose a control bar shall be welded in the following cases:

- Manufacturing of single products;
- Serial production — product standard sample;
- Alteration of structures of main units and parts;
- Application of new materials and welding procedures.
7.4.7 The control bars shall be attached to the longitudinal joint of a boiler or pressure vessel in such a way that the weld of the control bar is a continuation of the weld of the boiler or pressure vessel. The welding technique of the control bar shall be the same as employed in the welding of the boiler or pressure vessel weld.

The following specimens shall be cut out as shown in Fig. A12.2.5-1 and tested in accordance with the requirements of Appendix 10: one transverse tensile test specimen, two transverse bend test specimens, three impact test specimens.

The conditions of cutting specimens out of structures of Class III (see 8.2.1 Part IV of the Rules) and test conditions shall comply with 3.1 and 3.2 of Appendix 12.

7.5 WELDING OF SHIP PIPELINES

7.5.1 The type of welded joints in pipes shall comply with national standards.

7.5.2 Welding consumables for pipelines shall be chosen on the basis of steel grades used for their manufacture taking the requirements of 7.2.4 into account.

7.5.3 In the welded butt joints of pipes the complete root penetration shall be provided. Welding with the use of removable backing rings is permitted.

7.5.4 The use of the remaining backing rings in butt joints is permitted in pipelines where those rings do not adversely affect the performance. The remaining backing rings shall not be used for flange-to-pipe butt joints.

7.5.5 The welded joints in pipes shall be heat treated on pipes of low-alloyed steels or in the case of gas welding of steam mains operating at temperatures above 350 °C. Heat treatment method and the relevant procedure are determined proceeding from the chemical composition, purpose and required properties of pipes.

7.5.6 When welding pipes of chromium-molybdenum steel containing 0.8 % or more of chromium and more than 0.16 % of carbon, the edges to be welded shall be preheated to a temperature 200 to 230 °C. This temperature shall be maintained during the welding process.

7.5.7 Welding edges of the copper piping with a wall thickness of 5 mm and over shall be preheated up to 250 – 350 °C prior to welding. Nickel-copper pipes shall be welded without preheating. It is not permitted to braze joints of copper-nickel pipes.

7.5.8 When welding cargo pipelines of liquefied gas tankers, welded butt joints with the complete root penetration may be used without any restrictions. For design temperature below minus 10 °C butt welding shall be welded on both sides or be equivalent to butt joint welded on both sides. Welding may be performed with use of a backing ring, consumable insert or inert gas backup on first pass.

7.5.9 Backing rings shall be removed after welding pipelines of design pressure exceeding 1 MPa and design temperature of minus 10 °C and below. The scope of non-destructive testing shall be not less than specified in Table 8.2.3 for class I pipelines.

7.5.10 Butt-welded joints of liquefied gas pipelines made of carbon, carbon-manganese, low-alloy steel shall be heat treated after welding.

7.6 WELDING OF CASTINGS AND FORGINGS

7.6.1 Pre-heating or other technological measures which provide the necessary welding quality of steel castings and forgings independently of ambient air temperature, shall be undertaken when:

1. The carbon content of steel castings and forgings exceeds 0.25 %;

2. The carbon content of steel castings and forgings being the part of the hull structure of ships intended for navigation in ice (castings and forgings of sternframes, stems,
propeller shaft brackets and similar structures) exceeds 0.23%.

7.6.2 The preheating temperature and the heat treatment procedure for castings and forgings shall be determined depending on the design, size and service conditions in accordance with 7.1.4, 7.1.12, 7.1.16.

7.6.3 The faults in castings and forgings may be repaired by welding only if the steel has been previously checked for weldability (see 4 of Appendix 10) and the service conditions of the cast or forged part were considered.

Faults are eliminated by welding before final heat treatment is commenced. Faults which appear systematically in castings and forgings shall not be eliminated by means of welding.

7.6.4 Faults in castings shall be eliminated after sprues and heads have been removed and the castings have been thoroughly cleaned of sand, scale and extraneous inclusions. The surface subject to re-welding shall be ground to sound metal so as to ensure full penetration throughout the welded area.

The walls of areas to be re-welded shall be gently sloped and the prepared deepening surface shall not have sharp corners.

7.7 WELDING OF CLAD STEELS

7.7.1 The edge preparation for welding shall comply with technical documents approved by the River Register.

The edges shall be prepared by machining or grinding.

The edges of parts to be assembled shall be fit and shall not be out of alignment on the clad side.

7.7.2 The corrosion resistance of weld metal on the clad side shall be equal to that of the cladding. The thickness of the corrosion-resistance layer of the weld shall not be less than that of the cladding.

The chemical composition of weld metal on the clad side (except the root zone) shall correspond to the chemical composition of the cladding metal.

7.7.3 As a rule, the weld shall be made first on the base plate surface and then on the clad side. Welding on the base plate side shall be done so that no melting of the cladding layer occurs. Prior to welding of the clad side the weld root shall be ground to sound metal by machining or grinding only. For the root pass the same welding consumables shall be used as for the clad layer welding. The clad layer shall be welded so as to prevent mixing of the alloyed metal with non-alloyed one. The cladding layer shall be welded using welding electrodes and wires of the smallest diameter. The welding is carried out at a low current intensity. The weld on the clad surface shall be made up of at least two layers. When welding the cladding layer, transverse weaving of electrode is not permitted. Where the root top layer width is such that it shall be disposed in several passes, the last one shall be made along the middle of the weld.

7.7.4 When welding pipes of clad steel, where welding on both sides is impossible, the entire joint shall be welded using welding consumables corresponding to the cladding material. When welding clad sheet steel, the entire joint shall also be welded with the use of welding consumables suitable for the cladding material.

7.8 WELDING OF HIGH STRENGTH STEEL

7.8.1 The welding consumables intended for welding of high strength steels shall be approved in accordance with 9.5 and the welding methods — in accordance with 7.1.2.

7.8.2 Compliance of the method and procedure of welding with requirements of the Rules shall be agreed by the River Register after fabrication testing by an agreed program. For this purpose the manufacturer of welded structures shall submit the documented preheating temperature, the liner power consumption during welding, the post-weld heat treatment and the temperature between runs.

The manufacturer shall use a system of welding modes’ recording and control including the temperature measurement between
runs and shall submit the inspection results to the River Register upon request.

7.8.3 Welded joints shall be made by multi-pass welding.

7.8.4 It is not permitted to fire arc outside the edges prepared for welding.

Temporary mounting fittings shall be welded-on with local heating provided.

Temporary fittings are removed by machining with subsequent dressing flush with the base metal surface.

7.8.5 The edges prepared by gas cutting shall be subsequently machined. Roots shall be dressed by machining only. Heating for straightening is permitted only if the required properties of the base metal and welded joint are ensured.

7.9 WELDING OF CAST IRON

7.9.1 Defects in castings made of cast iron may be eliminated by welding using a welding procedure tested according to the program agreed with the River Register.

7.10 BRAZING

7.10.1 Brazed joints in the items shall be executed in conformity with GOST 19249 or technical documentation agreed by the River Register.

7.11 WELDING OF ALUMINIUM ALLOYS

7.11.1 Welding operations shall be performed by the most expedient method, which ensures the joints quality required by 8 of the present Part of the Rules, mechanical properties in compliance with 9.6 and corrosion resistance not worse than that of the base metal. Chemical composition of the weld shall match that of the base metal.

7.11.2 Wherever possible, welded joints shall be located in areas exposed to the lowest stresses. Welding shall be effected in the down-hand position.

7.11.3 Directly before welding (tack welding) the edges of aluminium or aluminium alloy components shall be degreased with special solvents (acetone, alcohol, turpentine) and then cleaned with wire brushes. Jacked spots shall also be cleaned with a steel wire brush before welding. In the case of multi-pass welding each pass of deposit shall be brushed before the next pass is applied.

7.11.4 Welding consumables of aluminium and aluminium alloys must be cleaned in order to eliminate oxide film.

7.11.5 Aluminium alloys welding may be welded on remaining or removable backings. The removable backings shall be made of stainless steel. The remaining backings shall be made of the same alloy grade as that used for the weldments.

7.11.6 In case of a double-pass welding it is necessary to dress the root of the weld by chipping, planning or milling to sound metal before a sealing pass is applied to the back of the weld. The root shall not be dressed by abrasive disks.

7.11.7 It is permitted to hot-straighten the structures made of aluminium and aluminium alloys. The heating temperature shall correspond to the properties of a given alloy.

7.11.8 Where a flux is used, it shall be neutral.

7.11.9 In the area where structures made of aluminium alloys shall be riveted, all welding operations shall be completed prior to riveting operations.

7.12 WELDING OF COPPER ALLOYS, HEAVY METALS AND OTHER NON-FERROUS METALS

7.12.1 Welding of copper and copper alloys, as well as of heavy metals and other non-ferrous metals shall be carried out in accordance with the technical documentation agreed with the River Register.
8 INSPECTION OF WELDED JOINTS

8.1 INSPECTION MANAGEMENT

8.1.1 Inspection of welding operations and welded joints during fabrication of structures and components shall be performed by the technical control service with the Recognition Certificate issued by the River Register. The inspection results shall be registered according to the procedure adopted at the works, filed until the commissioning of the item and submitted to the River Register for the consideration.

8.1.2 Non-destructive testing of welds may be effected by the following methods:

.1 Visual examination (visual inspection);
.2 Magnetic particle examination (magnetic particle inspection);
.3 Dye penetrant examination (dye penetrant inspection);
.4 Radiographic examination (radiographic inspection, X- or gamma-ray examination);
.5 Ultrasonic examination (ultrasonic inspection);
.6 In process of and by results of tests for tightness.

Other testing methods may be used in compliance with GOST 18353.

The application of a particular non-destructive testing method is set up in the technical documentation of the design depending on the structure and the type of welded joint.

The non-destructive testing is to be performed in compliance with the national standards or by methods agreed with the River Register.

Where the heat treatment of welded assemblies is required, the final non-destructive testing of welded joints shall be carried out upon its completion.

For welding of higher strength steels and complex shape structures (e.g. joints in cargo masts and posts), non-destructive testing shall be performed not earlier than 72 hours after welding is completed.

Non-destructive testing of welded joints shall be effected by laboratories recognized by the River Register.

8.1.3 The following requirements are imposed on testing of independent cargo tanks of types A and B (see 1.2.1.8 Part IX of the Rules), as well as semi-membrane tanks:

.1 If the design temperature is minus 20 °C or below, all butt welded joints made with full penetration of cargo tanks shell plates shall undergo 100% radiographic examination;
.2 At the design temperature above 20 °C all intersections of butt weld joints with full penetration and not less than 10% of other butt weld joints with full penetration of cargo tanks structures shall undergo radiographic examination;
.3 In each case weld joints of other cargo tanks structures including welding of stiffeners as well as other reinforcement and fittings shall undergo non-destructive testing;
.4 All testing methods and assessment criteria shall be agreed with the River Register for compliance with requirements of the Rules.

In cases prescribed by approved technical documentation ultra-sonic inspection may be carried out instead of or in addition to radiographic examination.
8.1.4 Testing of independent cargo tanks of type C (see 1.2.1.8 Part IX of the Rules) and pressure vessels shall be performed in accordance with the requirements of 6.6 Part IX of the Rules.

8.1.5 Non-destructive testing of weld joints of liquefied gas tankers structures, or independent tanks structures which provide support for tanks with inner insulation, shall be performed with respect to the requirements of 6.7.30.2 Part IX of the Rules.

8.1.6 Scope and methods of weld joints inspection to be carried out for liquefied gas tankers built-in tanks and membrane tanks shall be approved by the River Register for compliance with requirements of the Rules.

8.1.7 Non-destructive testing of liquefied gas tankers pipelines weld joints shall be performed in accordance with the requirements of 6.12.9.2 Part IX of the Rules and 8.2.3 (complete radiographic examination).

8.1.8 Weld joints of liquefied gas tankers additional barrier structures shall undergo radiographic examination in scope agreed with the River Register.

If the outer hull plating is a part of additional barrier, all butt sheerstrake welded joints and intersections of all butt welded joints with side plating shall undergo radiographic examination.

8.1.9 On completion of welding operations on a given structure the technical control service specifies locations of non-destructive testing according to the technical documentation approved by the River Register. In case of doubt the examination of additional areas may be performed.

8.1.10 In case if revealed defects parameters exceed permissible limits specified by 8.3, testing shall go on along both sides of the inspected area until satisfactory results are obtained. In addition, two lengths of the same weld shall be inspected in other areas for each radiograph with unsatisfactory rating (see 8.3).

The results of additional inspection shall be submitted together with the initial inspection documents before the defects have been rectified. Where the scope of initial and additional inspections of the weld exceeds 50 % of the weld length, the weld shall be additionally inspected along the whole length.

8.1.11 Examination of the same weld by both ultrasonic and radiographic methods is permitted.

8.1.12 When shell-planting welds are inspected, the radiograph shall be located at the intersection on the butt axis so as to partially cover the seam as shown in Fig. 8.1.12-1.

When carrying out ultrasonic examination, on each side of the butt 100 mm lengths shall be examined as shown in Fig. 8.1.12-2.

Fig. 8.1.12-1. Radiograph location when inspecting welds

Fig. 8.1.12-2. Groove examination on each side of the butt
8.2 SCOPE OF NON-DESTRUCTIVE TESTING

8.2.1 The scope of non-destructive testing of the hull welds is specified according to the technical documentation approved by the River Register according to Table 8.2.1-1.

The number of radiographs of the weld lengths in the shell plating for 0.5L amidships is calculated by the formula:

\[ N = \frac{L(B + H)T}{45}, \]

where \( N \) is number of areas subject to testing; \( L, B, H \) are length, breadth and board depth of the ship (m);

\( T \) is factor depending on the ship length which is determined according to Table 8.2.1-2.

**Table 8.2.1-2**

<table>
<thead>
<tr>
<th>Coefficient ( T )</th>
<th>Length of a ship ( L ) (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>80 and more</td>
</tr>
<tr>
<td>0.5</td>
<td>50 ( \leq L &lt; 80 )</td>
</tr>
<tr>
<td>0.15</td>
<td>25 ( \leq L &lt; 50 )</td>
</tr>
<tr>
<td>Not standardized</td>
<td>Less than 25</td>
</tr>
</tbody>
</table>

8.2.2 The welded joints of steam boilers, pressure vessels and heat exchangers shall undergo non-destructive testing within the scope specified in Table 8.2.2 depending on the structure class (see 8.2.1 Part IV of the Rules).

**Table 8.2.2**

**Scope of non-destructive testing of welded joints of steam boilers, pressure vessels and heat exchangers**

<table>
<thead>
<tr>
<th>Class of the structure (see 8.2.1 Part II of the Rules)</th>
<th>Type of welded joint</th>
<th>Scope of radiographic or ultrasonic examination of welded joint as percentage of total weld length</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Longitudinal</td>
<td>100</td>
</tr>
<tr>
<td>II</td>
<td>On agreement with the River Register</td>
<td>25</td>
</tr>
<tr>
<td>III</td>
<td>Circumferential</td>
<td>On agreement with the River Register</td>
</tr>
</tbody>
</table>

* Scope of welded joint visual examination — 100 % of total weld length. Results of visual examination may be supplemented by magnetic particle testing or liquid penetrant testing.

8.2.3 The welded joints of piping depending on its class indicated in Table 8.2.1 of Part IV of the Rules shall undergo non-destructive testing within the scope specified in Table 8.2.3.

**Table 8.2.3**

Scope of pipeline welds non-destructive testing

<table>
<thead>
<tr>
<th>Pipeline class</th>
<th>Outer diameter of pipe (mm)</th>
<th>Scope* of radiographic or ultrasonic examination of welded joint as percentage of number of butts</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>( \leq 75 )</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>&gt; 75</td>
<td>100</td>
</tr>
<tr>
<td>II</td>
<td>( \leq 100 )</td>
<td>Random</td>
</tr>
<tr>
<td></td>
<td>&gt; 100</td>
<td>100</td>
</tr>
<tr>
<td>III</td>
<td>Any</td>
<td>Random</td>
</tr>
</tbody>
</table>

* Scope of welded joint visual examination — 100 % of number of butts. Results of visual examination may be supplemented by magnetic particle testing or liquid penetrant testing.

8.2.4 In addition to the structures specified in Tables 8.2.1, 8.2.2 and 8.2.3, such elements of machinery and deck gears as joints in cargo masts and posts, etc. shall undergo non-destructive testing. The weld lengths to be tested in these structures shall be established upon agreement with the River Register.

Welded joints quality of stress-bearing elements of cargo-handling appliances metal structures (see 6 Part V of the Rules) shall be inspected by radiographic or by other non-destructive method approved by the River Register. Not less than 10% of the welded joints shall be subject to inspection. The places of intersection of welded joints shall be subject to mandatory testing. Circular continuous butt-welded joints shall be examined over their whole length.

8.2.5 The River Register may determine a distribution of non-destructive testing weld lengths differing from that specified in the approved by the River Register technical documentation depending on the particular conditions under which welding is carried out.

8.2.6 The works shall determine on the basis of radiographic and ultrasonic testing the percentage of welded joint defects not less
### Table 8.2.1-1

**Scope of ship hull welds non-destructive testing**

<table>
<thead>
<tr>
<th>Location of inspection points</th>
<th>Type of welded joint</th>
<th>Visual examination 1,2 (%)</th>
<th>Radiographic or ultrasonic testing, number of radiographs</th>
<th>Ship area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Through the length 0.5 L amidships</td>
<td>outside 0.5 L amidships</td>
<td></td>
</tr>
<tr>
<td>1. Butts of plating (mainly intersections with seams) of the design deck outside the hatch line; of the sheer strake (within 0.1H area below the design deck); of shoulders (within 0.1H area above the bottom); of the bottom; Butts of hatch side coamings; of thickened deck plates in the area of hatchway corners and at the ends of superstructures; of longitudinal bulkheads (within 0.1H area below the design deck)</td>
<td>Butt weld</td>
<td>100</td>
<td>0.60N</td>
<td>0.12N</td>
</tr>
<tr>
<td>2. Other hull plating butts 1 (mainly intersections with seams)</td>
<td>Ditto</td>
<td>100</td>
<td>0.20N</td>
<td>0.04N</td>
</tr>
<tr>
<td>3. Hull plating seams 2</td>
<td>←</td>
<td>←</td>
<td>←</td>
<td>←</td>
</tr>
<tr>
<td>4. Welded joints of longitudinal stiffeners (in longitudinal framing) of the design deck outside the hatch line; of the sheer strake (in 0.1H area below the design deck); of shoulders (in 0.1H area above the bottom); of longitudinal bulkheads (in 0.1H area below the design deck); of the bottom</td>
<td>←</td>
<td>100</td>
<td>1 radiograph per each 5 butts (mainly field butts)</td>
<td>Random 3</td>
</tr>
<tr>
<td>5. Welded joints of longitudinal stiffeners (in longitudinal framing) in other places not specified in 4</td>
<td>←</td>
<td>100</td>
<td>1 radiograph per each 10 butts (mainly field butts)</td>
<td>Ditto 3</td>
</tr>
<tr>
<td>6. Welded joints of transverse stiffeners (in transverse framing)</td>
<td>←</td>
<td>←</td>
<td>←</td>
<td>←</td>
</tr>
<tr>
<td>7. Sternframe welded joints</td>
<td>←</td>
<td>←</td>
<td>←</td>
<td>←</td>
</tr>
<tr>
<td>8. Welded joints between the deck stringer and the sheerstrake (within the area of intersection with butt welds)</td>
<td>Fillet weld or tee-joint with full penetration</td>
<td>100</td>
<td>4 controlled lengths along one plate 5</td>
<td>←</td>
</tr>
</tbody>
</table>

1. Results of visual examination may be supplemented by magnetic particle testing or liquid penetrant testing.
2. All welded joints (including those not specified in the Table) shall be subject to testing.
3. The number of radiographs shall be up to 20 % of the total number of radiographs stated for the area 0.5 L amidships.
4. Where ice strengthened, the ice strake butts are particularly subject to testing.
5. Intersections between seams and butts are subject to testing.

than once in six months and report the results to the River Register.

The index of defects in welded joints $K$ (%) shall be determined by the formula:

$$K = 100/\ell,$$

where $\ell$ is the total inspected weld length, where the weld quality is found unsatisfactory (m);
s is the total inspected weld length (m).

The number of inspected weld lengths shall be increased by 10 % for every percent of rejected welds if the percentage of defects is more than 5 %.

8.2.7 At the refitting and repair of ships the number of inspected weld lengths is determined depending on the shape and purpose of structures and scope of welding taking into account the requirements of 8.2.1 – 8.2.6.

8.3 ASSESSMENT OF WELD QUALITY

8.3.1 The assessment of the weld joints quality by means of radiography or ultrasonic examination may be performed by a three-point scale, or by other scales1 agreed with the River Register.

The three-point scale assessment criteria are specified according to 8.3.3.

For other testing methods the assessment of the weld joints quality shall be performed taking in account defect dimensions permitted by national standards and by scales approved by the River Register.

8.3.2 The assessment criteria for particular methods of inspection and acceptable marks are specified in Tables 8.3.2-1 and 8.3.2-2.

Testing results are recorded to the quality control document (see 8.1.1), which shall contain the list of defective weld lengths, their dimensions, types, marks of defects and their location.

When using the data from Tables 8.3.2-1 and 8.3.2-2, the following shall be considered:

1 For defects with footnote 1 the maximum length of a single undercut shall not exceed 0.5 t, with the total length of undercuts at each controlled weld section not exceeding 5 % of its length;

2 The maximum length of a single defect with footnote 2 shall not exceed t with the total length of incomplete fusion at each controlled weld length not exceeding 5 % of its length;

3 Minimum mark of welded joints which have footnote 3 in Table 8.3.2-1 shall be raised to II for locations with high stresses or vibration.

8.3.3 Three-point quality assessment scale of welded joints in steel structures includes the following:

1 Mark III.

The welded joint is free from internal defects or the following defects are present:

- Isolated gas or metal (tungsten) inclusions, each with dimensions up to 0.1 of the weld thickness, but not more than 2 mm;
- Isolated slag inclusions each with dimensions up to 0.3 of the weld thickness, but not more than 3 mm, with the area not exceeding 5 mm².

The average number of revealed defects shall not exceed one for each 100 mm of the weld length;

2 Mark II.

The weld is free from cracks, pipes, incomplete or poor fusion. The maximum permissible length, width and total length of pores, slag or tungsten inclusions, chains and clusters of these defects as well as oxide inclusions for any 100 mm of the inspected weld length are specified in Table 8.3.3.2;

3 Mark I.

The weld is free from cracks, pipes, incomplete or poor fusion. The maximum permissible length, width and total length of pores, slag or tungsten inclusions, chains and clusters of these defects as well as oxide inclusions for any 100 mm of the inspected weld length are specified in Table 8.3.3.3.

---

1 GOST R ISO 5817, GOST R ISO 10042.
**Table 8.3.2-1**

**Permitted dimensions of hull welds defects**

<table>
<thead>
<tr>
<th>Method of examination</th>
<th>Type of defect or method of its classification</th>
<th>Acceptable size, minimum mark of welded joint or other requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual</strong></td>
<td>Weld appearance</td>
<td>Weld shall be uniform and smoothly transient into the base metal</td>
</tr>
<tr>
<td></td>
<td>Cracks</td>
<td>Not permitted</td>
</tr>
<tr>
<td></td>
<td>Undercuts&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.1t, but not more than 1.0 mm</td>
</tr>
<tr>
<td></td>
<td>Incomplete fusion of single-sided weld&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.1t, but not more than 1.5 mm</td>
</tr>
<tr>
<td></td>
<td>Other surface defects</td>
<td>Quality level C as per GOST R ISO 5817</td>
</tr>
<tr>
<td><strong>Radiographic</strong></td>
<td>By three-point scale</td>
<td>II</td>
</tr>
<tr>
<td></td>
<td>By standard radiographs</td>
<td>III</td>
</tr>
<tr>
<td><strong>Ultrasonic</strong></td>
<td>By three-point scale</td>
<td>On agreement with the River Register</td>
</tr>
<tr>
<td><strong>Dye penetrant or magnetic particle</strong></td>
<td>According to GOST 21105, GOST 18442, GOST R ISO 9934, GOST R ISO 3452</td>
<td>Cracks are not permitted&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> – <sup>3</sup> See 8.3.2.1 – 8.3.2.3 respectively.

<sup>4</sup> Class (level) of sensitivity II according to GOST 18442, Б — according to GOST 21105.

Note: t is the thickness of welded metal (mm).

**Table 8.3.2-2**

**Permitted dimensions of defects of weld joints of boilers, equipment, pipelines and parts of arrangements**

<table>
<thead>
<tr>
<th>Method of examination</th>
<th>Type of defect or method of its classification</th>
<th>Acceptable size, minimum mark of welded joint or other requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Appearance of joint</td>
<td>Weld shall be uniform and smoothly transient into the base metal</td>
</tr>
<tr>
<td></td>
<td>Cracks</td>
<td>Not permitted</td>
</tr>
<tr>
<td></td>
<td>Undercuts&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.2t, but not more than 2.0 mm</td>
</tr>
<tr>
<td></td>
<td>Incomplete fusion of single-sided weld&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.05t, but not more than 1.0 mm</td>
</tr>
<tr>
<td></td>
<td>Other surface defects</td>
<td>Quality level C as per GOST R ISO 5817</td>
</tr>
<tr>
<td><strong>Radiographic</strong></td>
<td>By three-point scale</td>
<td>III</td>
</tr>
<tr>
<td></td>
<td>By standard radiographs</td>
<td>II</td>
</tr>
<tr>
<td><strong>Ultrasonic</strong></td>
<td>By three-point scale</td>
<td>III</td>
</tr>
<tr>
<td></td>
<td>By standard radiographs</td>
<td>II</td>
</tr>
<tr>
<td><strong>Dye penetrant or magnetic particle</strong></td>
<td>GOST 18442, GOST R ISO 9934, GOST R ISO 3452.</td>
<td>Cracks are not permitted&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup>, <sup>2</sup> See 8.3.2.1 – 8.3.2.2 respectively.

<sup>3</sup> Class (level) of sensitivity II according to GOST 18442, Б — according to GOST 21105.

Note: t is the thickness of the welded metal (mm).
### Table 8.3.3.2
Sizes of defects permitted for welded joints of mark II quality

<table>
<thead>
<tr>
<th>Thickness of welded items</th>
<th>Pores and inclusions Width (diameter)</th>
<th>Clusters Length</th>
<th>Chains Length</th>
<th>Total length of defects (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 5</td>
<td>0.6</td>
<td>2.0</td>
<td>2.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Over 5 to 10</td>
<td>1.0</td>
<td>3.0</td>
<td>4.0</td>
<td>6.0</td>
</tr>
<tr>
<td>10 to 20</td>
<td>1.5</td>
<td>5.0</td>
<td>6.0</td>
<td>9.0</td>
</tr>
<tr>
<td>20 to 25</td>
<td>2.0</td>
<td>6.0</td>
<td>8.0</td>
<td>12.0</td>
</tr>
<tr>
<td>25 to 35</td>
<td>2.5</td>
<td>8.0</td>
<td>10.0</td>
<td>15.0</td>
</tr>
<tr>
<td>35 to 45</td>
<td>3.0</td>
<td>9.0</td>
<td>12.0</td>
<td>18.0</td>
</tr>
<tr>
<td>45 to 65</td>
<td>4.0</td>
<td>12.0</td>
<td>16.0</td>
<td>20.0</td>
</tr>
<tr>
<td>65 to 90</td>
<td>5.0</td>
<td>12.0</td>
<td>20.0</td>
<td>30.0</td>
</tr>
</tbody>
</table>

### Table 8.3.3.3
Sizes of defects permitted for welded joints of mark I quality

<table>
<thead>
<tr>
<th>Thickness of welded items</th>
<th>Pores and inclusions Width (diameter)</th>
<th>Clusters Length</th>
<th>Chains Length</th>
<th>Total length of defects (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 5</td>
<td>0.8</td>
<td>2.5</td>
<td>4.0</td>
<td>6.0</td>
</tr>
<tr>
<td>Over 5 to 10</td>
<td>1.2</td>
<td>3.5</td>
<td>6.0</td>
<td>10.0</td>
</tr>
<tr>
<td>10 to 20</td>
<td>1.2</td>
<td>3.5</td>
<td>6.0</td>
<td>10.0</td>
</tr>
<tr>
<td>20 to 25</td>
<td>2.0</td>
<td>6.0</td>
<td>8.0</td>
<td>12.0</td>
</tr>
<tr>
<td>25 to 35</td>
<td>2.5</td>
<td>8.0</td>
<td>10.0</td>
<td>15.0</td>
</tr>
<tr>
<td>35 to 45</td>
<td>3.0</td>
<td>10.0</td>
<td>12.0</td>
<td>18.0</td>
</tr>
<tr>
<td>45 to 65</td>
<td>4.0</td>
<td>15.0</td>
<td>20.0</td>
<td>30.0</td>
</tr>
<tr>
<td>65 to 90</td>
<td>5.0</td>
<td>15.0</td>
<td>25.0</td>
<td>40.0</td>
</tr>
</tbody>
</table>
9 WELDING CONSUMABLES

9.1 GENERAL PROVISIONS

9.1.1 The structures subject to the technical supervision of the River Register in process of manufacturing and repair, shall be welded only using the welding consumables which have documents issued by the River Register according to requirements of 2.5 RTSC.

9.1.2 For all welding materials intended for welding of liquefied gas tankers cargo tanks, deposited weld metal and butt welded joints shall be tested in accordance with the requirements of Appendix 12.

9.1.3 Chemical composition of deposited weld metal for welded joints of liquefied gas tankers is specified in accordance with the technical documentation approved by the River Register.

9.1.4 The welding consumables’ specifications shall contain at least the following data:
- The name, grade, type and purpose of the welding consumable;
- The grade of the welding consumable in accordance with the Rules;
- The chemical composition of deposited metal;
- The mechanical and technological properties of deposited metal and welded joint;
- The welding procedure and conditions;
- The brief description of the manufacture process of welding consumables as well as quality control methods;
- Testing program.

9.1.5 In general, for the purpose of welding consumables approval the following shall be determined:
- Mechanical properties of the weld metal and butt weld;
- Resistance of weld and butt weld to hot cracking at welding tee-joint assembly.
- The following shall be determined additionally, if so required by the Rules:
  - Diffusible hydrogen content in the deposited metal (see 9.2.4 and 9.2.7);
  - Resistance of the weld metal and welded joint to cold cracking at welding (see 9.2.5 and 9.2.8);
  - Corrosion resistance of the welded joint in sea water (see 9.2.6 and 9.2.9).
- The scope of test for welding consumables batch is specified according to Appendix 12.

9.1.6 Fillet weld electrodes including those for welding with sloping and lying electrode, are submitted to the following tests:
- Determination of the deposited metal properties according to 3.1 of Appendix 12;
- Tee-joint testing;
- Hydrogen test according to 9.2.7.

9.2 WELDING CONSUMABLES FOR HULL STRUCTURAL STEELS

General provisions

9.2.1 Welding consumables for normal strength hull structural steel are divided into grades 1, 2 and 3; those for welding of higher strength hull structural steel — grades 1Y, 2Y, 3Y; those for welding of high strength hull structural steel — grades 3Y, 4Y and 5Y.

Grades of welding consumables for welding high strength steel have an additional index, which indicates the minimal yield limit of the material (see 9.5).
Compositions of welding consumables which are admitted for automatic welding are marked as follows:

Two-pass welding — T;
Multi-pass welding — M;
Two- and multi-pass welding — TM.

Material compositions admitted for semi-automatic welding are marked with index S.

9.2.2 The mechanical properties and impact energy $KV$ to be determined by results of the deposited metal testing shall comply with Table 9.2.2-1, those of the welded joint — Table 9.2.2-2 for the relevant grade of welding consumable.

9.2.3 Welding consumables for hull structural steels shall be chosen in accordance with Table 7.2.4.

9.2.4 Proceeding from the diffusible hydrogen content in the deposited metal, which is determined according to 9.2.7, welding consumables may be designated (see 9.1.5) by the River Register as “I”, “II” or “III” according to Table 9.2.4. The method of determining the hydrogen content shall be indicated in the approval testing protocol. The diffusible hydrogen content calculation shall be corrected to the standard conditions by temperature and pressure ($20^\circ C$ and $101.3$ kPa).

<table>
<thead>
<tr>
<th>Hydrogen content index</th>
<th>Hydrogen content in the deposited metal (maximum, cm$^3$ per 100 g of the deposited metal), determined by:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>vacuum method</td>
</tr>
<tr>
<td>H</td>
<td>15</td>
</tr>
<tr>
<td>HH</td>
<td>8</td>
</tr>
<tr>
<td>HHH</td>
<td>5</td>
</tr>
</tbody>
</table>

**Table 9.2.4**

**Index of diffusible hydrogen content in deposited metal**

<table>
<thead>
<tr>
<th>Welding consumable</th>
<th>Tensile properties of deposited metal</th>
<th>Impact energy $KV$ obtained at impact testing$^1$ of deposited metal</th>
<th>Tensile strength $R_m$ (MPa)</th>
<th>Angle of bending until the first crack occurs (grad)</th>
<th>Impact energy $KV$ obtained at impact testing$^1$ of welded joint for</th>
<th>Angle of bending until the first crack occurs (grad)</th>
<th>Minimum average value for three test specimens (J)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>Purpose — for steel of (strength)</td>
<td></td>
<td></td>
<td></td>
<td>electrodes and combinations for semi-automatic welding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1, 2, 3 normal</td>
<td>400-560</td>
<td>305</td>
<td>22</td>
<td>45</td>
<td>Not standardised</td>
<td>47</td>
<td>34</td>
</tr>
<tr>
<td>1Y</td>
<td>higher</td>
<td>490-660</td>
<td>375</td>
<td>47</td>
<td>Not standardised</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>2Y, 3Y</td>
<td>1200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$^1$ Deposited metal received by using welding consumables of grades 1 and 1Y shall be tested at the temperature $+20$ °C, grades 2 and 2Y — at $0$ °C, grades 3 and 3Y — at $–20$ °C.

**Table 9.2.2-1**

**Required mechanical properties of deposited metal**

**Table 9.2.2-2**

**Required mechanical properties of welded joint**

$^1$ Deposited metal received by using welding consumables of grades 1 and 1Y shall be tested at the temperature $+20$ °C, grades 2 and 2Y — at $0$ °C, grades 3 and 3Y — at $–20$ °C.

$^*$ For test assemblies welded in the vertical position — not less than 34 J.
9.2.5 Welding consumables of any grade intended for welding normal strength steel with the carbon content of 0.22 % and more or similar steel to other steels as well as for welding higher strength steel shall ensure that no post-welding cold cracks are formed in the weld metal and welded joint when the welding is conducted at a temperature down to –25 °C and the sulphur and phosphorus content in the weld metal do not exceed 0.03 % of each element.

9.2.6 Welding consumables intended for welding of hulls of river-sea navigation ships shall ensure equal corrosion rates of welded joint (the weld metal and area of thermal effect) and the base metal in sea water.

9.2.7 Hydrogen test shall be performed by method stated in Appendix 9.

9.2.8 The cold-cracking resistance of the weld metal and the welded joint is determined according to the method stated in Appendix 7.

9.2.9 The sea water corrosion resistance of the welded joint is determined by results of testing performed according to the method stated in Appendix 6. Tests to determine the mentioned resistance may be carried out also using alternative procedures if their compliance with the requirements of the Rules is approved by the River Register.

9.3 WELDING CONSUMABLES FOR BOILER STEEL

9.3.1 Welding consumables for boiler steel are fully covered by the requirements of 9.2 for welding of hull structural steel, except the cold-cracking resistance and sea water corrosion resistance testing. Additionally the requirements of the present Chapter shall be considered.

9.3.2 For the purpose of testing welding consumables for boiler steel an additional set of specimens for post-ageing impact testing in accordance with 2 of Appendix 10 shall be prepared from the deposited metal test assemblies and butt welds.

9.3.3 When testing welding consumables intended for steels to be used at 350 °C and above, tensile tests at maximum working temperature shall be carried out to determine proof stress \( R_{p0.2} \).

Tests are performed in accordance with requirements of national standards\(^1\), and tests results are assessed taking into account the same standards.

9.4 WELDING CONSUMABLES FOR WELDING STEEL INTENDED FOR MANUFACTURING OF THE SHIP MACHINERY

9.4.1 Welding consumables approved for welding of hull structural or boiler steels may be approved for welding steels intended for manufacturing of the ship machinery, arrangements and deck gears, piping without additional testing when they are made of hull structural steel or boiler steel, or steel similar to hull structural steel by its chemical composition and mechanical properties specified by the present Part of the Rules.

In all other cases welding consumables for these objects shall be tested on that steel, which they are intended for.

9.5 WELDING CONSUMABLES FOR HIGH STRENGTH STEEL

**Deposited metal tests**

9.5.1 The preparation of the test assemblies, their dimensions and quantity, as well as the deposited metal tests shall comply with the requirements of 2.1, 3.1, 4.2, 5.2 and 5.3 of Appendix 12 proceeding from the welding consumables used.

Results of the specimens tests shall meet the requirements of Table 9.5.1.

**Welded joint test**

9.5.2 The preparation of the test assemblies, their dimensions and quantity, as well as the welded joint tests shall comply with the requirements of 3.2, 4.3, 5.2 and 5.3 of Ap-

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\(^1\) GOST 9466, GOST 2246.
pendix 12 proceeding from the welding consumables used.

Test assemblies shall be made of high strength steel with a minimum tensile strength complying with the declared grade.

Results of the specimens tests shall meet the requirements of Table 9.5.2.

**Determination of the hydrogen content**

9.5.3 Welding consumables shall undergo testing in order to determine the hydrogen content according to 9.2.7 and shall comply with the requirements for the metal with the index of hydrogen content HH.

### 9.6 WELDING CONSUMABLES FOR ALUMINIUM AND ALUMINIUM ALLOYS

9.6.1 Welding consumable intended for welding a particular alloy shall be tested on that alloy.

9.6.2 The test results obtained on specimens described in 8.2 of Appendix 12 shall satisfy the following requirements:

For welded joint specimen the tensile strength \( R_m \) shall be not less than \( 0.9 R_m \) of the base metal, the angle of bending — not less than \( 120^\circ \) over a mandrel with a diameter four-fold the specimen thickness;

For weld metal specimens the tensile strength \( R_m \), the yield point \( R_{0.2} \), the elongation \( A \) and the reduction of area \( Z \) shall be specified on agreement with the River Register.

No defects shall be revealed in the tee-joint samples fracture surface which can not be negligible in accordance with the requirements of Tables 8.3.2-1 and 8.3.2-2.

### 9.7 GROUNDINGS NOT-REMOVED PRIOR TO WELDING

9.7.1 The possibility of approval of grounding is established according to the test results of tee-joint samples. Tests of butt joints may be required there are any doubts in the uniqueness of test results of tee-joints.

<table>
<thead>
<tr>
<th>Grade ( )</th>
<th>Minimal yield limit (MPa)</th>
<th>Tensile strength ( R_m ) (MPa)</th>
<th>Yield point ( R_{0.2} ) (MPa)</th>
<th>Elongation ( A ) (%)</th>
<th>Impact energy KV (J)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3Y</td>
<td>42</td>
<td>530-680</td>
<td>420</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>46</td>
<td>570-720</td>
<td>460</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>4Y</td>
<td>50</td>
<td>610-770</td>
<td>500</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>55</td>
<td>670-830</td>
<td>550</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>5Y</td>
<td>62</td>
<td>720-890</td>
<td>620</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>69</td>
<td>770-940</td>
<td>690</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Welded joint provided by using welding consumables of grade 3Y shall be tested at the temperature -20 °C, grade 4Y — at -40 °C, grade 5Y — at -60 °C.

<table>
<thead>
<tr>
<th>Welding consumables</th>
<th>Tensile properties of the deposited metal</th>
<th>Impact testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade ( )</td>
<td>Minimal yield limit (MPa)</td>
<td>Tensile strength ( R_m ) (MPa)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3Y</td>
<td>42</td>
<td>530-680</td>
</tr>
<tr>
<td></td>
<td>46</td>
<td>570-720</td>
</tr>
<tr>
<td>4Y</td>
<td>50</td>
<td>610-770</td>
</tr>
<tr>
<td></td>
<td>55</td>
<td>670-830</td>
</tr>
<tr>
<td>5Y</td>
<td>62</td>
<td>720-890</td>
</tr>
<tr>
<td></td>
<td>69</td>
<td>770-940</td>
</tr>
</tbody>
</table>

1 Welded joint provided by using welding consumables of grade 3Y shall be tested at the temperature -20 °C, grade 4Y — at -40 °C, grade 5Y — at -60 °C.

Butt joint sample without grooving at manual welding is required when deep-fusion electrodes are used.

9.7.2 Grounding shall be tested on high structural steel of the highest grade from those for which it is intended. Testing is conducted by those welding methods for which the grounding shall be used.

9.7.3 Testing method is specified in Appendix 8.
TEST METHOD OF SHIP STRUCTURAL MATERIALS FOR NON-COMBUSTIBILITY

1 General requirements

The following materials shall be tested: homogeneous and composite non-metal ship structural materials: construction, finishing, insulation materials etc.

Proceeding from the test results materials are divided into two groups according to 2.1 Part III of the Rules: non-combustible and combustible ones.

2 Test specimens

Test specimens shall be of cylindrical shape with diameter \((45 \pm 2)\) mm, height of \((50 \pm 3)\) mm and volume of \((80 \pm 5)\) cm\(^3\). Five specimens shall be tested.

When the material thickness is less than 50 mm, the specimens shall be made up of single circles with diameter of 45 mm which shall be put horizontally into the holder and fixed in it. Density of the specimen shall be the same as that of the material tested. Thickness of specimens of composite materials shall be brought to the required value of 50 mm by the proportional thickness change of material of single components.

Material of the specimen end surfaces shall be the same as that of the front-face (outer) surface.

Where it is impossible to make specimens of the required dimensions, separate components shall be tested.

Each specimen shall have 2 mm-diameter opening on the top in the axis direction for thermocouple.

Prior to testing specimens shall be kept at the temperature of \((60\pm5)\) °C for 20 hours, then cooled down to the ambient temperature and weighed with 0.1 g accuracy.

3 Testing equipment

Tests shall be conducted on the device shown on Fig. A1.1.

Fig. A1.1. Testing device for non-combustibility tests;

It is an electrical furnace 6 mounted on a special pedestal 11. The furnace is a cylindrical reaction chamber formed by the tube 8
with the walls \((10 \pm 2)\) mm thick made of aluminous material with density \((3000 \pm 300)\) kg/m³. The reaction chamber is heated by one or several electric coils 7 laid outside the tube in such a way to provide uniform temperature zone of \((750 \pm 10)\) °C at least 65 mm high inside the chamber. The space between the tube and the protective housing 10 made of steel 1 mm thick is filled with insulation 9 made of non-flammable heat insulating material. From above and from below insulation is covered by cardboard or plate made of non-flammable heat insulating material \((10 \pm 1)\) mm thick.

The reaction chamber in its lower part houses a cone air stabilizer 13 made of steel 1 mm thick which is fitted with by means of a gasket made of non-flammable heat insulating material. The inner surface of the stabilizer is polished and the outer surface is insulated from the outside by fibre insulation 12 which is 25 mm thick.

At the upper open end of the reaction chamber an exhaust shroud 4 is installed which is made of steel 1 mm thick and insulated from the outside by fibre insulation 5 which is 25 mm thick. The furnace 6 shall be mounted on the pedestal 11 in such a way;

- that the distance from the lower end of the stabilizer to the device foundation is at least 250 mm.

The specimen holder 3 is suspended to the lower end of the tube which is fixed to the lath 1 moving towards the guide 2.

The cylindrical holder (Fig. A1.2) shall be made of chromium-nickel heat-resistant steel. The bottom of the holder is a perforated plate 0.5 mm thick. The weight of the holder shall be within 10–40 g.

The exhaust shroud 4 (see Fig. A1.1) is equipped with the fixation device for thermocouples inserted into the reaction chamber.

For temperature measurements chromel-alumel protected thermocouples shall be used.

Fig. A1.2. The specimen holder
with the outer diameter of 1.5 mm. The diameter of the thermocouple wire is 0.2 mm. The thermocouple response time is 15–20 s. Temperature is registered by means of secondary device with measurement limits 0 – 1000 °C and error not exceeding 0.5 %.

In order to produce constant temperature mode in the reaction chamber electric current shall be fed to the electric coils via voltage stabilizer and autotransformer. The maximum permitted voltage deviation from the nominal value is ±5 %.

4 The device calibration

Prior to the operation it is necessary to make certain that all the equipment is in working condition, i.e. the secondary device is correct, thermocouples have been installed and connected to the device and the specimen introducer operates smoothly.

When the specimen is newly introduced or the electrical coils have been replaced, it is necessary to determine the location of uniform temperature zone along the height of the furnace reaction chamber. Temperature is measured along the whole height of the reaction chamber at the distance of 10 mm from the wall in three points evenly distributed along the circumference. The zone shall be detected where temperature fluctuations do not exceed ±10 °C. This zone shall be not less than 65 mm high.

5 Testing

Prior to testing it is necessary to make certain that all the equipment is in working condition and protected from draught and direct sunlight or artificial illumination.

Before testing specimens, the furnace shall be warmed and the inside temperature of (750±10 °C) shall be maintained for 10 min.

A specimen shall be put into the holder. To measure the temperature inside the specimen a thermometer shall be inserted through 2 mm-diameter hole and fixed in the centre of the specimen.

To measure the temperature in the furnace the hot thermojunction shall be located at 10 mm distance from the reaction chamber wall in the centre of the height of uniform temperature zone.

To measure the specimen surface temperature the hot thermojunction of another thermocouple shall be located in the centre of the specimen height and be in contact with its surface in the point antipode to the thermo-couple for measuring the temperature in the furnace.

The holder with the specimen must be smoothly introduced into the reaction chamber within not more than 5 s. The specimen shall be located in the centre of uniform temperature zone and be equally distant from the chamber walls. A stop-watch and secondary device are switched on at the moment of the specimen introduction.

During tests the following shall be determined: the maximum temperatures in the furnace, on the specimen surface and inside it, initial self-ignition time and the prolongation of combustion.

The specimen shall be tested within 20 min or until reaching the maximum temperatures.

After testing the specimen shall be weighed and the percentage mass loss shall be calculated.

6 Test results

Material is found non-combustible, when during the tests of all the five specimens the following has not been observed:

- Increase of the average temperature in the furnace by more than 50 °C compared with (750±10) °C;
- Increase of the average temperature on the specimen surface or inside it by more than 50 °C compared with (750±10) °C;
- Flame burning for more than 10 s;
- The average mass loss by 50 % or more compared with the initial mass for specimens prepared for testing.

When the material does not comply with at least one of the above requirements, than it is found combustible. The test results shall be filed as follows:
Test report of materials for non-combustibility

Date ________________________ Name, mark, GOST, specification ________________________
Specimen humidity ________________________ Material composition ________________________

Test data

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Specimen characteristic</th>
<th>Readings of thermocouples (°C)</th>
<th>Time (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>in the furnace</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>on the surface of the specimen</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>inside the specimen</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temperature difference</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weight (%)</td>
<td>initial</td>
<td>maximal</td>
</tr>
<tr>
<td></td>
<td>Weight (g)</td>
<td>Temperature initial</td>
<td>Temperature maximal</td>
</tr>
<tr>
<td></td>
<td>Dimensions (cm), volume (cm³)</td>
<td>Before testing</td>
<td>After testing</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusion ________________________ Performer ________________________ (signature)
TEST METHOD OF SHIP STRUCTURAL MATERIALS FOR FLAME PROPAGATION

1 General requirements

The following materials shall be tested: finishing and facing materials, varnishes, paints applied on combustible or non-combustible base as well as construction and insulation materials in cases specified by Part III of the Rules, when flame propagation ability of their surfaces shall be assessed.

Proceeding from the test results materials are divided into two groups according to 2.1.3 Part III of the Rules: slowly or rapidly propagating flame along its surface.

The degree of flame propagation along the surface of the metal or composition is defined by index \( I \) which is dimensionless quantity determined by the present test method.

2 Test specimens

Test specimens shall be made of the materials or compositions to be tested and shall be \((140 \pm 2) \text{ mm wide and } (320 \pm 2) \text{ mm long. The actual thickness of the specimens is not standardised. Three specimens shall be tested.}

Test specimens shall be manufactured using the same technology as adopted for the manufacture of the given structure.

In process of testing finishing and facing materials, varnishes, paints shall be applied to the same base surface as in the structure.

Prior to testing the specimens shall be kept at the temperature of \((60 \pm 5) \text{ °C for 20 hours, then cooled down to the temperature of the room where testing is performed.}

The tested surface of the specimen shall be divided by marking into 10 equal sections (sections 0, 1, 2, ...,9). Marks on the surface shall coincide with the marks on the frame of the specimen holder.

3 Testing equipment

The test device is shown on Fig. A2.3-1. The device consists of an upright 7, a radiation panel 5, an exhaust device 2, a specimen holder consisting of the frame 4 and the prop 6, electrical-type instruments and monitoring devices. The frame is made of steel 0.8–1.0 mm thick. On the frame edges each 30 cm are shown by marks (see Fig. A2.2, No. 0–9). The radiation panel is an assembly of three infrared radiation burners that can operate on liquefied and natural gas. The heating temperature of the burner ceramics surface shall be 850–900 °C. The heat-resistant steel net screen is mounted before the ceramics in order to increase radiation and to reduce the influence of air flows.

Combustion products are collected by the exhaust device with dimensions 700×360×360 mm made of steel plate mounted above the specimen holder 45 cm higher than the panel 5 at the distance of 10 mm from it. The upper part of the device is fitted with a thermocouple 1 of 0.5 mm-diameter wire to measure the temperature of smoke gases which is connected to a secondary device with measurement limits 0–400 °C and error not exceeding 0.5 %.

The igniting gas burner 3 with 2 mm-diameter aperture is mounted in front of the radiation panel.
Fig. A2.3-1. Device for ship structural materials testing for flame propagation;

Fig. A2.3-2. Device for flame propagation testing;

The device is arranged in such a way that the igniting flame 20 mm high touches with the specimen surface in the centre of the upper (zero) section.

4 Testing

Prior to testing it is necessary to make certain that all the equipment including monitoring instruments is in working condition and have calibration documents. During the tests the normal ambient conditions shall be maintained, i.e. air temperature 18–22 °C, relative humidity 50–80 %.

During testing forced ventilation of the room where testing is being conducted shall be switched off and the equipment shall be protected from draught. The radiation panel shall be heated up to temperature (875±25) °C maintained within 10 min. For a new installation as well as after repair or replacement of the components of the installation it is necessary to calibrate the equipment and to determine:

The temperature of smoke gases $t_0$ for testing of non-combustible specimen of asbestos-cement plate;

The installation heat factor $\beta$ which is determined by the quantity of heat applied to the specimen surface per minute which is necessary for rise of the temperature of smoke gases by 1 °C.

It is determined $\beta$ on the test specimen with thickness of 10 mm and density of 1.75 g/cm³ which is fixed in the holder frame and inclined at angle of 30° to the radiation panel fixed in the vertical position. The specimen holder shall be installed in such a manner that the distance from the specimen edge to the panel grid is 70 mm.

In the beginning $t_0$ shall be measured. Then the ignited gas calibrating burner with a slot nozzle shall be installed at half-height of the specimen (the nozzle thickness is 40 mm, the slot is 0.5 mm, the gas consumption is from 2 to 6 l per min). Temperature of smoke gases $t_1$ shall be measured.

The factor $\beta$ is calculated by the formula:

$$\beta = \frac{qQ}{(t_1 - t_0)},$$

where $q$ is specific heat of combustion of the gas (kJ·l⁻¹);

$Q$ is the gas consumption of the calibrating burner (l·sec⁻¹).

For the testing purposes specimen of a material or composition shall be fixed in the holder frame and put in front of the heated radiation panel in the same way as during the
calibration procedure. Material samples of thickness less than 10 mm shall be tested on base chrysotile cement plate of dimensions 320 x 140 x 10 mm.

The following shall be determined during testing:

- \( \tau_0 \) — the time from the beginning of the test to the ignition of the upper (zero) section at permanently burning igniting flame;
- \( \tau_1, \tau_2, \tau_3 \ldots \tau_i \) — the time required for the flame front to pass the specific section of the specimen surface, sec (\( i \) is the number of sections on which flame has been propagated);
- Distance \( l \) covered by the propagated flame during tests, in mm;
- Maximal temperature of the smoke gases \( t_{\text{max}} \) (°C);
- Time \( \tau_{\text{max}} \) from the beginning of the test until the maximal temperature has been reached (sec).

The measured values shall be fixed in the test report in order to determine the flame propagation index \( I \).

The test shall be conducted either within 10 min or until the flame stops spreading over the specimen surface.

### 5 Test results

Index \( I \) shall be calculated for each specimen according to the test results:

\[
I = \left[ 0.115 \beta (t_{\text{max}} - t_0) \left( \frac{\tau_{\text{max}}}{t_0} \right) \right] \left[ 1 + 0.2 \sum_{i=1}^{n} \frac{\tau_i}{t_0} \right]^{0.5},
\]

where 0.115 — coefficient (1/W); 0.2 — coefficient (cm/m).

The arithmetic mean of indices values for three tests shall be calculated. For this purpose: for combustible materials with slow flame propagation the arithmetic mean of the flame propagation index shall be \( I \leq 20 \); for combustible materials with rapid flame propagation the arithmetic mean of the flame propagation index shall be \( I > 20 \).

The test results shall be filed as follows:

**Test report of materials and compositions for flame propagation**

<table>
<thead>
<tr>
<th>Date</th>
<th>Name, mark, GOST, specification</th>
<th>Measuring instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Material composition</td>
<td>Specimen humidity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Installation heat factor ( \beta ) (kJ/[sec \cdot deg])</th>
<th>Temperature of smoke gases for testing of non-combustible specimen ( t_0 ) (°C)</th>
<th>Time from the beginning of the test to the ignition of the specimen ( \tau_0 ) (sec)</th>
<th>Maximal temperature of the smoke gases ( t_{\text{max}} ) (°C)</th>
<th>Time from the beginning of the test to the ignition of the specimen ( \tau_{\text{max}} ) (sec)</th>
<th>Time required for the flame front to pass the specific section of the specimen surface ( \tau_i ) (sec)</th>
<th>Maximal distance covered by the propagated flame ( l ) (mm)</th>
<th>Flame propagation index</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Conclusion: __________________________ Performer: __________________________

(signature)
1 General requirements

The following materials shall be tested: deck coatings 5 mm thick and over which are applied on the surface of the metal deck and cannot be withdrawn in the event of fire. Deck coatings less than 5 mm thick cannot be tested by this Method. The present Method applies to specimens of deck coatings without insulation from below the metal plate which imitates the ship’s deck.

Proceeding from the test results materials are divided into two groups according to 2.1.4 Part III of the Rules: hardly-ignitable and easily ignitable ones.

2 Test specimens

Test specimens are (625±5) mm thick, (625±5) mm long, thickness of the base steel plate is 5 mm and thickness of the coating is 5 mm. Two specimens shall be tested.

Test specimens shall be manufactured using the same technology as adopted for the manufacture of the given structure.

The material of the deck coating in the same condition as used in service conditions shall be applied on the steel plate with dimensions 625 × 625 mm and thickness 5 mm.

Prior to testing the specimens shall be kept for 5 days at air relative humidity 40–70% and temperature (20 ± 5) °C.

3 Test furnace

Coatings shall be tested in a fire furnace with rectangular opening of clear dimensions 600×600 mm. Where a fire furnace of larger opening is used, in order to decrease the furnace opening down to 600×600 mm a detachable frame made of refractory reinforced concrete shall be used.

The fire chamber of the furnace shall be of such dimensions as to prevent the contact of the flame with the lower surface of the specimen. The fire chamber shall be at least 100 mm high.

The furnace shall be made of ordinary brick with lining of refractory brick or other refractory (insulation) materials to prevent excessive loss of heat through the walls.

The furnace may be heated using low-pressure gas burners or electric coils in order to establish the temperature conditions in accordance with the standard temperature — time dependence: 5 min — 538 °C, 10 min — 704 °C, 15 min — 760 °C.

The accuracy of temperature adjustment shall be such as the area bounded by the curve of the average furnace temperature differs from the area bounded by the standard curve by not more than 15 % during the first ten minutes of the test and by not more than 10 % — to the end of the 15th minute.

The temperature conditions in the furnace during tests shall be measured by four thermocouples located symmetrically in the furnace opening.

Hot ends of thermocouples shall be located at the distance of 50 mm from the heated surface of the specimen. The surface shall be heated uniformly.

Temperature shall be registered by means of secondary device with measurement limits 0–900 °C and error not exceeding 0.5 %.
The deck coating shall be ignited using the ignition gas burner. The diameter of the burner aperture is 1–2 mm and the flame height is 20–30 mm.

The space where testing is conducted shall be equipped with the forced ventilation.

### 4 Testing

The test specimen shall be put on the furnace opening with the deck coating up.

In order to preclude the penetration of furnace gases through gaps between the specimen edges and the furnace flange, sealing rolls of non-combustible heat insulating materials shall be used.

During testing provision shall be made to prevent draught and air flows above the specimen surface.

After the specimen has been arranged, working order of testing equipment and availability of calibration certificates has been checked, the furnace shall be actuated.

During tests when smoke or degradation products of the coating material have been appeared, flame of the ignition burner shall be carried over the specimen surface within 10 s with the intervals of 1 min. The aperture of the ignition burner shall be at the distance of 5 mm from the surface of the coating. The burner inclination angle is $45^\circ$ (Fig. A3.4).

If the material of the deck coating has been deformed or distended, it is necessary to make precaution in order not to damage the coating surface by the burner.

Two test specimens shall be tested for each type of the deck coating. The prolongation of test is 15 min.

The following shall be determined during tests:

- the time from the beginning of tests to the moment of ignition and the prolongation of combustion;
- the type of combustion (along the whole surface, local), the location of combustion, the flame height etc.
- damage of the coating.

### 5 Test results

The material of the deck coating is considered as hardly-ignitable when none of the specimens demonstrate combustion with flame for more than 10 s after the igniting burner flame has been removed. Otherwise the material is considered as easily-ignitable.

The test results of the deck coating specimens shall be filed as follows:

---

Fig. A3.4. The igniting burner;
Test report of deck coatings for ignitability

Date

The description of the deck coating specimen

Measuring instruments

### Test Results

<table>
<thead>
<tr>
<th></th>
<th>The prolongation of test of the specimen (min)</th>
<th>Time from the beginning of tests to the moment of ignition (min)</th>
<th>The prolongation of combustion (min)</th>
<th>The nature of combustion (location, the flame height etc.) and the extent of damage of the coating</th>
<th>Estimation of ignitability (conclusion)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
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<tr>
<td>3</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Conclusion

Performer

(signature)
METHOD OF FIRE TESTS OF TEXTILES

1 Purpose

The method is intended for evaluation properties of textiles to withstand ignition, steady-state combustion and flame propagation.

On the basis of the test results textiles are divided into easily ignitable and hardly-ignitable ones.

The following materials shall undergo testing: textiles and films used in shipbuilding for manufacturing curtains and drapery.

2 Definitions

The prolongation of residual combustion is the time when the material burns with flame after the combustion source has been removed.

Residual smouldering is smouldering of the material after flame burning has been stopped or the combustion source has been removed.

Surface flash is flash of the material surface involving mainly surface nap and not affecting the basic textile.

Steady-state combustion is residual combustion for 5 sec and more.

3 Test specimens

For testing purposes eight test specimens with the dimensions of 220×170 mm shall be cut out in warp and weft directions. When the textile has sides differing from each other, then the specimens shall be prepared from each side.

Prior to testing the specimens shall be kept at temperature (20±5) °C and relative humidity (65±5) % within at least 24 hours. Each specimen after having been removed from the conditioning atmosphere shall be tested for 3 min or put into the sealed container till the beginning of the tests.

Fire-proof-pretreated textiles shall undergo accelerated water leaching and be tested before this treatment and after it.

During leaching the specimen is submerged for 72 hours into a reservoir with tap water of room temperature. The water shall be changed every 24 hours. The reservoir shall be such as the ratio of the mass of the textile and water in it is 1:20. Then specimens shall be dried at 70 °C. After these operations they shall be conditioned.

4 Test device

The general view of the device is shown in Fig. A4.4-1. The device consists of test frame 1, foundation 4, vertical uprights 2, burner holder 5 and liquefied gas (propane-butane) burner 3.

Test frame is made of stainless steel stripe of 2×10 mm, which is the base for studs for the specimen fixation and limiting sprigs of diameter (2±0.1) mm. The burner holder can be moved on the metal base in the horizontal direction towards the specimen and in the opposite direction.

The holder shall ensure the arrangement of the burner case axis in one of three positions: vertically upwards, horizontally and at the angle of 60° to the horizontal. The positions that the burner can take relatively to the specimen are shown on Fig. A4.2, a, b.
During testing the device is arranged in a chamber protecting it from draughts. The chamber with dimensions $(700 \pm 25) \times (325 \pm 25) \times (750 \pm 25)$ mm is made of metal plate 0.5–1.0 mm thick. On the top of the chamber there are 32 symmetrically located ventilation holes of diameter $(13 \pm 1)$ mm. Each vertical wall of the chamber in its lower section shall also have similar holes of total area not less than 32 cm² closed by chokes. One of the walls with the dimensions of $700 \times 750$ mm is a glass door that can be closed. The chamber is provided with holes for the tube supplying gas to the burner and remote installation of the burner in the necessary position. The chamber floor is lined with non-combustible insulation material. The inner surfaces are painted black.

5 Testing

Prior to testing on the base of the testing apparatus a layer of cotton wool shall be placed (without synthetic additives) of 10 mm thickness free from threads and dust. Cotton wool is conditioned together with test samples. Before testing gas burner shall be warmed for at least 2 min. The flame height shall be $(40 \pm 2)$ mm in the vertical position of the burner. Test specimen is fastened on the frame in such a way that the bottom edge of the textile is extended over the lower stud for 5 mm. The burner is fixed in horizontal position. The chamber door is closed and the burner is being moved towards the specimen till it reaches the position shown on Fig. A4.4-2, a. After 5 sec the burner is moved away from the specimen. If no steady combustion is observed, a new specimen shall be placed on the frame and in this position the exposure time is increased up to 15 sec.

If no steady combustion is observed, the burner position shall be changed according to Fig. A4.4-2, b, in such a way that the flame touches the bottom edge of the specimen. In this position the exposure time for the new specimen is also 5 sec and, in the absence of steady-state combustion, after the used specimen has been replaced with a new one — 15 s.
For testing five specimens such ignition conditions shall be provided which allow reaching steady-state combustion during experiments in the sequence stated above. When no steady-state combustion is observed, specimens shall be tested in conditions which give the maximum length of charred section. If residual smouldering is observed during tests, the specimen is withdrawn after it has been stopped.

During the tests the prolongation of residual combustion or smouldering of cotton wool is registered.

After testing the length of charred section is measured by means of a hook and a set of weights. For this purpose the specimen is folded in two parallel to the longer side along the maximal visible part of the charred section and is slightly ironed. From one side of the charred section the hook is inserted at the distance of 8 mm from adjacent outer and bottom edges and is moved upwards inside the specimen until the tear is strong enough to hold the weight.

The weight mass for tearing the tested textile depending on its density is the following: when the surface density of the tested textile is less than 200 g/m² — 100 g, when the density is 200 to 600 g/m² — 200 g, when the density is over 600 g/m² — 400 g.

6 Determination of criteria

Textile is considered as easily combustible and not passed tests, when the following is observed at testing:

- Prolongation of residual flame burning over 5 s for any of 10 (or more) specimens tested by pilot flame from the surface;
- Burning-through till any edge for any of 10 (or more) specimens tested by pilot flame from the surface;
- Ignition of cotton wool under any of 10 (or more) specimens;
- Surface flash on any of 10 (or more) specimens spread for more than 100 mm from the ignition point either with charring of the outer layer or without charring.

Note. Where no warp-and-weft directions are present five specimens are sufficient.

Average length of charred section exceeding 150 mm is observed on any batch consisting of five specimens tested by pilot flame from the surface or the edge.

If the analysis of test data shows that any batch complies with the requirements of one or more of the first four criteria, than repeated testing of one full set comprising five specimens may be conducted. When the second set also does not comply with any of the criteria, the textile is considered as easily combustible and not passed the test.

Textile is considered as hardly combustible and passed the test, when none of the above criteria is observed in process of testing. The test results shall be stated in the test report according to the stated form.

Report of fire tests of textiles

Date  Ne  Devices
Name, mark, technical specification and the material composition
Surface density
## Test data

<table>
<thead>
<tr>
<th>Registered parameter</th>
<th>In warp direction</th>
<th>In weft direction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8</td>
<td>1 2 3 4 5 6 7 8</td>
</tr>
<tr>
<td>Ignition time (sec):</td>
<td></td>
<td>Resulting</td>
</tr>
<tr>
<td>surface edge</td>
<td></td>
<td>parameters</td>
</tr>
<tr>
<td>Time of residual</td>
<td></td>
<td>Resulting</td>
</tr>
<tr>
<td>combustion (sec)</td>
<td></td>
<td>parameters</td>
</tr>
<tr>
<td>Burning-through till</td>
<td></td>
<td>Resulting</td>
</tr>
<tr>
<td>edges</td>
<td></td>
<td>parameters</td>
</tr>
<tr>
<td>Ignition of cotton</td>
<td></td>
<td>Resulting</td>
</tr>
<tr>
<td>wool</td>
<td></td>
<td>parameters</td>
</tr>
<tr>
<td>Length of charred</td>
<td></td>
<td>Resulting</td>
</tr>
<tr>
<td>section (mm)</td>
<td></td>
<td>parameters</td>
</tr>
<tr>
<td>Surface flash (mm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Conclusion**

Test manager: ____________________________  Performer: ____________________________

(signature)  (signature)
METHOD FOR TESTING FIRE-RESISTANT STRUCTURES

1 PURPOSE

The present method is intended for determination of the degree of integrity of structures of types A and B (see 1.2.1.9 and 1.2.1.10 Part III of the Rules) including doors.

Prior to testing the drawings of samples with dimensions of all structure details, joints, cable and other penetrations, connections and methods of fastening the insulation shall be submitted (for testing doors design of hinges, locks, door-handles, air gratings, beat out panels shall be indicated as well as the materials they are made of) and specification with the list of materials used and their parameters, including name of the manufacturer, grade, composition, density, specific heat, heat conductivity, combustibility and speed of flame spread.

2 TEST SPECIMENS

2.1 Metal base of samples of structures of type A shall comply with the following:
   .1 Material — sheet steel or other equivalent material (e.g., aluminium alloy);
   .2 Base thickness: steel (4.5±0.5) mm, aluminium alloy (6.0±0.5) mm;
   .3 Base shall be supported by stiffeners located 600 mm apart from each other;
   .4 Dimensions of stiffeners (mm): steel bulkheads (65±5) × (65±5) × (6±1); steel decks (100±5) × (70±5) × (8±1); aluminium alloy bulkheads (100±5) × (75±5) × (9±1); aluminium alloy decks (150±5) × (100±5) × (9±1).

When the metal base for structures of type A is not made of steel or aluminium alloy, the samples with the shape similar to shape of the actual structure shall be prepared.

2.2 When insulation of structures of types A or B is made of panels, the samples shall contain at least one such panel of the maximum width used and one joint of panels.

2.3 Samples of ceilings of type B shall be installed at the bottom part of the steel deck and shall be tested together with it. If the ceiling structure comprises lighting or ventilation facilities, it is required to conduct tests of samples containing such facilities in order to make sure that fire-resistance properties of the ceiling are not degraded.

2.4 Samples of doors of types A and B:
   .1 Doors shall undergo testing together with door-cases which fully correspond to those which are fitted on a ship;
   .2 Doors of type A together with door-cases shall be installed in a steel bulkhead of the relevant fire resistance;
   .3 Doors of type B together with door-cases shall be installed in a bulkhead of type B or in a bulkhead that shall be tested together with the door;
   .4 Doors shall be tested together with accessories (door-handles, catches, locks, hinges etc.) provided by the door design;
   .5 Doors shall not be locked during tests;
   .6 Bulkhead sections with doors that can be exposed to fire from either side in actual service conditions shall be tested from that side where the most severe conditions are assumed. For hinged doors such conditions are provided when the door is opened in the direction of non-heated surface.
2.5 Samples of structures shall undergo testing in non-painted and non-coated condition. Where insulation materials and panels are made inseparably of coating, they may be tested in finished state.

2.6 To determine the integrity one structure sample shall be tested. Samples of decks and ceilings shall be tested from the bottom, and bulkhead samples — from that side where the worst result is assumed. If it is difficult to determine the worst result beforehand, two samples shall be tested.

2.7 Prior to testing the sample shall be conditioned at relative humidity of (55±15)% and temperature (20±5)°C for the time period required to keep the mass of insulation permanent.

The temperature of sample before tests shall not exceed 40°C.

3 TESTING

3.1 Test furnace

3.1.1 Testing of samples of fire-resistant structures shall be conducted on open-flame furnaces providing uniform distribution of heat flow along the whole surface of the specimen.

Samples of bulkheads and doors shall be tested on furnaces intended for testing specimens in vertical position, and samples of decks and ceilings — in horizontal position.

3.1.2 Samples of structures including bulkheads with doors, shall be mounted on the furnace so as the exposed area is at least 4.65 m² at the height of the bulkhead sample or length of deck (ceiling) sample of at least 2.44 m.

3.1.3 During tests the furnace shall provide the following rate of temperature rise depending on the time:

1. During first 10 and 30 min, as well as after 30 min of testing the area bounded by the mean temperature curve in the furnace shall not differ from the area bounded by standard curve by more than ±15, ±10 and ±5% correspondingly;

2. After first 10 min of testing the mean temperature in the furnace shall not differ from the standard curve by more than ±10°C.

3.1.4 The temperature inside the furnace shall be continuously measured during tests by at least four thermocouples of a diameter not less than 0.75 mm and not over than 1.5 mm, so located as to provide uniform heating.

The distance between the hot thermojunction and the nearest point of the specimen shall be about 100 mm.

3.1.5 During the tests the excessive pressure in the furnace equal to (10 ± 2) Pa (1 mm of water column) shall be measured and checked at the following points:

- When testing bulkheads and bulkheads with doors — at the point lying approximately at the level of 0.75 of the specimen height;
- When testing decks and ceilings — 100 mm below the specimen surface.

3.1.6 In the structure of the furnace for testing ceilings of type inspection openings shall be provided for the inspection over the upper part of the specimen. These openings shall be fitted with closures.

3.2 Fastening of test specimens on the furnace

3.2.1 Test specimens shall be fastened on the furnace as follows:

1. Specimen of structure of type A and of ceiling of type B together with a steel deck shall be so fastened from all sides as to prevent from shifting and to provide flame- and smoke-tightness along the whole perimeter;

2. Specimen of bulkhead of type B shall be fastened in its upper edge, while side and bottom edges shall be fastened — in a method used on a ship. If bulkheads with sliding edges are applied on a ship, such structure shall be reproduced on the specimen. Fastening of the specimen shall provide flame-tightness.

3.3 Measurement of temperature on the specimens

3.3.1 For measuring temperature of non-heated surface the following type of thermocouples shall be used:
Both wires of the thermocouple (thermoelectrodes) with a diameter of 0.5 mm shall be soldered to one side of a copper disc with a diameter of 12 mm and thickness of 0.2 mm in diametrically opposite places and overlap the copper disc by at least 4 mm. Discs shall be covered by plate made of nonflammable insulating material with dimensions 30 × 30 mm and thickness of 2 mm. Plate material shall have a density of 900 kg/m³ ±10 % and heat conductivity of 0.13 W/m·°C ±10 % at a temperature of 100 °C.

3.3.2 Plate on nonflammable material which presses the copper disc to the specimen surface shall be glued to the latter.

3.3.3 Thermocouples for measuring temperature of the base made of aluminium alloy shall be made from wire with a diameter not over 0.75 mm.

3.3.4 When lining coating of insulation materials or panels (see 2.5) is combustible, then in places of mounting of thermocouples it shall be removed in a such way that the thermocouples are in contact with the insulation material or panel material.

3.3.5 Temperature of non-heated surface of the specimen shall be measured in time intervals not exceeding 5 min by thermocouples mounted in the following points:

1. Four thermocouples — each in the centre of each one-fourth of the specimen area at least 100 mm clear of any joints;
2. One thermocouple in the centre of the whole specimen area at least 100 mm clear of any joints;
3. One thermocouple opposite each of two centre stiffeners (for structures of type A);
4. One thermocouple at a joint, if any, at the level of 0.75 of the specimen height for structure of type A;
5. One thermocouple at a vertical joint at the level of 0.75 of the specimen height for structure of type B;
6. At other points where higher temperature is assumed.

3.3.6 Thermocouples on the surface of door samples which is opposite to the exposed one, are mounted at the points according to 3.3.5.1 and 3.3.5.2 at least 100 mm clear of door edges, locks, catches or door hinges.

3.3.7 During tests temperature of the base made of aluminium alloy of structure with double-side insulation shall be measured. Metal-based thermocouples shall be mounted at points according to 3.3.5.1 and 3.3.5.2.

3.3.8 The mean temperature on non-heated surface for samples of structures of type A is determined as the arithmetic mean of temperatures measured at the points specified in 3.3.5.1 – 3.3.5.3; for samples of structures of type B it is measured — as the mean value of temperatures measured at the points specified in 3.3.5.1 and 3.3.5.2.

4 ASSESSMENT OF TEST RESULTS

4.1 Specimens of structures of type A shall be tested for 60 min, and of type B — for 30 min.

For steel-based specimens of bulkheads and decks of type A tested to determine its compliance with type either A-15 or A-30, the test may be finished after 15 min or 30 min respectively.

4.2 A specimen of structure of type A or B is considered as passed the tests due to heating feature under the following conditions:

The mean temperature determined as per 3.3.8 for structures of types A and B does not exceed the initial temperature by more than 139 °C;
Maximum temperature at any of the points specified in 3.12 does not exceed the initial temperature by more than 180 °C for structures of type A and by more than 225 °C — for type B.

Proceeding from the time during which the mentioned temperature intervals are met during tests, the following designations are assigned to the structures:

<table>
<thead>
<tr>
<th>Type A</th>
<th>Type B</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 min — A-60;</td>
<td>15 min — B-15;</td>
</tr>
<tr>
<td>30 min — A-30;</td>
<td>0 min — B-0</td>
</tr>
<tr>
<td>15 min — A-15;</td>
<td></td>
</tr>
<tr>
<td>0 min — A-0</td>
<td></td>
</tr>
</tbody>
</table>
4.3 A specimen of aluminium-alloy-based load-carrying structure of type A with double-side insulation is considered as passed the tests, when the mean temperature of the base determined at the points specified in 3.3.7 does not exceed the initial temperature by more than 200 °C at any moment of the test.

4.4 When during tests a flame is observed on non-heated side of the specimen, it is considered as failed the flame-tightness tests.

4.5 The specimen is considered as passed smoke- and/or burning gases-tightness tests when during standard tests cotton wool wad when it is brought to any place of the specimen including cracks, slots or other openings which may form in the material as well as to the clearance between the door and the door frame and being held at the distance of 25 mm for 30 s is not ignited.

The cotton wool wad shall have dimensions 10×10×2 cm and weight 3 to 4 g. Each wad can be used only once.

4.6 Steel-based structure free of openings shall meet the requirements for type A structure as regards smoke- and flame-tightness.

4.7 Structures of types A and B are considered as passed the tests when the requirements of 4.2 – 4.5 are met.

4.8 During tests it is necessary to watch all parameters which are not included into assessment parameters but may cause the risk at fire (e.g., producing smoke or toxic vapours from non-exposed side of the specimen).

4.9 After finishing fire tests a report shall be drawn up containing the following data:
   - name of the manufacturer of the structure;
   - date of test;
   - the description and drawing of the specimen with the indication of its components and distinctive mark of the manufacturer;
   - test conditions;
   - test method and observations (including photographs and temperature curves);
   - test results (assigned type of fire resistance, temperature rise;
   - and points of its rise, places of cracks, sagging, shifting of door angles relatively to the door frame).
DETERMINATION OF CORROSION RESISTANCE OF WELDED JOINT IN SEA WATER

1 Corrosion resistance of welded joint in seawater shall be determined at tests of welding consumables intended for welding the shell plating, the main deck and other parts of river-sea navigation ships being permanently or occasionally in contact with seawater.

2 Three specimens shall be cut out of the test sample for testing purposes (Fig. A6.2):

Surfaces of the specimens shall be ground so that the deflection from the parallel of planes A and B does not exceed ±0.03 mm. This fact may be controlled by profile record obtained after grinding. The grinding shall be carried out no earlier than 8 days after welding the specimen.

3 The side of the specimen where the welding has been finished shall be exposed to testing. Both sides and the faces shall be degreased; then protective covering for preventing corrosion during tests shall be placed over the rear side of the specimen, the faces and the front side of 8—10 mm width along its contour (e.g. at least four layers of ethynol paint of grade ЭЖК-40).

Immediately before testing the front side of the specimens shall be again degreased and washed.

4 Corrosion-resistance tests of the specimens shall be conducted in special installations in well-aerated artificial seawater of the following composition (g/l): NaCl — 26.52; MgCl₂ — 2.45; MgSO₄ — 3.30; CaCl₂ — 1.14; KCl — 0.73; NaHCO₃ — 0.20; NaB₂ — 0.08.

The water temperature shall be 32—35 °C, the water flow rate relatively to the water surface — about 10 m/s.

Spent water shall be replaced on the basis of 1 l per each specimen per one day. The duration of tests is at least 1000 h. Interruptions in tests other than for water replacement are not allowed.
After tests the specimens shall be cleaned by methods which provide the complete removal of corrosion products and do not bring to damage or dilution of the specimen metal.

Corrosion products may be removed by etching in 15% solution of hydrochloric acid with addition of inhibitors ПБ-5 in the amount of 1.5 g/l.

After etching the specimens shall be washed by water, dried and exposed to profile recording according to the scheme in Fig. A6.5.

Fig. A6.5. Scheme of profile recording of welded specimen:
1 — line of measurements (on sections A measurements are made every 5 min, on sections B — every minute);

Depth of corrosion damage of the metal is determined relatively to the contour surface of the specimen. According to the measurement data for the base metal, heat-affected zone and the weld the average values shall be adopted for all tested specimens:

1. maximum corrosion depth (mm);
   \[ h_{\text{max}} = \sum h_{\text{b.m.}}, h_{\text{max}} ; h_{\text{max}} ; \]

2. average corrosion depth (mm);
   \[ h_{\text{av}} = \frac{\sum h_{\text{b.m.}}}{N_{\text{b.m.}}}, h_{\text{av}} ; h_{\text{av}} ; \]
   \[ h_{\text{av}} = \frac{\sum h_{\text{haz}}}{N_{\text{haz}}}, h_{\text{av}} ; h_{\text{av}} ; \]
   \[ h_{\text{av}} = \frac{\sum h_{\text{w}}}{N_{\text{w}}}, h_{\text{av}} ; h_{\text{av}} ; \]

3. average corrosion rate (mm/year);
   \[ k_{\text{b.m.}} = 365 \frac{h_{\text{av}}}{\tau}, k_{\text{haz}} = 365 \frac{h_{\text{av}}}{\tau}; k_{\text{w}} = 365 \frac{h_{\text{av}}}{\tau}; \]

where \( h_{\text{b.m.}} \), \( h_{\text{haz}} \), \( h_{\text{w}} \) — sums of corrosion depth measurements at particular measurement points in three stated areas of its location;

\( N_{\text{b.m.}}, N_{\text{haz}}, N_{\text{w}} \) — number of measured values of corrosion depth in three stated areas of its location;

\( \tau \) — test duration in moving solution (day);

365 — number of days in a year.

Welding consumables are considered corrosion-resistant, when the corrosion rates of the weld, heat-affected zone and the base metal are equal and the general character of the metal corrosion does not affect the strength of welded joint.
DETERMINATION OF CRACK-RESISTANCE OF WELDING JOINT

1 Scope of application
and design dimensions of specimen

1.1 Crack resistance of welded joint at welding of assembly butt sample shall be determined at tests of welding consumables other than intended for welding only carbon steels of thickness not over 10 mm.

1.2 Design dimensions of a sample, in mm, are shown on Fig. A7.1.2.

The sample plates 2 cooled down to −25 °C shall be connected by butt joint 1. The plates 2 and ribs 4 shall be made of steel of the same grade.

1.3 Thickness of the sample plates 2 is taken equal to the maximum thickness of the plate material of the given steel grade, for welding of which the tested welding consumable is intended.

The sample width B when testing coated metal electrodes is taken as 500 mm and that of welding wire and filler wire in combination with a flux and shielding gas at mechanical weld methods — 700 mm.

Under all testing conditions of welding consumables, where heating is used to dry the edges to be welded (see 5.3 and 6.2), the sample width shall be 1000 mm.

1.4 Scarf of the plate edges along the butt joint 1 shall have maximum depth of V- or X-form unsymmetrical preparation from those stipulated for joints of the given plate thickness at welding with using the tested welding consumables.

2 Preparation of welding consumables
and welding modes

2.1 Moisture contents in tested welding consumables (electrodes, fluxes, shielding
gases) shall reach the upper level of the permissible norm stated in the technical documentation for its supply and application.

2.2 Welding of the sample plates shall be commenced at modes which have been used or provided for welding structures of the given steel grade in manufacturing environment and, where such data are not available — at modes recommended by the electrode passport for structures of the given steel grade.

3 Cooling of the specimen

3.1 Welding of butt joint shall be commenced at plate temperature of 25 °C and with cooling of plates in the weld area down to its initial temperature after each pass.

3.2 The specimen shall be cooled by solid carbon dioxide which pieces of a mass not exceeding 1–2 kg shall be laid in a uniform layer along the whole surface of the plates excepting edges prepared for welding.

The mass of solid carbon dioxide applied simultaneously to the specimen is 40–60 kg. For the period of cooling the specimen shall be covered with tarpaulin.

3.3 The prolongation of cooling of the specimen down to the set temperature prior to welding of butt joint of the plates is not specified.

The prolongation of cooling of the specimen down to the initial temperature after each bead of the butt weld has been applied shall be determined by the curve of Fig. A7.3.3 depending on the specimen plate temperature measured by thermometers with a negative scale. Thermometers shall be placed in blind openings 3 (see Fig. A7.1.2) in the plates filled with gasoline or other liquid non-freezing at low temperatures.

4 Welding conditions of plate butt when testing coated metal electrodes

4.1 Welding of the plate butt joint when testing coated metal electrodes shall be commenced without removing solid carbon dioxide from the plate surface.

Fig. A7.3.3. Typical curve of the cooling prolongation of the specimen by solid carbon dioxide down to required temperature;

4.2 Immediately before welding the edges to be welded and adjacent plate surfaces for a width not less than 100 mm on either sides shall be cleaned from moisture, frost and ice.

5 Welding conditions of plate butt joint when testing welding consumables for automatic hidden arc welding, welding in shielding gas and powder wire

5.1 At automatic welding the plate butt joint prior to the beginning of each pass solid carbon dioxide shall be moved away from the specimen surface and shall be put back after the pass is finished to cool plates to reach the given negative temperature. The cooling time of the specimen without carbon dioxide layer shall not exceed the time required to commence the next pass.

5.2 Before commencing each pass the edges to be welded and adjacent plate surfaces for a width not less than 100 mm on either preparation sides shall be cleaned from moisture, frost and ice.

5.3 When commencing butt welding with more than two passes, in addition to the edge cleaning according to 5.2 before applying each bead the edges shall be dried by gas burner
flame. The metal temperature near the edges after drying shall not exceed 50–60 °C and on the edges it shall be maintained equal to 25 °C.

5.4 When a butt joint of the specimen is commenced by two-side automatic welding, after finishing the last pass the plate metal shall be cooled down to the initial temperature and than a set of new ribs shall be mounted and welded to this side of the specimen; then the specimen shall be turned down and the older ribs shall be cut off. An interruption of welding of the plate butt joint due to the mentioned operation shall not exceed 6 h. Before starting welding the butt joint from the other side the plates shall be cooled down again to the initial temperature.

6 Welding conditions of plate butt joint when testing welding consumables for semi-automatic hidden arc welding, welding in shielding gas and powder wire

6.1 Semi-automatic welding of plate butt joint shall be commenced in compliance with the requirements of 4.1 and 4.2 of the present Appendix.

6.2 When commencing butt joint of the specimen welding with more than two passes, the edge cleaning from moisture, frost and ice and its drying by the burner flame shall be made according to 5.2 and 5.3 of the present Appendix.

7 General requirements to welding conditions of plate butt joint of the specimen

7.1 The weld root shall be dressed after the grooving is finished from one side. The weld root may be dressed to a depth of 3 – 4 mm. Cracks revealed at the weld root dressing are considered as a sign of defect.

7.2 To prevent cracking at butt welding of assembly specimen only those means may be used which are applied or provided for mandatory application at welding manufacture using the tested materials.

8 Investigation of welded sample and estimation of test results

8.1 Welded sample after one day shall be exposed to tapping by hammer of a mass 5 kg in the immediate vicinity of the weld (but not the weld itself), after which the weld shall be inspected to reveal external cracks. If any, the welding is considered as non-satisfactory (see 8.3 of the present Part of the Rules) and no further investigation of the sample is performed.

8.2 When the external inspection results are satisfactory, the sample shall undergo further investigation. Macrosections and specimens shall be prepared as the following:

1 From the sample by means of heat cutting two samples for longitudinal macrosections and three samples for transverse macrosections and 5-fold round specimens for tensile testing shall be prepared according to Fig. A7.8.2-1. Dimensions of the samples on Fig. A7.8.2-1 are given taking into account tolerances for cutting and mechanical grinding of specimens and macrosections.

2 From each sample for transverse macrosections one macrosection shall be prepared according to Fig. A7.8.2-2, a;

3 From each sample for longitudinal macrosections the following shall be prepared:

one macrosection (Fig. A7.8.2-2, b) along the central vertical longitudinal plane of the weld and one macrosection along the horizontal longitudinal plane secant to the weld and heat-affected zone (Fig. A7.8.2-2, c), when the plate is made of carbon steel.

Several layer macrosections (Fig. A7.8.22, e) with grooving as in Fig. A7.8.2-2, d, when the plate is made of low-alloy steel. A number of macrosections depends on the ratio of the thickness of one macrosection (4 – 5 mm) and the thickness of the sample.

8.3 Macrosection surfaces shall be etched by 10% solution of nitric acid and after one day shall be inspected to reveal the cracks formed. Inspection is carried out with the naked eye and using optical devices with 50-fold magnification.
Fig. A7.8.2-1. Scheme of cutting out samples for macrosections from the sample butt joint:
0 — discard; 1, 3, 5 — samples for transverse macrosections and round breaking specimens;
2, 4 — samples for longitudinal macrosections

Fig. A7.8.2-2. Scheme of macrosections prepared from the samples

Three following variants of inspection are possible:

1. No cracks are revealed on macrosections, the test results are considered as satisfactory and no further investigation is performed;

2. On macrosections cracks are revealed with a length over 1 mm regardless of their quantity or cracks with a length less than 1 mm if their quantity per the total etched surface of the macrosection exceeds 2 cracks per 100 cm². In this case the test results are considered as not satisfactory;

3. On macrosections cracks are revealed with a length less than 1 mm with their total quantity per the total etched surface of the macrosection not exceeding 2 cracks per 100 cm². In this case additional tensile test of three round 5-fold specimens with a diameter of 6 or 10 mm shall be made. The specimens shall be prepared from the weld metal of transverse macrosections of that weld layer by the thickness which presents the maximum...
number of cracks. Such specimens shall be prepared not earlier than after 30 days after the welding is commenced or shall be exposed to boiling in water at a temperature of 100 °C for 3 days before testing.

Test results are considered satisfactory, when mean values of yield stress, tensile strength, percentage elongation and percentage area reduction correspond to the norms of Table 9.2.2-1 of the present Part of the Rules.

When the test results of breaking specimens are not satisfactory, repeated testing of two assembly samples welded under the same conditions may be conducted (see Fig. A7.1.2).
DETERMINATION OF EFFECT OF NON-REMOVED GROUNDINGS ON WELDABILITY

1 Test program

1.1 The grounding shall be tested on samples specified in Table A8.1.1. The sample length shall be sufficient for the preparation of all required specimens. Design parameters of edge preparation on the samples (i.e. clearance, the angle of preparation, the facing size) are taken according to the national standards. Grounding of the plates from which the samples are made shall be made prior to welding of the latter. Grounding is covered only on a half of the sample length; it shall be not removed before welding from the joining edges.

1.2 Thickness of the grounding layer on samples shall exceed the thickness specified by the manufacturer for common use by 20% but shall not be less than 20 μm.

1.3 Samples specified in Table A8.1.1, are welded in usual welding modes adopted for the given type of welding consumables. Tee-joint sample at manual welding in downhand position shall be so welded as the weld has the minimum leg. Tee-joint sample at welding in CO₂ medium in vertical position is welded upwards.

Samples at hidden arc welding may be made by either automatic or semi-automatic welding.

1.4 Butt joint sample without grooving at manual welding is required, when deep-fusion electrodes are used.

1.5 Butt joint sample without grooving at hidden arc welding and at welding in CO₂ medium is required, when single-side welding with weld back-formation is used.

2 Preparing specimens from samples

Butt-weld samples

2.1 Each butt-weld sample before being cut to specimens is subject to radiographic control. The control results shall confirm that the quality of welds welded by grounding complies with the requirements of 8.3 of the present Part of the Rules.

2.2 One set of test specimens shall be made of non-grounded and grounded parts of each butt-weld sample. Each set shall comprise of: two flat tensile specimens, two bend specimens (one of them shall be so bend that the weld top is in tension zone and the other that the weld root is in tension zone); three impact test specimens with a notch (see 2.8 of Appendix 10) on the weld centre (from a sample of a thickness over 10 mm); three impact test specimens with a notch on the fusion line (from a sample of a thickness over 10 mm); one transverse macrosection.

Tee-weld samples

2.3 One set of test specimens shall be made of non-grounded and grounded parts of each tee-weld sample. Each sample shall comprise of first weld tensile test specimen, second weld tensile test specimen and macrosection.
### Types of samples for grounding testing

<table>
<thead>
<tr>
<th>Welding</th>
<th>Type and dimensions of samples</th>
<th>Thickness of the material (mm)</th>
<th>Edge grooving</th>
<th>Welding position</th>
<th>Welding conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butt-weld sample</td>
<td>Primer at half-length of the sample</td>
<td>6-8</td>
<td>Without grooving (see 1.5)</td>
<td>D</td>
<td>For welding electrodes of 4 mm diameter shall be used. The weld root from the back side is welded after being cut</td>
</tr>
<tr>
<td>Manual</td>
<td></td>
<td>12-15</td>
<td>V-shaped</td>
<td>D V</td>
<td></td>
</tr>
<tr>
<td>Tee-weld sample</td>
<td>Single-pass weld</td>
<td>6-8</td>
<td>Without grooving</td>
<td>D</td>
<td>For welding electrodes of 4 mm diameter shall be used.</td>
</tr>
<tr>
<td>Automatic or semi-automatic hidden arc welding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butt-weld sample similar to manual welded sample</td>
<td></td>
<td>14-15</td>
<td>Without grooving (see 1.5)</td>
<td>D</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18-20</td>
<td>V-shaped</td>
<td>D</td>
<td>Welding of samples is commenced at two passes with one pass from each side</td>
</tr>
<tr>
<td>Tee-weld sample similar to manual welded sample</td>
<td></td>
<td>18-20</td>
<td>Without grooving</td>
<td>D</td>
<td>Each weld shall be welded at one pass with a leg of 5 – 6 mm</td>
</tr>
<tr>
<td>Welding in CO₂ (semi-automatic)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butt-weld sample similar to manual welded sample</td>
<td></td>
<td>6-8</td>
<td>Without grooving (see 1.5)</td>
<td>D</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14-16</td>
<td>V-shaped</td>
<td>D V</td>
<td>Welding of samples is commenced at two passes with one pass from each side</td>
</tr>
<tr>
<td>Tee-weld sample similar to manual welded sample</td>
<td></td>
<td>12-15</td>
<td>Without grooving</td>
<td>D V</td>
<td>Each weld shall be welded at one pass with a leg of 5 – 6 mm</td>
</tr>
</tbody>
</table>

* One sample shall be prepared for each of specified welding positions.

Note: Welding position: D — downhand; V — vertical.

### 3 Test specimens

#### 3.1 Flat tensile test specimens are prepared according to 2.4 of Appendix 12.

#### 3.2 Bending test specimens are prepared and tested according to 9.2 of the present Part of the Rules and Appendix 12.

#### 3.3 Impact test specimens are prepared according to 2.1 of Appendix 12. Temperature of impact test specimens with a notch in the weld centre shall comply with that specified in Table 9.2.2-2 of the present Part of the Rules. Specimens with a notch on the fusion line shall be tested at a temperature of 20 °C.
3.4 Transverse macrosection shall have thickness of about 20 mm (measured along the weld) and width of at least for 5 mm to either side from the weld. Macrosection shall be inspected for incomplete fusion and porosity.

3.5 Fracture tee-weld specimen shall have a size along the weld of 35 mm or over. For fracture of tee-weld specimens one of welds on the specimen shall be cut off. The broken weld is inspected for porosity in the fracture and for the fracture mode.

4 Estimation of test results

4.1 Test results of specimens prepared from grounded and non-grounded parts of butt-weld sample for tensile testing, bend test and impact testing shall comply with the requirements of Table 9.2.2-2 of the present Part of the Rules.

4.2 Macrosections of welded joints prepared from grounded and non-grounded parts of the sample shall confirm the same condition of the weld. No cracks, pores of inadmissible size, slag inclusions, incomplete fusion, non-fusion or other defects shall be present on it. Special attention shall be drawn to complete fusion of tee-weld roots.

4.3 Porosity susceptibility of fillet welds at welding on grounding shall be assessed according to the fracture pattern of the tee-weld specimens. Presence of porosity in weld fracture and the fracture mode are assessed separately for the first weld and the second weld. Continuous porosity in the weld root is a sign of non-usability of that grounding for tee-weld and fillet-weld joints at the given welding method. Single small pores are not considered as a rejection sign.
METHOD OF DETERMINATION OF DIFFUSIBLE HYDROGEN CONTENTS IN DEPOSITED METAL

1 General provisions

1.1 Method of determination of hydrogen contents is based on its free diffusion from the deposited metal in vacuum.

1.2 The following definitions are used in the present Appendix:

.1 Diffusible hydrogen — is a part of hydrogen in solid metal which is removed from the weld metal by means of free diffusion at room temperature;

.2 Residual hydrogen — is a part of hydrogen solved in solid metal which may be removed from the weld metal by means of heating up to 600 – 650 °C or melting of the weld metal in vacuum;

.3 Total hydrogen — is a sum of diffusible hydrogen and residual hydrogen.

1.3 Diffusible hydrogen contents in the deposited metal is determined for the following purposes:

determination of norms of hydrogen content for the particular grade of electrodes;

checking of single batches of electrodes as delivery condition and prior to launching;

supplementary quality control of electrodes in accordance with request of the customer.

1.4 Index of diffusible hydrogen contents in the deposited metal is its volume diffused from the specimen during tests for 5 days and related to 100 g of the deposited metal.

1.5 When it is necessary to determine the total hydrogen contents \( V_{\text{total}} = V_{\text{dif}} + V_{\text{res}} \), residual hydrogen may be educed by heating or melting in vacuum of the same specimen which was used for the determination of diffusible hydrogen according to the present Appendix (see 2.3).

2 General requirements

2.1 Tests shall be performed on electrodes with a diameter of 3 to 5 mm with approximately 100% output of the deposited metal as related to the mass of the electrode rod. If powdered metal is contained in the electrode coating and, therefore, the output of the deposited metal is over 100 % as related to the mass of the electrode rod, its diameter may be chosen different with due regard of the quantity of the deposited metal. For example, an electrode with powdered metal coating giving 130 % of the deposited metal with a rod diameter of 3.5 mm is approximately equivalent to an electrode with a rod diameter of 4 mm.

2.2 Tested electrodes prior to welding shall be dried according to specifications of the manufacturer.

2.3 As material for plates on which metal shall be deposited at testing, low carbon steel shall be used with carbon content not over 0.20, silicon — 0.30, sulphur — 0.05%.

When it is necessary to determine total hydrogen contents, the plates before welding shall be degasified in conditions equivalent to hot vacuum extraction conditions.

2.4 Sample for determining hydrogen content is a plate with a deposited bead. The bead is formed at melting of approximately
150 mm of the electrode length. The deposition rate shall be assigned according to melting of 1.2 to 1.3 cm of the electrode length at deposition of 1 cm of the bead length. The bead is deposited on a steel finished plate assembled with runoff tabs. The plate size is shown on Fig. A9.2.4.

![Fig. A9.2.4 Steel finished plate assembled with runoff tabs: 1 — runoff tab, 2 — plate.](image)

2.5 Arrangement for the preparation of welded samples shall be made of copper of grades М0 – М3 GOST 859. The arrangement shall comply with GOST 23338. Prior to deposition the arrangement temperature shall be (20±5) °C.

2.6 Welding current strength at deposition shall comply with passport data of the manufacturer of electrodes, it shall be taken equal to average value from the recommended current range for tested electrode with a chosen rod diameter. Deviations of welding current strength shall not exceed ±5 A.

3 Preparation of sample before deposition

3.1 The plate and runoff tabs prior to deposition shall be together ground and marked.

3.2 The plate of dimensions 100×25×8 mm after grinding shall be sawn off at sharp edges.

3.3 The plate and runoff tabs after machining and sawing shall be washed in toluene or benzene and then in acetone and ethyl alcohol to remove dirt, oil and moisture.

3.4 The plate prior to the bead deposition shall be weighed with accuracy up to 0.01 g.

3.5 The plate and runoff tabs prior to preparation of welded samples shall be kept in dessicator with silica.

4 Preparation of test samples

4.1 For testing electrodes of one grade (batch) four parallel experiments shall be made. Deposition on each sample shall be performed by a new electrode.

4.2 On each sample consisting of a central plate and attached runoff tabs which shall be fastened in the arrangement a single bead shall be deposited along the longitudinal axis of the plate. Neither transverse oscillations of the electrode nor arc fault shall be allowed during deposition. If any external defects are revealed in the deposited bead, the sample shall be rejected.

Deposition mode shall comply with the requirements of 2.5 and 2.6. Length of deposited bead shall be 125 – 130 mm; deposition shall be started and terminated at runoff tabs.

4.3 During deposition of each sample the ambient conditions shall be recorded: the ambient air temperature (°C) and humidity (g of water per 1 m³ of air).

5 Processing of deposited samples

5.1 After deposition has been finished, the sample shall be taken out of the arrangement where the deposition was commenced and put into a vessel with icing water (with temperature equal to the ice melting point). The volume of water shall be 8 – 10 l.

5.2 Runoff tabs shall be hammered from the cooled deposited sample put in grips. Runoff tabs are not used in the analysis.

The sample shall be kept in grips in order to strip the weld surface and clean the sample from slag and drops of deposited metal. Samples shall be cleaned by metal brush which shall be periodically moistened in icing water. Drops of deposited metal shall be removed by chisel.

5.3 After stripping the sample shall be taken by pincers and shall be washed in series
in baths with ethyl alcohol, acetone and ethyl ether, for 10 s per each bath. After washing the sample shall be wiped by cotton cloth.

5.4 Washed sample shall be immediately dried in the hot air flow from residuals of solvents being kept by pincers at the distance of approximately 15 mm over the open coil of electric oven with an output of about 1 kW.

Weld fractures shall be dried from each side of the sample for 10 s, weld surfaces and the back side of the sample — for 5 s.

5.5 The sequence of operations and exposure time (sec):
- Removal of the sample from the testing arrangement 10
- Cooling of the sample in icing water 10
- Breaking of the sample and cleaning of the specimen 60
- Washing of the specimen 30
- Drying of the specimen 30
- Putting the specimen in a vessel 5
- Total time for the specimen preparation 145
- Air exhaust from the vessel up to vacuum 60–70

All operations from the end of welding till the beginning of analysis take 6 minutes.

6 Testing and calculation method of hydrogen contents

6.1 Measuring device for the determination of diffusible hydrogen content (see GOST 23338) shall be made of molybdenum glass. Recommended wall thickness is about 2 mm. The general view of the device is shown in Fig. A9.6.1.

6.2 The device shall be put in operating mode in the following way:
- Inner surfaces of the device and the manometer capillaries shall be thoroughly dried with ethyl alcohol;
- Manometer 5 shall be filled with vacuum dibutylphthalate (oil liquid);
- All vacuum joints shall be greased with fresh Ramsay grease;
- Vacuum shall be induced down to 0.8 to 1.0 Pa [(6 to 8)\(10^{-3}\) mm Hg] at opened taps 2, 3 and 4 and closed tap 1 (see Fig. A9.6.1);
- Tap 2 shall be opened and tap 3 shall be closed (tap 1 is closed, tap 4 is opened); the pressure in the device shall be checked by vacuum gauge.

Fig. A9.6.1. Device for the determination of diffusible hydrogen content:
1-4 — vacuum taps; 5 — pressure gauge; 6 — flask; 7 — vacuum-gauge lamp

6.3 After 5 days the device shall be checked for vacuum tightness:
- Vacuum of 0.8 to 1.0 Pa [(6 to 8)\(10^{-3}\) mm Hg] shall be established (tap 2 is opened, taps 1 and 3 — are closed, tap 4 — is opened);
- Tap 2 shall be opened and tap 3 shall be closed (tap 1 is closed, tap 4 — is opened); the pressure in the device shall be checked by vacuum gauge.

The device is considered vacuum-tight and ready to work when the pressure in it after 5 days is max. 13 Pa [1\(\cdot10^{-1}\) mm Hg].

6.4 Ready-to-work device shall be kept under vacuum (taps 1, 2, 3 are closed, tap 4 is opened).

6.5 Prior to each analysis the device shall be checked by the evacuation time from the atmospheric pressure to 2.7 Pa [2\(\cdot10^{-2}\) mm Hg].

In order to do it, the air is pumped into the device (taps 1, 3, 4 are opened, tap 2 is closed) and then pumped out with time from the moment of opening the tap 2 till establishing vacuum of 2.7 Pa [2\(\cdot10^{-2}\) mm Hg] measured by means of a stopwatch (taps 2, 3, 4 are opened, tap 1 is closed).

The time for establishing vacuum of 2.7 Pa [2\(\cdot10^{-2}\) mm Hg] shall not exceed 60 s.

6.6 After putting the device into the ready-to-work condition, the idle correction shall be
measured. It shall be determined after preventive washing of the polished parts and in all cases when the device has come out of normal operating conditions (failure of the pressure gauge, flasks 6, improper sequence of work with tap etc.).

6.7 In order to determine the idle correction the device shall be kept under vacuum for 5 days with a ballast of glass of 20 to 25 cm³ imitating a specimen arranged inside.

After manufacture the ballast shall be thoroughly dried with ethyl alcohol and kept under vacuum for 5 h at depression of 0.8 to 1.0 Pa [(6 to 8)·10⁻³ mm Hg] as follows:

1 Establish vacuum of 0.8 to 1.0 Pa [(6 to 8)·10⁻³ mm Hg] (taps 2 and 4 are opened, taps 1 and 3 — are closed);

2 — Open tap 3 (taps 2, 4 are opened, tap 1 is closed, forevacuum pump is operating continuously);

3 Measure the idle correction of the device;

4 After 5 h of the pump operation close taps 3 and 4 simultaneously, switch off the pump and keep the device under vacuum for 5 days (taps 1, 2, 3 and 4 are closed);

5 After the device has been kept under vacuum for 5 h the difference of the pressure gauge levels shall be measured and the value of the idle correction shall be recorded (h_{ic}, cm).

6.8 The following shall be made when the specimen is put into the device:

1 Let the air enter the device at the opened taps 1, 3, 4 and closed tap 2;

2 Separate and incline the lower part of the flask 6, put the specimen inside and then put it back by grinding thoroughly;

3 Establish vacuum in the device with the specimen at opened taps 4, 2 and 3 and closed tap 1.

6.9 Vacuum after placing the specimen into the device shall be reached up to pressure of 2.7 Pa [2·10⁻² mm Hg] for not more than 60 s.

6.10 After depression of 2.7 Pa [2·10⁻² mm Hg] has been established, close taps 3 and 4 simultaneously, then close tap 2 and switch off the vacuum pump. Such position of the taps shall be kept during the whole analysis of the specimen.

6.11 In 5 days, specimen shall be taken out from the device as follows: open tap 4, then taps 3 and 1 (tap 2 shall be kept closed), separate the lower part of the flask containing the specimen, incline it horizontally, remove the specimen from the flask with slight shaking.

6.12 Ready-to-work device shall be kept under vacuum of 13 Pa [1·10⁻¹ mm Hg] (tap 4 is opened, taps 1, 2 and 3 are closed).

6.13 When preparing the device for work after long-term downtime (for 2 to 3 months), the operations listed in 6.2 to 6.7 shall be carried out.

6.14 For testing, each specimen with the deposited bead shall be placed in a separate analysis device (see Fig. A9.6.1) not later than 5 s after drying subject to requirements of testing instructions developed by the device manufacturer. The specimens shall be kept in the device for 5 days at room temperature.

6.15 Upon expiry of time specified in 6.14, difference of the liquid levels in the pressure gauge (h) shall be recorded with an accuracy of up to 0.5 mm of oil head. After that the specimen shall be withdrawn from the device.

6.16 ±At the moment of taking the readings from the pressure gauge the air temperature in way of the measuring instruments (t\textsubscript{amb}) shall be recorded. This temperature shall be measured with a thermometer with an accuracy of up to 0.5 °C.

6.17 The specimen withdrawn out of the device shall be weighed with accuracy of up to 0.01 g.

6.18 The weight of the deposited metal shall be determined as the difference of the
specimen weight \( P_{sp} \) and weight of the plate \( P_p \) prior to deposition:
\[
P_{d.m} = P_{sp} - P_p.
\]

6.19 The specimen volume after welding shall be determined by the formula:
\[
V_{sp} = P_{sp} / 7.85,
\]
where \( P_{sp} \) — specimen weight after welding (g);
7.85 — density of low carbon steel (g/cm³).

6.20 Volume of emitted hydrogen, in cm³, reduced to 20 °C and 101.3 kPa [760 mm Hg], shall be calculated by the formula:
\[
V_{H_2} = 298 \cdot 10^{-3} \left( V_{flask} - V_{sp} \right) \left( \Delta h + \Delta h_{i.c} \right) / \left( 273 + t_{amb} \right),
\]
(A.9.6.20)
where \( 298 \cdot 10^{-3} / \left( 273 + t_{amb} \right) \) — coefficient accounting for the reduction of gas to 20 °C and 101.3 kPa [760 mm Hg] (at the oil density in the pressure gauge of 1.045 g/cm³ and mercury density of 13.55 g/cm³), cm⁻¹;
\( t_{amb} \) — air temperature in the room at the moment of taking the pressure gauge readings (°C);
\( V_{flask} \) — flask volume (cm³);
\( V_{sp} \) — specimen volume (cm³);
\( \Delta h \) — difference in liquid levels in the pressure gauge (cm);
\( \Delta h_{i.c} \) — idle correction of the device (see 6.7 of the present Appendix) determined for each particular device and being constant for all experiments (cm).

6.21 The volume of emitted hydrogen, cm³ \([V_{H_2}]\) shall be reduced to 100 g of the deposited metal:
\[
[V_{H_2}] = V_{H_2} \cdot 100 / P_{d.m}.
\]

7 Processing of the analysis results

7.1 The obtained results shall be filed as the test report.

Comparison of the test results of electrodes shall be carried out when the test report is submitted to assess the influence of test conditions.

7.2 Arithmetic mean of four determinations shall be taken as the final index of diffusible hydrogen content for electrodes of the same brand (batch).

8 Measurement error

8.1 % The difference in the liquid levels in the pressure gauge shall be measured with accuracy max. ± 0.5 mm; herewith, the measurement error of diffusible hydrogen content shall be max. ± 1.5.

8.2 When calculating the volume of diffusible hydrogen, the idle correction shall be accounted for the whole time of the analysis (5 days). The idle correction \( (h_{i.c}) \) is negative as regards the difference in liquid levels in the pressure gauge \( (h) \), shall be expressed in centimetres and in calculations according to the formula (A.6.6.20) shall be added to \( h \).
TESTING METHODS OF MATERIALS

1 GENERAL REQUIREMENTS

1.1 Requirements of this Appendix cover types and methods of testing of materials specified in 2 to 6 of the present Part of the Rules.

1.2 Requirements of the present Appendix regulate testing conditions, types and dimensions of test specimens as well as requirements to their manufacture.

1.3 Types and procedures of special tests for the materials intended for specific use and evaluation criteria unless guidelines are provided in the Rules, shall be agreed with the River Register.

1.4 During tests, requirements of national standards1 shall be also met.

1.5 Samples for specimen preparation shall have undergone the same treatment (e.g. heat treatment) as the product from which they have been taken. Test specimens shall be prepared in such a manner that the material properties are not affected.

1.6 Testing machines shall ensure the required measuring accuracy as per GOST 28840, be regularly checked and calibrated by authorized authorities.

2 TESTING OF METALS

Ambient air temperature

2.1 Unless otherwise provided by the present Appendix, the ambient temperature during the tests shall comply with the requirements of GOST 28870.

Tensile test

2.2 During tensile test in accordance with the requirements of the Rules and national standards2, the following characteristics of mechanical properties of materials shall be determined:

1. Yield stress $R_e$ is the stress value measured at the commencement of plastic deformation at yield, or the stress value measured at the first peak on the deformation curve obtained during metal yielding even when that stress does not exceed values of any of the subsequent peaks observed on the curve of plastic deformation at yielding.

2. Loading rate up to yield stress in the range of elastic deformations shall exceed $30 \text{ MPa/sec}$ for steel and cast iron and $10 \text{ MPa/sec}$ for materials for which iron is not the basic element;

3. When no well-defined yield phenomenon exists, proof stress shall be determined. Proof stress $R_p$ is the stress at which plastic deformation reaches the prescribed value expressed in percentage of the initial effective length ($0.2\%$ is the elongation for $R_{p0.2}$).

4. The rate of loading shall be as stated in 2.2.1;

5. Tensile strength $R_m$ is the stress value corresponding to the maximum load directly before the test specimen destruction.

1 GOST R 52927, GOST 5521.

2 GOST R 52927, GOST 5521, GOST 5520, GOST 977, GOST 8536.
To determine the tensile strength $R_m$ the specimen shall be subject extension up to the fracture by the smoothly rising loading. The strain rate in mm/min during this procedure for plastic materials shall not exceed the ratio of 40% of effective length to the time of the deformation process above the yield stress or the proof stress until fracture of the specimen;

4 percentage elongation after fracture $A$ is the ratio of an increment of the gauge length after fracture to the original gauge length, expressed in %;

5 percentage reduction of area after fracture $Z$ is the ratio of difference between the original and the minimum cross-sectional areas of the test specimen after fracture to the original cross-sectional area, expressed in %. It is defined on proportional cylindrical specimens;

6 When carrying out tensile tests at the increased temperature, the test temperature shall be indicated in the subscript, e.g. $R_m/350, A_{5/350}, Z_{350}$.

2.3 The tensile test is performed on specimens in accordance with Fig. A10.2.3-1 to A10.2.3-5, where:

- $d_0$ — diameter of the gauge length (mm);
- $a_0$ — thickness of the gauge length of the flat test specimen or the strip (mm);
- $b_0$ — width of the gauge length of the flat test specimen or the strip (mm);
- $L_c$ — gauge length of the specimen (mm);
- $L_0$ — effective length of the specimen (mm);
- $r$ — transition radius (mm);
- $S_0$ — cross-sectional area of the effective length (mm²);
- $D$ — outside diameter of the pipe (mm);
- $t$ — actual wall thickness of the pipe (mm);

Type of test specimen shall be selected according to Table A10.2.3.

Test specimens of rectangular cross-section with the effective length $L_0 = 5.65 \sqrt{S_0}$, or cylindrical specimens with the effective length $L_0 = 5d_0$ are called proportional.

Required percentage elongation $A_0$ of such non-proportional specimens with effective length for instance $L_0 = 200$ mm, shall be calculated as per formula, %,

$$A_0 = 2A_s \left( \frac{\sqrt{S_0}}{L_0} \right)^{0.40}, \quad (2.3)$$

where $A_s$ is the elongation norm stated for proportional specimen, in %.

2.4 Tensile testing for grey cast iron shall be carried out on the cylindrical specimen in accordance with Fig. A10.2.4.
### Table A10.2.3

<table>
<thead>
<tr>
<th>Semi-manufactured article</th>
<th>Type of specimen</th>
<th>Specimen dimensions (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forgings, castings, rolled steel sections</td>
<td>See Fig. A10.2.3-1</td>
<td>Proportional cylindrical specimens: $d_0 = 14 \pm 0.2$; $L_0 = 70$; $L_T = 85$; $r = 10$; $r = 20$ for materials with elongation $A_l \leq 10%$ and nodular cast iron</td>
</tr>
<tr>
<td></td>
<td>See Fig. A10.2.3-1, A10.2.3-3</td>
<td>For rods and products of small dimensions a specimen with the effective length $L_0 = 5,65 \sqrt{S_0}$ and dimensions other than specified may be permitted; in this case $L_T = L_0 + d_0$</td>
</tr>
<tr>
<td>Rolled steel plates, flats and sections</td>
<td>See Fig. A10.2.3-2</td>
<td>Flat proportional specimens: $a_0 = \text{rolled steel thickness}$; $b_0 = 25$; $L_0 = 5,65 \sqrt{S_0}$; $L_T = L_0 + 2 \sqrt{S_0}$; or flat non-proportional specimens: $a_0 = \text{rolled steel thickness}$; $b_0 = 25$; $L_0 = 200$; $L_T = 225$; $r = 25$. When rolled steel thickness exceeds 30 mm, specimens may be used in accordance with Fig. A10.2.3-1 with $d_0 = 14$ mm with axis of the specimen being at the distance of 0.25 of the steel thickness from the surface.</td>
</tr>
<tr>
<td>Pipes</td>
<td>See Fig. A10.2.3-4 and A10.2.3-5</td>
<td>$a_0 = t$; $L_0 = 5,65 \sqrt{S_0}$; $L_T = L_0 + D$; $a_0 = t$; $b_0 = 12$; $L_0 = 5,65 \sqrt{S_0}$; $L_T = L_0 + 2b_0$</td>
</tr>
</tbody>
</table>

### Impact test

2.5 In all cases, for impact tests, the specimens of the largest dimensions for a given material thickness shall be manufactured, the longitudinal axis of the specimen shall be in the middle between the surface and section centre in the thickness. The notch is to be cut perpendicular to the surface.

![Fig. A10.2.4 Tensile test cylindrical specimen for grey cast iron](image)

2.6 Tests to determine brittle fracture resistance (crack resistance), for example, drop-weight tests may be performed in addition or in lieu of impact tests.

2.7 Impact test of structural elements may be omitted for the base metal but however required for tests of welded joints.

2.8 The impact toughness $KCU$ or impact energy $KU$ shall be determined on Charpy U-notch type test specimens in accordance with Fig. A10.2.8-1 and impact energy $KV$ — on Charpy V-notch type test specimens in accordance with Fig. A10.2.8-2.

The impact energy $KV$ and $KU$ shall be determined on three test specimens and the impact toughness $KCU$ — on at least two test specimens. The impact energy $KV$ and $KU$ is determined as average from tests results of three test specimens according to Table A10.2.8, with none of three obtained results being less than 70% of the required minimum value.

When impact energy $KCU$ is determined on two specimens, each obtained result shall not be less than the required minimum value.

2.9 The impact toughness may be determined on specimens without notch. In that case the cross-sectional area of such specimens shall be $(10 \pm 0.11)\times(10 \pm 0.11)$ mm at the length of $(55 \pm 0.60)$ mm.
Fig. A10.2.8-1. Charpy U-notch type specimen for impact toughness \( KCU \) or impact energy \( KU \) tests: for impact toughness \( KCU \) test \( h \) is taken equal to \((8\pm0.10)\) mm; for impact energy \( KU \) test — \( h = (5\pm0.09) \) mm

Fig. A10.2.8-2. Charpy V-notch type specimen for impact energy \( KV \) tests: \( a = (10\pm0.10), a = (7.5\pm0.10) \) mm or \( a = (5\pm0.06) \) mm

<table>
<thead>
<tr>
<th>Specimen dimensions (mm)</th>
<th>Average impact energy for three specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>10x10x55</td>
<td>( E )</td>
</tr>
<tr>
<td>10x7.5x55</td>
<td>( 5/6 E )</td>
</tr>
<tr>
<td>10x5x55</td>
<td>( 2/3 E )</td>
</tr>
</tbody>
</table>

Note. \( E \) — required minimum impact energy (J)

2.10 Tests shall be carried out on pendulum impact machines with the energy at least 150 J.

The distance between the supports is to be \((40\pm0.5) \) mm. The pendulum shall break the test specimen in the plane of symmetry of the notch from the side opposite to it, the distance between the planes of symmetry of the notch and the pendulum shall not exceed 0.5 mm.

For tests at low temperatures the test specimens shall be supercooled in order to reach the necessary temperature. When the tests are carried at the temperature down to minus 60 °C, the test specimens shall be supercooled to minus 4 °C; permitted deviation of temperature from the required value shall not exceed \( \pm2 \) °C.

2.11 The aging resistance shall be checked by impact tests of specimens according to Fig. A10.2.8-1. Samples for making impact test specimens shall be pre-elongated to reach a 10% residual deformation.

After that the samples shall be heat treated at temperature of \((250\pm5)°C\) within at least 30 minutes. Test specimens shall not be heated over the temperature defined during machining. Unless otherwise specified, the aged specimens shall represent the impact energy value not less than 50 % the minimum impact energy \( KV \) or impact toughness \( KCU \) as prescribed in 2 to 5 of these Rules defined at 20 °C on non-aged specimens; in all cases the impact energy shall be at least 27 J and the impact toughness – at least 290 kJ/m².

**Technological tests**

2.12 Bend tests shall be carried out on specimens made as in Fig. A10.2.12.

The specimen edges on the side being tensioned may be rounded to a radius of 1 to 2 mm.

Bend tests of plates and sections shall be carried out on the specimens with the following dimensions:

\[ a = t \ (t — \text{plate or section thickness}); \]

\[ b = 30 \text{ mm}. \]

When the plate or section thickness exceeds 25 mm, the specimen may be machined on one side up to thickness of 25 mm. During the tests the mandrel shall be arranged on the side of the machined surface.

Bend tests of forgings, castings and billets shall be carried out on specimens with the following dimensions: \( a = 20 \) mm; \( b = 25 \) mm.

The test results are considered satisfactory, if the prescribed angle of bend is reached without fracture. If the specimen straightens back after being released from the mandrel, repeated test is not required.
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**Hardness tests**

2.13 Hardness may be determined by Brinell (HB), Vickers (HV), Rockwell (HRC) according to GOST 9012, GOST 2999 and GOST 9013, respectively.

**Dropweight tests**

2.14 Where required by the Rules, dropweight tests and assessment of the test results are carried out according to technical documentation agreed upon with the River Register. The specimens shall have the following dimensions, mm: 25×90×360; 19×50×130; 16×50×130.

When the specimens are prepared by flame cutting, their dimensions shall be increased by 25 mm but at least by a plate thickness. At one side of the specimen the rolled surface shall be left. Unless otherwise specified, the specimens may be cut of any orientation.

**Technological tests for pipes and tubes**

2.15 Flattening tests are carried out on pipes or tubes with outside diameter \( d \leq 400 \text{ mm} \) and the wall thickness \( t \leq 0.15 \).

The length of the pipe test specimen \( L \) shall be equal to 1.5d and be 10 to 100 mm. Distance \( H \) between the pressure plates shall be calculated as per formula (mm)

\[
H = \left(1 + \frac{c}{c + t/d}\right) t,
\]

where \( c \) — a coefficient taken in accordance with the material.

At complete flattening the distance between pressure plates shall be 2.25t.

For welded pipes or tubes, the weld shall be placed in the plane perpendicular to the direction of bending.

Test results are considered satisfactory if no cracks are discovered on the flattened specimen by visual examination.

2.16 Drift expanding tests are carried out on pipes or tubes with outside diameter \( d \) of up to 150 mm and the wall thickness of up to 9 mm. A drift shall be forced into the test specimen until the required expansion is reached.

The length of the specimen and the angle of the drift are stated in Table A10.2.16.

**Chemical analysis**

2.19 The methods of determination of chemical composition of metals and permissible deviations are stated by national standards\(^1\).

1. GOST 5640, GOST 8233.
2. GOST 52927, GOST 5521, GOST 977, GOST 26358.

---

**Table A10.2.16**

<table>
<thead>
<tr>
<th>Material</th>
<th>Length of test specimen</th>
<th>Angle of the drift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>( \leq 2d )</td>
<td>30°</td>
</tr>
<tr>
<td></td>
<td>1.5d, but ( \geq 50 \text{ mm} )</td>
<td>45°, 60° or 120°</td>
</tr>
<tr>
<td>Copper, aluminium, copper- and aluminium-based alloys</td>
<td>( 2d \div 3d )</td>
<td>45°</td>
</tr>
</tbody>
</table>

Test results are considered satisfactory, if no cracks are discovered by visual examination on the specimen expanded to the prescribed dimension.

2.17 Ring expanding tests are carried out on steel pipes or tubes with diameter of 110 to 508 mm with the wall thickness not exceeding 30 mm. Ratio of the pipe thickness to its outside diameter shall be max. 0.13. Specimen is to be a pipe section 10 to 15 mm long.

The ring is to be expanded until it breaks by means of two mandrels of diameter not less than triple wall thickness. For welded pipes or tubes, the weld plane shall be perpendicular to the direction of expansion.

Test results are considered satisfactory, if no marks, burrs, burrages, cracks, exfoliations are discovered by visual examination on the specimen.

**Analysis of macro- and microstructure of the material**

2.18 Where required by the Rules, macro- and microstructure of metals is analyzed according to national standards\(^1\).

---

1. GOST 5640, GOST 8233.
Methods of non-destructive examination of materials

2.20 When performing radiography testing of the material the results shall be fixed as radiographic images with a summary of test assessment attached.

2.21 Ultrasonic testing of materials and semi-manufactured products is carried out using pulse-echo methods. Dual-search units shall be used for checking.

Single-dual and prismatic search units are used for more precise checking.

Workability and accuracy of the test equipment shall be checked regularly.

The method for determination of a flaw size is established in accordance with GOST 14782 or technical documentation agreed upon with the River Register.

The assessment criteria and size of permissible flaws shall be agreed upon with the River Register as a part of technical documentation for the product.

The surface of the products shall provide the uniform acoustic contact with the search unit.

The ultrasonic testing is performed after heat treatment at the stage of manufacture when the product is of the simplest shape.

2.22 Magnetic particle inspection shall be carried out using the equipment checked at different test conditions. The material surface under test shall have appropriate intensity of the field.

If needed, demagnetization of the product after inspection shall be prescribed in the technical documentation.

3 TESTING OF NON-METALS

Testing conditions

3.1 Conditioning of test specimens before testing shall be carried out at ambient air temperature of (23±2) °C and relative humidity of (50±5)%.

Where test conditions have no considerable effects on the stability of the test results, conditioning may be omitted.

3.2 Test specimens of rubberized woven cloth are cut in the warp or weft direction with the axis being parallel to the fibres of warp or weft, respectively.

Tensile test

3.3 Tensile strength of glass-reinforced plastic shall be determined on the test specimens made according to Fig. A10.3.3-1 with dimensions specified in Table A10.3.3-1 and Fig. A10.3.3-2.

![Fig. A10.3.3-1. Specimen for tensile test of glass-reinforced plastic](image1)

### Table A10.3.3

<table>
<thead>
<tr>
<th>Parameter description</th>
<th>Value (mm)</th>
<th>Parameter description</th>
<th>Value (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$l_1$</td>
<td>≥150</td>
<td>$b_1$</td>
<td>20±0.5</td>
</tr>
<tr>
<td>$l_2$</td>
<td>115±5</td>
<td>$h_1$</td>
<td>10±0.5</td>
</tr>
<tr>
<td>$l_3$</td>
<td>60±0.5</td>
<td>$i$</td>
<td>From 1 to 10</td>
</tr>
<tr>
<td>$l_4$</td>
<td>50±0.5</td>
<td>$r$</td>
<td>60</td>
</tr>
<tr>
<td>$l_5$</td>
<td>≥250</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Fig. A10.3.3-2. Specimen for tensile test of glass-reinforced plastic](image2)

3.4 The tensile strength and elongation at rupture of laminated textiles are determined on test specimens 50±1 mm wide and with original length between the grips of testing machines of 200±5 mm.

The pre-load applied is 2 N for cloths of density 200 g/m³ or less, 5 N for cloths of...
density from 200 up to 500 g/m³ and 10 N for cloths of density above 500 g/m³.

The moving rate of the testing machine grip is to be 100±20 mm/min.

Elongation at rupture shall be determined according to 2.2.4.

3.5 The tear propagation strength of laminated textiles is determined on rectangular test specimens measuring of (225±5)×(75±5) mm. An incision 80±1 mm long shall be made in the middle of one of the specimen ends parallel to its longitudinal edge. The ends of the incised specimen are then fixed in the grips of the testing machine so that the beginning of the incision made is parallel to the direction of the breaking load applied. The moving rate of the testing machine grip is 100±10 mm/min.

The breaking load is calculated as the arithmetic mean of successive maximum values.

3.6 The strength of interlayer bonds in laminated textiles is determined on rectangular test specimens of (50±1)×(200±5) mm. The specimen coating is carefully cut down to the cloth and exfoliated with a knife on 50 mm length on the side of the oblique notch as in Fig. A10.3.6 (the exfoliated element is hatched). The ends formed are clamped in the grips of the testing machine.

3.7 The tear strength of adhesive bond joints of laminated textiles is determined on test specimens made in such a manner that the middle of the joint coincides with that of the test specimen and the joint width overlaps the test specimen by 25 mm. The shape and dimensions of test specimens are determined according to 3.3. The adhesive applied shall comply with the conditions of the products manufacture.

The tear strength of retro-reflective materials is determined on specimens 25±1 mm wide with the initial length of 100±5 mm between the grips of the testing machine.

The moving rate of the testing machine grip is 100±5 mm.

Materials with an adhesive layer are tested after removal of protective paper.

The strength of the adhesive bond between the retro-reflective material and the adhesive layer is determined on specimens 25±1 mm wide and 200±5 mm long.

Before testing, protective paper is removed from the adhesive layer of the material on a length of 80±5 mm and placed on the surface being tested with dimensions of (50±5)x(90±5) mm.

The loose end of the specimen is secured in the dead lock of the testing machine. Separation of the specimen is achieved by turning the panel by 180° round the axis passing through the specimen end opposite to the loose one.

Compression tests

3.8 Compression strength of glass-reinforced plastics shall be determined on the test specimens according to Fig. A10.3.3-1 and Table A10.3.8.

Table A10.3.8

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value (mm)</th>
<th>Value</th>
<th>Value (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$l_1, l_2$</td>
<td>Any type</td>
<td>$b_2$</td>
<td>10±0.5</td>
</tr>
<tr>
<td>$l_3$</td>
<td>80</td>
<td>$r$</td>
<td>160</td>
</tr>
<tr>
<td>$b_1$</td>
<td>20</td>
<td>$r$</td>
<td>10</td>
</tr>
</tbody>
</table>

3.9 Compression strength of rigid foamed plastics shall be determined on parallelepiped specimens with side dimensions of (50.0±0.5)×
The load shall be increased uniformly. The loading rate shall not exceed 5 mm/min.

**Determination of modulus of elasticity for glass-reinforced plastics**

3.10 The modulus of elasticity shall be determined on the test specimens made: under tension according to 3.3, under compression - according to 3.8.

Extension of the test specimen is determined at initial load \( P_0 \) and maximum load \( P_{\text{max}} \) which is equal to 2 and 8 to 10\% of the breaking load, respectively.

**Bend Test**

3.11 Bend tests of rigid foamed plastics shall be carried out on the test specimens (120±1.2) mm long, (25.0±0.25) mm wide and (20.0±0.2) mm thick. The distance between the supports shall be 100 mm, radius of rounding of the punch and supports shall be (5.0±0.2) mm. The rate of punch feed shall be (10±2) mm/min.

3.12 Bend tests of glass-reinforced plastics shall be carried out on test specimens, the length of which is 20-fold their thickness and the width of 25 mm. The distance between the supports shall equal 16-fold thickness of the specimen. The load applied to the middle of the test specimen shall be smoothly increased until the latter breaks.

**Bend tests of laminated textiles**

3.13 The tests are carried out on rectangular test specimens of (300±5)×(25±5) mm which are fixed in the test device as in Fig. 10.3.13. When the specimen is fixed, the distance between the grips \( l \) shall be 30 mm.

After the test specimen has been fixed, the grips are brought together until they touch. At this time, the force upon the specimen shall be 10 N.

During the test the movable grip makes 500 cycles of reciprocating movement with a frequency of 2 Hz and an amplitude of 50 mm.

![Fixing of specimens of laminated textiles in the test device:](image)

**Determination of relative glass content in glass-reinforced plastics by mass**

3.14 A specimen of \((10±1.0)\times(10±1.0)\times t\) mm, where \( t \) is a plate thickness is placed into the muffle furnace where resin is burned away from the specimen at the temperature of \((625±25)\, ^\circ\text{C}\);°

The relative glass content by weight, in \%, is calculated by the following formula;

\[
S = \left( \frac{G_{2} - G_{0}}{G_{1} - G_{0}} \right) 100\%.
\]

where \( G_1 \) — weight of the furnace together with the test specimen before the resin burning out (g);

\( G_2 \) — mass of the furnace together with the test specimen after the resin burning out (g);
Appendix 10

$G_0$ — weight of the empty annealed furnace (g).

The weight shall be determined with an accuracy of up to 0.01 g.

**Determination of apparent density of foam plastics**

3.15 The apparent density of rigid foams shall be determined on test specimens of regular shape with a volume of at least 100 cm$^3$.

Before conditioning in accordance with 3.1 the test specimens shall be dried at (40±5) °C to their constant mass. The apparent density is determined as the ratio of the specimen weight to its volume, in m$^3$.

**Determination of shrinkage of plastics at limiting temperature**

3.16 A test specimen with dimensions of (100±1)×(100±1)×(15±0.5) mm is conditioned at the limited temperature for the tested plastic for 48 hours.

Shrinkage is determined as the ratio, in %, of linear deformation to the appropriate original size of the specimen.

**Water absorption tests**

3.17 Water absorption shall be determined on test specimens of (50±1)×(50±1) mm with a thickness equal to that of the product but not exceeding 50±1 mm.

Before testing the test specimens shall be dried to constant weight. After drying and weighing the specimens are immersed into distilled water and kept at 23±2 °C for 24 hours, then the specimens are weighed again. Water shall be removed from the specimen surface.

Water absorption is calculated as a mass fraction of absorbed water related to the weight of dry specimen.

Water absorption of foamed plastics is calculated as weight of absorbed water related to the surface area of the specimen.

3.18 A sample with dimensions determined from the required number and size of the specimens, is immersed into fresh water with temperature of 23±2 °C to a depth of 1.25 m and is soaked for 7 days.

Before testing, as well as a day or seven days after immersion, the sample is weighed.

After soaking test specimens are prepared from the sample for carrying out necessary tests.

**Aging tests**

3.19 A sample with dimensions determined depending on the required number and dimensions of test specimens, is conditioned in semi-immersed condition in the artificial sea water at a temperature of 23±2 °C for 30 days. During conditioning the sample shall be subjected every day to two-hour ultra-violet irradiation with 500 W lamp placed at a distance of 50 cm from the sample. After soaking test specimens are prepared from the sample for carrying out necessary tests.

3.20 Two samples with dimensions determined depending on the required number and dimensions of test specimens, are kept suspended for 7 days at ambient temperature of 70±1 °C, one of them being placed in a closed volume above water. After conditioning equal number of test specimens is prepared out of each sample for carrying out tests.

3.21 Folding and shape stability tests after ageing are carried out on square test specimens with the side of 100±5 mm which are folded in two directions, parallel to the edges and at right angles to each other, unfolded and then folded again along the same folds in the opposite direction. After each folding the edges are smoothed down with the fingers.

**Oil product resistance tests**

3.22 A disc-shaped test specimen with a diameter of 70±5 mm is inserted into the testing device as in Fig. A10.3.22.

The testing device is filled up to the level of 20 mm with a mixture of organic compounds, hydrocarbons and alcohols in the following proportions:

- 30% of 2,3,4-trimethylthelane;
- 50% of toluene;
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Fig. A10.3.22. Fitting of foam plastic specimen into testing device:

1 — test specimen; 2 — cylindrical chamber;
3 — base plate with an aperture of 30 mm diameter;
4 and 8 — fly-nuts; 5 and 7 — threaded pins for clasping the chamber with fly-nuts; 6 — cover

15% of diisobutylene;
5% of ethanol.
Other oil products may be used such as diesel oil, petrol etc.
The test specimen is conditioned in the above mentioned substances for 22 hours at a temperature of 20±2 °C.

When the test specimen is extracted, it shall be slightly dried, the wetted surface shall be folded in two and pressed.
The wetted surfaces shall not stick together. When touched by finger the surface shall not stain it.

3.23 A sample with dimensions determined from the required number and size of test specimens (see 6.4.4, 6.5.2 of the present Part of the Rules) is immersed in diesel oil or high-octane gasoline with the temperature of 23±2 °C to a depth of 100 mm and kept for 14 days.

After conditioning test specimens are prepared from the samples for carrying out tests provided by the present Part of the Rules.

3.25 Samples with dimensions determined from the required number and size of test specimens (see 6.4.4, 6.5.2 of the present Part of the Rules) is immersed in crude oil, fuel oil, diesel oil, high-octane gasoline or kerosene with the temperature of 23±2 °C to a depth of 100 mm and kept for 14 days.

After conditioning test specimens are prepared from the samples for carrying out tests provided by the present Part of the Rules.

Water resistance tests

3.26 A sample with dimensions determined depending on the required number and dimensions of test specimens is immersed in artificial sea water with a temperature of 23±2 °C and kept for 5 months.

After conditioning test specimens are prepared from the samples for carrying out all necessary tests.

3.27 In case of laminated textiles a sample of 300×200 mm glued along the perimeter shall be conditioned in salt water with salt concentration of 3.3 to 3.8% for 4 hours at a water temperature of 40±1 °C at a depth of 500 mm from the water surface.

3.28 Specimens of retro-reflective material of (70±5)×(150±5) mm fixed on the aluminum panel and having an X-shaped diagonal cut are conditioned in artificial sea water with a temperature of 23±2 °C in semi-submerged condition in closed volume for 16 hours.

After conditioning the salt remains on the specimen surface shall be washed off.
Specimens of retro-reflective material manufactured and mounted in conformity with 3.25 are soaked in distilled and artificial sea water for 16 h in closed volume.

3.29 Specimens of retro-reflective material of (70±5)×(150±5) mm fixed on the aluminum panel are conditioned in sprayed 5% salt solution at a temperature of 35±2 °C for 5 days.

During conditioning the specimens shall be dried for 2 hours every 22 hours.
Air permeability tests

3.30 A disc-shaped test specimen having a diameter of 350 mm is covered with wax in such a way that its central part, 290 mm in diameter, is free from wax; then it is clamped between the flanges of the testing installation as in Fig. A10.3.30.

![Fig. A10.3.30. Clamping of a disc-shaped specimen in the testing installation](image)

From below a positive air pressure of 27.5 kPa acts upon the test specimen. In 10 to 15 min the specimen is so immersed in water that its uppermost point is 13 mm below the water surface.

In 1 min all air bubbles shall be removed from the surface of the specimen.

Within the following 5 min no bubbles shall rise to the surface.

Cold resistance tests

3.31 Cold resistance testing of laminated textile is carried out on rectangular test specimens with of (100±5)×(50±5) mm. The specimens are bent by 90° after being conditioned at minus 30 to minus 35 °C for 1 hour and at minus 60 to minus 65 °C for 10 min.

For testing installation layout, see Fig. A10.3.31.

The distance between parallel parts of the specimen at the end of the test shall be 4 times its thickness.

Ozone resistance tests

3.32 A test specimen is bent through 180° round the mandrel with a diameter equal to 6 times the specimen thickness, and is exposed to air with ozone concentration of 50 ppm for 1 hour at a temperature of 30±2 °C and the relative humidity of 26%.

![Fig. A10.3.31. Testing installation layout for cold resistance tests:](image)

A sample with dimensions determined depending on the required number and dimensions of test specimens is successively exposed to ambient air at a temperature of minus 40±5 °C to +70±5 °C at 8-hour intervals for foam plastics and at 24-hour intervals for retro-reflective materials.

Vibration load tests

3.33 The test specimen with the type and size determined from the operating conditions, is mounted on a vibration-testing machine and subjected to vibration loads having the following parameters:

- oscillation amplitude — 2.5 mm;
- frequency range — 5 to 500 Hz with a frequency step of 32 Hz and an amplitude of vibration acceleration of 10 g.

Determination of retro-reflection factor

3.34 The retro-reflection factor is determined on square specimens of 150±5 mm. The entrance and observation angles are adopted in accordance with Table 6.9.7 of the present Part of the Rules.

Measurements are taken at the turning angles of reference plane between 0 and 180° with the spacing of max. 30°.

3.35 The retro-reflection factor for a material staying under a film of water is determined on specimens of (150±5)×(75±5) mm fixed on a vertical plane in the transverse direction.

During tests the specimen stays under a continuously moving film of water. Measurements are taken at the observation angle of 0.2 and entrance angle of 5°.
Adhesion tests
3.36 The adhesion test of retro-reflective materials is made on square specimens of 100±5 mm.

Two specimens are fitted between glass plates 3 mm thick, with their retro-reflective surfaces facing each other and under a load with weight of 18 kg and conditioned in the heating chamber at a temperature of 65±2 °C for 8 h.

After being conditioned, the specimens are cooled at a temperature of 23±2 °C for 5 min.

Abrasion-resistance test
3.37 The abrasion-resistance test of retro-reflective materials and laminated textiles is made on specimens of (150±5)×(425±5) mm secured on an aluminum panel.

The panel fixed in the testing machine is subjected to 1000 cycles of the reciprocating action of bristles at a frequency of 37±2 cycles per minute.

For testing, trimmed black bristles of a pig are used arranged in 60 openings 4 mm in diameter on a block of (90±5)×(40±5)×(12.5±5) mm and having a total weight of 450±15 g. The bristles shall project above the block surface by not more than 20 mm.

3.38 The contaminant-resistance test of retro-reflective materials is made on square specimens of 150±5 mm secured on an aluminum panel.

The specimens are covered with a contaminant layer 0.075 mm thick, a laboratory glass is placed above and so they are kept for 24 h.

After conditioning the specimens are wiped clean of the contaminant with a soft cloth wetted in white spirit, washed with 1% solution of a detergent and rinsed in water.

The contaminant used for testing shall have the following composition by weight: 8 parts of soot, 60 weight parts of mineral oil and 32 weight parts of white spirit.

Fungus-resistance test
3.39 Retro-reflective materials and laminated textiles are tested for fungus resistance using square specimens of 75±2 mm secured on an aluminum panel. The specimens are conditioned in the soil for two weeks. After being conditioned the specimens are wiped clean with a soft cloth wetted in the 70% solution of ethyl alcohol and then conditioned in accordance with 3.1 for 48 h. The microbiological activity of the soil is determined on untreated cotton cloth. After being soil-conditioned for 5 days, the ultimate strength of the cloth with a density of 400 to 475 g/m² shall not be less than 50% of the initial value.

4 WELDABILITY TEST
4.1 Weldability tests are performed during type approval of materials.
Rolled steel, steel castings, steel forgings and aluminum alloys used in welded ship structures are subject to weldability test.

4.2 The weldability of materials at type approval tests shall be checked during welding using the same methods that are assumed to be used during manufacture of structures. Welding methods shall be specified in the Type Approval Certificate.

4.3 During the weldability test the following shall be determined:
1. Chemical composition and mechanical properties of the parent metal;
2. Cold cracking resistance;
3. Susceptibility to ageing according to 2.11;
4. Properties of the welded joint according to 9 of the present Part of the Rules;

4.4 Features and properties specified in 4.3 are determined on metal plates or other products with maximum thickness taken from at least three different casts.

4.5 For metallic materials other than steel the weldability in specified conditions is determined according to the results of tests according to procedures approved by the River Register.
INSPECTION AND ACCEPTANCE METHODS OF MATERIALS

1 GENERAL REQUIREMENTS

1.1 Requirements of this Appendix cover inspection and acceptance methods of materials specified in 2 to 7 of the present Part of the Rules and shall be used by manufacturer's quality control departments or testing laboratories.

1.2 When developing technical documents requirements of this Appendix shall be taken into account.

2 STEEL AND CAST IRON

2.1 Hull structural steel

Sampling

2.1.1 The test samples shall be prepared as follows.

The test samples of plates and flats more than 600 mm wide shall be taken from one end so that the sample axis is located in the middle between the longitudinal axis of the plate or flat and their edge (see Fig. A11.2.1.1-1).

The test samples of plates and flats with 600 mm or less wide shall be taken from one end so that the sample axis lies at 1/3 distance from the flat edge or outside edge of the shell (see Figs. A11.2.1.1-2, A11.2.1.1-3 and A11.2.1.1-4).
The test samples of bars and other similar semi-manufactured products are taken from one end so that the sample axis is parallel to the direction of rolling. If the cross-sectional area of the test specimens is equal to the total cross-sectional area of the semi-manufactured article, they may be tested non-machined (before impact testing the test specimens shall be machined).

In other cases the specimens shall be taken so that their axes lie:

1/3 of half-diagonal from the vertex — for non-cylindrical semi-manufactured products (Fig. A11.2.1.1-5);

1/3 of radius from the outside edge — for cylindrical semi-manufactured articles (Fig. A11.2.1.1-6).

The tensile and impact test specimens are cut in such a way that their longitudinal axes is perpendicular to the direction of the last rolling of the material except sections, bars and flats 600 mm and less wide.

The test specimens for the determination of impact energy $KV$ are cut in such a way that their longitudinal axes are either parallel or perpendicular to the direction of the last rolling.

The notch is to be cut perpendicular to the rolled surface and not closer than 25 mm to a flame-cut or sheared edge.

**Scope of tests**

2.1.2 Rolled steel is presented for tests in batches. Each batch shall consist of the same type, the same cast and in the same condition of supply. Unless otherwise provided by this Appendix, one test specimen for tensile testing and one set of specimens (except for Grade E, E32, E36 and E40 steel, see 2.2 of the present part of the Rules) for impact testing shall be tested from each batch presented with the weight not exceeding 50 tonnes.

The chemical composition of steel shall be determined based on results of analysis of the samples taken from each ladle of each cast.

If the batch weight exceeds 50 tonnes, one tensile test and one impact test for the set of specimens shall be made additionally for each 50 tonnes or fraction thereof.

If the batch presented consists of plates which thickness varies by more than 10 mm, or sections and bars which thickness or diameter vary by more than 10 mm, one more test of both types shall be carried out in addition.

2.1.3 If the material is supplied in the as-rolled condition, one set of specimens for impact testing shall be tested from each batch of 25 tonnes or fraction thereof.

2.1.4 The scope of impact testing for Grade E, E32, E36 and E40 steel shall be as follows:

- for plates and wide flats — each item shall be tested;
- for sections and bars — one set shall be tested from each batch of 25 tonnes or fraction thereof.

Where sections are supplied in the as-rolled or controlled rolled condition, one set of specimens shall be tested from each batch of 15 tonnes or fraction thereof.

**Examination**

2.1.5 The surface quality and dimensions are checked for compliance with requirements
of 2.2.5 of the present Part of the Rules as well as requirements of national standards ¹.

2.2 Steel for boilers and pressure vessels

Sample preparation

2.2.1 The test samples shall be prepared in accordance with the requirements of 2.1.1.

Test specimens for determining tensile and impact toughness \( KCU \) shall be cut transverse to and those for determining the impact energy \( KV \) shall be cut longitudinally to the direction of the last rolling.

Scope of tests

2.2.2 Each rolled plate shall be submitted for testing. For rolled carbon steel plates up to 12 mm thick as well as steel sections 10% of total amount of plates (rolls) or sections but not less than two plates of the same thickness (diameter or shape), the same cast and heat treatment are allowed to be taken for the tests.

At least one specimen shall be taken from the semi-finished product for tensile and bend tests and at least one set of specimens – for impact testing.

The number of specimens for tensile and long-term strength tests at increased temperatures is specified in accordance with technical documentation agreed upon with the River Register.

From plates (rolls) with a weight exceeding 6 t or a length exceeding 15 m the samples for test specimens shall be cut out on both ends.

Examination

2.2.3 The surface quality and dimensions are checked for compliance with requirements of 2.3.3 of the present Part of the Rules as well as requirements of national standards ².

2.3 Steel pipes and tubes

Sample preparation

2.3.1 Samples for preparation of specimens shall be taken from one end of at least two pipes or tubes of the batch.

Scope of tests

2.3.2 Pipes and tubes shall be tested by batches. A batch is to consist of pipes and tubes of the same size made from steel of the same heat and heat-treated under similar conditions.

The number of pipes or tubes in a batch shall not exceed:

- 400 — for pipes and tubes with an outer diameter of max. 76 mm;
- 200 — for pipes and tubes with an outer diameter above 76 mm.

A rest of pipes or tubes which is less than half the number stated shall be included in a relevant batch and one which is half and over — to be considered a separate batch.

For testing purposes one specimen shall be taken from each sample for tensile test, flattening test or the tensile test of rings (two specimens when welded pipes and tubes are tested) and drift expanding test. All pipes shall be subjected to hydraulic pressure tests. The test pressure shall be set in accordance with national standards ³ or technical documentation agreed with the River Register and shall not be less than that stated in 10.6 Part IV of the Rules.

Examination

2.3.3 All tube and pipes are subject to visual inspection. The surface quality and dimensions are checked for compliance with requirements of 2.4.4 of the present Part of the Rules as well as requirements of national standards specified in 2.3.2.

¹ GOST 5521, GOST R 52927.
² GOST 5520, GOST 1050.
³ GOST 8731, GOST 8733, GOST 10705, GOST 1060.
2.4 Steel for chain cables

Scope of tests

2.4.1 The rolled bars as per GOST 535 are submitted for testing in batches. A batch not more than 50 t in weight shall comprise bars of the same cast and supply condition with diameters varying by max. 4 mm. One sample is taken out from each batch of rolled bars from which one tensile test specimen and, if necessary, a set of test specimens for impact testing (KV) are made.

Preparation of test specimens

2.4.2 Test specimens shall be taken from the sample in the longitudinal direction at a distance of one-sixth of the diameter from the surface or as close as possible to this position according to Fig. A11.2.4.2.

Examination

2.4.3 The surface quality and dimensions are checked for compliance with requirements of 2.5.5, 2.5.6 of the present Part of the Rules as well as requirements of technical documentation (see 2.5.2 of the present Part of the Rules).

2.5 Steel forgings

Sample preparation

2.5.1 Sample dimensions shall be sufficient for the required tests and possible repeated tests and its cross-sectional area shall be at least equal to that of that part of the forging which it represents. The samples shall be integral with each forging. The samples shall be taken in such a manner that the axes of the specimens cut of them are located at a distance not exceeding 10% its diameter or thickness.

2.5.2 Test samples shall not be cut from forgings until all heat treatment has been completed except for cases when the components are subject to carburising.

2.5.3 Generally, one tensile test specimen and a set of impact test specimens shall be prepared from a sample.

2.5.4 Forgings shall be submitted for testing individually or in batches. The location and number of sampling shall be as follows:

1. Forgings for rudder stocks, pintles, shafts, connecting rods etc.
2. one longitudinal sample shall be taken from the end of each forging according to Figs. A11.2.5.4.1-1, A11.2.5.4.1-2 and A11.2.5.4.1-3 (position A).
On agreement with the River Register a sample may be cut transverse according to positions B, C and D. Where a forging exceeds both 4t in weight and 3 m in length, one sample shall be taken from each end;

.2 Pinion forgings: one transverse sample according to Fig. A11.2.5.4.2 (position B) shall be taken if a diameter of the toothed portion after final machining exceeds 200 mm, or according to Fig. A11.2.5.4.2 (position C), where the dimensions preclude sampling in accordance with position B. Where the diameter is 200 mm or less, longitudinal samples shall be taken in accordance with Fig. A11.2.5.4.2 (position A). Where the final length of the toothed portion exceeds 1250 mm, one sample shall be taken from each end;

.3 Gear wheel forgings: one sample shall be taken from each forging in the transverse direction according to Fig. A11.2.5.4.3 (position A or B);

.4 Gear wheel rim forgings made by expanding: one sample shall be taken according to Fig. A11.2.5.4.4 (position A). Where the final diameter exceeds 2500 mm or the weight exceeds 3t, two samples shall be taken according to Fig. A11.2.5.4.4 (positions A and B);

.5 Sleeve and shell forgings: one transverse sample shall be taken according to Fig. A11.2.5.4.5 (position A or B). Where the final length exceeds 1250 mm, one sample shall be taken from each end of the forging according to Fig. A11.2.5.4.5 (positions A and B);

.6 Crank web forgings: one transverse sample shall be taken from each forging.

.7 Solid-forged crankshafts: one longitudinal sample shall be taken from the end of the forging from the coupling side according to Fig. A11.2.5.4.7 (position A).

Fig. A11.2.5.4.2. Location of sampling from pinion forgings

Fig. A11.2.5.4.3. Location of sampling from gear wheel rim forgings

Fig. A11.2.5.4.4 Location of sampling from gear wheel rim forgings made by expanding

Fig. A11.2.5.4.5. Location of sampling from sleeve and shell forgings

Fig. A11.2.5.4.7. Location of sampling from solid-forged crankshaft forgings

Where the forging weight exceeds 3 t, one sample shall be taken from each end according to 2.5.4.7 (positions A and B). Where, however, the elbow is formed by machining or flame cutting, the additional transverse sample shall be taken according to Fig. A11.2.5.4.7 (position C);
8 Crankshaft and other forgings with defined grain flow direction: the number of samples and the sampling location are established in accordance with technical documentation agreed upon with the River Register;

9 Forgings subject to carburising: unless otherwise stated in the present Part of the Rules, for both preliminary tests after forging and final tests after carburising, duplicate number of samples shall be taken from positions as detailed in subparagraphs 1 to 8 for the respective forgings. The samples shall be taken in one direction only irrespective of the dimensions and weight of the forgings. The samples shall be machined to a diameter of D/4 or 60 mm, whichever is less.

For preliminary tests after forging the samples shall pass blank carburising and heat treatment simulating that which will be subsequently applied to the forging. For the final acceptance tests samples shall pass blank carburising and heat treatment along with the forgings which they represent.

At the option of the forgings or gear manufacturer, test samples of large cross-section may be either carburised or blank carburised, but they shall be machined to the required diameter prior to the final quenching and stress relieving heat treatment.

Alternative procedures for the testing of forgings to be carburised may be used. In such a case, testing procedures shall be agreed upon with the River Register for compliance with the requirements of the Rules.

Note. For pinion and gear wheel forgings (see 2.5.4.2, 2.5.4.3 and 2.5.4.4) the specimens for mechanical tests may be cut out of the sample which is forged separately from the metal of the same heat under conditions similar to that for forgings. In this case the sample shall be heat treated together with forgings of the batch.

Scope of tests

2.5.5 Smaller forgings shall be submitted for testing in batches made up of items coming from the same heat, having the same dimensions and weight and have been heat treated in the same furnace charge. Test specimens may be prepared directly from one of the forgings of the batch or from a separately forged sample with the deformation degree being equal to the reduction ratio of the forgings and which has been heat treated together with the forgings. For each batch of forgings at least one set of test specimens shall be prepared.

The scope of tests is established according to the requirements of Table A11.2.5.5.

<table>
<thead>
<tr>
<th>Weight of forging</th>
<th>Number of forgings (batch) for the first set of specimens for tensile and impact testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>m &lt; 25</td>
<td>200</td>
</tr>
<tr>
<td>25 ≤ m &lt; 50</td>
<td>100</td>
</tr>
<tr>
<td>50 ≤ m &lt; 100</td>
<td>50</td>
</tr>
<tr>
<td>100 ≤ m &lt; 200</td>
<td>25</td>
</tr>
<tr>
<td>200 ≤ m &lt; 500</td>
<td>10</td>
</tr>
<tr>
<td>500 ≤ m ≤ 1000</td>
<td>5</td>
</tr>
</tbody>
</table>

Note. If the number of forgings exceeds the specified number by 50% or more, a new batch shall be formed.

2.5.6 When a forging is intended for the preparation of a number of blanks, the required testing scope shall be determined based on the total length or weight of the forging provided that the blanks thus obtained have been subject to heat treatment in the same furnace charge.

2.5.7 A batch testing procedure may also be used for rolled sections with diameter up to 250 mm, used instead of forgings where the batch shall consist of the following:

- either material from the same rolled length of semi-manufactured product cut into individual blanks having been heat treated in the same furnace charge; or;
- rolled bars of the same diameter and heat with a total weight not exceeding 2.5t having been heat treated in the same furnace charge.

2.5.8 Hardness tests are required for:

- gear wheel forgings after completion of heat treatment of the gear teeth. The hardness shall be determined at four points equally located at the distance equal from each other around the circumference. Where the final diameter of the toothed portion exceeds 2500 mm, the hardness shall be determined in eight test points. Where the width of a gear
wheel rim forging exceeds 1250 mm, the hardness shall be determined at eight points at both ends of the forging; small crankshaft and gear forgings which have been batch tested. In such cases the hardness test shall be carried out on each forging; forgings which have undergone induction hardening, nitriding or carburising.

**Examination**

2.5.9 The surface quality is checked for compliance with requirements of 2.6.5 of the present Part of the Rules as well as requirements of national standards.

2.6 Steel castings

*Sample preparation*

2.6.1 Samples may be made directly from the casting or the test samples may be cast to it. Samples shall be at least 30 mm thick.

The use of separately cast samples is permitted; in this case the dimensions of the sample shall correspond to the dimensions of the casting.

2.6.2 Where two or more test samples are to be taken from a casting, the sampling points shall be located as far from each other as possible.

2.6.3 The samples shall be heat treated together with the castings which they represent.

2.6.4 At least one test sample shall be taken from each casting. Where one casting consists of metal from several ladles, one sample shall be taken from each of the ladles.

If the weight of a casting in cleaned condition exceeds 10t or it has a complex shape, at least two samples shall be taken.

The castings shall be submitted for inspection and control testing in the cleaned condition with sprues, heads and burrs removed.

*Scope of tests*

2.6.5 Castings may be presented for tests in batches. All castings in a batch shall be of similar dimensions and shape, cast from the same ladle of treated metal and heat treated in the same furnace charge. For batch testing specimens may be prepared either from separately cast test samples or from one of the castings of the batch.

2.6.6 At least one tensile test specimen and one set of impact test specimens shall be taken from each sample.

**Examination**

2.6.7 The surface quality is checked for compliance with requirements of 2.7.4 of the present Part of the Rules as well as requirements of GOST 977.

2.7 Steel propeller castings

*Sample preparation*

2.7.1 Separately cast samples shall be taken from the same ladle as the casting and heat treated in the same furnace charge.

For each casting or batch of castings one sample shall be taken for the preparation of specimens.

*Scope of tests*

2.7.2 Each propeller casting shall be submitted for testing.

Castings of less than 1.0 m diameter made from metal of the same cast and heat treated in the same furnace charge may be submitted in batches. For a casting or batch of castings the following tests shall be carried out:

- tensile test — at least on one specimen;
- impact test — at least on one set of specimens;
- microstructure investigation.

**Examination**

2.7.3 The surface quality is checked for compliance with requirements of 2.8.2 of the present Part of the Rules as well as requirements of national standards.

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1 GOST 1050, GOST 8536.
2 GOST 977, GOST 8054.
### 2.8 High strength steel for welded structures

#### Sampling

2.8.1 The axes of tensile test specimens shall be perpendicular to the direction of the last rolling except for wide flats 600 mm or less wide as well as sections and bars for which the orientation of the specimen is determined in accordance with technical documentation agreed upon with the River Register. Flat tensile specimens shall be prepared in such a way that the rolled surface is preserved at least on one side of the specimen. Where cylindrical tensile test specimens are used, their axes are to be located at the distance of 0.25 thickness from the surface.

The impact testing of steel plates and wide flats more than 600 mm wide shall be performed in accordance with 2.8 Appendix 10 on specimens with the longitudinal axis being perpendicular to the direction of rolling (transverse specimens). For rolled products of other cross-sectional shape the impact testing shall be carried out on longitudinal specimens.

#### Scope of tests

2.8.2 Each plate (rolled length) shall undergo tensile and impact testing after heat treatment.

For rolled products quenched and tempered in continuous furnaces the scope of testing including the number of specimens and the direction of their cutting out, is determined in accordance with technical documentation agreed upon with the River Register.

At least one tensile specimen and three impact test specimens shall be prepared from each test sample.

Tensile testing may be performed on specimens with longitudinal axes perpendicular to the plate surface; the reduction of cross-sectional area shall be determined as well.

#### Examination

2.8.3 The surface quality and dimensions are checked for compliance with requirements of 2.9.1 of the present Part of the Rules as well as requirements of GOST R 52927.

### 2.9 Nodular graphite iron castings

#### Sample preparation

2.9.1 The test samples may be either cast separately or gated to the casting. The dimensions of the samples, when cast separately, shall be in accordance with Figs. A11.2.9.1-1, A11.2.9.1-2, A11.2.9.1-3; the sample length shall be selected according to the type of the machine for tensile testing.

![Fig. A11.2.9.1-1. Dimensions of U-shaped samples](image)

![Fig. A11.2.9.1-2. Dimensions of type II V-shaped samples](image)

![Fig. A11.2.9.1-3. Dimensions of V-shaped samples](image)

The samples may have other dimensions or they may be taken directly from one of the castings of the batch.
Where separately cast test samples are used, they shall be cast in moulds made from the same type of material as used for the casting moulds. The samples shall be stripped from the moulds at the metal temperature not exceeding 500 °C.

2.9.2 When castings are supplied in the heat treated condition, the test samples shall be heat treated together with the castings of the batch which they represent.

2.9.3 Samples for metallographic examination may be taken either parts from the tensile test specimens or separately cast sample provided that the latter is taken from the ladle at the end of the casting period.

Scope of tests

2.9.4 At least one sample shall be taken from each casting. Where one casting consists of metal from several ladles, one sample shall be taken from each of the ladles.

2.9.5 Castings with weight in cleaned condition of 1 t or less may be submitted for testing in batches. Each batch shall consist of castings of the same shape and size cast from the same ladle. One separately cast test sample shall be taken from each 2 t of cleaned castings of the batch.

2.9.6 At least one tensile test specimen and, if required, a set of impact test specimens shall be prepared from each test sample.

Examination

2.9.8 The surface quality is checked for compliance with requirements of 2.11.3 of the present Part of the Rules as well as requirements of GOST 26358.

2.10 Grey iron castings

Sample preparation

2.10.1 Samples are casted separately as cylinders gated to castings or made directly from castings.

Separately cast test samples shall be cast in moulds made from the material similar to that used for the casting moulds. The samples shall be stripped from the moulds at the metal temperature not exceeding 500 °C.

2.10.2 Where castings are supplied in the heat treated condition, the test samples shall be heat treated together with the castings of the batch which they represent.

2.10.3 A tensile test specimen shall be prepared from each sample.

Scope of tests

2.10.4 At least one sample shall be taken from each ladle. Where one casting consists of metal from several ladles, one sample shall be taken from each of the ladles.

2.10.5 Castings with weight in cleaned condition of 1 t or less may be submitted for testing in batches. Each batch shall consist of castings of the same shape and size cast from the same ladle. One separately cast test sample shall be taken from each 2 t of cleaned castings of the batch.

Examination

2.10.6 The surface quality and dimensions are checked for compliance with requirements of 2.12.2 as well as requirements of GOST 26358.

3 COPPER AND COPPER-BASE ALLOYS

3.1 Semi-manufactured products of copper and copper-base alloys

Sampling

3.1.1 Tensile test specimens from sheet material shall be cut transversely to the direction of rolling (forging), and from tubes, rods, sections and forgings — longitudinally to the direction of rolling.

Tubes, rods and sections with a diameter (or thickness) of 40 mm and less may be subject to tensile tests in rough condition.

Forging samples may be forged separately or integrally. The samples shall have the same degree of upsetting as the most loaded cross-section of the forging.
Casting samples may be cast separately, gated to the casting or taken directly from it. In all cases the samples shall be cut after the final heat treatment (in the supply condition).

**Examination**

3.1.2 The surface quality is checked for compliance with requirements of 3.1.4 of the present Part of the Rules as well as requirements of technical documentation (see 3.4 RTSC) agreed upon with the River Register for compliance with requirements of the Rules.

3.2 Propeller castings

**Sample preparation**

3.2.1 Separately cast samples for determining the mechanical properties of propeller alloys shall be taken from each ladle and shall have the dimensions as shown in Fig. A11.3.2.1.

Samples for proof testing may be taken directly from castings or be cast integrally.

**Scope of tests**

3.2.2 Out of each sample one cylindrical specimen shall undergo the tensile test according to the requirements of Table A10.2.3; for castings made of alloys of grades 1 and 2 the alpha α phase content shall be determined as well.

![Fig. A11.3.2.1. Dimensions of separately cast samples](image)

**Examination**

3.2.3 The surface quality is checked for compliance with requirements of 3.2.2 of the present Part of the Rules as well as requirements of technical documentation (see 3.4 RTSC) agreed upon with the River Register for compliance with requirements of the Rules.

4 ALUMINIUM ALLOYS

4.1 Wrought aluminium alloys

**Preparation of test specimens**

4.1.1 Samples for mechanical properties determination shall be taken so that to provide the following orientation of the longitudinal axis while preparing test specimens:

- for plates and flats less than 25 mm thick — transverse to the grain direction;
- for rods and sections — along the grain direction;
- for pressed panels — along the grain direction.

For forgings, punchings, plates and flats over 25 mm thick the sampling point, sample size and method of cutting samples are defined according to technical documentation agreed with the River Register. Samples shall be either integrally forged to forgings or taken directly from the latter.

Blanking of test specimens as well as their preparation shall be performed by methods preventing from possible change of the alloy properties due to heating or cold hardening.

Tensile testing is performed on specimens in accordance with 2.2, 2.3 of Appendix 10.

**Scope of tests**

4.1.2 Aluminium alloy semi-manufactured products are submitted for testing in batches. Each batch shall consist of semi-manufactured products of the same grade, dimensions and supply condition. Forgings or punchings in the batch shall undergo the heat treatment in the same furnace charge.

A batch of plates and pressed panels shall have a weight not exceeding 2 t, that of sections and rods — not exceeding 1 t.
For carrying out tests at least three semi-manufactured products shall be taken from each batch and at least one product — from each batch of forgings or punchings. At least one tensile test specimen shall be taken from each of semi-manufactured products.

When the test results are not satisfactory, repeated tests are carried out. For repeated testing samples shall be taken from other semi-manufactured products of the same batch. When repeated test results are satisfactory, the batch may be accepted.

**Examination**

4.1.3 The surface quality is checked for compliance with requirements of 4.1.2 of the present Part of the Rules as well as requirements of technical documentation agreed upon with the River Register for compliance with requirements of the Rules.

4.2 Cast aluminium alloys

**Sample preparation**

4.2.1 The samples may be integrally or separately cast. The sample thickness shall be not less than the minimum thickness of the casting. The cooling of the samples shall be effected in conditions similar to that of the cooling of castings.

When castings are intended for parts subject to high load values, the thickness of the samples shall be not less than that of the highest loaded zone of the casting and shall be specified in the drawing.

**Scope of tests**

4.2.2 Aluminum alloy castings are divided into test groups according to purpose of products they are intended for. The scope of testing shall correspond to Table A11.4.2.2.

The scope of testing for castings with cast-on samples shall be established in accordance with technical documentation agreed with the River Register. Tensile tests are conducted to determine the yield stress, tensile strength and elongation. In well-grounded cases yield stress determination may be omitted.

For checking of piston castings up to 120 mm in diameter, tensile tests may be omitted. In such a case, only hardness shall be determined.

**Examination**

4.2.3 The surface quality is checked for compliance with requirements of 4.2.2 of the present Part of the Rules as well as requirements of technical documentation (see 3.4 RTSC) agreed upon with the River Register for compliance with requirements of the Rules.

5 NON-METALLIC MATERIALS

5.1 Glass-reinforced plastics

**Sample preparation**

5.1.1 Sampling for specimens to determine physical and mechanical properties of glass-reinforced plastics shall be made simultaneously with the formation process of the item

<table>
<thead>
<tr>
<th>Test group</th>
<th>Conditions of application</th>
<th>Examples of application</th>
<th>Type of test</th>
<th>Scope of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Cast items subject to loads and exposed to corrosion</td>
<td>Parts of internal combustion engines, pumps, compressors, fans, valves</td>
<td>Determination of chemical composition</td>
<td>Per cast</td>
</tr>
<tr>
<td></td>
<td>Tensile test</td>
<td>1 cast</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Parts operating at high temperature and exposed to oil fuel, petroleum products</td>
<td>Pistons of internal combustion engines, compressors</td>
<td>Determination of chemical composition</td>
<td>Per cast</td>
</tr>
<tr>
<td></td>
<td>Tensile test</td>
<td>Each cast</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hardness test</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
using the same procedure and from the same materials with the same glass fibre content.

Samples from which specimens for tensile test and determination of glass content by weight are made shall have length of 500 mm, width of 400 mm, and samples for compression test specimens shall be 10 to 12 mm thick.

The location of samples relative to the item formed shall be specified in documentation agreed with the River Register for compliance with the requirements of the Rules.

The samples may be taken from allowances of the item formed, and in well-grounded cases — directly from the item.

Sampling shall be performed after establishment of stable physical and mechanical properties of glass-reinforced plastics. The period required for that shall be stated by the manufacturer of the adhesive compound. Modulus of elasticity and tensile strength may be determined by non-destructive examination methods as agreed upon with the River Register.

**Examination**

5.1.2 The surface quality is checked for compliance with requirements of 6.3.1 of the present Part of the Rules as well as requirements of technical documentation (see 3.4 RTSC) agreed upon with the River Register for compliance with requirements of the Rules.

5.2 Laminated textiles

**Sampling**

5.2.1 Sampling for test specimens shall be taken from each batch of laminated textiles taking into account requirements of 3.2 of Appendix 10 at the distance of 0.1 m from the edge and at least 1 m from the roll end. Samples shall be taken 24 h after fabrication at the earliest.

**Examination**

5.2.2 The surface quality is checked for compliance with requirements of 6.4.6 of the present Part of the Rules as well as requirements of technical documentation (see 3.4 RTSC) agreed upon with the River Register for compliance with requirements of the Rules.

5.3 Foam plastics

**Sample preparation**

5.3.1 Samples shall be cut out in the middle of a foam plastic block from the part with the most uniform cell structure.

**Examination**

5.3.2 The surface quality is checked for compliance with requirements of 6.5.2, 6.5.3 of the present Part of the Rules as well as requirements of technical documentation (see 3.4 RTSC) agreed upon with the River Register for compliance with requirements of the Rules.

5.4 Retro-reflecting materials for life-saving appliances

**Sample preparation**

5.4.1 The sample for the preparation of specimens is taken from each batch of retro-reflective materials at least one meter from the roll end.

Prior to preparation of specimens, the sample is conditioned for 24 hours in accordance with 3.1 of Appendix 10.

**Examination**

5.4.2 The surface quality is checked for compliance with requirements of 6.9.9 of the present Part of the Rules as well as requirements of technical documentation (see 3.4 RTSC) agreed upon with the River Register for compliance with requirements of the Rules.
TESTING METHODS FOR WELDED JOINTS AND WELDING CONSUMABLES AND ESTIMATION OF THEIR RESULTS

1 General provisions

1.1 In-process tests shall be performed on all butt welds:
   .1 for each base material;
   .2 for each welding consumable and welding method;
   .3 for each weld position.

The thickness range for each in-process test shall be established in accordance with technical documentation agreed upon with the River Register.

1.2 Tensile strength during testing of welded joints of gas tanker structures shall be not less than required for the base metal. Tensile strength of the weld metal being less than that of the base metal is allowed provided that during tensile testing of a specimen taken across the weld, tensile strength is not less than that of the weld metal as prescribed by the present Part of the Rules. In any case, the test results shall include specimen destruction point.

1.3 During bend tests of welded joints of gas tanker structures on a mandrel with diameter of 4 times the specimen thickness, there shall be no cracks at bend angle of up to 180°.

1.4 The V-notch type specimens of gas tanker structure welded joints shall be subject to impact testing at a temperature specified for basic materials to be welded (see 9 of the present Part of the Rules).

1.5 When the weld metal of gas tanker structure rolled flat products is subject to impact testing, impact energy shall be at least 27 J, for sections — at least 41 J.

1.6 Results of impact tests along fusion line, heat affected zone shall comply with requirements to the base metal for longitudinal and transverse specimens depending on the type of test specimens.

1.7 Impact tests for stainless steel and aluminum alloy welded joints of gas tanker structures may be omitted.

1.8 In-process tests of welded joints for gas tanker pipelines shall be also performed. These tests shall be similar to those specified in 1.1, 2.3, 2.7 of this Appendix.

The tests shall be performed in accordance with 1.2 to 1.6 of this Appendix.

2 Preparation of samples, specimens and estimation of the test results

Sample preparation

2.1 Samples for the purpose of determination of the deposited metal properties for all welding consumables may be prepared from hull structural steel of any grade. Butt and tee-joint weld samples shall be prepared from steel of the grade which the welding consumables are intended for. When the welding consumable is intended for welding steels of different grades, butt weld samples shall be prepared from steel of the highest grade.
Samples shall be welded at normal temperature and the subsequent pass shall be made after the previous pass has been cooled to 250 °C and less, but not less than to 100 °C; welded samples shall not be heat treated.

Before being cut into specimens, butt weld samples shall undergo the radiographic inspection, the results of which shall confirm the absence of inadmissible defects.

Samples shall be welded in the presence of the Surveyor of the River Register.

2.2 Where welding consumables shall be approved for both DC and AC welding, samples shall be DC welded.

2.3 Butt weld samples from steel plates of gas tanker hull structures shall be prepared so that the welding direction is the same as the rolling direction.

Preparation of test specimens

2.4 From the welded joint samples the specimens are taken for testing of the deposited metal, tensile, bend and impact testing of the weld metal. The dimensions of specimens are taken in accordance with requirements of Appendix 10.

Fig. A12.2.4. Dimensions of tensile test specimen

Fig. A12.2.5-1. Dimensions of impact test specimen from single-side weld sample

Fig. A12.2.5-2. Dimensions of impact test specimen from double-side weld sample;

The shape and dimensions of a cylindrical tensile test specimen shall comply with GOST 1497.

Test specimens shall be kept at a temperature not exceeding 250 °C for 16 hours prior to tensile testing in order to remove hydrogen.

2.5 Impact test specimens shall be taken from the weld sample as shown in Figs. A12.2.5-1 and A12.2.5-2.

2.6 Weld reinforcement on tensile and impact test specimens from a butt weld shall be removed on both sides flush with the base metal. Edges of a bend test specimen may be rounded to a radius of max. 2 mm.

2.7 For each gas tanker weld sample, the following procedure for testing of welding method is established:

.1 Tensile tests for specimens taken across the weld;

.2 Impact tests for specimens taken across the weld. The bend test may be performed so that the weld top or root is within the tension area or side-band test may be performed. However, where strength levels of the base material and weld metal are different, tests on specimens taken along the weld may be required instead of tests on transverse specimens;
Appendix 12

3 One set of V-notch type specimens for impact test shall be taken from points as shown in Fig. A12.2.7;

![Fig. A12.2.7](image)

Fig. A12.2.7. Sampling points for welds with single-edge preparation (a) and double-edge preparation (b)

1 — central weld line; 2 — fusion line; 3, 4 and 5 — 1, 3 and 5 mm from the fusion line, respectively

4 Macrostructure analysis and determination of deposited metal hardness.

**Estimation of test results**

2.8 Bend test results are considered satisfactory if after bending over a mandrel having a diameter equal to three times the specimen thickness no cracks occur on the extended side of the specimen.

Surface cracks less than 3 mm in length shall be ignored.

2.9 If the results of the tensile and bend tests do not comply with the requirements specified in 9 of the present part of the Rules, testing shall be repeated on a double number of specimens.

2.10 The impact testing is carried out on three specimens with temperature controlled with the accuracy of 2 °C. The average value of obtained impact energy shall meet the requirements of Tables 9.2.2-1 and 9.2.2-2 of the present Part of the Rules. The impact energy value obtained for one specimen may be below the required average value but shall not be less than 70% of the stated value.

2.11 If the results of impact testing do not comply with the requirements of Tables 9.2.2-1 and 9.2.2-2 of the present Part of the Rules, then additional tests may be carried out on a set of three specimens. Additional tests are permitted if the obtained value of the impact energy is below the required average value for not more than two specimens and is less than 70% of the required value for not more than one of them.

2.12 The hot cracking resistance tests of welding consumables shall be carried out in accordance with 3.3 of this Appendix. The test results are considered satisfactory when neither surface or inner cracks nor considerable porosity occur in tee-joint weld sample.

2.13 The cold-cracking resistance test results are estimated according to provisions of 8.1 to 8.3 of Appendix 7.

2.14 Based on the results of the sea water corrosion resistance tests of welded joints the average corrosion rate of the weld metal and heat affected zone, the average corrosion rate of the base metal in weld zone and within some distance from the weld shall be determined. The ratio of corrosion rate of welded joint components shall be within 0.9 to 1.1.

3 Testing of electrodes for manual arc welding

**Deposited metal tests**

3.1 For deposited metal testing in the downhand position two samples shall be welded; one of them is welded with the electrode 4 mm in diameter and the other — with electrodes of the largest manufactured diameter. If electrodes are manufactured only of one diameter, a single sample is sufficient.

A sample of deposited metal shall comply with Fig. A12.3.1.

The metal shall be welded by several passes, and the direction of each subsequent pass shall be opposite to the previous one. The thickness of each pass shall be at least 2 mm, but max. 4 mm.

Test results of the specimens cut out from the sample according to Fig. A12.3.1 shall be in compliance with Table 9.2.2-1 of the present Part of the Rules.
3.2 To determine the butt weld properties in each welding position (downhand, vertical-upward, vertical-downward, overhead, horizontal-vertical) for which electrodes are intended, one sample shall be welded in each position. Electrodes intended for downhand and vertical-upward positions may be used also for horizontal-vertical welding.

If the electrodes are intended only for welding in downhand position, two samples shall be welded in this position. Butt weld samples for electrode testing shall comply with Fig. A12.3.2.

From samples welded in overhead position the preparation of impact test specimens is not required.

Samples are welded taking the following into account:

Downhand position. The first pass shall be made with 4 mm diameter electrode; the other passes except the last two layers — with electrodes 5 mm or more in diameter.

The passes of the last two layers shall be made with electrode of the largest manufactured diameter.

Where the second sample in downhand position is required, the first pass shall be made...
with electrode 4 mm in diameter, the next one — with electrode 5 or 6 mm in diameter, other passes — with electrodes of the largest manufactured diameter.

**Horizontal position.** The first pass shall be made with electrode 4 or 5 mm in diameter, subsequent passes — with electrodes 5 mm in diameter.

**Vertical-upward and overhead positions.** The first pass shall be made with electrode 3.25 mm in diameter, the other passes — with electrodes 4 or 5 mm if such diameters are recommended for welding in these positions.

**Vertical-downward position.** The electrode diameter and the sequence of welding of test sample shall be taken according to manufacturer’s recommendations.

Back sealing pass is made with 4 mm diameter electrode after dressing the root pass to sound metal in the same welding position in which the base weld has been made.

Test results of the specimens cut out from the sample according to Fig. A12.3.2 shall be in compliance with Table 9.2.2-2 of the present Part of the Rules.

![Diagram of butt weld sample](image)

*Fig. A12.3.2 Butt weld sample for testing of electrodes for manual arc welding*
**Hot-cracking resistance tests**

of weld metal and welded joint

3.3 To determine hot-cracking resistance three tee-joint samples shall be prepared so as shown in Fig. A12.3.3. Test samples are welded with electrodes of different diameters.

The lower edge of the vertical plate shall be smooth and fit closely to the lower plate surface. Uneven spots shall be removed before welding.

Tack welds shall be made on the butt ends of the plates. The lower plate shall be stiffened additionally by welding of three transverse ribs to protect it against deformation.

Welding shall be performed in the gravity position according to GOST 11969. The fillet welds shall be single-pass joined at the maximum current recommended by the manufacturers for the particular type and size of electrodes.

The second weld shall be executed immediately after the first weld has been finished and shall end at that side of the sample where the first one has been started. Both welds shall be effected at constant speed without weaving.

The electrode length necessary to make a weld 120 mm long is stated in Table A12.3.3.

<table>
<thead>
<tr>
<th>Diameter of electrode (mm)</th>
<th>Consumed length of electrode (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>First bead</td>
</tr>
<tr>
<td>5</td>
<td>200</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
</tr>
</tbody>
</table>

After welding the slag shall be removed from the welds; after the welds have got cooled completely they shall undergo examination or non-destructive control to reveal cracks.

Then the first fillet is machined or gouged and the second one is broken so that the weld root is tensioned.

**Testing of fillet weld electrodes**

3.4 Welding of a tee joint shall be carried out according to Fig. 12.3.4. Tee-joint samples shall be welded in each position, for which electrodes are intended (i.e. downhand, vertical-upward, vertical-downward, overhead). Samples shall be welded using electrodes of the diameter which is recommended by the manufacturer for the given welding position. The length of the sample shall be at least such as to allow the deposition of the entire length of the electrode being tested. The first weld on the sample shall be made...
with an electrode of the largest manufactured diameter, the second one — with an electrode of the smallest manufactured diameter. From three sections about 25 mm wide three macro-sections shall be prepared. On the macro-sections the hardness of the weld metal, the heat-affected zone and the base metal shall be measured as shown in Fig. A12.3.4.

**4 Testing of wire – flux combinations**

*General requirements*

4.1 The present requirements apply to wire – flux combinations intended for automatic multi-pass and two-pass welding. If the combination is intended for both techniques, tests shall be carried out for each technique.

*Combinations for multi-pass welding*

*Deposited metal testing*

4.2 The sample shall be welded in the downhand position according to Fig. A12.4.2. The welding direction of each subsequent layer deposited on the test assembly shall be opposite to the previous one. The thickness of each pass shall be not less than the wire diameter, but in all cases not less than 4 mm.

Test results of the specimens cut out from the sample according to Fig. A12.4.2 shall be in compliance with Table 9.2.2-1 of the present Part of the Rules.

*Butt weld test*

4.3 The sample shall be welded in the downhand position according to Fig. A12.4.3. The thickness of each pass shall be not less than the wire diameter, but in all cases not less than 4 mm. Test results of the specimens cut out from the sample according to Fig. A12.4.3 shall be in compliance with Table 9.2.2-2 of the present Part of the Rules.

*Combinations for two-pass welding*

4.4 Two samples shall be welded in accordance with Fig. A12.4.4:

- for grades 1 and 1Y (see 9.2.1 of the present Part of the Rules) one sample 12 to 15 mm thick and the other — 20 to 25 mm thick;
- for grades 2, 2Y, 3, 3Y (see 9.2.1 of the present Part of the Rules) one sample 20 to 25 mm thick and the other — 30 to 35 mm thick.

If welding consumables are intended for welding of both normal and higher strength steels, two samples shall be prepared of higher
strength steel. Two samples of normal strength steel may be additionally made.

The steel grade, the wire diameter and the edge preparation for welding shall comply with requirements of Table A12.4.4.

The gap between the plate edges shall not exceed 1 mm. The sample shall be welded in two passes. After the first pass and before the next one, the sample shall be cooled in open air down to 100 °C.

Test results of the specimens cut out from the sample according to Fig. A12.4.4 shall be in compliance with Table 9.2.2-1 and 9.2.2-2 of the present Part of the Rules.
5 Testing of wire-shielding gas combinations

General requirements

5.1 The present requirements cover wire – shielding gas combinations as well as fluxcored and flux-coated wire (for welding with or without a shielding gas).

During type approval of combinations (see Appendix 1 RTSC) intended for welding of fillet welds, the requirements of 3.4 of this Appendix shall be complied with.

When type approving combinations for automatic multi-pass welding the requirements of 4.2 of this Appendix shall be complied with, when welding the sample of the deposited metal the layer shall be at least 3 mm thick.

The composition approved for semi-automatic multi-pass welding may be applied for automatic welding without carrying out any additional tests.

Combinations for multi-pass welding

Deposited metal tests

5.2 For deposited metal tests two samples shall be welded in the downhand position according to Fig. A12.3.1: one sample — using wire of the smallest diameter, and the other — using wire of the largest diameter. If
When welding samples the thickness of each layer of the deposited metal shall be 2 to 6 mm.

Test results of the specimens cut out from the sample according to Fig. A12.3.1 shall be in compliance with Table 9.2.2-1 of the present Part of the Rules.

**Butt weld tests**

5.3 For each welding position which the combination is intended for, one sample shall be welded as in Fig. A12.3.2. When welding samples the first pass shall be made with the smallest manufactured diameter. The subsequent passes shall be executed: for downhand position — with wire of the largest manufactured diameter and for the rest positions — with wire of the largest diameter recommended by the manufacturer for the given position.
Steel grade, wire diameter and edge preparation during sample welding

<table>
<thead>
<tr>
<th>Plate thickness (mm)</th>
<th>Edge preparation</th>
<th>Maximum diameter of wire (mm)</th>
<th>Grade of welding consumable</th>
<th>Steel grade on samples¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>normal strength</td>
<td>higher strength</td>
</tr>
<tr>
<td>12–15</td>
<td></td>
<td>5</td>
<td>¹A</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>¹1Y</td>
<td>A32, A36, A40</td>
</tr>
<tr>
<td>20–25</td>
<td>![Image]</td>
<td>6</td>
<td>¹1Y, ²A or D</td>
<td>A32, A36, D32, D36, D40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>²2Y</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>³Any</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>³3Y</td>
<td>Any</td>
</tr>
<tr>
<td>30–35</td>
<td>![Image]</td>
<td>7</td>
<td>⁴A, B or D</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>⁴2Y</td>
<td>A32, A36, D32, D36, D40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>⁵3Y</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>⁵Any</td>
<td>Any</td>
</tr>
</tbody>
</table>

¹See 9.2.1 of the present Part of the Rules

If the combination is intended only for welding in the downhand position, an additional test sample shall be prepared using wire of the diameters other than those applied for the first sample. If the only one diameter of wire is manufactured, than one test assembly shall be prepared.

Test results of the specimens cut out from the sample according to Fig. A12.3.2 shall be in compliance with Table 9.2.2-1 and 9.2.2-2 of the present Part of the Rules.

**Combinations for automatic two-pass welding**

5.4 Tests are performed in accordance with requirements of 4.4 of this Appendix with regard to the following.

Two samples shall be prepared in accordance with Fig. A12.4.4: one 12 to 15 mm thick and the other 20 to 25 mm thick.

If the combination is intended for welding steel plates more than 25 mm thick, two samples shall be prepared: one sample about 20 mm thick and the other — of the maximum thickness provided for welding of the given combination.

Edges shall be prepared depending on the thickness of the sample to be welded as in Fig. A12.5.4.

![Fig. A12.5.4. Preparation of edges for welding;](image)

6 Testing of consumables for shielding gas arc welding

6.1 Requirements of 4.4 of this Appendix cover welding consumables for shielding gas arc welding with regard to requirements of 6.2 of this Appendix.

The welding may be conducted by a single pass and the edge preparation may be omitted.

6.2 For testing purposes two samples shall be prepared according to Figs. A12.6.2-1, A12.6.2-2 — 25 mm thick and 35 to 40 mm
Thick. Steel grades for samples shall comply with Table A12.4.4 for samples 25 to 35 mm thick.

Test results of the specimens cut out from the samples according to Figs. A12.6.2-1, A12.6.2-2 shall comply with Table 9.2.2-1 and 9.2.2-2 of the present Part of the Rules for automatic welding.

7 Tests of welding consumables for one-side backing welding

7.1 The scope and conditions of testing are determined according to requirements 3 and 4.1 to 4.4 of this Appendix or the relevant welding procedures taking the provisions below into account.

The deposited metal test sample shall be prepared according to Figs. A12.3.1 and A12.4.2 depending on the welding procedure. Two butt-weld test samples of minimum and maximum thickness shall be prepared according to Fig. A12.7.1.

The edge preparation, the gap dimensions and welding modes shall correspond to recommendations of welding consumables manufacturer.

The mechanical properties of the deposited metal shall comply with Table 9.2.2-1 of the present Part of the Rules, and those of the welded joint — with Table 9.2.2-2 of the present Part of the Rules for the relevant grades of welding consumables. Where welding consumables have been approved earlier by the River Register for standard welding procedure (without backing), only one sample for the welded joint testing shall be prepared as shown in Fig. A12.7.1.
Fig. A12.7.1. Sample for testing of welding consumables intended for standard one-side welding procedure (without backing)

8 Welding consumables for aluminum and aluminium alloys

8.1 Three butt-weld and three tee-joint test samples shall be welded for testing purposes.

8.2 For testing purposes three butt-weld test samples shall be prepared from the plates of the following thickness:
- 5 mm or less;
- approximately 10 mm;
- exceeding 10 mm.

Test samples shall be welded in the downhand position. The edge preparation for welding shall be performed in accordance with requirements of this Appendix for the welding method applied.

The dimensions of samples shall be sufficient for manufacture of all the necessary specimens taking in account the possible repeated tests. The following specimens shall be prepared from each butt-weld sample and shall be tested:
- three flat transverse specimens for tensile test. The weld reinforcement shall not be removed before testing;
- three transverse specimens for bend test. The weld reinforcement shall be removed before testing. The specimen shall be bend in such a way that the pass made in the last turn is located within the tension area;
- three cylindrical specimens for tensile test of weld metal cut out in the longitudinal direction. The specimens shall be prepared only from samples 10 mm and more thick.

8.3 Tee-joint samples shall be made according to 3.3 of this Appendix and be subject to fracture test in order to check the weld metal for fracture pattern, porosity, cracks and other flaws.
One of the three tee-joint samples shall be welded with the wire of the smallest diameter, the second one — with the wire of the largest diameter and the third one — with the wire of the medium diameter.
Part XI

ADDITIONAL REQUIREMENTS FOR SHIPS TO BE OPERATED ON EUROPEAN INLAND WATERWAYS
1 GENERAL PROVISIONS

1.1 SCOPE AND APPLICATION

1.1.1 This part of the Rules sets requirements, which, in addition to requirements of Parts 0 to X of the Rules, shall be met by ships intended for operation both on inland waterways of the Russian Federation and on European inland waterways, which mean inland waterways of European countries, except for inland waterways of European Russia and inland waterways of the Republic of Ukraine without the Danube.

1.1.2 Directive 2006/87/EC and UNECE Resolution No. 61 classify water basins of European inland waterways as follows:
- zone 1 (maximum significant wave height is up to 2.0 m with a 5% probability of overtopping)
- zone 2 (maximum significant wave height is up to 1.2 m with a 5% probability of overtopping)
- zone 3 (maximum significant wave height is up to 0.6 m with a 5% probability of overtopping)
- zone 4 (maximum significant wave height is up to 0.3 m with a 5% probability of overtopping)

Here, “significant wave height” means the average of heights of 10% of the total number of waves having the greater heights measured between wave trough and wave crest, observed over a short period.¹

UNECE Resolution No. 61 correlates zone 1 of European inland waterways with Î class basins of European Russia inland waterways with specified wave height of 2.0 m with a 1% probability of overtopping, zone 2 with Ð class basins of European Russia inland waterways with specified wave height of 1.2 m with a 1% probability of overtopping, and zone 3 with Ë class basins of European Russia inland waterways with specified wave height of 0.6 m with a 1% probability of overtopping.

Due to difference in probability of overtopping in zones of European inland waterways and Î, Ð and Ë class basins, the requirements of this part of the Rules, which are dependent on wind and wave conditions of operation basin, for ships entering European inland waterways, are stricter than the requirements of other parts of the Rules.

1.1.3 Additional (see 1.1.1) requirements for ships in this part of the Rules are grouped as per subjects corresponding to subjects of main parts of the Rules. When required, both water basin classes as classified in the Regulations for Classification and Survey of Vessels and zones of European inland waterways are specified.

¹ Definition is given in 1-1.5 of UNECE Resolution No. 61.
2 HULL AND HULL EQUIPMENT

2.1 HULL DESIGN

2.1.1 Wave bending moment shall be determined by the formula (2.2.10-2) Part I of the Rules, in which wave height \( h \) is derived from Table 2.1.1 in meters.

<table>
<thead>
<tr>
<th>Basin class</th>
<th>Wave height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O (zone 1 of European inland waterways)</td>
<td>2.5</td>
</tr>
<tr>
<td>P (zone 2 of European inland waterways)</td>
<td>1.5</td>
</tr>
<tr>
<td>J (zone 3 of European inland waterways)</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Note. In case of any changes of the navigation conditions corresponding to the main class notation (navigation area, season, permitted wave height for specified probability of overtopping) assignment of the design wave height shall be agreed with the River Register in each particular case.

2.1.2 The following requirements are imposed to collision bulkhead arrangement:

1. In ships navigating in zones 2 and 3 (corresponding to P and J class basins) the collision bulkhead shall be between 0.04 \( L \) and 0.08 \( L \) aft of the forward perpendicular, where \( L \) is ship length;

2. In all passenger ships the distance between the collision bulkhead and the forward perpendicular shall be between 0.04 \( L \) and 0.04 \( L + 2 \) m.

2.1.3 Hydrofoil ships, strength of which complies with 5.2 – 5.5 Part I of the Rules, are considered to be fit for hull-borne navigation on wave of below height (m) in basin of class:

<table>
<thead>
<tr>
<th>Basin class</th>
<th>Wave height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O (zone 1 of European inland waterways)</td>
<td>2.5</td>
</tr>
<tr>
<td>P (zone 2 of European inland waterways)</td>
<td>1.5</td>
</tr>
<tr>
<td>J (zone 3 of European inland waterways)</td>
<td>0.75</td>
</tr>
</tbody>
</table>

2.1.4 When a hydrofoil is underway, design wave height \( h \) shall be taken at least equal to that specified below (m) for basin of class:

<table>
<thead>
<tr>
<th>Baseline</th>
<th>Wave height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>1.625</td>
</tr>
<tr>
<td>P</td>
<td>1.000</td>
</tr>
<tr>
<td>J</td>
<td>0.500</td>
</tr>
</tbody>
</table>
3 STABILITY. FLOODABILITY. FREEBOARD. MANEUVERABILITY

3.1 PASSENGER SHIP STABILITY

3.1.1 Passenger ship intact stability for standard loading conditions specified in 1.3.2 Part II of the Rules is considered to be sufficient, if the following requirements are met:

.1 Maximum arm of static stability curve \( l_{\text{max}} \) shall not be less than 0.20 m at angle of heel \( \theta_{\text{max}} \geq 15^\circ \). However, if downflooding angle \( \theta_{\text{downfl}} < \theta_{\text{max}} \), arm of static stability curve at the downflooding angle \( \theta_{\text{downfl}} \) shall not be less than 0.20 m;

.2 Downflooding angle \( \theta_{\text{downfl}} \) shall not be less than 15°;

.3 Area below righting arms curve depending on position of \( \theta_{\text{downfl}} \) and \( \theta_{\text{max}} \) shall be at least equal to values specified in Table 3.1.1.3;

.4 Initial metacentric height \( h \) calculated with free surface correction taken into account shall not be less than 0.15 m;

.5 Angle of heel shall not exceed 12° for each of the following two situations:

  under combined effect of heeling moments due to one-sided accumulation of passengers and wind.

  under combined effect of heeling moments due to one-sided accumulation of passengers and centrifugal force caused by turning;

.6 Under combined effect of total heeling moment due to one-sided accumulation of passengers, wind pressure and centrifugal force caused by turning, the minimum freeboard shall not be less than 200 mm;

.7 For ships with watertight hull openings located below the bulkhead deck (deadlights and manholes closed with covers attached with closely spaced bolts, sliding doors, etc.), the residual safety clearance (i.e. vertical clearance available between maximum draught plane and lowest edges of watertight openings) shall not be less than 100 mm under combined effect of three heeling moments specified in 3.1.1.6.

3.1.2 The heeling moment \( M_t \) due to one-sided accumulation of persons in kN-m shall be determined by the formula:

\[
M_t = gP y = g \sum P_i y_i ,
\]

where \( P \) is total mass of persons on board (t) calculated by adding up the maximum permitted number of passengers and the maximum number of shipboard crew under normal operating conditions;

\( y \) is distance of centre of gravity of total mass of persons \( P \) from the centre line (m);

<table>
<thead>
<tr>
<th>Case</th>
<th>Static stability curve area ( A ), m-rad</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ( \theta_{\text{max}} = 15^\circ )</td>
<td>0.07 m-rad to angle ( \theta = 15^\circ )</td>
</tr>
<tr>
<td>2 ( 15^\circ &lt; \theta_{\text{max}} &lt; 30^\circ )</td>
<td>( \theta_{\text{max}} \leq \theta_{\text{downfl}} ) m-rad to angle ( \theta_{\text{max}} )</td>
</tr>
<tr>
<td>3 ( 15^\circ &lt; \theta_{\text{downfl}} &lt; 30^\circ )</td>
<td>( \theta_{\text{max}} &gt; \theta_{\text{downfl}} ) m-rad to angle ( \theta_{\text{downfl}} )</td>
</tr>
<tr>
<td>4 ( \theta_{\text{max}} \geq 30^\circ ) and ( \theta_{\text{downfl}} \geq 30^\circ )</td>
<td>0.055 m-rad to angle ( \theta = 30^\circ )</td>
</tr>
</tbody>
</table>

Note. \( l_{\text{max}} \) is maximum arm of static stability curve (m); \( \theta \) is angle of heel (deg); \( \theta_{\text{downfl}} \) is downflooding angle (deg); \( \theta_{\text{max}} \) is angle of heel corresponding to maximum arm of static stability curve (deg); \( A \) is static stability curve area (m-rad).
3 Stability. Floodability. Freeboard. Maneuverability

\[ g \text{ is acceleration of gravity: } g = 9.81 \text{ m/s}^2; \]

\[ P_i = \text{mass of persons accumulated on area } A_i \text{ (t); } \]

\[ n_i = \text{number of persons per square meter; } \]

\[ n_i = 4 \text{ for free deck areas and deck areas with movable furniture; for deck areas with fixed seating furniture such as benches, } n_i \text{ shall be calculated by assuming an area of 0.45 m in seat width and 0.75 m in seat depth per person.} \]

The calculations shall be carried out for an accumulation of persons both to starboard and to port.

The distribution of persons shall correspond to the most unfavourable one from the point of view of stability. Cabins shall be assumed unoccupied for the calculation of the persons’ heeling moment.

3.1.3 The mass per person shall be taken equal to 75 kg, and the centre of gravity of a person shall be taken as 1 m above the lowest point of the deck at 0.5L ignoring any deck curvature.

A detailed calculation of deck areas, which are occupied by persons, may be dispensed with if the following values are used:

\[ P = 1.1 F_{\text{max}} \cdot 0.075 \text{ for day trip ships;} \]

\[ P = 1.5 F_{\text{max}} \cdot 0.075 \text{ for cabin ships,} \]

where \( F_{\text{max}} \) is maximum permitted number of passengers on board with \( y = B/2 \) (m).

3.1.4 The heeling moment \( M'_w \) resulting from the static wind pressure on a ship (kN·m) shall be determined by the formula:

\[ M'_w = p_w S (z_r + 0.5T), \]

where \( S \) is windage area (m\(^2\)) calculated as specified in 2.2.3 and 2.2.4 Part II of the Rules, for the loading conditions considered according to 3.1.1.

\( z_r \) is height of centre of windage above the waterplane (m) according to the loading conditions considered as specified in 3.1.1.

\( p_w \) is specific wind pressure equal to 0.15 kN/m\(^2\) for I class basins (zone 3 of European inland waterways) and 0.25 kN/m\(^2\) for O and P class basins (zones 1 and 2 of European inland waterways).

3.1.5 The heeling moment \( M_{ct} \) having effect on a ship during transient turning (kN·m) shall be determined by the formula:

\[ M_{ct} = 0.102 \delta v^2 D (z_g - 0.5T)/L, \]

where \( L \) and \( T \) are wetted length and draught, respectively (m).

\( \delta \) is block coefficient (if not known, taken as 1.0).

\( D \) is ship displacement under the given loading conditions (kN).

\( z_g \) is height of centre of gravity above the baseline (m).

\( v \) is calm-water full speed at straight course (m/s).

\( \delta \) is coefficient of 0.45.

3.1.6 The maximum permitted number of passengers shall not exceed any of the following values:

- number of passengers, for which the existing evacuation areas are proven
- number of passengers that has been assumed for the stability calculation
- number of available berths for passengers on cabin ships used for voyages including overnight stays

For cabin ships, which are also used as day trip ships, the number of passengers shall be calculated for use, both as a day trip ship and as a cabin ship, and entered in the certificate of seaworthiness.

The River Register shall set the maximum permitted number of passengers and enter this number in the certificate of seaworthiness.

The maximum permitted number of passengers shall be displayed on board of the ship.

3.2 STABILITY OF CONTAINER SHIPS

3.2.1 A cargo of containers is considered to be fixed when each individual container is firmly secured to the ship's hull and when its position cannot be altered during navigation.

3.2.2 Stability of container ships shall be verified by one of the below methods.
Method 1

3.2.3 In the case of ships carrying non-fixed containers, the following requirements shall be met to provide ship’s stability:

1. The metacentric height $h$ shall not be less than 1.00 m;

2. Under the combined action of the centrifugal force produced by the turning of the ship, the wind pressure and the flooded free surfaces, the angle of heel shall not exceed 5°, and the margin line (see 1.2.1.28 Part II of the Rules) shall not be submerged.

3.2.4 The heeling arm resulting from the centrifugal force due to the turning of the ship (m) shall be determined by the following formula:

$$l_{cf} = C_{cf}v^2 \left( z_g - 0.5T \right)/L,$$  

(3.2.4)

where $C_{cf}$ is parameter taken as 0.04 (s²/m).

$v$ is maximum speed of ship in relation to the water (m/s).

$z_g$ is height of centre of gravity of ship (m).

$T$ is midship draught of loaded ship (m).

$L$ is ship hull length measured at maximum draught level (m).

3.2.5 The heeling arm (m) resulting from the effect of wind shall be determined according to the following formula:

$$l_w = 9.81C_{w}S \left( z_r + 0.5T \right)/D,$$  

(3.2.5)

where $C_{w}$ is parameter taken as 0.025 (t/m²).

$S$ is windage area of ship (m²).

$D$ is ship’s displacement weight (kN).

$z_r$ is height of centre of windage above the waterplane under the loading condition considered (m).

3.2.6 The heeling arm (m) resulting from the free surfaces exposed to rainwater and residual water inside the hold or double bottom shall be determined according to the following formula:

$$l_{fs} = 9.81C_{fs} \sum_{i=1}^{n} \left( b_i l_i \left( b_i - 0.55I_i \right) \right)/D,$$  

(3.2.6)

where $C_{fs}$ is parameter taken as 0.015 (t/m²).

$b_i$ is breadth of $i$-th hold or $i$-th section of hold divided to compartments by longitudinal watertight bulkheads $^1$ (m).

$l_i$ is length of $i$-th hold or $i$-th section of hold divided to compartments by transversal watertight bulkheads (m).

$n$ is number of holds or sections of hold divided to compartments by transversal watertight bulkheads.

3.2.7 The stability of a ship loaded with non-fixed containers shall be considered adequate when the actual value of height of centre of gravity of ship $z_g$ is not more than the value $z_g^\text{max}$ which is the least of values calculated by formulae (3.2.7-1) and (3.2.7-2):

for various displacements covering the whole range of possible draughts (m).

$$z_g^\text{max} = \left[ z_m + 0.5B(0.5C_{cf}T - h_{oe} - h_b)/H_{fb}^a \right]/\left(0.5BC_{cf}/H_{fb}^a + 1\right),$$  

(3.2.7-1)

where $0.5B/H_{fb}^a$ shall not be less than 11.5 (11.5 = 1/tan 5°) or

$$z_g^\text{max} = z_M - 1.00;$$  

(3.2.7-2)

$z_g^\text{max}$ is maximum permissible height of centre of gravity of ship (m).

$z_M$ is metacentric height above the baseline (m) as determined from hydrostatic curves or from formulae in 3.2.8.

$H_{fb}^a$ is actual freeboard at 0.5$L$ (m).

$C_{cf}$ is value for centrifugal force produced by turning.

$$C_{cf} = (0.7v)^2/\left(9.81 \cdot 1.25L\right) = 0.04 v^2/L;$$  

(3.2.7-3)

$T$ is midship draught (m).

$v$ is maximum speed of ship before start of turning (m/s).

$l_h$ is heeling arm resulting from effect of wind (m) (see 3.2.5).

$^1$ Flooded sections of hold with free surfaces result from division into compartments by longitudinal or transversal watertight bulkheads, which form sections isolated from each other.
\( l_h \) is heeling arm resulting from the free surfaces of water inside the hold or double bottom (m) (see 3.2.6).

\( B \) is hull breadth at maximum ship draft level (m).

**3.2.8** If hydrostatic curves are unavailable, the value \( z_M \) (m) for the calculation according to 3.2.7 can be determined by the following approximation formula:

For pontoon ships

\[
    z_M = B^2 \left[ 12.5 - \left( \frac{T}{H} \right) T \right] + 0.5T ,
\]

(3.2.8-1)

where \( H \) is hull height representing the minimum vertical distance between the upper keel edge and the lowest deck point on board the ship (m);

\( T \) is defined in 3.2.7;

for other ships

\[
    z_M = B^2 \left[ 12.7 - 1.2 \left( \frac{T}{H} \right) T \right] + 0.5T ,
\]

(3.2.8-2)

**3.2.9** In case of ships carrying fixed containers, the following requirements shall be met to provide ship's stability:

1. The metacentric height \( h \) shall not be less than 0.50 m.
2. Under the combined action of the centrifugal force produced by the turning of the ship, the wind pressure and the liquid cargo's free surfaces (if any), no hull opening shall be submerged.
3. The heeling arm resulting from the centrifugal force produced by the turning of the ship, the wind pressure and the liquid cargo's free surfaces (if any) shall be determined by the formulae referred to in 3.2.4 to 3.2.6.
4. For each load case, free surface correction for half the fuel and fresh water supply must be taken into account.

**3.2.10** The stability of a ship loaded with fixed containers shall be considered adequate, if the actual value \( z_g \) is less than or equal to \( z_{g\max} \).

**Method 2**

**3.2.11** The stability of ships carrying fixed containers is considered as complying with the requirements of the Rules if criteria applicable to stability of cargo ships as specified in 3.2 Part II of the Rules are met.

**3.2.12** The stability of ships carrying non-fixed containers must satisfy the following requirements:

1. The metacentric height \( h \) shall not be less than 1.00 m;
2. The angle of heel \( \theta_{w.cf} \) resulting from the combined effect of the heeling moments produced by the static pressure of wind \( M'_w \) (see formula (3.1.4)) and the effect of the centrifugal force on turning \( M_{cf} \) (see formula (3.1.5))\(^1\) shall not exceed 5° or the critical angle \( \theta_n \), at which the upper edge of the freeboard deck is submerged, whichever of these angles is less; in other words, one of the following requirements must be satisfied:

\[
    \theta_{w.cf} \leq \theta_{perm} = 5^\circ
\]

or

\[
    \theta_{w.cf} \leq \theta_{perm} = \theta_k , \text{ if } \theta_k < 5^\circ .
\]

**3.2.13** The angle of heel \( \theta_{w.cf} \) shall be determined from the static stability curve depending on values \( M'_w \) and \( M_{cf} \) as a result of constructions given in Fig. 3.2.13, where the coordinates origin is moved to point \( 0' \) on the moment curve corresponding to the static angle of heel \( \theta_s \) resulting from the applied static moment \( M'_w \) calculated by the formula (3.1.4).

The angle of heel \( \theta_{w.cf} \) is determined by selecting a straight line \( BD \) parallel to the ordinates axis, assuming that the hatched areas \( 0'CA \) above the curve up to the moment \( M_{cf} \) and \( ABD \) below the curve are equal.

**3.2.14** In determining the permissible moment produced by the dynamic inclinations \( M_{perm} \) the permissible angle of heel \( \theta_{perm} \) shall not exceed 5°, and the margin line shall not be submerged.

**3.2.15** If the requirements stated in 3.2.12 and 3.2.14 are not satisfied, containers must be secured.

\(^1\) For calculation of \( M_{cf} \) according to the formula (3.1.5) the ship’s speed before start of turning is taken as 0.8 of the full speed.
3.3 REQUIREMENTS FOR DAMAGE
TRIM AND STABILITY OF PASSENGER
SHIPS IN CASE OF FLOODED
COMPARTMENTS

3.3.1 Buoyancy of the ship in the event of
flooding shall be proven for the standard load
conditions specified in 1.3.2 Part II of the
Rules. Proof of sufficient stability shall be
determined for the three intermediate stages
of flooding (25%, 50% and 75% of com-
partment flood buildup) and for the final stage
of compartment flooding.

3.3.2 Ships operating in zones 1, 2 and 3 of
European inland waterways shall comply with
the 2-compartment criterion, except for ships
of 45 m long and shorter and ships designed
to carry at most 250 passengers, which may
comply with the 1-compartment criterion.
However, ships required to comply with the
2-compartment criterion and operating in
zones 2 and 3 of European inland waterways,
may comply with the 1-compartment criterion
provided that they have double hull with
minimum 0.6 m distance between inner and
outer skins and the space between outer and
inner skin complies with the 2-compartment
criterion.

3.3.3 The following assumptions shall be
taken into account in the event of flooding:

.1 The extent of damage corresponding to
the 1-compartment and 2-compartment crite-
rion shall be taken according to Table 3.3.3.1;

.2 For 1-compartment floodability, the
bulkheads can be assumed to be intact if the
distance between two adjacent bulkheads is
greater than the damage length. Longitudinal
bulkheads at a distance of less than B/3 from
the outer plating measured perpendicular to
the centre line from the shell plating at the
maximum draught shall not be taken into
account for calculation purposes;

.3 For 2-compartment criterion, each
bulkhead within the extent of damage shall be
assumed to be damaged;

.4 The lowest point of every non-
watertight opening (e.g. doors, windows,
hatches) shall lie at least 0.10 m above the
damaged waterline. The bulkhead deck shall
not be immersed;

.5 The compartment permeability coeffi-
cient is assumed to be 0.95. If it is proven by
calculations that the permeability coefficient
of any compartment is less than 0.95, the
calculated value can be used instead.

In any case, the permeability coefficient
values to be adopted for the following com-
partments shall not be less than:

- passenger compartments 0.95
- engine room 0.85
- luggage and provision store rooms 0.75
- double-bottom compartments, fuel 0 or 0.95
tanks and other tanks (depending on
their intended purpose)

Free surface effect for the intermediate
stages of flooding shall be calculated depend-
ing on the damaged compartment surface
area;

.6 If any ship damage of extent less than
specified in 3.3.3.1 to 3.3.3.2 may produce
more detrimental effect to damage trim

### Table 3.3.3.1

<table>
<thead>
<tr>
<th>Floodability criterion</th>
<th>Extent of damage (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
</tr>
<tr>
<td></td>
<td>h</td>
</tr>
<tr>
<td>Hull side</td>
<td></td>
</tr>
<tr>
<td>1-compartment</td>
<td>B/5</td>
</tr>
<tr>
<td>2-compartment</td>
<td>0.59</td>
</tr>
<tr>
<td>Hull bottom</td>
<td></td>
</tr>
<tr>
<td>1-compartment</td>
<td>B/5</td>
</tr>
<tr>
<td>2-compartment</td>
<td>B/5</td>
</tr>
</tbody>
</table>

**Note**: 1. b is depth at side, breadth at the bottom; h is a vertical dimension.
2. Length of damage \( l = 1.20 + 0.07L \) (m).
3 Stability. Floodability. Freeboard. Maneuverability

and/or damage stability (see 3.3.3.4, 3.3.5), such a damage shall be taken into account for floodability verification calculation purposes.

3.3.4 For all intermediate stages of flooding referred to in 3.3.1, the following conditions shall be met:

.1 The heeling angle at the equilibrium position of the ship in unsymmetrical flooding before taking any righting measures shall not exceed 15°;

.2 The maximum righting lever shall be at least 0.02 m until the first non-watertight opening becomes immersed or until heeling angle of 25° and more is reached;

.3 Non-watertight openings shall not be immersed until the equilibrium position for each intermediate stage considered has been reached.

3.3.5 In the final stage of flooding, the following conditions shall be met taking into account the heeling moment due to one-sided accumulation of passengers as calculated in 3.1.3 Part II of the Rules:

.1 The heeling angle \( \theta_2 \) (Fig. 3.3.5) shall not exceed 10°;

.2 In the equilibrium position, the positive area under the righting lever curve shall not be less than 0.0065 m·rad at righting lever value of \( l_R \geq 0.05 \) m. These conditions shall be met until the first non-watertight opening is immersed or, in any case, until heeling angle \( \theta_m = 25° \) is reached (Fig. 3.3.5);

.3 The non-watertight openings shall not be immersed until the equilibrium position has been reached; if such openings are immersed before this point, the rooms accessible through such opening are deemed to be flooded for stability calculation purposes.

3.3.6 If cross-flooding ducts to reduce asymmetrical flooding are provided in the ship hull, they shall meet the following conditions:

.1 Cross-flooding shall take place automatically;

.2 Cross-flooding ducts shall not be equipped with shut-off devices;

.3 Maximum permissible righting time shall not exceed 15 minutes.

3.4 LOAD LINE

3.4.1 Load line for ships operating in zones 1 to 4 of European inland waterways consists of a horizontal band with additional freeboard lines, which are applied as prescribed by technical documentation approved by the River Register (Fig. 3.4.1). The lower edge of this horizontal band is a trace of the maximum draught plane for zone 3 of European inland waterways. Zone 4 of European inland waterways has no equivalent on the Russian inland waterways and is characterized by standardized wave height of 0.3 m.

...
3.5 FREEBOARD AND SAFETY CLEARANCE

3.5.1 For the purpose of this chapter, ships shall be divided into three types:
- type A — decked ships;
- type B — tankers and equivalent ships;
- type C — open ships.

3.5.2 As far as the considered ships are concerned, the River Register regulates both the freeboard and safety clearance, i.e. vertical clearance measured between the maximum draught plane and the lowest point, above which the ship cannot be considered watertight.

3.5.3 Minimum freeboard height for ships of type A operating in zones 1 and 2 of European inland waterways is determined in Table 3.5.3.

Table 3.5.3

<table>
<thead>
<tr>
<th>Ship length, m</th>
<th>Minimum freeboard height, mm, for European inland waterway zone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>≤ 30</td>
<td>250</td>
</tr>
<tr>
<td>40</td>
<td>340</td>
</tr>
<tr>
<td>50</td>
<td>440</td>
</tr>
<tr>
<td>60</td>
<td>570</td>
</tr>
<tr>
<td>70</td>
<td>570</td>
</tr>
<tr>
<td>≥ 80</td>
<td>570</td>
</tr>
</tbody>
</table>

3.5.4 Minimum freeboard height for ships of type B operating in zones 1 and 2 of European inland waterways is determined in Table 3.5.4.

Table 3.5.4

<table>
<thead>
<tr>
<th>Ship length, m</th>
<th>Minimum freeboard height, mm, for European inland waterway zone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>≤ 30</td>
<td>180</td>
</tr>
<tr>
<td>40</td>
<td>250</td>
</tr>
<tr>
<td>50</td>
<td>330</td>
</tr>
<tr>
<td>60</td>
<td>420</td>
</tr>
<tr>
<td>70</td>
<td>420</td>
</tr>
<tr>
<td>≥ 80</td>
<td>420</td>
</tr>
</tbody>
</table>

3.5.5 Minimum freeboard height for platform ships shall be determined as per standards provided for ships of type B.

3.5.6 Minimum freeboard height (mm) for ships of type C irrespective of their length shall not be less than:

<table>
<thead>
<tr>
<th></th>
<th>for European inland waterway zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1000</td>
</tr>
<tr>
<td>2</td>
<td>600</td>
</tr>
</tbody>
</table>

Here, the total height of freeboard and coaming, (mm) for these ships shall not be less than:

<table>
<thead>
<tr>
<th></th>
<th>for European inland waterway zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1200</td>
</tr>
<tr>
<td>2</td>
<td>1000</td>
</tr>
</tbody>
</table>

3.5.7 For ships of types A and B operating in zone 2 of European inland waterways, the safety clearance defined in 3.5.2 shall not be less than 600 mm.

For ships of type C, as well as for other ships operating with open holds this clearance shall be increased by 400 mm in zone 2. However, this increase applies only to the coamings of open holds.

3.5.8 For ships of types A and B operating in zone 3 of European inland waterways the safety clearance shall not be less than 300 mm.

3.5.9 For ships of type C operating in zone 3 of European inland waterways the safety clearance shall not be less than 500 mm.

3.5.10 The basic freeboard $H_0$ of ships operating in zone 3 of European inland waterways with a continuous deck without superstructures or sheer shall be 150 mm.

3.5.11 In freeboard calculations for ships with superstructures or sheer, corrections for freeboard may be taken into account provided that such corrections are introduced by the designer and calculated according to 3.5.12 to 3.5.14.

3.5.12 Minimum freeboard height value $H_{\text{max}}$, mm, with a correction for freeboard for ships with superstructures shall be determined by the following formula:

$$H_{\text{min}} = H_0 (1 - \lambda) - (\beta_1 S_1 + \beta_2 S_2)/15,$$

(3.5.12)
where $H_0$ is basic freeboard (see 3.5.10) (mm).

$\lambda$ is coefficient accounting for effect of all superstructures.

$\beta_1, \beta_2$ are coefficients accounting for effect of sheer and superstructures in fore and aft parts of the ship, respectively.

$S_{e1}, S_{e2}$ are design sheers in fore and aft parts of ship, respectively (mm).

3.5.13 The coefficient accounting for effect of superstructures shall be determined by the following formula:

$$\lambda = \sum l_e / L_1,$$  \hspace{1cm} (3.5.13-1)

where $L_1$ is maximum ship hull length without rudder and bowsprit (m);

$l_e$ is design length of superstructures (m);

$$l_e = l(2.5 B - 1.5) h / (0.6 H),$$  \hspace{1cm} (3.5.13-2)

where $l$ is effective length of superstructure (m);

$b$ is average breadth of superstructure. Superstructure with $b \geq 0.6$ shall be considered in calculation;

$B$ is ship breadth in the middle of superstructure considered (m);

$h$ is average height of superstructure considered (m) measured from the deck (for cargo hatches $h$ is obtained by subtracting half the safety clearance specified in 3.5.8 to 3.5.9 from this height). In calculation $h$ shall not be more than $0.6 h_{\text{max}}$;

$h_{\text{max}}$ is maximum significant wave height characterizing the zone under consideration (m).

3.5.14 Coefficients $\beta_1$ and $\beta_2$ accounting for effect of sheer shall be calculated as per the following formulae:

$$\beta_1 = 1 - 3 l_{e1} / L_1,$$

$$\beta_2 = 1 - 3 l_{e2} / L_1,,$$

where $L_1$ is defined in 3.5.13;

$l_{e1}, l_{e2}$ is design length of fore and aft superstructures, respectively, determined by the formula (3.5.13-1). A superstructure or its part, the length of which does not exceed 0.25 $L$ from the ends, shall be taken into account.

The design sheer shall be determined by the following formula:

$$s_e = ps,$$  \hspace{1cm} (3.5.14-2)

where $s$ is effective sheer in the fore or aft end (mm). Value $s$ shall not exceed 1000 mm in the fore end and 500 mm in the aft end;

$p$ is coefficient determined from Table 3.5.14;

Table 3.5.14

<table>
<thead>
<tr>
<th>$x/L$</th>
<th>$p$</th>
<th>$x/L$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\geq 0.25$</td>
<td>1</td>
<td>0.10</td>
<td>0.4</td>
</tr>
<tr>
<td>0.20</td>
<td>0.8</td>
<td>0.05</td>
<td>0.2</td>
</tr>
<tr>
<td>0.15</td>
<td>0.6</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

$x$ is $x$-coordinate measured from the end to the point where sheer is equal to 0.25$s$ (Fig. 3.5.14).

![Fig. 3.5.14. Determination of $x$-coordinate](image)

For intermediate values of ratio $x/L$, coefficient $p$ is determined by linear interpolation.

When $\beta_2 s_e > \beta_1 s_e$, the value of $\beta_2 s_e$ shall be taken equal to $\beta_1 s_e$.

3.5.15 The minimum freeboard calculated as per 3.5.12 shall not be negative.

3.5.16 The safety clearance for passenger ships shall not be less than the sum of:

additional lateral immersion measured along the outside plating, resulting from the permissible heeling angle according to 3.1.1.5; residual safety clearance according to 3.1.1.7.

For ships without bulkhead deck, the safety clearance shall not be less than (mm):

- for European inland waterway zone
  - 1900
  - 1000
  - 500

3.5.17 The minimum freeboard height of passenger ships shall not be less than the sum of:

additional lateral immersion measured along the outside plating, resulting from the permissible heeling angle according to 3.1.1.5;
3.6 MANEUVERABILITY OF SHIPS

3.6.1 Requirements of this chapter apply to the following inland navigation ships:
- ships that are 20 meters long and more;
- ships with product of length, breadth and draught \( LBT \) equal to 100 \( \text{m}^3 \) and more;
- tugboats and pushers used for towing (pushing) the above ships in any way.

3.6.2 A ship is considered to meet the respective maneuverability requirements of this chapter if under load condition specified in 3.6.3 it satisfies:
- forward speed criterion (see 3.6.4);
- turning capability criterion (see 3.6.5, 3.6.7);
- course changing capability criterion (see 3.6.7);
- stopping criterion (see 3.6.8, 3.6.9, 3.6.10);
- astern propulsion criterion (see 3.6.11).

3.6.3 The maneuverability test for ships and convoys shall be conducted with ship loaded to at least 70% of its cargo carrying capacity with maximum possible uniform cargo distribution. If the test load is less, downstream navigation shall be limited to this load of the ship. Here, the ship bottom clearance shall not be less than 20% of ship draught but not less than 0.5 m.

3.6.4 Ships and convoys shall develop speed of at least 13 km/h through the water. This requirement does not apply to tugboats and pushers running without convoy.

3.6.5 The turning capability of ships and convoys whose length does not exceed 86 m and width does not exceed 22.9 m shall be considered adequate, when during an upstream turning maneuver at initial speed of 13 km/h through the water, the limit values for stopping the downstream navigating ship as determined in 3.6.9 are complied with.

3.6.6 Ships and convoys shall be capable of making evasive actions beforehand. The capability of making such actions shall be proved through respective maneuvers to be made during tests according to 3.6.7. A ship or convoy is considered to meet the requirements of the Rules for course changing capability and turning capability, if rate of turn values \( r_1 \) and \( r_2 \) resulted from the tests are not less than values, and time \( t_1 \) does not exceed values, specified in Table 3.6.7.

3.6.7 The ship capability of making evasive actions and of turning shall be tested as follows. For a ship or convoy running at constant speed through the water \( v_0 = 13 \text{ km/h} \) at the start of the maneuver (time \( t_0 = 0 \text{ s} \), rate of turn \( r_0 = 0^\circ/\text{min} \), rudder angle \( \delta_0 = 0^\circ \), selected engine speed is kept constant), evasive action to port or starboard shall be made by changing the rudder angle. When the maneuver starts, the rudder shall be turned by angle \( \delta \). The rudder angle \( \delta \) (for example, 20° to starboard) shall be kept until the rate or turn value \( r_1 \) in achieved as determined in Table 3.6.7 for appropriate sizes of the ship/convoy. After the rate of turn value \( r_1 \) is reached, the time \( t_1 \) shall be noted and the rudder shall be turned to the same angle to stop turning. The time value shall be noted. When the rate of turn \( r_1 \) is reached, the rudder shall be reversed to the same angle \( \delta \) to stop turning. The time value shall be noted. When the rate of turn \( r_1 \) is


3 Stability. Floodability. Freeboard. Maneuverability

### Table 3.6.7

<table>
<thead>
<tr>
<th>Dimensions of ship (convoy), ( L \times B ) (m)</th>
<th>Required rate of turn ( r_1 = r_3 ) (deg/min) at rudder angle ( \delta )</th>
<th>Limit values for time ( t_4 ) in shallow and deep water, s</th>
</tr>
</thead>
<tbody>
<tr>
<td>All self-propelled ships and single-line convoys sized up to 110x11.45</td>
<td>20</td>
<td>550 m for ships and convoys ( L &gt; 110 ) m long or ( B &gt; 11.45 ) m wide</td>
</tr>
<tr>
<td>Single-line convoys sized up to 193x11.45 or two-line convoys sized up to 110x22.90</td>
<td>12</td>
<td>480 m for ships and convoys ( L \leq 110 ) m long and ( B \leq 11.45 ) m wide.</td>
</tr>
<tr>
<td>Two-line convoys sized up to 193x22.90</td>
<td>8</td>
<td>Stopping is considered to be complete, if the ship has been stopped relative to the bank.</td>
</tr>
<tr>
<td>Two-line convoys sized up to 279x22.90 or three-line convoys sized up to 193x34.35</td>
<td>6</td>
<td><strong>3.6.10</strong> In still water (current velocity less than 0.2 m/s) the ship stopping distance shall not exceed the following values:</td>
</tr>
<tr>
<td>Note. ( h ) is water depth; ( T ) is ship draught; (*) non regulated.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The values of rate of turn \( r_1 \) and \( r_3 \) required to reach rate of turn \( r_4 = 0 \) depending on sizes of ships/convoys and water depth \( h \) are specified in Table 3.6.7.

The following maneuvers shall be completed:

- a turn to starboard with rudder angle of 20°;
- a turn to port with rudder angle of 20°;
- a turn to starboard with rudder angle of 45°;
- a turn to port with rudder angle of 45°.

**3.6.8** Ships and convoys are considered to be capable of stopping in proper time when moving downstream, if requirements 3.6.9 and 3.6.10 are met.

**3.6.9** In running water (current velocity of 1.5 m/s), the ship stopping distance shall not exceed the following values:

- 550 m for ships and convoys \( L > 110 \) m long or \( B > 11.45 \) m wide
- 480 m for ships and convoys \( L \leq 110 \) m long and \( B \leq 11.45 \) m wide.

Stopping is considered to be complete, if the ship has been stopped relative to the bank.

**3.6.10** In still water (current velocity less than 0.2 m/s) the ship stopping distance shall not exceed the following values:

- 350 m for ships and convoys \( L > 110 \) m long or \( B > 11.45 \) m wide
- 305 m for ships and convoys \( L \leq 110 \) m long and \( B \leq 11.45 \) m wide.

**3.6.11** A ship is considered to meet the requirements for astern propulsion, if during astern motion in still water the ship can reach a speed of not less than 6.5 km/h.

**3.6.12** In addition to requirements in 3.6.4 to 3.6.11, the following requirements shall be met:

- For manually operated control systems, a single turn of the wheel shall correspond to a rudder angle of at least 3°.
- For powered control systems, when the rudder blade is fully immersed, it shall be possible to achieve an average angular velocity of 4°/s within the entire range of rudder angles. This requirement shall also be met with ship at full speed, for rudder angles from 35° of a side to 35° of other side. In addition, it should be ascertained that the rudder is capable of keeping maximum angle at maximum
propulsion power. For active steering equipment or special types of rudder, this provision applies with their peculiarities taken into account.
4 FIRE PROTECTION

4.1. FIRE PROTECTION OUTFIT STANDARDS

4.1.1 Ships shall be provided with fire protection outfit as per standards specified in Table 6.1.5 Part III of the Rules. Besides, requirements in 4.1.2 to 4.1.8 shall be met.

4.1.2 Besides two sets of fire outfit, on the passenger ships the additional sets shall be provided for every 80 m (of part thereof) of total length of all passenger and service rooms on the deck where they are located or, if such decks are more than one, on the deck with the greatest total length of those rooms, i.e. two sets of fire outfit and two emergency breathing apparatuses (see 7 Part III of the Rules).

4.1.3 Two additional sets of fire outfit for each vertical fire zone shall be provided on the passenger ships carrying more than 36 passengers.

4.1.4 No additional sets of fire outfit shall be provided for stairway enclosures that form separate vertical fire zones and for vertical fire zones in the ship ends that do not contain accommodations and machinery spaces.

4.1.5 At least two sets of fire outfit on the passenger ships shall be stored in accessible places of each vertical fire zone.

4.1.6 Two spare bottles or two spare apparatuses shall be provided for each required self-contained breathing apparatus. All air bottles for apparatuses shall be interchangeable.

4.1.7 The passenger ships carrying not more than 36 passengers and the cargo ships fitted with means for complete recharging air bottles with purified air may have only one spare bottle or one spare breathing apparatus for each required self-contained breathing apparatus.

4.1.8 The passenger ships carrying more than 36 passengers shall have two spare bottles or two spare apparatuses for each required self-contained breathing apparatus.
5 POWER INSTALLATION AND SYSTEMS

5.1 POWER INSTALLATION

5.1.1 The power installation of a loaded inland navigation self-propelled ship (or of a pusher with loaded convoy) shall provide speed at least 13 km/h at calm water \(^1\) and at least 6 km/h made good when moving upstream.

5.1.2 The power installation of the ship with a single main engine, when the main engine turbo supercharger has been failed, shall provide such a motion speed that the ship could remain steerable.

5.2 SYSTEMS

5.2.1 Control stations, stairwells and internal evacuation areas on the passenger ships carrying more than 36 passengers shall be fitted with natural or mechanical smoke extraction systems. Smoke extraction systems shall satisfy the following requirements:

- They shall have sufficient smoke extraction capacity;
- They shall comply with the operating conditions for passenger ships;
- If smoke extraction systems also serve as general-purpose ventilation for the rooms, this shall not hinder their function as smoke extraction systems in the event of fire;
- Smoke extraction systems shall have a manually operated triggering device;
- Mechanical smoke extraction systems shall additionally be able to be operated from a station permanently manned by crewmembers;
- Natural smoke extraction systems shall be fitted with an opening mechanism operated either manually or by a power source inside the fan;
- Manually operated triggering devices and opening mechanisms shall be accessible from inside or outside the room being protected.

---

\(^1\) Calm water is a water area with current velocity of less than 0.1 km/h and still water surface (slight ripple is allowed) at wind speed of up to 3 m/s.
6 SHIP ARRANGEMENTS AND OUTFIT

6.1 STEERING GEAR

6.1.1 Lower journal of rudderstock shall be protected with a stainless steel liner or in some other way agreed with the River Register.

Keyed taper connection of rudderstock with rudder blade or steerable nozzle shall be protected from corrosion.

6.1.2 If ship is equipped with a rate-of-turn regulator, this regulator shall meet the following requirements:

.1 Operation of rate-of-turn regulator shall not result in spontaneous motion of rudder;

.2 Where, in addition to the rate-of-turn regulator, there are other steering control systems, it shall be possible to distinguish clearly at the steering position which of these systems is active. It shall be possible to shift from one system to another immediately;

.3 Requirements of 7.1.1 to 7.1.5 shall be met.

6.2 ANCHOR ARRANGEMENT

6.2.1 Total weight $\Sigma m_a$ of bow anchors of ships to be operated in zones 1 and 2 of European inland waterways shall be determined through calculations using dependences specified in Table 6.2.1.

A ship shall be equipped with anchors whose total weight complies with the design value $\Sigma m_a$ within 15% tolerance.

6.2.2 Ships shall be equipped with stern anchors whose total weight is not less than 0.25 of total design weight of bow anchors.

Ships with overall length exceeding 86 m shall be equipped with stern anchors whose total weight shall be not less than 0.5 of total design weight of bow anchors.

Table 6.2.1

<table>
<thead>
<tr>
<th>Zone of European inland waterways</th>
<th>Equipment number $N_c$</th>
<th>Total weight $\Sigma m_a$ of bow anchors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-propelled ships</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$50 \leq N_c &lt; 500$</td>
<td>$N_c + 50$</td>
<td></td>
</tr>
<tr>
<td>$500 \leq N_c &lt; 3000$</td>
<td>$1.38N_c - 153$</td>
<td></td>
</tr>
<tr>
<td>$\geq 3000$</td>
<td>$N_c + 987$</td>
<td></td>
</tr>
<tr>
<td><strong>Non-self-propelled ships</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$150 \leq N_c &lt; 500$</td>
<td>$N_c + 50$</td>
<td></td>
</tr>
<tr>
<td>$500 \leq N_c &lt; 2500$</td>
<td>$1.82N_c - 360$</td>
<td></td>
</tr>
<tr>
<td>$\geq 2500$</td>
<td>$0.484N_c + 2875$</td>
<td></td>
</tr>
<tr>
<td><strong>Tugboats</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$50 \leq N_c &lt; 200$</td>
<td>$1.596N_c - 6.57$</td>
<td></td>
</tr>
<tr>
<td>$200 \leq N_c &lt; 2500$</td>
<td>$N_c + 130$</td>
<td></td>
</tr>
<tr>
<td>$\geq 2500$</td>
<td>$1.79N_c - 204$</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.2.2

<table>
<thead>
<tr>
<th>Zone of European inland waterways</th>
<th>Equipment number $N_c$</th>
<th>Total weight $\Sigma m_a$ of bow anchors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-propelled ships of more than 60 m in length and more than 350 t in carrying capacity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$50 \leq N_c &lt; 350$</td>
<td>$N_c$</td>
<td></td>
</tr>
<tr>
<td>$350 \leq N_c &lt; 400$</td>
<td>$350$</td>
<td></td>
</tr>
<tr>
<td>$400 \leq N_c &lt; 800$</td>
<td>$0.75 N_c + 60$</td>
<td></td>
</tr>
<tr>
<td>$800 \leq N_c &lt; 1400$</td>
<td>$1.47 N_c - 511$</td>
<td></td>
</tr>
<tr>
<td>$1400 \leq N_c &lt; 2000$</td>
<td>$0.711 N_c + 552$</td>
<td></td>
</tr>
<tr>
<td><strong>Non-self-propelled ships of more than 60 m in length and more than 350 t in carrying capacity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$50 \leq N_c &lt; 350$</td>
<td>$N_c$</td>
<td></td>
</tr>
<tr>
<td>$350 \leq N_c &lt; 400$</td>
<td>$350$</td>
<td></td>
</tr>
<tr>
<td>$400 \leq N_c &lt; 800$</td>
<td>$0.75 N_c + 60$</td>
<td></td>
</tr>
<tr>
<td>$800 \leq N_c &lt; 1200$</td>
<td>$1.92 N_c - 896$</td>
<td></td>
</tr>
<tr>
<td>$1200 \leq N_c &lt; 2000$</td>
<td>$0.855 N_c + 379$</td>
<td></td>
</tr>
<tr>
<td><strong>Tugboats of more than 350 t in carrying capacity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$25 \leq N_c &lt; 300$</td>
<td>$1.15 N_c + 7.89$</td>
<td></td>
</tr>
<tr>
<td>$300 \leq N_c &lt; 350$</td>
<td>$350$</td>
<td></td>
</tr>
<tr>
<td>$350 \leq N_c \leq 1200$</td>
<td>$N_c$</td>
<td></td>
</tr>
</tbody>
</table>
6.2.3 Number of stern anchors shall be selected at the ship owner’s discretion. For pushers and ships with overall length exceeding 86 m total weight of stern anchors may be distributed to one or two anchors.

The lightest anchor weight shall not be less than 45% of the total weight of stern anchors.

Ships may not be equipped with stern anchor, if total weight of stern anchors determined according to 6.2.2 for normal holding power anchors is less than 150 kg. Stern anchors are not required for pushed barges.

6.2.4 Minimum required length of a bow anchor chain for displacement ships is specified in Table 6.2.4.

<table>
<thead>
<tr>
<th>Overall ship length $L$, m</th>
<th>Minimum length of anchor chain (m) for ships of class</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L &lt; 30$</td>
<td>$L + 10$ but not less than 40</td>
</tr>
<tr>
<td>$30 \leq L &lt; 50$</td>
<td>$L + 15$</td>
</tr>
<tr>
<td>$50 \leq L &lt; 100$</td>
<td>$L + 10$</td>
</tr>
<tr>
<td>$L \geq 100$</td>
<td>$L + 25$</td>
</tr>
</tbody>
</table>

Obtained value $l_a$ shall be rounded for ships equipped with two bow anchors to the nearest value $L_a$ multiple of shot length, and for ships equipped with one bow anchor to the nearest value $L_a$ from the range of manufactured anchor chains (m).

If the total length of anchor chains of two bow anchors is characterized with odd number of shots, then length of one of the chains shall be taken one shot more and connected to a heavier anchor if anchors are different in weight.

6.2.5 Length of each chain of stern anchors shall not be less than 40 m. However, length of each chain of stern anchors for ships to be anchored with bow downstream shall not be less than 60 m.

6.3 LIFE-SAVING APPLIANCES

6.3.1 All deck areas intended for passengers and not enclosed on passenger ships shall be provided with lifebuoys according to European standard EN 14144:2003 on both sides of the ship with maximum 20 m spacing between them.

Half of all the prescribed lifebuoys shall be fitted with buoyant lines of at least 30 m in length and 8 to 11 mm in diameter. The other half of the prescribed lifebuoys shall be fitted with self-igniting battery-powered lights, which will not be extinguished in water.

6.4 SPECIAL WHEELHOUSE ARRANGEMENTS FOR RADAR STEERING BY ONE PERSON

6.4.1 Noise level at the navigator’s head level in the steering position under the specified operation conditions shall not exceed 70 dB(A).

6.4.2 No posts, pillars, window frames or any above-deck obstacles shall be placed in the navigator’s normal line of vision.

6.4.3 The wheelhouse for steering by one person shall be designed in such a way that the navigator shall be able to accomplish his/her task while seated. All indicators or instruments, as well as all ship controls shall be so arranged that the navigator can use them conveniently during the voyage without leaving his/her seat and without losing sight of the radar screen, and the ventilation system capacity in the wheelhouse shall be sufficient to provide trouble-free operation of equipment control systems built in the control panel at high ambient air temperatures.

6.4.4 The radar display shall be placed in the wheelhouse forward of the navigator’s position in such a way that the navigator can observe the image on the screen with no change in his/her position. The radar image shall not be disturbed by masking or screening effect and shall continue to be perfectly visible without hood or glare shield, irrespective to lighting conditions inside or outside the wheelhouse. The rate-of-turn indicator shall be installed directly above or below the radar screen or be incorporated within.

6.4.5 When a rate-of-turn meter is used, it shall be possible to switch off the rate-of-turn meter in any assigned position with no change in the selected speed.
The meter's control shall be able of turning through an arc so as to provide precision of required positioning. The neutral position of the meter control shall clearly differ from other positions. It shall be possible to smoothly control the meter scale illumination.

6.4.6 The navigation lights shall be controlled from the navigation lights control switchboard, where light indicators shall be arranged so as to match the actual arrangement of the navigation lights. Failure of a navigation light shall result in the respective light indicator to go out, and the navigation light failure alarm shall be generated.

6.4.7 It shall be possible to generate an audible warning signal while performing steering operations.

6.4.8 The automatic light indicators to indicate operation of the navigation lights according to 10.7.7 Part VI of the Rules shall be installed on the control panel of the wheelhouse. The navigation light switches shall be used at the same time as switches for the respective automatic light indicators of those navigation lights operation.

6.4.9 The colour of the automatic light indicators of navigation light operation shall match the actual colour of the navigation lights.

6.4.10 It shall be possible to activate audible warning signals with foot when simultaneously performing steering operations. That requirement shall not apply to the "do not approach" signal referred to in the police regulations for the navigation of the European countries in case of traffic incident or onboard accident, which might result in leakage of dangerous carried materials (this audible signal represents short sound continuously repeated for at least 15 minutes and followed by a long one).

6.4.11 A ship shall be steerable with a rudder control lever. This lever shall be manipulated manually by the navigator. The angular movement of the lever relative to the ship axis shall exactly match the movement of the rudder blade(s). Each movement of the rudder control lever shall be accompanied by exact indication of the rudders position. The rudders shall remain in position when the control lever position does not change. The neutral position of the lever shall be indicated by a perceptibly and audibly distinguishable click.

6.4.12 If ship is equipped with special rudders, for example, those used for astern motion only or a bow thruster, these rudders and bow thruster shall be operated with special levers as prescribed by 6.4.11.

This requirement also applies to convoys, if the steering gear of a ship other than propelling the convoy is used during motion of the convoy.

6.4.13 Requirements of 11.12 Part IV of the Rules shall be met as applicable.

6.4.14 Devices shall be available to provide remote dropping anchors for emergency stop of the ship from the ship control position.

6.4.15 A ship of more than 86 m long and more than 23 m wide shall be equipped with devices to remotely drop the bow anchor of the ship being controlled or moored alongside.

6.4.16 The navigator shall be enabled to control the swivelling spotlight when performing steering operations.

6.4.17 There shall be a voice intercommunication system on board.

It shall enable the navigator to communicate with the ship bow or the head barge of the convoy, the master's cabin, the crew accommodation, and the ship stern or last barge of the convoy, if no other means of direct communication from the wheelhouse is possible. The voice intercommunication system shall be so arranged that the navigator can easily use it from his/her seat while carrying out the steering operations. At all locations equipped with such an intercommunication system reception shall be by loudspeaker and transmission by microphone. Transmission/reception mode shall be selected with a button.
Communication between the ship bow and ship stern between the head and the last barge of the convoy may be arranged by radiotelephone.

6.4.18 Where a ship complies with requirements 6.4.1 to 6.4.17, the following statement shall be entered in the documents issued by the River Register for this ship: “The ship has special wheelhouse arrangements for radar steering by one person”.

6.5 SIGNAL MEANS

6.5.1 In addition to navigation lights prescribed by 9.2 Part V of the Rules, ships shall be equipped with all-round blue flashing light with visibility range of 3.7 km.
7 ELECTRIC EQUIPMENT

7.1 RATE-OF-TURN METER

7.1.1 The rate-of-turn meter power supply shall be separated from power supply of other electrical consumers.

7.1.2 The gyroscopes, sensors and rate-of-turn indicators used in the rate-of-turn meters shall meet the minimum technical requirements and test conditions for rate-of-turn indicators for the inland waterways.

7.1.3 Electronics in the rate-of-turn meters shall meet requirements in 6, 7, as well as 9.5, 10.4, 14.2 of Appendix 15 to RTSC, and rate-of-turn indicator shall meet requirements 3.13 Part VIII of the Rules.

7.1.4 The proper functioning of the rate-of-turn meter shall be displayed at the steering position in the wheelhouse by means of a green warning light.

7.1.5 Any lack of or unacceptable variations in the supply voltage and an unacceptable fall of the gyroscope rotation speed shall be indicated at the steering position in the wheelhouse.
Part XII

REQUIREMENTS FOR CNG-FUELLED SHIPS
1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION

1.1.1 This Part of the Rules specifies requirements for ships with onboard equipment fuelled with compressed natural gas (CNG) subject to requirements stated in Parts 0–XI of the Rules.

1.1.2 This Part of the Rules applies to ships, except oil tankers, on which main and auxiliary engines and independent boilers are fuelled with CNG containing more than 85% methane (hereinafter gas-fuelled ships).

1.1.3 The requirements stated in this Part of the Rules shall be used for design, construction and operation of ships given in 1.1.2, and for conversion of ships in service of other types to gas-fuelled ships.

1.2 TERMS AND DEFINITIONS

1.2.1 Terms related to the Rules common terminology and their definitions are stated in 2.1 and 2.2 Part 0 of the Rules. Terms and definitions relating to ship power unit and systems are given in 1.2.1 Part IV of the Rules.

1.2.2 The following terms are used in this Part of the Rules:

1. Non-hazardous atmosphere means gaseous atmosphere in ship spaces and within open decks, in which natural gas (methane) concentration is below the settings of high gas concentration alarm;

2. Gas-hazardous zone means a zone with gas containing systems and facilities, including superimposed open deck spaces;

3. Gas-hazardous space means a space as follows:
   a hold space where a CNG tank is located;
   an enclosed or semi-enclosed deck space where a CNG tank is located;
   open deck within a gas-hazardous zone and within 2.4 m vertically from it;
   a space within 3 m from external surface of an unenclosed gas-containing system on open deck;
   open deck and spaces located less than 3 m in any direction from CNG ventilation outlets, gas-outlet pipes and similar arrangements;
   a space with direct access to any gas-hazardous space or to any space within a gas-hazardous zone, except as mentioned above, which has no arrangement for permanent maintenance of non-hazardous atmosphere certified by the River Register as compliant with the Rule requirements.

The following is not considered as gas-hazardous:

a space containing CNG-fuelled installation conforming to requirements stated in 4, 5, 6, 7, 8 and 9 of this Part;
control stations, accommodation and utility spaces not located above gas-hazardous space and having inlets and openings conforming to requirements stated in 2 of this Part;

a space beyond the open deck space containing CNG tank and equipment conforming to requirements 2, 6 and 7 of this Part, provided that a hold space located below is not gas-hazardous;
4. **Gas-containing system** means a system designed for CNG storage and supply to consumers;

5. **CNG tank** means a tank designed as a primary gas fuel tank;

6. **Semi-enclosed space** means a space bounded by structures protecting from precipitations and damage of internal equipment during transport operations but providing free ventilation of the space;

7. **Hold space of gas-hazardous zone** means a space bounded by hull structures and comprising a gas-containing system or a part thereof.

### 1.3 INFORMATIVE INSTRUCTIONS

1.3.1. There shall be informative instructions on safe use of CNG fuel onboard a gas-fuelled ship. These instructions shall contain at least the following information:

- description of CNG physical and chemical properties;
- measures to be taken in case of CNG leakage;
- fire-fighting methods and agents;
- methods for draining, purging andstripping CNG tanks, as well as systems, piping and ship equipment with gas-filled chambers;
- emergency actions;
- guide for use of protective equipment provided on a gas-fuelled ship;
- guide for emergency actions to be taken by officers in case of natural gas leakage or fire related to CNG use;
- first aid guide;
- onboard prohibitions on:
  - open fire;
  - smoking;
  - use of sparking equipment or tools;
  - use of equipment operating at temperature above gas mixture self-ignition point (for natural gas mixture with air, at temperature above 400 °C);
  - use of chemicals reacting actively with gas.
2 GAS-FUELED SHIP HULL AND SUPERSTRUCTURE

2.1 GENERAL REQUIREMENTS

2.1.1 CNG tanks shall be arranged in the hull or directly on open deck of a ship.

In case of open deck location, CNG tanks shall be installed in the aft part of the ship beyond the crew’s main workplaces in a such way to provide gas-fueled ship safety under normal operating conditions and in any emergencies, including those caused by damage of CNG tanks.

In case of open deck location, CNG tanks shall be installed in a semi-enclosed space at a distance not less than 0.2B from outer shell, where B is ship’s beam.

2.1.2 CNG tanks shall be attached to the hull in such way to preclude them from displacement caused by dynamic and static loads.

CNG tank design shall allow for compression and expansion of structures due to temperature changes without any near-limit stresses in the tank’s elements and hull structures.

CNG tank attachments shall be designed for static loads as per formula:

\[ F_{1st} = 1.5mg \]  
\[ F_{2st} = 1.3mg \]

where \( F_{1st} \) and \( F_{2st} \) are static loads (N) acting on CNG tank attachments in the longitudinal and transverse directions respectively;

\( m \) — mass (kg) of a tank fully filled with CNG;

\( g \) — acceleration of gravity taken equal to 9.81 m/s²

2.1.3 CNG tank attachments shall include stops designed to withstand horizontal forces arising at ship collision and equal to 0.5 and 0.25 of CNG tank weight and directed to the bow and to the aft respectively, to protect structural elements of CNG tanks from damage.

There shall be arrangements (wedges, stops, etc.) provided to prevent CNG tank floating-up under buoyancy force in case of space flooding up to the full-load draught.

Stresses in hull structure elements shall not exceed the yield point.

2.1.4 The strength calculation of CNG tanks and their supports shall assume independent action of loads given in 2.1.2 and loads arising at list of 30°, as well as no superimposing such loads with forces arising from the hull deformation on the seaway.

2.1.5 Structural provisions shall be taken to prevent CNG tanks displacement relatively to the hull under inertia force due to rolling.

2.1.6 Machinery, cargo and utility spaces shall be isolated from hull spaces where CNG tank are located by means of cofferdams or A-60 fireproof structures.

2.1.7 The access to gas-hazardous spaces shall be provided for their inspection. The access shall be provided:

1. into hull spaces — directly from open deck through openings, hatches and manholes with clear size at least 800×800 mm;
2. to open deck spaces — through openings or manholes in vertical walls with clear size at least 800×800 mm.

2.1.8 Gas-hazardous deck shall have a sparkproof coating.

Door and hatch fasteners of gas-hazardous zone spaces shall be made of a sparkproof material.
Tools for operation in gas-hazardous zone, as well as gear of relevant personnel shall have sparkproof design.

2.1.9 Measures shall be taken to seal hull located gas-hazardous spaces in the points where piping and cables pass through bulkheads to prevent gas penetration from a gas-hazardous space to adjacent spaces.

2.1.10 Entries and openings to control stations, accommodation and utility spaces shall be located on bulkheads not faced to the gas-hazardous zone. If top edges of entries and openings are below the level of CNG tank, such entries and openings may be located on bulkheads faced to the gas-hazardous zone.

2.1.11 Portholes in external bulkheads of superstructures and deckhouses faced to a gas-hazardous zone shall be of blind (non-opening) type. This requirement does not apply to wheelhouse windows.

2.1.12 Location of ship gear control stations and ship stores within a gas-hazardous zone is prohibited.
3 CNG TANKS

3.1 GENERAL REQUIREMENTS

3.1.1 CNG tanks shall comply with applicable requirements stated in Part IV of the Rules. Standard cylinders designed for operating pressure up to 25 MPa or tanks custom fabricated for the gas-fuelled ship may be used as CNG tanks.

Operating pressure in standard cylinders shall be assigned according to the specification of cylinder manufacturer, which is to have River Register's Recognition Certificate. Operating pressure in CNG tanks custom fabricated for a gas-fuelled ship shall be assigned basing on results of the River Register's review of relevant tank specifications and on results of the tank testing to design pressure according to 6.2.41–6.2.42 RTSC.

3.1.2 CNG tanks shall be grouped. Each group of 2–4 tanks shall be equipped with a separate stop valve. A group of gas cylinders/tanks shall be divided into sections, each of them shall be provided with a stop valve.

3.1.3 CNG tanks shall be painted in red and marked with inscription “Methane”.

3.1.4 CNG tanks/cylinders shall not be located in the same spaces with oxygen or compressed air cylinders.

3.1.5 Gas cylinders shall be placed on frames (racks). There shall be soft gaskets provided between clamps and cylinder surfaces, as well as between support surfaces of frames (racks). Gaskets shall be manufactured of a noncombustible material.

3.1.6 Each CNG tank shall be equipped with a pressure relief valve according to applicable requirements of 8.17.9, 8.17.10, 8.17.11 Part IV of the Rules.

Pressure relief valves of CNG tanks located in the hull or on open deck of a gas-fuelled ship, shall be connected to gas-outlet pipes conforming to requirements of 4.1.11.

3.1.7 Filling CNG tanks shall be provided from both sides of the ship.

Filling (bunkering) piping shall be designed not only for CNG tank filling (bunkering) but also for CNG discharge from these tanks (until their full emptying). If it is impossible or impracticable to use CNG filling piping for CNG discharge, there shall be dedicated piping for CNG discharge conforming to the same requirements as applied to CNG filling piping.

Each filling (bunkering) piping shall be provided with two stop valves mounted serially. One of them shall function as an emergency valve, and one of them shall be remotely controlled from wheelhouse and bunkering control station (if any).

Filling piping shall be connected to external flexible bunkering piping through a quick connection installed on filling piping end section; type and sizes of such a connection shall be approved by the River Register for CNG bunkering operations.

The end section of ship filling piping shall be equipped with gas-tight blind manufactured of a sparkproof material.

The blind shall be permanently attached to the end section of filling piping by chain or cable with length sufficient for blind removal and replacing to prevent blind loss when it is removed for bunkering.
Provisions shall be made for purging external flexible piping connected to the end section of the filling piping, as well as any part of the filling piping between stop valves mounted on it or other stop valves and CNG tank, by pressurized compressed inert gas, which is to be discharged to gas-outlet pipes.

Bunkering piping components designed for connection with onshore piping shall be manufactured of a sparkproof material.

Provisions shall be made for ship grounding by means of onshore ground connector during CNG filling from shore.

3.1.8 If ship filling piping is fitted with equipment for gas fuel sampling and for gas quantity/quality testing (e.g. gas fuel pressure indicators, meters, mixture analyzers, etc.), such equipment shall be installed downstream of the filling piping's inboard stop valve in such a way, that any item of given equipment may be cut off from ship filling piping without affecting this piping capacity.

Above equipment for gas fuel quantity/quality testing shall have the River Register's Compliance Certificate.

End connection of a sampling device shall be closed with a blind conforming to the same requirements as end blinds of ship filling piping or with such device's regular sampling container.

Containers with gas fuel samples shall be stored within well ventilated areas outside the ship spaces.

3.1.9 The inert gas system shall be provided for stripping CNG residues from cavities, which are supposed to be further filled with CNG, by means of purging with inert gas, which is then discharged to gas-outlet pipes.

It is recommended to use a system, which uses nitrogen supplied from shore as an inert gas. Amount of nitrogen in high pressure cylinders shall be sufficient for three purgings of all the cavities designed to be filled with CNG or inert gas. Inert gas piping shall be routed to all cavities, which are to be purged. Nitrogen storage cylinders shall comply with requirements applicable to CNG storage tanks.

Inert gas may also be prepared on board by means of nitrogen generators or inert gas generators having the Compliance Certificate issued by the River Register.
4 EQUIPMENT FOR CNG SUPPLY TO CONSUMERS

4.1 GENERAL REQUIREMENTS

4.1.1 Equipment for the CNG supply to consumer shall include the following:

.1 pressure regulators for CNG supplied to consumers (main and auxiliary engines, self-contained boiler)
.2 pressure-relief and shut-off valves
.3 CNG supply pipelines
.4 instruments, alarm and protection system
.5 gas-outlet pipes for extraction and removal of natural gas
.6 pipeline covers, cowls and trunks
.7 auxiliary equipment and spare parts for installation, operation and repair
.8 inert gas system specified in 3.1.9 as well as used for filling protective jackets with inert gas if so stipulated by ship design

4.1.2 Equipment for CNG supply may be located in the engine room if the requirements specified in this section are met.

The pipelines and any devices, which may be the source of CNG leakage, shall be located on the open deck outside the engine room and other bilge spaces. CNG pipelines shall not be laid closer than 760 mm from the outer shell plating.

In order to avoid flame propagation in the CNG pipelines they shall be fitted with flame arresters.

4.1.3 Main gas valve outside the engine room shall be provided to stop natural gas supply from the CNG tanks to consumers. Design of the main gas valve shall enable its manual control at the place of installation, as well as automatic closing.

Remote opening and closing the main gas valve from the wheelhouse shall be provided.

Installation of two sequential main gas valves (one provided with manual control and the other one automatic with remote control) is allowed.

4.1.4 Each CNG consumer shall be equipped with three automatic valves. Two valves shall be installed sequentially in the pipeline supplying gas to the consumer. The third valve shall be installed in the gas-outlet pipeline, which vents gas to atmosphere from the gas supply pipeline section between the two sequential valves.

Control of these valves shall be arranged to provide automatic closing the two sequential valves and simultaneous automatic opening the gas-outlet valve in case of CNG consumer shutdown or any fault that requires stopping CNG supply to the consumer.

One of the two stop valves and the gas-outlet valve may be combined in one valve box arranged in such a way that to provide closing the gas supply pipeline and opening the gas-outlet pipe in case of a fault that requires stopping CNG supply to the consumer.

The design of the stop and gas-outlet valves with automatic control shall enable their manual closing and opening.

4.1.5 The part of the CNG pipeline between the main gas valve and stop valves on the pipelines supplying gas to individual consumers shall be equipped with pressure-relief valves connected to the gas-outlet system.

If CNG pressure regulator installed at CNG tank outlet has an integral pressure-
relief valve, no pressure-relief valve on the pipelines after the main gas valve is required.

4.1.6 CNG pipelines shall not be laid through control stations, accommodation and service spaces, in the cargo holds, through ship's ventilation trunks and ducts.

CNG pipelines may be laid inside other ship spaces if the following conditions are met:

.1 CNG pipeline is a double-wall pipeline with gas fuel in the inner pipe;
.2 The space between the pipeline walls is filled with inert gas under pressure exceeding the gas fuel pressure;
.3 Inert gas pressure in the pipeline system is constantly monitored with the alarm system sensors;
.4 Upon alarm actuation, two sequential valves on the pipeline, which supplies gas to the consumer (see 4.1.4), close automatically before inert gas pressure falls below the gas fuel pressure, and the third valve on the gas-outlet pipeline opens automatically;
.5 After the main gas valve (see 4.1.3) is closed, the inner gas fuel supply pipeline between the main gas valve and respective CNG consumer is automatically purged with inert gas;
.6 A system where the space between the pipeline walls is ventilated by an exhaust ventilation system may be considered equivalent to provisions of 4.1.6.2 to 4.1.6.5. Capacity of such a ventilation system shall be determined by calculation from gas fuel rate and structure and location of the jacket pipes/ducts. The requirements of 4.1.8 shall be met as well.

4.1.7 CNG pipelines shall be protected against corrosion using a method agreed with the River Register.

The gas fuel pipelines in vicinity to connections with the CNG tanks/cylinders shall have circle bends to prevent pipeline damage from hull structure vibrations.

4.1.8 The following requirements are imposed upon CNG pipeline jacket duct ventilation system:

.1 Circulation rate shall not be less than 30 air changes per hour;
.2 Pressure in the jacket duct shall be less than the atmospheric pressure;
.3 The fan motors shall be located outside the jacket ducts;
.4 The ventilation outlet openings shall be located in places where explosive natural gas and air mixture cannot be ignited;
.5 The ventilation inlet openings shall be located to avoid ingress of natural gas or mixture of natural gas and air into the ventilation system. Those openings (ventilation inlets) shall be equipped with non-return devices unless ventilation system inlets are equipped with gas detectors;
.6 The ventilation system shall start automatically when gas fuel supply to CNG pipeline is started, and shall keep operating continuously as long as the gas is supplied through the pipeline;
.7 When the ventilation system fails to provide the required air change rate, the main gas valve (see 4.1.3) shall close automatically;
.8 The sensors of a gas detection system shall be places in the jacket ducts; this system may be part of the CNG supply equipment alarm and automatic protection system. Upon actuation of these sensors or the alarm system, the requirement of 4.1.6.4 shall be met;
.9 Inertisation (inert gas supply) and degassing of the part of the CNG pipeline system located in the engine space shall be provided.

4.1.9 CNG pipelines may transit through a space where natural gas is not used may be allowed if the requirements of 4.1.6 to 4.1.8 are met. CNG pipelines and their jackets shall have no detachable joints or fittings within these spaces.

4.1.10 CNG pipeline jacket ducts with exhaust ventilation shall end at a ventilation cowl or trunk.

Ventilation cowls or trunks shall be located nearby flanges, valves, pressure regulators and other gas equipment, including those installed directly at the CNG consumers.
Ventilation cowl or trunk shall be connected to exhaust ventilation system and shall be arranged so that air could to flow over the CNG consumer and be evacuated through the upper part of that ventilation cowl or trunk.

The air flowing through the ventilation cowl or trunk shall be continuously monitored by the natural gas detection system linked to the alarm and automatic protection system.

4.1.11 CNG pipelines and gas equipment shall be connected to the gas-outlet pipe system through the gas-outlet valves specified in 4.4 and through pressure-relief valves.

The gas-outlet pipe system shall be designed to direct the outgoing natural gas upwards.

The exhaust opening of the gas-outlet pipes shall be located above the open deck at height at least 1 m higher than wheelhouse.

For explosion/fire safety the gas/air mixture discharged from the gas-outlet pipes shall be additionally diluted with air supplied from the continuously operating ventilation systems in order to decrease total concentration of natural gas in the gas/air mixture.

Protective screens shall be installed at the discharge openings of the gas-outlet pipes to avoid ingress of foreign objects.

Instead of or in addition to the specified gas-outlet pipe system, a system may be provided to supply gas/air mixture from the gas-outlet pipes to combustion chamber of a self-contained boiler or a high-temperature organic heating fluid heater in order to force oxidation of the natural gas in the gas/air mixture from the gas-outlet pipes.

4.1.12 No stop valves may be installed on the pipelines connecting the pressure-relief valves to the gas-outlet pipe system.

4.1.13 CNG pressure indication devices shall be provided:
   .1 after the main gas valve
   .2 after each pressure regulator (reduction valve) in the system
   .3 before each consumer (when one pressure regulator serves a group of consumers)

4.1.14 The alarm system shall provide light and sound signals on deviation of a monitored parameter from the normal value and on actuation of the automatic protection in the following cases:
   .1 CNG pressure drop at the main gas valve
   .2 CNG pressure drop before each consumer
   .3 inert gas pressure drop in the protective jacket of the pipeline (see 4.1.6)
   .4 loss of vacuum or power supply to fans of the CNG pipeline jacket duct exhaust ventilation system
   .5 detection of natural gas in air running through CNG pipeline jacket ducts, ventilation cowls or trunks;
   .6 low or no valve pneumatic drive air pressure
   .7 loss of power supply of units/devices included in the equipment

4.1.15 In case of faults specified in 4.1.14, except for CNG drop before any individual consumer, the protection system shall actuate and the main gas valve shall automatically close.

When all the consumers shut down or switch to liquid petrol fuel, the main gas valve shall automatically close.

If the backup stop valves on pipelines supplying CNG to consumers and the gas-outlet valves are equipped with automatic drives, then automatic closing of the stop valves and opening of the gas-outlet valves shall be provided in case of faults specified in 4.1.14 except for CNG pressure drop before any individual consumer or all consumers shutdown or switching to liquid petrol fuel.

4.1.16 The design of automatic stop valves, including the main gas valve, shall provide automatic closing the valves in case of power loss on their drives.

The automatic gas-outlet valves shall open at power loss on their drives.
4.1.17 Indicators of parameters specified in 4.1.13 shall be installed in the engine room. CNG pressure after the main gas valve indicator shall be installed in the wheelhouse.

Signaling devices of the alarm and automatic protection system pertaining to cases listed in 4.1.14 shall be installed in the engine room and in the wheelhouse.

4.1.18 CNG pipelines shall be painted yellow with red rings.

4.1.19 If CNG tanks are located on a barge connected to the pusher with automatic coupling device, the requirements of 3.1.9 shall be met. Measures shall be taken to exclude damage and/or leakage of the pipeline supplying gas to the pusher as a result of the barge motions relative to the pusher. The use of standard flexible rubber/metal hoses for this purpose is allowed.

4.1.20 Two stop valves shall be installed sequentially before the detachable joint of the pipeline supplying gas from the CNG tanks on the barge to the pusher. These valves and the pipeline nearby shall meet the requirements of 3.1.9.

4.1.21 A gas heating equipment shall be provided for the gas supplied to CNG pressure regulators, in order to avoid icing gas equipment as a result CNG cooling due to pressure drop.

Only hot water from the inner engine cooling loop or the room heating system may be used for heating CNG.

4.1.22 The gas supply pipes from CNG tanks to consumers shall be seamless.

Where pressure is low (the final sections just before the consumers), standard rubber/metal hoses may be used.

The gas-outlet pipes shall be seamless.

4.1.23 CNG filtration shall be provided for removal of resins and mechanical impurities. The gas filter shall be installed on the gas line before the first stage reduction valve.

4.1.24 The gas fuel receiving stations shall be located on the open deck naturally ventilated.

4.1.25 A stop valve with manual local control and remote control from a safe accessible place shall be provided on each gas fuel intake pipeline near the inlet flange.
5 CNG CONSUMERS

5.1 MAIN AND AUXILIARY ENGINES

5.1.1 The engines of gas-fueled ships shall be adopted for using CNG in accordance with requirements specified in this section; this shall be confirmed by the manufacturer's documents and the River Register's documents on compliance with the Rules.

5.1.2 Power installation of a ship with dual fuel (gas + diesel oil) engines shall enable ship cruising and maneuvering using either gas or liquid petrol fuel.

5.1.3 If dual fuel (gas + diesel oil) engines are used at a gas-fueled ship, the following requirements shall be met:
   - The main engines shall operate stably with either natural gas or liquid petrol fuel at medium and high loads.
   - Auxiliary engines, which are used to drive generators of the ship's electric power plant, shall be made gas-fueled only if prolonged medium or high loading of the diesel generators can be ensured.
   - The engines shall start, stop (except for emergency shutdown), run idle and run slow using liquid petrol fuel. Switching between liquid fuel and gas fuel shall be carried out automatically.
   - The engine shall be provided with an emergency shutdown device.

5.1.4 The following requirements shall be met if gas (gas reciprocating) engines with spark ignition are used on a gas-fueled ship:
   - The main engines and ship's electric power plant (except for emergency diesel generators) shall be located in two separate machinery spaces.
   - Power of the main engines shall be enough to provide ship's speed as specified in 1.12 Part IV of the Rules and ship maneuverability as specified in 6, Part II of the Rules, with shaft generators simultaneously running.
   - The engines specified in 5.1.3 shall operate using combined cycle (liquid petrol fuel for ignition only) and using liquid petrol fuel only without any need in readjustment.
   - During switch of the dual-fuel main engines from liquid petrol fuel to gas fuel and back, engine shaft rpm may change by 5% to 10% for maximum 15 s.
   - Flame arresters shall be provided at engine exhaust pipelines.

5.1.5 A fuel supply control system shall automatically switch the dual-fuel engine from CNG to liquid petrol fuel when engine load rises above the threshold value, at which intermittent supply of liquid petrol fuel still enables stable natural gas operation. Interlocking shall be provided to prevent the fuel equipment from switching to CNG if the engine load is below that threshold.

5.1.6 When the main engine threshold load specified in 5.1.7 is reached, the engine shall be automatically switched from CNG to liquid petrol fuel and back, upon operator's commands from a remote or local control station.

5.1.7 The dual-fuel engine automatic control system shall:
   - Automatically stop CNG supply and switch the engine to liquid petrol fuel when
pressure in the CNG supply system falls below the setpoint;

2. Start CNG supply to the engine only after the cooling water reaches the temperature setpoint;

3. Automatically stop CNG supply in case of any spontaneous shutdown of the engine (including automatic protection);

4. Automatically stop CNG supply and switch the engine to liquid petrol fuel when the alarm system generates alarm on any monitored parameter;

5. Generate command pulses to the automatic control system of the CNG supply equipment in cases that require stop of CNG supply to the engine.

5.1.10 The alarm and remote/local indication systems of dual-fuel engine shall be supplemented with components for:

.1 indication of actual operation using CNG or liquid petrol fuel in the wheelhouse and at the local control station

.2 indication of CNG pressure before the engine at the local control station

.3 light and sound alarm on actuation of the engine automatic protection in the wheelhouse

5.1.11 Measures shall be taken to prevent from explosive concentration of vapours and gas in the engine crankcase due to natural gas leakage into the crankcase from the engine cylinders.

It is allowed to ventilate the crankcase by connecting it to the engine intake line and to provide a flame arrester at the crankcase ventilation pipeline.

5.2 SELF-CONTAINED BOILERS

5.2.1 A forced draught system shall be provided for self-contained boiler to make a draught as required for natural gas operation.

5.2.2 Combustion chamber of the self-contained boiler shall have no spaces or cavities where natural gas may accumulate.

5.2.3 The boiler's combustion burners shall be able to use liquid petrol fuel, CNG or liquid petrol fuel and CNG simultaneously.

5.2.4 The gas burners shall be arranged so that the CNG is ignited by flame of the liquid petrol fuel nozzle. When the boiler uses gas fuel, a permanent ignition source for the gas/air mixture shall be installed in the gas burner flame. The power of that ignition source shall be enough for immediate reignition of the flame.

5.2.5 Measures specified in 4.1.4 shall be taken to provide purging of the pipelines supplying CNG to the burners.

5.2.6 The boiler automation system shall:

.1 Automatically stop natural gas supply when CNG pressure before the boiler is below the setpoint;

.2 Automatically stop natural gas supply and stop the boiler when the boiler alarm system generates alarm on any monitored parameter;

.3 Automatically ignite natural gas by activating the liquid petrol fuel nozzle, then automatically deactivate the liquid petrol fuel nozzle if the boiler uses CNG only;

.4 Automatically stop CNG supply in case of flame failure;

.5 Indicate actual operation using CNG or liquid petrol fuel in the wheelhouse and at the local station;

.6 Generate light and sound alarm on actuation of the boiler automatic protection in the wheelhouse;

.7 Generate command pulses to the automatic control system of the CNG supply equipment in cases that require stop of CNG supply to the boiler.

5.2.7 If the self-contained boiler is used for burning or forced inertisation of the gas/air mixture from the gas-outlet pipes, its furnace or combustion chamber shall be equipped with a nozzle for gas/air mixture supply to the furnace or chamber from gas-outlet manifold. There shall be provided some means for vapour condensation or cooling of water or high-temperature organic heating fluid heater at the boiler output for situations when the boiler produces more heat than it is needed for the ship.
6 VENTILATION OF SPACES

6.1 NORMALLY MANNED SPACES

6.1.1 The enclosed spaces, including the machinery spaces, which accommodate gas-containing system components subject to systematic inspection for their technical condition and proper operation and fixed gas analyzers, shall be equipped with induced ventilation independent of other ventilation systems and operated from outside these spaces.

Measures shall be provided to start the ventilation system of these spaces before maintenance personnel enters them. The warning sign to start the ventilation system shall be placed at the entry of these spaces.

6.1.2 The ventilation system of the machinery spaces with the gas fuel engines and boilers shall be independent of the ventilation systems serving other spaces. Ventilation of the machinery space shall be of supply-and-exhaust type to provide necessary depressurisation in the space.

The use of the main engines as means of exhaust ventilation is allowed if gas control system sensors are located at the engine's air intake points.

Natural ventilation of the machinery space shall be provided for idle time.

The ventilation system of gas-hazardous machinery spaces or engine rooms shall provide at least 30 air changes per hour. The air circulation shall involve the whole volume of the space without dead zones. Such spaces may also be served by a ventilation system that provides 15 air changes per hour in case of no gas in the space and automatically increases air change rate up to 30 air changes per hour as soon as gas is detected in the space.

6.1.3 The exhaust ventilation ducts shall evacuate the gas/air mixture upwards. The exhausts openings shall be located above the deck and in such a way to exclude gas ingress into the superstructure spaces.

6.1.4 Machinery space supply ventilation inlet openings shall be located so as to minimize induction of outgoing gas from any ventilation exhaust opening.

6.1.5 The exhaust ventilation ducts of the gas-hazardous spaces shall not pass through the machinery space, accommodation and service spaces, control stations.

The exhausts of these ducts shall have spark arresters.

6.1.6 The fan motors shall be located outside the ventilation ducts.

The exhaust fans of the enclosed gas-hazardous spaces and machinery space shall be installed outside these spaces.

6.1.7 The machinery and other spaces where potentially explosive concentration of the natural gas may form up (volumetric concentration of methane in the air between 4.4 % and 17 %) shall be provided with emergency exhaust ventilation. This ventilation shall be automatically started when methane concentration reaches 1 % by volume in the served space; at the same time, natural gas supply to consumers shall be stopped.

6.1.8 The semi-closed spaces on the open deck, which accommodate gas-containing system components, shall have natural ventilation to prevent accumulation of natural gas in any part of these spaces.
6.1.9 The in-hull spaces accommodating CNG tanks (or cylinders) shall be equipped with induced ventilation providing at least 30 air changes per hour.

6.2 OCCASIONALLY MANNED AND OTHER SPACES

6.2.1 The bilge spaces and other occasionally manned spaces where natural gas may accumulate shall have induced ventilation to prevent formation of explosive concentration of the natural gas, which may get ignited when these spaces are entered.

The fans shall comply with the requirements of 6.1.6.

6.2.2 Inlet openings of the ventilation system that serves accommodation spaces, service spaces and control stations shall not be face toward the gas-hazardous zone. They shall be so located to prevent induction of gas from the gas-outlet pipes, gas-hazardous space exhaust ventilation openings, exhaust pipes of the gas engines and boilers.
7 GAS CONTROL IN SPACES

7.1 GENERAL REQUIREMENTS

7.1.1 The spaces located in the gas-hazardous zone (including machinery spaces and CNG tank spaces) shall be equipped with a methane detection system.

7.1.2 Light and sound alarm shall actuate in the spaces with the methane detection system sensors and in the wheelhouse if methane concentration in the air reaches 0.5% by volume.

Gas supply to the machinery space shall be automatically stopped and alarm shall be simultaneously generated when methane concentration in the air reaches 1% by volume at any measurement point.

7.1.3 The places for fixed natural gas detection system's sensors shall be selected depending on methane density, presence and direction of air flows, and most probable places of CNG leakage.

7.1.4 Methane concentration in the place of any sensor shall be observed using a secondary indicating device located in a permanently manned space.

7.1.5 Portable equipment may be used for gas control of spaces in the gas-hazardous zone except for the machinery space and closed bilge space with CNG tanks, if such an equipment is used for testing before entering the space and every 30 minutes during staying in the space.

7.1.6 The ship shall be equipped with at least two sets of portable gas control equipment.

Devices shall be provided to enable sampling air from spaces in the gas-hazardous zone using portable equipment while staying outside such spaces.

7.1.7 Explosion-proof sensors with intrinsically safe circuit shall be used.

7.1.8 Design of the methane detection system components shall enable their testing and calibration. Calibration and tests shall be carried out within the time frames specified by the equipment manufacturer.

7.1.9 The gas control alarm system shall have an automatic switchover device to switch to an emergency source in case of ship mains power loss.

7.1.10 Gas concentration in accommodation and service spaces shall be tested with portable equipment specified in 7.1.6.
8.1 GENERAL REQUIREMENTS

8.1.1 Fire protection of the gas-fueled ships shall comply with the requirements of Part III of the Rules. The list of used fire equipment and fire fighting systems shall be determined depending on class, type and purpose of the ship considering the requirements specified in this section.

8.1.2 The spaces for storage of CNG tanks and ventilation ducts serving those spaces shall be separated from accommodation, service, cargo and machinery spaces with A-60 structural boundaries. The spaces for storage of CNG tanks may be separated from other (low fire hazard) spaces with A-0 structural boundaries.

Gas fuel tanks located on the open deck shall be separated from accommodation, service, cargo and machinery spaces with an appropriate screen compliant with requirements to A-60 boundaries.

8.1.3 The machinery space and in-hull spaces, which accommodate CNG tanks, as well as other enclosed spaces of the gas-hazardous zone shall be equipped with a fire fighting system in accordance with Part III of the Rules.

8.1.4 Fire smothering system shall be provided for the machinery space and other spaces accommodating gas-containing system components.

When determining the design volume of the protected space, the volume of the equipment located inside the space shall not be deducted from the total volume of the space.

8.1.5 The spaces accommodating gas-containing system components shall be equipped with automatic fire detection alarm system and fire smothering system release warning system.
9 ELECTRIC EQUIPMENT

9.1 GENERAL REQUIREMENTS

9.1.1 The explosion hazardous spaces on the gas-fueled ships using CNG include (in addition to those specified in Table 1.4.1, Part III of the Rules) the internal volumes of the gas-outlet pipes and exhaust/supply ventilation ducts of spaces in the gas-hazardous zone.

9.1.2 Protection degree of electric equipment installed in the explosion-hazardous spaces of the gas-hazardous zone shall not be less than specified in 16.2, Part VI of the Rules for the spaces of appropriate category.

In the bilge spaces accommodating gas tanks, there may be laid cable routes and may installed explosion-proof indication and alarm instruments compliant with GOST R 51330.0 with pressurised or explosion-resistant enclosures, as well as electric drives for pipeline valves with explosion-resistant enclosures.

9.1.3 All the cables passing through the explosion-hazardous spaces and areas shall be laid in steel gastight seamless pipes.

9.1.4 Metal mechanical protections for cables laid on the upper deck and passing through the explosion-hazardous areas shall be grounded, at least, at both ends of each protection (casing, steel pipe, armouring braid).

9.1.5 The following consumers shall be compulsorily supplied from the main switchboard buses:

.1 switchboard for methane-in-air alarm
.2 switchboard for control and alarm of equipment for CNG supply to consumers
.3 switchboard of fans serving gas-hazardous spaces, ventilation ducts and trunks, and fans used to pressurise explosion-proof electric equipment

9.1.6 The following consumers shall be compulsorily supplied from the emergency switchboard buses through individual lines:

.1 switchboard for methane-in-air alarm
.2 switchboard of fans used to pressurise explosion-proof electric equipment

9.1.7 Start of electric fans serving explosion-hazardous spaces shall be interlocked with opening doors into these spaces and starting the electric equipment in these spaces, in such a manner that entry into these spaces and start of electric equipment are possible not before the fans started and operated for a time as necessary for ten air changes in the space.

9.1.8 Lighting system of the explosion-hazardous spaces and areas shall be subdivided into at least two circuits supplied from different switchboards.

9.1.9 The switches and protective devices of the lighting system of the explosion-hazardous spaces and areas shall be installed outside these spaces and areas and shall be able to brake all phase lines.

9.1.10 Lighting fixtures of the explosion-hazardous spaces and areas shall be explosion-proof with pressurised enclosure or explosion-resistant enclosure.

9.1.11 Any sparking electric devices shall be located so that they are not flown by ventilation air, which may be contaminated by leaked natural gas.
10 PERSONNEL PROTECTION

10.1 GENERAL REQUIREMENTS

10.1.1 The ships with gas-containing system equipment installed in enclosed spaces in the hull shall be provided with at least two sets of protective outfit suitable for safe entering spaces filled with natural gas and working in these spaces. This outfit shall be accessible.

The watch personnel shall be equipped with personal portable gas detectors.

10.1.2 The set of protective outfit mentioned in 10.1.1 shall include the following:

1. self-contained breathing apparatus operating with compressed air, with cylinders of capacity at least 1200 NL. Each cylinder shall have a protective coating to prevent from sparking upon contact with metal surfaces;

2. protective clothing, footwear, gloves made of an antistatic material, and tight protective goggles;

3. steel-cored life line and intrinsically safe belt;

4. explosion-proof lamp;

5. toxic compound detector.

10.1.3 For breathing apparatuses mentioned in 10.1.2.1, charged spare air cylinders with total capacity of at least 3600 NL per apparatus shall be provided.

10.1.4 Compressed air devices of the breathing apparatuses shall be inspected for compliance with the Rules requirements and tested once a year according to RTSC.

10.1.5 Special footwear of the crew members shall have non-sparking brass or wooden nails or no nails at all.
Part XIII

EQUIPMENT OF PASSENGER SHIPS
FOR CARRYING DISABLED PERSONS ONBOARD
1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION

1.1.1 This Part complements 9 and 10 Part I, 3 Part III, 6 and 8 Part V as well as 11 Part VI of these Rules and establishes requirements to the design and equipment of passenger, pleasure and crew ships in order to provide for carrying disabled persons.

1.2 TERMS AND DEFINITIONS

1.2.1 Terms related to the Rules common terminology and their definitions are stated in 2.1 and 2.2 Part 0 of these Rules. The following terms are used in these Rules:

1. Disabled persons means persons capable of moving without any assistance as defined in 1.2.1.2 and having difficulties in using transport and seeking attention and adaptation of services commonly rendered to all passengers to their specific needs. The disabled persons include elderly people, people on wheelchairs, people with congenital physical defects or physical defects caused by any physical (sensor or motor, permanent or temporal), mental or psychosocial disease or deterioration, pregnant women and people accompanying children;

2. Unassisted movement ability means capability of moving in a space without any assistance, keeping body balance during movement, at rest and postural change, using a public transport:

First degree means ability to move without any assistance but for longer time periods, partial performance and at a reduced distance with the help of auxiliary technical means, if required.

Second degree means ability to move with regular partial assistance with the help of auxiliary technical means, if required.

Third degree means inability to move without any assistance and requirement for permanent assistance.

1.3 INFORMATION SUPPORT

1.3.1 For marking of spaces and equipment, areas and sections as well as routes of movement for the disabled person, the symbols and pictograms adopted in GOST 52131 shall be used.

Direction signs and rules of conduct on board the ship shall be attached on walls. The letters shall be at least 15 mm high.

1.3.2 Muster lists and safety plan shall be displayed prominently in areas designated for disabled persons.

These lists and plan shall be placed at a height allowing them to be clearly read by people on wheelchairs with the text clearly perceptible to vision impaired people.

1.3.3 The crew muster lists shall indicate ship areas designated to be used by disabled persons.

These lists shall also contain special measures to be taken in case of emergency situation with respect to disabled persons.

1.3.4 Information on assistance shall be readily available on the movement routes and within the spaces designated for disabled persons.

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1 As defined in the revision of "b", 6 of the Order of the Ministry of Labour of the Russian Federation dated 20/11/2014 No.664 n.

2 GOST R 12.4.026, GOST R 51671.
2 PASSAGES, DOORS, SILLS AND COAMINGS

2.1 REQUIREMENTS TO PASSAGES

2.1.1 Clear width of passages within main corridors of passenger, accommodation and public spaces as well as deck passages leading to lifeboat and liferaft embarkation areas shall be at least 1.3 m.

2.1.2 Passages stated in 3.1.1 shall ensure free movement of disabled persons.

2.1.3 The areas where there are inclinations (ramps, deck deflections) as well as passages and corridors shall be provided with non-slip coating, which does not build up static electricity, handrails and other arrangements, which may be held on to.

2.1.4 The clear width of escapes from spaces designated for disabled persons shall be at least 0.90 m.

The clear width of side openings used for embarkation and disembarkation of disabled persons shall be at least 1.50 m.

2.2 REQUIREMENTS TO DOORS

2.2.1 Doors of passenger spaces except for those with escapes into corridors shall open outwards. When in open position, the doors shall rest against the wall and be secured in this position.

Door openings shall be at least 0.90 m wide.

Doors of lavatories designated for disabled persons shall open outwards or shall be of sliding type. Locking arrangements shall be integral with door handles.

The width of door openings shall provide for free movement of disabled persons including people on wheelchairs, but in any case shall be at least 0.90 m.

2.2.2 In the direction of opening of doors for disabled persons there shall be a platform of at least 0.60 m between the internal edge of the door frame from the lock and adjacent wall perpendicular to the edge.

2.2.3 Doors of specific design (revolving doors, double-swing doors) are not allowed.

Where sliding doors are fitted, guideway shall be below the floor level.

The lift cabin door shall be of sliding or folding type with clear width of at least 0.9 m.

2.2.4 The distance between the internal edge of the door frame from the lock side and adjacent vertical wall shall be at least 0.50 m.

2.2.5 The passenger space doors shall be designed to prevent their unauthorized locking or otherwise fastening.

2.3 REQUIREMENTS TO SILLS AND COAMINGS

2.3.1 Door sills shall be avoided within passenger areas. Where door sills are provided, they shall be max. 25 mm high.

The height of coamings on weather decks shall be as low as possible provided the hull strength and integrity are not degraded. Where drain openings covered with fine mesh with water discharge overboard are provided for hull integrity, coamings may be completely excluded.

Where height of door sills and coamings exceeds 25 mm, they shall be of removable type or consist of low soft rubber sections or there shall be arrangements (removable ramp) providing for free movement of disabled persons including people on wheelchairs.
3 LADDERS, GANGWAYS, RAMPS, LIFTS

3.1 REQUIREMENTS TO LADDERS

3.1.1 Inclination angle of ladders for movement of disabled persons shall not exceed 32°. Ladders shall be oriented along the ship. The ladders shall have soiling in accordance with GOST 26314 and clear width of at least 0.9 m.

Ladder handrails shall be designed according to 4.1.3.

3.1.2 Ladder steps shall have non-slip coating and be free of any projections or recessions. Ladder steps shall be max. 0.18 m high and at least 0.30 deep.

3.1.3 Transverse step plates shall be max. 0.3 m long and max. 0.03 m high to allow for movement of wheelchairs along the ladders. Openings in the perforated surface shall be max. 0.01 wide or 0.03 m long. To eliminate difference in levels between ladder and pier or deck, flaps at each end of the ladder shall be used.

3.2 REQUIREMENTS TO STAIRS

3.2.1 The stairs inclination angle shall not exceed 38°. Stairs shall be of straight type and located aft or forward of the ship. Stairs steps shall be max. 0.18 m high and at least 0.30 deep.

Note that a person on wheelchairs is incapable of coping with an inclination steeper than 1:20 (3°) without any assistance and come up an inclination steeper than 1:4 (14°) is extremely difficult even with the assistance. Where a ladder with high inclination (for example, 1:4) is required on some quays, the ladder shall be max. 2 m long.

Stairs steps shall have non-slip coating and be free of any projections or recessions. Stairs shall be equipped with handrails according to 4.1.4.

The deck area directly upstream of stairs or steps shall be marked with plating made of material with color standing in contrast with that of the rest deck plating.

3.3 REQUIREMENTS TO GANGWAYS

3.3.1 Passenger gangways shall be at least 0.9 m wide. Gangways shall be equipped with handrails according to 4.1.5.

3.3.2 Gangways shall be provided with flaps from both sides to exclude difference in levels between the gangway and deck and/or quay.

3.4 REQUIREMENTS TO RAMPS

3.4.1 The inclination of ramps on routes for movement of disabled persons and inclined deck areas shall not exceed 5%.

3.5 REQUIREMENTS TO LIFTS

3.5.1 A lift or elevator shall be provided between decks for movement of disabled persons. Passenger lift and elevator electrically driven from the ship's electric powerplant shall be provided with a standby drive included into emergency consumer list to be supplied from emergency diesel generator in case of failure in the ship's electric powerplant.

Elevator shall be also provided with a standby manual drive.

3.5.2 Lifts designated for disabled persons shall meet the following requirements:
Cabin shall be at least 1.1 m wide and at least 1.4 m deep.

Lift control panel shall be 0.9 to 1.2 m above the floor.

Handrails shall be arranged within the lift according to 4.1.1.

Free space in front of the lift cabin door shall be at least 1.4×1.4 m.
4 GUARD RAILS AND HANDRAILS

4.1 GENERAL REQUIREMENTS

4.1.1 Handrails arranged 0.9 m above the deck level shall be fitted along the walls of corridors and deck superstructures as well as within lifts as guides and supports for disabled persons.

The corridors above 1.5 m wide shall be fitted with handrails from both sides.

Handrails shall be of circular section 40 to 50 mm in diameter. Distance between handrails and wall shall be at least 60 mm. Ends of handrails shall be bent towards the wall.

4.1.2 The clear width of passages in guard rails used for embarkation and disembarkation of disabled persons shall be at least 1.50 m.

4.1.3 Passenger ladders shall be equipped with handrails from both sides, with some handrails located 0.9 m and others 0.75 m above the leading edge of the step. Handrails shall extend beyond the ladder by at least 0.30 m at entry and exit areas. Each handrail shall have at least three stanchions. These handrails shall be restrict the movement along other routes.

4.1.4 Handrails at both sides of stairs shall be located 0.90 m above the leading edge of the step, be continuous over the entire length of stairs and extend by 0.3 m downwards and upwards.

4.1.5 Gangways shall be equipped with handrails from both sides, with some handrails located 1.0 m and others 0.75 m above the gangway surface and extending by 0.3 m from both ends. Each handrail shall have at least three stanchions.

4.1.6 Exposed deck areas designated for disabled persons shall be surrounded by fixed bulwarks or guardrails at least 1.1 m high.

4.1.7 Rails shall be located at least 1.1 m above the deck.
5 REQUIREMENTS TO SPACES

5.1 GENERAL REQUIREMENTS

5.1.1 Spaces for disabled persons shall not be located below the embarkation decks.

Passenger cabins for disabled persons shall be arranged on the same deck where public spaces are located (lounges, saloons, restaurants, dining rooms, sanitary rooms) close to emergency escapes.

5.1.2 Area for disabled persons within passenger compartment with seats shall be located near embarkation areas, lavatory and areas for life saving appliances.

Passenger compartment where area for disable persons is provided, shall have no steps above 30 mm high or inclinations steeper than 5 %. These spaces shall be provided with non-slip flooring.

5.1.3 Passenger service areas (for example, information offices and ticket desks) shall be accessible for disabled persons on wheelchairs.

5.1.4 Tables and chairs shall be designed to prevent their tilting over when used as a support, or tables and chairs shall be able to be secured for heavy weather. Distance between the tabletop and floor shall be at least 0.7 m.

Where tables and chairs in accommodation spaces and on decks are rigidly fixed, provision shall be made for a certain amount of seats (one per 100 persons, but at least four seats) specifically equipped and designated for people with motor system disturbance in accordance with requirements of 5.1.5.2.

5.1.5 Spaces designed for disabled persons shall meet the following requirements:

.1 the number of wall projections shall be as minimum as possible;
.2 sharp corners of spaces and furniture shall be rounded;
.3 wardrobes, racks and lockers shall be incorporated into walls;
.4 vertical pipelines shall be arranged in recesses or corners.

5.1.6 Provision shall be made for baby care room.

5.2 LAVATORIES AND TOILET COMPARTMENTS

5.2.1 Provision shall be made for at least one lavatory and one toilet compartment equipped so as to be used by disabled persons.

Dimensions of lavatory for disabled persons including those on wheelchairs shall be at least 1.65×1.8 m.

5.2.2 There shall be vertically and horizontally oriented handles of folding, rotary and fixed type on lavatory walls near toilet bowls. Handles shall be tightly fixed to the wall and secured by stay racks. Handles shall be arranged so as to allow disable persons to remove from the wheelchair to the toilet bowl and back without any assistance. Handles in the bathroom shall not prevent access to the toilet bowl and washbasin.

5.2.3 Toilet bowl seat shall be arranged approximately at a height of 0.45 m.

Provision shall be made to locate the toilet paper holder near the bowl and to allow it to be used with one hand.

5.2.4 In lavatories and toilet compartments: provision shall be made for non-slip flooring;
provision shall be made for adequate stability and reliable fastening of sanitary equipment;
provision shall be made for buried laying of pipes and buried wiring;
edges of furniture and bath shall not be sharp or shall be protected by specific coatings.

5.2.5 Provision shall be made for free space 0.60 m high and 0.70 m wide under washbasin sink. The distance between upper edge of the washbasin and floor shall be 0.80 to 0.85 m. Mirrors, towel holders and other accessories shall be arranged at a height accessible for people on wheelchairs. The mirror shall be lowered to the level of washbasin sink if required.

5.2.6 The faucet shall allow for easy operation and shall not require great forces to be applied to switch on/off (for example, it should be faucet with extended lever or elbow operated faucet). For vision impaired people provision shall be made for a faucet with dark handle standing in contrast with light surface of sink or bath.

5.2.7 For disabled person, provision shall be made for the following washbasin sinks:
- sink where drain, trap and pipeline are located near the wall with trap connected horizontally in order to be able to drive close to such a washbasin on a wheelchair;
- ergonomic washbasin with leading edge of sink or table curved inwards providing for support during washing up;
- sinks with position (height or inclination angle) to be easily changed by user at his discretion.

5.2.8 Lighting switches in spaces for disabled persons shall be arranged at least 0.9 m but max. 1.0 m above the deck.
6 SAFETY MEASURES

6.1 GENERAL REQUIREMENTS

6.1.1 Provision shall be made for at least one platform at least 1.5 m wide and at least 1.4 m deep for embarkation-disembarkation of disabled persons on the main deck on each side of the ship.

In addition, provision shall be made for at least one emergency escape 1.0 m wide from this deck.

6.1.2 Lifeboats and liferafts shall be arranged not more than 50 m from spaces occupied by disabled persons. Provision shall be made for disabled persons to change from wheelchairs to lifeboats and liferafts prior to their launching.

6.1.3 Life jackets shall be located in areas readily accessible for disabled persons provided in passages leading to exits.

Cabins designated for disabled persons shall be provided with additional life jackets in quantity equal to the number of berths in the cabin.

6.1.4 The collective life-saving appliances shall have additional seats for disabled persons in excess of those specified in 8.2 Part V of these Rules in a quantity of at least 10% of total number of persons, which are provided with collective life-saving appliances.

6.1.5 Ladders and areas available for disabled persons shall be lighted on a 24-hour basis.

Signs indicating the direction to emergency escapes as well as prohibitory and prescriptive signs shall be lighted.

6.1.6 Sills, ramps, rails and handrails shall be coated with paint standing in contrast with surroundings in accordance with GOST R 12.4.026.

6.1.7 Deck space in front of ladders or individual steps shall be coated with paint standing in contrast with surroundings.

Ladder handrails, front side of the first and last steps as well as coating of ladder ends shall be marked with yellow.

6.1.8 Spaces designated for disabled persons including lifts and lavatories shall be provided with emergency lighting.

6.1.9 For passenger ships of O and M class equipped for carrying disabled persons, provision shall be made for securing wheelchairs for heavy weather in passenger spaces.

6.1.10 Fire valves of ventilation pipelines shall be capable of closing automatically, if air temperature within the pipeline exceeds 70 °C. Provision shall be made for manual closing of these valves from the station continuously manned with ship officers and/or crew.

6.1.11 Doors and bulkheads between passenger corridors and cabins as well as between cabins themselves, walls and ladder doors connecting more than two decks as well as ceilings and bulkhead coatings and plating shall be made of fire-resistant materials.

6.1.12 Ladders, stairs, gangways and other areas available for disabled persons shall be well-lighted at all times. For artificial lighting daylight lamps shall be used.
7 ALARM AND COMMUNICATION SYSTEMS

7.1 GENERAL REQUIREMENTS

7.1.1 Provision shall be made for the audible and visual alarm system to provide disabled persons with current information.

Lifeboats, liferafts including those designated for disabled persons shall be marked with signs of information display for people on wheelchairs according to GOST 52131.

Visual and audible beacons shall be fitted near life-saving appliances to provide for orientation of vision and hearing impaired people.

Visual information means shall be provided with lighting including emergency lighting.

7.1.2 Arrangement for visual and audible general alarm shall be available on board the ship.

7.1.3 Two-way public address device shall be provided in public spaces in areas for disabled persons. Provision shall be made for visual and audible alarm indicating operation of this device.

7.1.4 Lavatories and lifts equipped for disabled persons shall be provided with two-way communication devices to call for help or emergency alarm actuation device in accordance with 16.1.14.1 Part VI of these Rules.

7.1.5 Provision shall be made for giving visual and audible alarm in spaces where disabled persons are not readily visible for crew members, ship's personnel or other passengers.

7.1.6 Loudspeaker system shall provide for clearly audible messages on all decks and in spaces available for passengers. Loud-speakers shall have an adequate power in order to make the transmitted messages clearly audible under noise level of at least 70 dB(A).
RUSSIAN RIVER REGISTER

RULES
FOR PREVENTION OF ENVIRONMENT POLLUTION FROM SHIPS
(RPPS)

MOSCOW 2015
The Rules for Prevention of Environment Pollution from Ships (RPPS) have been approved by the Order of Federal Autonomous Institution “Russian River Register” No. 38-п dated 12.10.2015 and brought into force since 01.09.2016 on the basis of the Decree of the Ministry of Transport of Russian Federation МС-126-р dated 01.09.2016.

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1 GENERAL PROVISIONS

1.1 SCOPE OF APPLICATION

1.1.1 The requirements of the Rules for prevention of environment pollution from ships (hereinafter referred to as the Rules) apply to the ships specified in 1.4 Part 0 of the Rules for Classification and Construction of Ships (RCCS), which engineering designs are submitted to Russian River Register after the present Rules has come into force, as well as to the ship machinery and equipment for prevention of environment pollution from these ships.

The Rules apply to ships in service excepting 2.1.2.4, 2.1.11, 2.2.3, 2.2.4.3, 2.8.1 – 2.8.9, 3.2.2, 3.2.4.5, 5.5.1, 5.5.8, 5.10.1 – 5.10.8, 7.1.1, 7.1.2.

Unless otherwise specified in future editions of the Rules, the Rules applicable during the ship construction apply to the ship components covered by 2.1.2.4, 2.1.11, 2.2.3, 2.2.4.3, 2.8.1 – 2.8.9, 3.2.2, 3.2.4.5, 5.5.1, 5.5.8, 5.10.1 – 5.10.8, 7.1.1, 7.1.2 of these Rules.

1.1.2 Survey of ships in service and technical supervision during manufacture and repair of ship machinery and equipment for prevention of environment pollution from ships are carried out in accordance with normative legal acts and other documents stated in 1.2 Part 0 RCCS.

1.1.3 Structures, arrangements and systems specified in 1.1.1 as well as ship machinery and equipment for prevention of environment pollution from ships in addition to the requirements of the present Rules shall comply with applicable requirements of the relevant parts of the RCCS.

1.1.4 Sea-going ships shall comply with the requirements of the Rules and applicable requirements of documents stated in Merchant Shipping Code of the Russian Federation in what concerns the provisions on the environment protection.

1.1.5 Ships engaged on international voyages shall comply with the requirements of the Rules and applicable requirements of the international agreements of the Russian Federation in what concerns the provisions on the environment protection.

1.2. TERMS AND DEFINITIONS

1.2.1 Terms related to the Rules common terminology and their definitions are stated in 2.1 Part 0 RCCS.

1.2.2 In the Rules the following terms are used:

1. Navigation endurance due to environmental safety conditions means the duration of ship service without need for coming to reception facilities for delivery of sewage, oil containing water, refuse and other wastes;

2. Clean ballast means ballast water loaded into a tank cleaned after the last oil carriage to a such extent as to prevent from the formation of visible oil traces, oil residues or emulsion on the water surface or under it as well as on the adjoining coastlines when discharging the ballast from the vessel immovable as regards the water surface into clean calm water at clear weather;

3. Boom barrier means the device for prevention of oil spreading along the water surface or changing its direction to collect it;
.4 Wet exhaust gases means exhaust gases whose humidity content corresponds to the complete formulation of the fuel combustion products;

.5 Harmful substances means any substances, which, being spilled into water, can damage human health or living resources, water flora and fauna, worsen rest conditions or impede other kinds of legal use of water resources; carbon monoxides (CO), nitrogen oxides (NOx) and hydrocarbons (CH) contained in exhaust gases and rendering them properties harmful for people and environment;

.6 Harmful substance emission means an amount of harmful substance emitted to the atmosphere with exhaust gases per unit time;

.7 Exhaust gases means a mixture of complete and uncomplete combustion products and excess air passing to the engine exhaust system;

.8 Opacity means visible dispersion of fluid and solid substances in exhaust gases formed as a result of incomplete burning of fuel and evaporated oil in engine cylinders;

.9 Sorbent boom means barrier made of sorbent material restricting oil spreading over deck;

.10 Pollution means a discharge of harmful substances or wastes containing it into the water environment;

.11 Incinerator (installation for refuse incineration) means an installation for incineration of refuse, oil sludge, oil sediments, oil residues and sewage sludge;

.12 Carbon monoxide concentration means volume fraction of carbon monoxide in exhaust gases in volume percent (hereinafter referred to as the vol. %)

.13 Concentration of nitrogen oxides reduced to NO2 means volume fraction of nitrogen oxides in exhaust gases, which they could take if transformed to equivalent volume of ideal gas with molecular mass of 13.85 and molecule ionization energy equal to propane C3H8 ionization energy, vol. %;

.15 Manifold means a pipeline with fittings located on the deck and designed for cargo handling or bunkering operations;

.16 MARPOL 73/78 means the International Convention for the Prevention of Pollution from Ships, 1973, as amended by the Protocol of 1978 relating thereto, approved by the IMO Marine Environment Pollution Committee;

.17 Instantaneous intensity of oil discharge is the intensity of oil discharge in litres per hour at any moment divided by the ship speed in knots at the same moment;

.18 Refuse (R) means any kind of food, domestic and operational wastes formed during normal ship operation subject to continuous or periodical removal;

.19 Oil means petroleum in any form including crude oil, oil fuel, oil residues, oil sediments and oil products;

.20 Oil-containing mixture means a mixture containing any amount of oil.

.21 Oil-containing water (OCW) means a mixture of water with any amount of oil;

.22 Oil sludge means separated sludge, oil from oil tanks drainage or any leakage from the equipment of the machinery spaces and exhausted oil;

.23 Oil sediments means the oil fraction, which cannot be piped or processed due to its consistency and requires for special methods or equipment to be removed from the ship;

.24 Oil residues mean any residues containing petroleum;

.25 Normative value of the permissible oil contents in the discharge means marginal normative value of oil concentration in the discharge as adopted by international (for sea waters) and national (for inland waterways) normative documents;
.26 Ozone-depleting substances mean chemical compounds based on chloro-, fluoro- and bromo hydrocarbons capable to react with ozone molecules in stratosphere, subject to control, defined in Article 1 Montreal Protocol on Substances that Deplete the Ozone Layer (1987), and listed in Appendices A, B, C and E to that Protocol;

.27 Carbon monoxide means a gaseous product of incomplete carbon oxidation making part of hydrocarbon fuel (identified by symbol "CO");

.28 Nitrogen oxides mean a mixture of various nitrogen oxides formed as a result of burning fuel and exhausting combustion products from engine cylinders (identified by symbol NOx);

.29 Domestic wastes mean wastes having been used as storage collectors or package before discharging as well as all kinds of objects made of plastics, paper, textile, glass etc. of other equivalent materials;

.30 Food wastes mean a kind of refuse consisting of wastes from preliminary food cookery and non-disposed remains;

.31 Operational wastes mean wastes formed as a result of any manufacturing or repair work as well as operation of the power plant and other ship equipment;

.32 Settling tank means a tank intended for collecting and settling tank washing water, contaminated ballast water, oil residues and other oil-containing mixtures;

.33 Deck oil-gathering system means a set of means and materials for oil spill response on deck;

.34 Half-port means a shutter in bulwark or in guard line for water drainage from deck;

.35 Maximum permissible specific average weighted emission of harmful substance means value of specific average weighted emission of harmful substances, above which the operation of engine is prohibited;

.36 Reception facilities mean offshore or coast facilities for the reception of all kinds of pollutants from the vessel to be passed for purification, disposal, destruction etc.

.37 Collecting tank means a tank for the collection and storage of non-treated fluids contaminated with harmful substances;

.38 Discharge means a release of harmful substances or wastes containing such substances from a ship, regardless of its reason, including any leakage, drain, removal, spill, overflow, pumping, emission or emptying;

.39 An alarm device is a device warning in case the normative value of permissible oil contents in the discharge has been exceeded;

.40 Sorbent means a porous, powdered or fibre material facilitating collection of oil due to its absorption, density and viscosity increase;

.41 Standard discharge connection means connection for discharge of oil-water mixture or sewage water corresponding to GOST R 7608-2013;

.42 TOW station means oil-containing water treatment plant;

.43 TDSW station means sewage water treatment and disinfection plant;

.44 Sewage water (SW) means drainage and other wastes from all types of lavatories, toilet bowls and urinals, drainage from wash bowls, bathrooms and scuppers located in medical accommodations (dispensary, sick bay etc.), drainage from rooms intended for animals, waste water from bathrooms, showers, baths and scuppers, waste water from laundries, waste water from sinks and other equipment of galleys, canteens etc., other kinds of sewage mixed with wastes named above;

.45 Emergency oil spill localization pack means a set of equipment and materials for localization and collection of oil spilled into the water;

.46 Oil handling operations means oil transfer to, from, and within the ship;

.47 Hydrocarbons mean vapour mixtures (identified by symbol CH) of all unburnt and partially oxidized hydrocarbons
of fuel and lubricating oil formed as a result of burning fuel and exhausting combustion products from engine cylinders;

48 Specific average weighted emission of harmful substance means amount of harmful substance emitted to the atmosphere with exhaust gases per 1 kW·h of effective engine operation during the full test cycle;

49 Sewage treatment plant means a sewage purifying and disinfecting plant;

50 Refuse-collecting facility means a tank or other equipment for refuse collecting and storage;

51 Refuse treatment plant means equipment for refuse grinding and reducing in volume;

52 Filtering equipment means filters or any combination of separators and filters so designed as to reduce oil contents in the discharge down to the normative value.
2 REQUIREMENTS TO SHIP'S EQUIPMENT AND FACILITIES FOR PREVENTION OF POLLUTION BY OIL

2.1 GENERAL REQUIREMENTS

2.1.1 Self-propelled ships and non-self-propelled ships with internal combustion engines on board shall be fitted with:
   .1 collection tank for oil-containing water;
   .2 oil-containing water pumping and delivery system;
   .3 standard discharge connections for delivering oil-containing water to reception facilities.

2.1.2 If the calculation performed according to the procedure described in Appendix 1 shows that equipment listed in 2.1.1.1 does not provide for the required navigation endurance due to environmental safety conditions, then ships shall be in addition fitted with:
   .1 filtering equipment;
   .2 an alarm device;
   .3 purified oil-containing water discharge system;
   .4 device for automatic interruption of discharge;
   .5 a collecting tank for oil residues.

2.1.3 The information on the navigation endurance due to environmental safety conditions shall be recorded in the ship’s documents.

2.1.4 The oil-containing water may be collected in portable tanks and in the machinery space bilges on the following ships (if so provided by information on stability and floodability):
   .1 less than 25 m in length;
   .2 with the total output of all internal combustion engines less than 220 kW (dealing with the requirements for onboard equipment and arrangements preventing the oil pollution);
   .3 for dynamically supported ships.

The accumulated oil-containing waters shall be discharged to reception facilities.

2.1.5 Cargo tanks and fuel tanks shall not be used as ballast tanks.

2.1.6 In the machinery space there shall be diagrams of fuel and lubricating oil systems located on a visible place showing the location of tanks as well as air, measuring and overflow pipes.

2.1.7 In oil tankers the cargo system diagrams and loading instructions shall be placed at the loading/unloading control station.

The diagrams shall indicate the location of tanks, fittings and gas, overflow and measuring lines.

In non-crewed non-self-propelled oil tankers the above diagrams and instructions shall be kept on the relevant tugs and pushboats.

2.1.8 Ships intended for handling oil and oil products (self-propelled and non-self-propelled fuelers, oil pumping stations, bilge and tank-stripping stations, ships for collection, storage, neutralization and disposal of oil-containing water and oil residues) shall be fitted with oil spill localization means complying with the requirements of 2.7.

2.1.9 Oil tankers as well as ships intended for handling oil and oil products (see 2.1.8) shall be designed and fitted with equipment suitable for restriction and collection of oil spills on deck during the oil handling opera-
tions and complying with the requirements of 2.8.

2.1.10 Collecting tanks and systems of collection, pumping, treatment and delivery of oil-containing water including all its equipment and pipelines shall be used neither for purposes other than their direct purpose nor combined with other systems.

2.1.11 Locations of facilities for reception and discharge of fuel shall be fitted with guard to contain possible oil spills. The upper edge of the guard shall be raised at least 150 mm above the device for connecting bunker hose. The guard shall be fitted with half-ports capable to being closed during bunkering operations or shall be fitted with splash-proof cover.

2.2 COLLECTING TANKS

2.2.1 The total capacity of collecting tanks shall be proved by the calculation performed according to the method described in Appendix 1.

2.2.2 Collecting tanks if located in the machinery spaces shall meet the requirements of 1.9.7 Part IV RCCS.

2.2.3 Collecting tanks of oil-containing water shall meet the requirements of 2.4.139 – 2.4.141 Part I RCCS.

2.2.4 A collecting tank shall be fitted with:

- an access hole for inner access and cleaning;
- an air pipe with a flame-arrester;
- a device sending visual and audible alarm to the wheelhouse or central control station when the tank is filled up to 80 per cent of the permissible liquid level;
- a system measuring the liquid level.

2.2.5 Collecting tanks shall be fitted with heating devices when:

- using heavy fuel for ship needs;
- a collecting tank is located in place where it may be subject to negative temperature during operation.

2.2.6 The heaters shall comply with the requirements of 10.13.9 – 10.13.15 Part IV and 16.2.32 – 16.2.34 Part VI RCCS.

2.2.7 Inner surfaces of collecting tanks intended for collection of post-separation oil residues shall be smooth (the tanks shall be designed with outer framing); the bottom shall be inclined towards the reception pipe.

2.3 PUMPING, DELIVERY AND DISCHARGE SYSTEMS

2.3.1 Arrangement and passage of system pipelines shall comply with the requirements of 10 Part IV RCCS.

2.3.2 Collecting tanks, fittings and pipelines of systems shall be calculated to pressure at least 1.5 of working pressure in the system.

2.3.3 Lines of the system of oil-containing water delivery to reception facilities shall be led to port and starboard. The pipelines may be led to one side only for ships listed in 2.1.4.

2.3.4 Oil-containing water delivery lines shall not be combined with other delivery lines.

2.3.5 Standard discharge connections for delivery of oil-containing water to reception facilities shall be located in places accessible for hose connections and be marked as provided by GOST R ISO 7608-2013.

2.3.6 The vessels intended for oil-containing water collection shall be fitted with standard discharge connections (see 1.2.2.41).

The vessels intended for reception of oil-containing water from river-sea navigation and sea-going ships shall be fitted with standard discharge flange connections of international type (see 5.4.2). Adapter couplings may be used for compatibility of standard discharge flange connections of international type with standard discharge connections.

2.3.7 Oil-containing water delivery systems shall be handled by pumps intended for these purposes.
2.3.8 Either a control station with remote control of discharge facilities or an effective communication system between the control station and the controlled discharge point shall be arranged near standard oil-containing water discharge connection.

Discharge equipment shall be started and stopped manually.

2.3.9 Shut-off fittings of oil-containing water delivery and purified oil-containing water discharge systems shall be so designed as to make them available for lead-sealing. This requirement does not apply to ships not fitted with their own means for pumping oil-containing water.

Note: The purified oil-containing water may be discharged from ships overboard if purification efficiency of oil-containing water corresponds to the specified standard, but only outside the areas specified in 257(d) of Technical Regulations on Safety of Inland Marine Transport Facilities approved by the Decree of the Government of the Russian Federation No. 623 dated 12.08.2010.

2.4 FILTERING EQUIPMENT

2.4.1 Filtering equipment shall provide for the effluent oil concentration in the mixture not exceeding the normative value at any incoming oil concentration in the mixture charged into the filtering equipment.

2.4.2 Filtering equipment shall be fitted with safety devices with pipes coming to the collecting tank. The safety device shall be adjusted for a pressure exceeding the working pressure by not more than 10%.

2.4.3 Elements of filtering equipment shall undergo hydraulic tests by a pressure equal to 1.5 of the working pressure before being covered with a protective coating.

2.4.4 The filtering equipment shall have a workable design. The total capacity of maintenance pumps shall not exceed the discharge capability of filtering equipment.

2.4.5 The filtering equipment shall be fitted with devices for oil-containing mixture discharge.

2.4.6 When filtering equipment is designed with preheating of oily mixture, the preheating may be carried out by means of steam or water coils. Electric heating shall be carried out in accordance with requirements of 16.2.32 – 16.2.34 Part VI RCCS.

2.4.7 Filtering equipment shall be designed so as to operate automatically.

2.4.8 Filtering equipment shall be fitted with local control stations capable to manually control the equipment and monitor its operation.

2.4.9 Pumps, filtering equipment and other facilities shall be fitted with pressure, temperature and level monitoring sensors as well as warning alarm and protection system.

2.4.10 Pumps, filtering equipment and other facilities in places where oil-containing water may be leaked, shall be fitted with leakage collecting facilities meeting the requirements of 10.13.17–10.13.21 Part IV RCCS.

2.4.11 Vertical sections of inlet pipes for oil-containing water and drainage of purified water from the filtering equipment shall be fitted with a sampling device of design approved by the River Register.

2.5 ALARM DEVICE

2.5.1 Alarm device shall be actuated when the oil content in the discharged water reaches the normative value.

2.5.2 Alarm device shall actuate the following signals:

1. a command for automatic interruption of a discharge;
2. a discharge interruption warning signal;
3. visual and audible signals when the oil content in the discharged water exceeds the normative value;
4. a signal on any malfunction of the alarm device.

All signals shall be sent to the place of watchkeeping.

2.5.3 The actuation time of the alarm device determined during the tests shall not exceed 20 sec.
2.5.4 The alarm device shall be so designed as to be fastened reliably; the electronic part of the device shall be designed taking into account the operating conditions.

2.5.5 The alarm device shall be fitted with inscriptions or symbols clarifying its purposes and operation.

2.5.6 The location of alarm device, the length of sampling pipe and the velocity of liquid flowing in it are to be so selected as the total actuation period shall not exceed 40 sec (the time from the moment of changing the oil concentration in the discharge till the moment when the signal for the discharge interruption is generated).

2.5.7 Sampling points shall be provided at all discharge lines subject to monitoring. The sampling device shall be fitted on vertical sections of the discharge line. It may be fitted on horizontal section when the drain pipe is completely filled by liquid during the whole discharge period.

2.6 DEVICE FOR AUTOMATIC INTERRUPTION OF DISCHARGE

2.6.1 A device for automatic interruption of discharge shall interrupt the oil-containing water discharge under the signal of the alarm device (see 2.5).

2.7 EMERGENCY OIL SPILL LOCALIZATION PACK

2.7.1 Ships specified in 2.1.8 shall be fitted with emergency oil spill localization pack providing oil spill collection when weight of spilled oil is 1.5 t or more.

Equipment being a part of the pack shall be delivered in accordance with the technical documentation approved by the River Register.

2.7.2 Emergency oil spill localization pack shall include:

- .1 floating boom barrier;
- .2 floating anchor buoy;
- .3 anchor of not less than 10 kg weight;
- .4 anchor chains and towing ropes;
- .5 sorbent
- .6 device for sorbent supply;
- .7 oil and waste sorbent collecting device;
- .8 capacity for storage and transportation of waste sorbent;
- .9 set of working clothes;
- .10 service manual for emergency oil spill localization pack.

2.7.3 Service manual for emergency oil spill localization pack shall include operation instructions on oil spill response from ship, as well as maintenance and disposal instructions.

2.7.4 Equipment being a part of emergency oil spill localization pack shall have Certificates issued by the River Register and meet the following requirements:

- .1 to ensure safe operation if it is stored at the air temperature of –30 up to +50 °C;
- .2 to ensure safe operation at the water temperature of –1 up to +30 °C;
- .3 to be rot-resistant, corrosion-resisting and to withstand influence of oil, oil products, sea water and fungi;
- .4 keep its characteristics during long-term exposure to sunlight.

2.7.5 Equipment of emergency oil spill localization pack, which tends to deteriorate with time, shall be marked with indication of service life and date of next inspection or replacement.

Boom barrier

2.7.6 The length of boom barrier is determined with regard to navigation area and oil spill localization technology in various operating situations, but in either case shall be not less than double ship’s breadth.

2.7.7 Parameters of the boom barrier shall comply with those specified in Table 2.7.7.

2.7.8 Boom barrier shall stand dropping afloat from the height not less than 5.5 m without being damaged and keep draught and freeboard constant on a seaway.

2.7.9 Materials used for construction of boom barriers shall be incombustible or combustible with slow flame propagation.
Table 2.7.7

<table>
<thead>
<tr>
<th>Basin class</th>
<th>Total height, mm, not more than</th>
<th>Freeboard, mm, not less than</th>
<th>Draught, mm, not less than</th>
<th>Mass per unit length, kg/m, not more than</th>
<th>Volume in storage per unit length, m³/m, not more than</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-СП, M-ДП, M</td>
<td>1700</td>
<td>500</td>
<td>890</td>
<td>12</td>
<td>0.08</td>
</tr>
<tr>
<td>О and О-ДП</td>
<td>850</td>
<td>200</td>
<td>460</td>
<td>7</td>
<td>0.05</td>
</tr>
<tr>
<td>P and Й</td>
<td>700</td>
<td>200</td>
<td>340</td>
<td>6</td>
<td>0.05</td>
</tr>
</tbody>
</table>

2.7.10 Boom barrier shall be so designed that to enable its manual installation or with the use of ship arrangements and lifting the barrier aboard by means of ship machinery.

2.7.11 Displacement of boom barrier floats per unit length considering ballast weight and forces arising from barrier mooring shall ensure the necessary freeboard of not less than value required by 2.7.7.

2.7.12 Ballast weight per unit length of the boom barrier shall be sufficient to keep it upright and to provide deviation of the boom skirt from the vertical axis in design operating conditions at an angle of not more than 15°.

2.7.13 Boom barrier shall be fitted with a device for fastening mooring ropes to the mooring arrangement, anchored buoys and the shore.

2.7.14 A number of boom barrier sections and design of its connections shall be chosen to provide suitable conditions for putting the boom barrier afloat, lifting aboard and oil spill localization.

2.7.15 Strength of boom barrier elements taking longitudinal tensile force shall be tested by the greatest forces generated in the boom barrier during its operation. Maximum permissible breaking strength shall be specified in boom barrier documentation.

2.7.16 Boom barrier shall be fastened on the ship by means of easily detachable fastenings.

Sorbent

2.7.17 The sorbet amount \( V_c \) required for oil collection is calculated by the formula (m³):\[
V_c = 1500/(H_c a_c),
\]
where \( H_c \) is sorbent’s oil capacity at water temperature 0°C (kg of oil per kg of sorbent); \( a_c \) is sorbent bulk density, kg/m³.

2.7.18 Water adsorption of the sorbent shall not exceed 10 kg of water per kg of sorbent. The guaranteed shelf life of sorbent shall be at least 1 year.

2.7.19 Devices for sorbent supply to oil spill area shall comply with the following requirements:

.1 sorbent spraying device supply rate shall be not less than 0.6 m³/h;

.2 devices may be manually operated, portable with autonomous power source or stationary powered by shipborne power sources.

Oil and waste sorbent collecting devices

2.7.20 Oil collecting devices shall have capacity corresponding to the water flow speed, spill amount and boom barrier design.

Set of working clothes

2.7.22 Set of working clothes shall include a jacket and trousers or coverall, special boots, gloves, protective hermetic glasses, respirator and head wear.

Material and seams of working clothes shall be water- and oil-tight.

Quantity of working clothes sets shall be not less than 4.

2.8 SHIP DESIGN AND EQUIPMENT FOR RESTRICTION AND COLLECTION OF OIL SPILLS ON DECK

Deck structures and systems

2.8.1 Cargo zone and oil storage spaces on deck shall have bar guards of not less than 150 mm high. Bars running along the side...
shall have half-ports to be closed during cargo handling operations.

2.8.2 To remove oil spilled during cargo handling from deck a drainage system equipped with scuppers, drain pipes and tank located under manifold shall be provided.

2.8.3 The drain tank shall be equipped with independent drainage means.

2.8.4 Drain holes shall be fitted with devices for preventing the admission of water into the drain tank upon completion of cargo handling operations.

2.8.5 Work platforms shall be provided under the manifold cargo connections; tanks for collection of spilled oil shall be provided under the work platforms.

2.8.6 The work platform and tank for reception of spilled oil shall be extended behind the cargo connections installed in the fore and aft parts of the manifold. The depth of the tank for collection of spilled oil shall be not less than 300 mm.

2.8.7 Covering of work platform shall be made of grating, through which the oil spilled from manifold could easily enter the tank for collection of spilled oil. The grating shall be composed of removable sections providing free access to the tank for collection of spilled oil. The grating surface shall not be slippery.

2.8.8 Edge of the work platform at the board side shall be faired with radius of 50 mm to prevent damage of cargo hoses during connecting/disconnecting.

Cargo area lighting

2.8.9 Location of manifold and other working areas of the deck shall be lighted.

2.8.10 The lighted zone shall include the outboard lightship waterline area to provide sufficient visibility of onshore terminal area, at which the cargo handling operations are performed.

Onboard equipment for removing oil from deck

2.8.11 Ships specified in 2.1.9 shall be equipped with deck oil-gathering systems for oil spill response on deck during cargo handling and bunkering operations.

2.8.12 The deck oil-gathering facilities shall restrict the spillage and collect the spilled oil of amount not less than 10 kg.

2.8.13 The list of deck oil-gathering facilities is specified in Table 2.8.13.

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorbent boom</td>
<td>m</td>
<td>≥ 3</td>
</tr>
<tr>
<td>Sorbent</td>
<td>m(^3)</td>
<td>≥ 0.15</td>
</tr>
<tr>
<td>Scoop</td>
<td>pcs.</td>
<td>1</td>
</tr>
<tr>
<td>Sorbing mop</td>
<td>pcs.</td>
<td>1</td>
</tr>
<tr>
<td>Sorbing cloth</td>
<td>pcs.</td>
<td>3</td>
</tr>
<tr>
<td>Oil-resistant rubber gloves</td>
<td>set</td>
<td>2</td>
</tr>
<tr>
<td>Respirator</td>
<td>pcs.</td>
<td>2</td>
</tr>
<tr>
<td>Disposable bags</td>
<td>pcs.</td>
<td>≥ 2</td>
</tr>
</tbody>
</table>

2.8.14 The deck oil-gathering facilities shall be stored on deck near the connection points of cargo and bunkerage hoses in containers, which shall be floating, weathertight and attached to the ship's hull.

2.8.15 The container shall be made according to the documentation approved by the River Register and using materials complying with the requirements of 2.7.4. It shall be painted in bright green water-resistant paint and fitted with plate indicating the list of stored items.
3 REQUIREMENTS TO SHIP'S EQUIPMENT AND FACILITIES FOR PREVENTION OF POLLUTION BY SEWAGE

3.1 GENERAL REQUIREMENTS

3.1.1 Crewed vessels shall be fitted with:
   1. a flushing system;
   2. a sewage collecting tank;
   3. standard discharge connections (see 1.2.2.41) for the delivery of sewage to reception facilities;

3.1.2 If the calculation performed according to the method described in Appendix 1 shows that equipment stated in 3.1.1.2 does not provide for the navigation endurance due to environmental safety conditions, then ships shall be additionally fitted with sewage treatment plant.

3.1.3 Collecting tanks, capacities, systems of collection, pumping, treatment and delivery of sewage water including all its equipment and pipelines shall be used neither for purposes other than their direct purpose nor combined with other systems (excepting 3.3.8 and 3.4.6).

3.2 COLLECTING TANKS

3.2.1 The total capacity of collecting tanks shall be proved by the calculation performed according to the method described in Appendix 1.

3.2.2 The collecting tanks shall comply with the requirements 2.4.138, 2.4.142 and 2.4.143 Part I RCCS.

3.2.3 Where applicable, collecting tanks shall be designed with the external framing. The bottom shall be inclined towards the reception pipe.

3.2.4 Collecting tanks shall be fitted with:
   1. an access hole for inner access and cleaning;
   2. a system for sediment loosening;
   3. a washing system;
   4. an air pipe;
   5. a device sending visual and audible alarm to the wheelhouse or central control station when the tank is filled up to 80 per cent of the permissible level;
   6. a system measuring the liquid level.

3.2.5 Collecting tanks located in places where they may be subject to negative temperature during operation shall be fitted with heating devices.

3.2.6 Collecting tanks shall be designed so to withstand the pressure not less than 1.5 of operating pressure in the system.

3.2.7 Water, vapour or compressed air may be used as a loosening agent.

3.2.8 Air pipes of collecting tanks shall be led to the open deck with outlets located in such a way that to prevent the smell of untreated sewage from getting into the ship's accommodation and service spaces.

3.2.9 Collecting tanks may be located in cargo spaces not intended for transportation of food or food products as well as in the machinery spaces.

3.3 PUMPING, DELIVERY AND DISCHARGE SYSTEMS

3.3.1 Pumping, delivery and discharge systems shall be designed and the lines shall be located in accordance with the requirements of Section 10 Part IV RCCS.
3.3.2 Fittings and lines of sewage pumping, delivery and discharge systems shall be designed to withstand pressure not less than 1.5 of operating pressure in the system.

3.3.3 Lines of the system of sewage delivery to reception facilities shall be led to port and starboard.

3.3.4 Sewage delivery lines shall not be combined with other discharge lines.

3.3.5 Standard discharge connections for delivery of sewage to reception facilities shall be located in places accessible for hose connections and shall be marked as provided by GOST R ISO 7608-2013.

3.3.6 The vessels intended for sewage collection shall be fitted with standard discharge connections (see 1.2.2.41).

The vessels intended for reception of sewage from river-sea and sea-going ships shall be fitted with standard discharge flange connections of international type (see 5.11.7). Adapter couplings may be used for compatibility of standard discharge flange connections of international type with standard discharge connections.

3.3.7 Sewage delivery systems shall be handled by pumps intended for these purposes.

3.3.8 Provision shall be made for outboard water washing of sewage delivery system pipes including hoses; used washing water shall be discharged to reception facilities or ship’s collecting tank.

3.3.9 Shut-off fittings of sewage discharge system shall be so designed as to make them available for lead-sealing operations.

Note: The purified sewage water may be discharged from ships overboard if sewage water purification efficiency corresponds to the specified standard, but only outside the areas specified in 257(d) of Technical Regulations on Safety of Inland Marine Transport Facilities approved by the Decree of the Government of the Russian Federation No. 623 dated 12.08.2010.

This requirement does not apply to ships not fitted with their own means for pumping sewage water.

3.3.10 Exhaust pumps shall be actuated and stopped manually. In the area of outlet location shall be provided either a station for observation and remote stop of pumps or telephone or radio communication between a place of observation and control post of exhaust means.

3.4 SEWAGE TREATMENT PLANT

3.4.1 Sewage treatment plant shall have a capacity corresponding with designed water consumption on a ship.

3.4.2 Sewage treatment plant with relevant pumps, pipes and fittings contacting with sewages shall be protected from the attack of pumped medium.

3.4.3 Sewage treatment plant should ensure the purification efficiency regulated by normative documents in force. Standardised purification efficiency shall be reached by sewage purification and disinfection only. Dilution of sewage to reach the required purification efficiency is not permitted.

3.4.4 Sewage treatment plant shall be tested at the manufacturer by test pressure equal to 1.5 working pressure and on the ship — by working pressure.

3.4.5 The space containing the sewage treatment plant shall be fitted with artificial exhaust ventilation.

3.4.6 Provision shall be made for washing and disinfection system of the sewage treatment plant and handling mechanisms, pipelines and fittings in order to ensure safety of maintenance, inspection and repair of the plant.

3.4.7 Sewage treatment plant shall be fitted with a sampling device for treated water.

3.4.8 Sewage treatment plant shall be designed for automatic operation as well as shall be fitted with local control stations capable to manually control the equipment and monitor its operation.
4 REQUIREMENTS TO SHIP'S EQUIPMENT AND FACILITIES FOR PREVENTION OF POLLUTION BY REFUSE

4.1 GENERAL REQUIREMENTS

4.1.1 Ships with people on board shall be fitted with refuse collecting facilities. Refuse generated onboard shall be collected and stored for delivery to reception facilities or shall be burned in ship's incinerator.

4.1.2 Ships may be fitted either with refuse treatment installations or incinerators at the option of the shipowner.

4.1.3 In ships mentioned in 2.1.4 the refuse may be collected in disposable dense polyethylene bags.

4.2 REFUSE COLLECTING FACILITIES

4.2.1 The total capacity of refuse collecting facilities shall be determined by calculation performed according to the method described in Appendix 1.

4.2.2 Refuse collecting facilities shall be attachable or built-in and have tightly-closing lids.

4.2.3 Refuse collecting facilities shall have smooth inner surfaces and fittings allowing them to be securely attached in the ship.

4.2.4 Refuse collecting facilities shall be installed on the open deck or in rooms ventilated and isolated from the accommodation and service spaces.

4.2.5 Inner surfaces of integrated refuse collecting facilities shall have bottom inclination not less than 30° towards the discharge outlet. The discharge outlets shall have no beads in the lower part and be fitted with lids so driven as to provide for the reliable operation under any service conditions of the ship.

4.3 INCINERATORS

4.3.1 For incinerators fitted with a feeding hopper locking lids of the latter shall be provided with a blocking device to avoid its simultaneous opening. Restrictions for the loading substances, if any (e.g. exhausted lubricating oil, oil sludge etc.) shall be indicated on a plate attached to the incinerator on a visible place.

4.3.2 For incinerators not fitted with a feeding hopper a loading hatch shall be fitted with a blocking device preventing from its opening:

1. during air supply to the combustion chamber for the burning process;
2. when temperature in the combustion chamber exceeds the flash point of the fuel used in a ship.

4.3.3 The incineration process shall be controlled either directly (visually) or indirectly (by instrument readings).

4.3.4 Design of the fuel nozzles or other devices for the fuel supply shall be approved by the River Register.

4.3.5 Fuel nozzles shall have a blocking device, which provides for a supply of oil fuel only in the following cases:

1. if a nozzle is in a working condition;
2. if air is supplied to the furnace;
3. if the feeding hopper is closed.

4.3.6 Fuel nozzles shall be fitted with devices which shut-off the fuel supply within not more than 5 seconds in cases when:
1. No air is supplied to the furnace;
2. The furnace flame is failed;
3. The electrical supply is broken;
4. The fuel pressure is below the permissible working pressure. Automatic fuel feeding cut-off shall be accompanied by visual and acoustic alarm.

**4.3.7 Fuel supply to nozzles shall be also stopped if it is not ignited for more than five seconds from the beginning of supply.**

**4.3.8 Fuel nozzles shall be shut-off by two shut-off devices one of which shall be located outside the space containing the incinerator.**

**4.3.9 In the absence of a separate exhaust ventilator for long-lasting operation the control program of fuel nozzles with automatic ignition fuel shall include:**

1. The furnace ventilation within at least three minutes before the ignition;
2. The furnace ventilation within at least three minutes after the fuel feeding has been shut-off.

**4.3.10 Incinerators with automatically controlled burning process shall be fitted with a protection and alarm as stated in Table 4.3.10.**

**4.3.11 Fuel and gas-discharging systems of the incinerators shall meet the requirements of 10 Part IV RCCS.**

**4.3.12 Heating surfaces of the incinerators shall be insulated as per 1.9.2 Part IV RCCS.**

**4.3.13 Burning residues shall be stored in removable locking capacities reliably protected against shifting.**

**4.3.14 Installation of incinerators in accommodation spaces is prohibited.**

When mounted in the machinery space, the incinerator shall be shielded from adjacent equipment; it shall be so located and fastened that to meet the requirements of 1.9 and 1.10 Part IV RCCS.

**4.3.15 When the incinerator is located in a separate compartment, the latter shall be fitted with: exhaust and input ventilation which provides for efficient air supply required for the operation of the incinerator, automatic fire alarm according to 11.4 Part IV RCCS.**

### 4.4 REFUSE TREATMENT DEVICES

**4.4.1 Devices for grinding of refuse shall grind it until the size of particles will be capable to pass through a hole of not more than 25 mm.**

**4.4.2 Refuse pressing devices shall decrease its initial volume in the mean by at least 5 times.**

#### Table 4.3.10

<table>
<thead>
<tr>
<th>Faultiness</th>
<th>Alarm</th>
<th>Automatic shutdown of the incinerator</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>High temperature of exhaust gases</td>
<td>+</td>
<td>+</td>
<td>A supplementary auxiliary ventilator is switched on in the absence of an exhaust ventilator If it is available</td>
</tr>
<tr>
<td>High temperature in the combustion chamber</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop of supply ventilator</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Stop of exhaust ventilator</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Temperature of heavy fuel:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low pressure of fuel</td>
<td></td>
<td>+</td>
<td>If a pump for additional pumping is required for normal operation</td>
</tr>
<tr>
<td>Unsuccessful ignition or breakdown of torch</td>
<td></td>
<td></td>
<td>Each nozzle shall be supplied with automatic shut-off device</td>
</tr>
<tr>
<td>Shortage of combustion air supply or low pressure</td>
<td></td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Automatic shut-off of fuel supply</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5 ADDITIONAL REQUIREMENTS TO SHIPS OF M-ÇП, M-ÇИП AND O-ÇИП CLASSES

5.1 SCOPE OF APPLICATION GENERAL REQUIREMENTS

5.1.1 The requirements of present Section are applied to ships of M-ÇП, M-ÇИП and O-ÇИП classes when they navigate in sea areas.

5.1.2 Requirements 1–4 of present Section of the Rules are applied to ships specified in 5.1.1 when they navigate in basins not attributed to sea areas.

5.1.3 Control devices, instruments and other parts of equipment for prevention of pollution by oil comprising electrical and electronic elements shall comply to the requirements of Part VI RCCS.

5.1.4 The monitoring and control devices shall bear distinct inscriptions or generally accepted symbols clarifying its purposes and operation.

5.2 FILTERING EQUIPMENT

5.2.1 Any vessel with gross tonnage of 400 and over shall be equipped with filtering equipment as per 2.4.1–2.4.11.

5.2.2 The requirement of 5.2.1 is not applied to vessels covered by the requirements of 5.5.2.

5.2.3 Oil-containing water filtering systems shall preclude the water discharge with oil concentration exceeding its maximum normative value (see Appendix 2).

5.3 ALARM DEVICE

5.3.1 The ship fitted with filtering equipment shall be equipped with an alarm device.

5.3.2 The requirements of 5.3.1 do not apply to the following ships:

.1 mentioned in 5.3.1 if they store contaminated ballast for delivering it to reception facilities; the ship shall undertake measures preventing from unforeseen discharge of contaminated ballast;

.2 fitted with collecting tank (tanks) to store all oil-containing water on board of the ship for delivering it to reception facilities occupied solely during voyages within special areas identified by MARPOL 73/78.

5.3.3 Ships fitted with an alarm device shall be equipped with an automatic discharge interrupting device which meets the requirements of 2.6. The automatic discharge-interrupting device may be dispensed with, when a ship does not discharge wastes in special areas identified by MARPOL 73/78.

5.3.4 The alarm device shall meet the requirements of 2.5.1–2.5.7 and 5.1.4 as well as applicable provisions of IMO resolutions.

5.3.5 The permitted accuracy of the alarm device readings shall be not lower than ±5 ppm.

5.3.6 The alarm device shall be made from seawater-resistant materials.
5.4 REQUIREMENTS TO PUMPING, DELIVERY AND DISCHARGE SYSTEMS OF OIL-CONTAINING WATER

5.4.1 Pumping, delivery and discharge systems of oil-containing water shall meet the requirements of 2.3.1 – 2.3.9.

5.4.2 Every ship shall be supplied with standard discharge flange connections of international type (see Fig. 5.4.2). The flange of standard discharge connection of international type is intended for pipes with an internal diameter of up to 125 mm and shall be made of steel or an equivalent material with a flat machined surface. The flange together with a gasket of oil-resistant material shall be designed for a working pressure of 0.6 MPa. Coupling is effected by means of six 20-mm screw bolts. Outlet branches shall be fitted with closures.

Fig. 5.4.2 Standard flange discharge connections of international type

5.4.3 Discharge lines for oil-containing mixture shall be led out to the open deck or board above the waterline at the maximal draught of the ship.

5.4.4 Ballast discharging lines from clean ballast tanks may be led out to a ship’ side below the waterline.

5.4.5 The pipes shall be capable of being drained to reception facilities.

5.5 COLLECTING TANKS

5.5.1 Ship shall be fitted with a tank (tanks) for the collection of oil-containing water (collecting tanks) which capacity is determined by the formula, m³:

\[ V = 0.35K T, \]  

(5.5.1)

where \( K \) is factor:

<table>
<thead>
<tr>
<th>Output of the main engines, kW</th>
<th>( K )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 110</td>
<td>0.4</td>
</tr>
<tr>
<td>From 111 to 220</td>
<td>0.8</td>
</tr>
<tr>
<td>&gt; 221</td>
<td>1.2</td>
</tr>
<tr>
<td>&gt; 441</td>
<td>1.6</td>
</tr>
<tr>
<td>&gt; 735</td>
<td>2.0</td>
</tr>
</tbody>
</table>

\( T \) is duration of voyage between ports equipped with reception facilities available for oil-containing bilge water reception, in days (\( T \) shall be taken for 7 days if not determined).

Ships with the total output of all main engines less than 220 kW may accumulate oil-containing water in portable tanks or in the machinery space bilges if it is stipulated in stability and floodability information.

5.5.2 Any vessel may be fitted only with oil-containing water collecting tanks when being in service within special areas determined by MARPOL 73/78. In this case the following conditions shall be complied with:

- the ship collecting tanks comply with the requirements of 5.5.1;
- all oil-containing water is kept on board for delivering it to reception facilities;
- the information about adequacy of reception facilities in calling ports and terminals of the vessel shall be submitted to the River Register;
- the Certificate of Prevention of Environment Pollution from Ship shall contain the record about ship’ servicing only in voyages listed in this paragraph.

5.5.3 Collecting tanks of ships with main engine running on heavy fuel with density exceeding 940 kg/m³ at 15 °C shall be fitted with devices for heating oil-containing water before discharging the tank (tanks) through the filtering equipment.
5.5.4 Every ship fitted with filtering equipment shall be fitted with a tank (tanks) for the collection of oil residues (sludge tanks) which minimum capacity shall be calculated by the formulas, m³:

1. for vessels not carrying water ballast in the fuel tanks:
   \[ V_1 = K_1 CT, \]  
   (5.5.4.1)

   where \( K_1 \) is the factor equal to 0.015 for vessels with heavy fuel for main engines subject to purification before use, or 0.005 for vessels where diesel and heavy fuel does not require purification before use;

   \( C \) is a daily fuel discharge, m³/d;

   \( T \) is the maximal duration of voyage between ports equipped with reception facilities available for oil residues reception, in days (\( D \) shall be taken for 30 days if it is not determined);

2. for vessels equipped with homogenizers, incinerators for oil residues or other onboard facilities for neutralization of oil residues approved by the River Register:
   \[ V_1 \] is taken equal to 50% of the value determined in 5.5.4.1 or 1 m³ at gross tonnage from 400 up to 4000, or 2 m³ at gross tonnage of 4000 and over, whichever is the greatest;

3. for vessels carrying ballast water in the fuel tanks:
   \[ V_2 = V_1 + K_2 V_B, \]  
   (5.5.4.3)

   where \( V_1 \) see in 5.5.4.1 or 5.5.4.2;

   \( K_2 \) is coefficient equal to:
   0.01 — for heavy fuel bunker tanks;
   0.005 — for diesel oil bunker tanks;

   \( V_B \) is the capacity of ballast tanks which may be used also for carrying oil fuel, tons.

5.5.5 To discharge the content of sludge tanks to the reception facilities a dedicated pump shall be installed. The pump shall meet the requirements of 5.5.12.

5.5.6 Provision shall be made to prevent sludge from discharge to bilges, tanks and pipelines of oil-containing water. Discharge line of the sludge tanks can be connected to the oil-containing water line leading to discharge connections specified in 5.4.2.

5.5.7 If ship is fitted with a separate tank for drainage and oil spilling storage, it shall have a capacity \( V_s \), m³:
\[ V_s = 2TP/10^4, \]  
(5.5.7)

where \( T \) is the maximal duration of voyage between ports equipped with reception facilities available for oil drainage and spilling reception, in days (if not determined, \( D \) is taken for 30 days);

\( P \) is the power of the main engines, kW.

5.5.8 Capacity of a separate shipboard tank (tanks) for exhaust oil storage shall be half times more than exhausted lubricating oil supplied from crankcases of all internal combustion engines and all installed ship machinery as well as lubricating oil of hydraulic drive contained in these system tanks.

5.5.9 Washing water from fuel and oil separators shall be discharged to special tank or to sludge tank.

5.5.10 A sludge tank shall be located directly under the heavy fuel separator. Where impracticable, the sludge tank shall be located near the heavy fuel separator in such way that to provide the largest possible inclination, possible straightness or big radius elbows of the inlet drainage pipe.

5.5.11 The sludge tank shall be so designed as to provide for free access of oil sludge to the suction line. Where impracticable, the suction line inlet or a submersible pump shall be so located as to provide the minimal distance for oil sludge to reach the suction inlet.

5.5.12 A pump for sludge pumping shall be self-priming, positive-displacement, be capable of operation in dry friction conditions and with delivery pressure of at least 0.4 MPa. The pump capacity may be calculated by the formula, m³/h:
\[ Q = V_s/t, \]  
(5.5.12)

where \( V_s \) is the capacity of a sludge tank determined as per 5.5.4, m³;

\( t \) is the duration of emptying which is equal to 4 hours.

In any case the pump capacity shall be at least 2 m³/h. The pump suction side shall
be connected only to the pipe leading on a
deck and to the sludge incinerator facilities
when provided in a ship. The suction height
shall not exceed 3 m.

5.5.13 Collecting tanks shall comply with
the requirements of 2.2.1 – 2.2.7.

5.5.14 The sludge tanks shall be fitted with
preheating systems. Preheating pipes shall be
located so as they are led along the tank pe-
rimeter beginning from the inlet opening and
then across the whole bottom on the level
sufficient to prevent it from complete cover-
ing with bottom deposits. The tank preheating
system shall be so designed that to provide for
preheating up to 60 °C.

5.5.15 The sludge tank throats shall provide
for access at any tank space. One of the
throats shall be located at the upper side of
the tank to provide for the operation of sub-
mersible pump.

5.5.16 The sludge tanks shall be designed
and arranged so to provide cleaning of tanks
and delivering of residues to the reception
facilities.

5.6 GENERAL REQUIREMENTS
TO OIL TANKERS

5.6.1 Length of any cargo tank of an oil
tanker or a cargo space of a ship not being
an oil tanker which is intended for oil trans-
portation in bulk with a capacity of at least
200 m³ and over, shall not exceed 10 m or
one of figures of Table 5.6.1 whichever is the
greatest.

5.6.2 Pipelines designed to pump the oil
and oil-containing water shall not be led
through the ballast tanks, excepting pipe sec-
tions made of seamless pipes equal in strength
to the ballast tank structures.

5.7 AUTOMATIC MONITORING AND
CONTROL SYSTEMS FOR DISCHARGE

5.7.1 Every oil tanker with gross tonnage of
150 and over shall be fitted with the auto-
matic monitoring and control systems for dis-
charge (for the purposes of this Chapter, hereinafter referred to as the System) in ac-
cordance with regulation 31 of Appendix I to
MARPOL 73/78 with the exception of the
following cases:

1 oil tanker is sailing in sea areas being
part of special areas delineated by Appendix I
to MARPOL-73/78;

2 oil tanker is sailing only within the sea
areas outside the special areas at a distance of
less than 50 nautical miles from the nearest
coast.

In this case the following conditions shall
be complied with:

all oil-containing mixtures is kept on board
for delivering to reception facilities;

the Certificate of Prevention of Environ-
ment Pollution from Ships contains the record
about ship’s servicing only in voyages listed in
5.7.1.1 and 5.7.1.2;

the Oil Record Book contains the record
about the discharged amount, time and dis-
charge port.

### Table 5.6.1

<table>
<thead>
<tr>
<th>Presence and location of bulkheads in cargo tank area</th>
<th>Length of cargo tank or space, m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No longitudinal bulkhead is present</td>
<td>(0.5b/B + 0.1)L but not less than 0.2L</td>
</tr>
<tr>
<td>One longitudinal bulkhead is present in longitudinal central plane</td>
<td>(0.25b/B + 0.15)L</td>
</tr>
<tr>
<td>Two or more longitudinal bulkheads are present:</td>
<td></td>
</tr>
<tr>
<td>for side tanks</td>
<td>0.2L</td>
</tr>
<tr>
<td>for central tanks:</td>
<td>0.2L</td>
</tr>
<tr>
<td>h/B ≥ 1/5: without longitudinal bulkhead in the central plane</td>
<td>(0.5b/B + 0.1)L</td>
</tr>
<tr>
<td>h/B &lt; 1/5: with longitudinal bulkhead in the central plane</td>
<td>(0.25b/B + 0.15)L</td>
</tr>
</tbody>
</table>

**Note.** b is the minimal distance from a ship side to outer bulkhead of the given tank, m, measured from the inner surface of outer plating at right angle to the longitudinal central plane on a level cor-
responding to assigned summer freeboard.

B is breadth of a ship at design waterline; L is length of a ship at design waterline.
5.7.2 The System equipment and applicable technical requirements shall comply with IMO Resolution MEPC.108(49) Revised Guidelines and Specifications to Automatic Monitoring and Control Systems for Oil Discharge for Oil Tankers.

5.7.3 The System shall be activated with any discharge of oil-containing mixture to the sea and automatically stop the discharge if the instantaneous intensity of the discharge does not exceed 30 litres per mile.

5.7.4 The System shall operate in all weather conditions, in which an oil tanker can be operated under normal conditions.

5.7.5 Any system fault shall result in the discharge interruption.

5.8 REQUIREMENTS TO DETECTORS OF OIL-WATER PHASE DIVISION BOUNDARY

5.8.1 Detectors of the oil-water phase division boundary may be either fixed or portable. When using only fixed devices they shall be installed in every settling tank.

5.8.2 The devices shall determine the position of the oil-water phase division boundary in the tank at any level.

5.8.3 The location of a fixed device or hatches for a portable one shall be selected considering the tank construction and influence of the ship motions.

5.8.4 The controls and the indicator of oil-water phase division boundary position of the fixed devices shall be located at the control station of cargo operations or in similar space.

5.8.5 Fixed devices should sustain the jet impact force of the tank washing facilities.

5.8.6 The device may be designed to determine the phase division boundary of fluids with densities that differ considerably. The device shall bear the plate indicating the conditions for its application and the necessary restrictions.

5.8.7 The device shall be so designed as to allow for its installation in explosive spaces. The device shall not generate radio interference noise.

5.8.8 The device shall be made from seawater-resistant materials.

5.8.9 The device shall operate in the ambient temperature range from –30 up to +55 °C.

5.8.10 The device shall indicate the oil–water phase division boundary by means of an indicating device. The constant indication of oil-water phase division boundary is not mandatory.

5.8.11 The device accuracy shall provide for the indication of oil-water phase division boundary within limits of ±25 mm from the actual.

5.8.12 It shall be possible to check the performance of the device on a ship.

5.9 SETTLING TANKS

5.9.1 Oil tanker with gross tonnage of 150 and over shall be fitted with a settling tank or a system of settling tanks.

5.9.2 The capacity of a settling tank or a system of settling tanks shall be at least 3 per cent of oil carrying capacity of an oil tanker with the exception of the following cases:

1. if tank washing facilities fitted on a ship are such as the settling tank or tanks are filled with washing water in a quantity sufficient for tank washing and feeding pumps with working liquid including ejectors, the reduction of settling tanks capacity may be admitted down to 2 per cent of oil carrying capacity of oil tanker;

2. when an oil tanker is fitted with tanks intended for clean ballast only, it may allow settling tank capacity equal to 2 per cent of oil carrying capacity. If on that ship tank washing facilities are such as the settling tank
or tanks are filled with washing water in a quantity sufficient for tank washing and feeding pumps with working liquid including ejectors, the reduction of settling tanks capacity may be admitted down to 1.5 per cent of oil carrying capacity of oil tanker;

.3 if on a combination carrier oil cargo is carried only in tanks with smooth walls, it can admit the reduction of settling tanks capacity down to 1 per cent of oil carrying capacity. If on that ship tank washing facilities are such as the settling tank or tanks are filled with washing water in a quantity sufficient for tank washing and feeding pumps with working liquid including ejectors, the reduction of settling tanks capacity may be admitted down to 0.8 per cent of oil carrying capacity of oil tanker.

5.9.3 The settling tanks shall be designed so that arrangement of input and output holes as well as baffles and water drains (if any) does not cause excessive turbulence and entrapping of oil and emulsion by water.  

5.9.4 The requirements of 5.9.1 – 5.9.3 may not be applied to an oil tanker when:

.1 she is engaged solely in voyages lasting not more than 72 h within the range of 50 miles clear of the nearest coast provided that she is keeping on board all oil-containing mixtures for delivering it to reception facilities;

.2 she is occupied with asphalt carrying provided that she is keeping on board all asphalt residues for delivering it as well as all washing water to reception facilities.

5.9.5 The requirements of 5.9.1 – 5.9.3 are applied to vessels not being oil carriers but fitted with cargo spaces built and used specially for oil transportation with the total capacity of 200 m³ and over.

5.9.6 If there is a line for oil-containing water discharge from bilges of the machinery spaces to the settling tanks, it shall include suitable facilities preventing from cargo and gas leakage into the machinery spaces.

5.10 REQUIREMENTS TO OIL TANKERS FOR PREVENTION OF POLLUTION BY OIL IN THE EVENT OF COLLISION OR TAKING THE GROUND

5.10.1 The requirements of the present Chapter are applied to oil tankers with a gross tonnage of 600 tons and over.

5.10.2 Oil tankers shall be fitted with ballast tanks not being oil tanks which are designed according to the requirements of 5.10.3–5.10.7.

5.10.3 Side ballast tanks shall be extended along the whole length of the cargo tanks and on the whole board depth or from the inner bottom plating up to the main deck; the distance from the cargo tanks to the moulded line of the outside plating taken in any cross-section perpendicular to the side plating shall not be less than the distance w (Fig. 5.10.3).

Fig. 5.10.3 Determining the sizes of side ballast tanks

5.10.4 Double bottom ballast tanks shall be extended along the whole length of the cargo tanks and in any cross-section to have the height h between the moulded line of the bottom plating and the cargo tank bottom (see Fig. 5.10.3) taken along the perpendicular to the bottom plating.

5.10.5 The distance w (see 5.10.3) and height h (see 5.10.4) shall be taken from Table 5.10.5.

5.10.6 In the bilge turn area or places where the bilge turn is not clear, at different h and w specified in 5.10.3–5.10.5 the distance w is preferable on levels exceeding 1.5h above the base line as shown at Fig. 5.10.3.

5.10.7 The ballast, measuring and ventilation lines coming to the ballast tanks shall not be led through the cargo tanks, excepting short sections provided they are all-welded or of equivalent construction.
5.10.8 Cargo pump rooms of the oil tankers with deadweight of 5000 tons and more shall be fitted with the double bottom so that the height of double bottom space in any cross-section is not less than 1 m.

Ballast pipelines may be located in double bottom of the cargo pump rooms provided any damage of these lines does not affect on the cargo system operation.

Suction wells in double bottom of both cargo tanks and cargo pump rooms shall be as small as practicable. The distance between the well bottom and the base plane of a ship measured at a right angle to this plane shall be not less than half height of double bottom space.

**5.11 REQUIREMENTS TO SHIP'S EQUIPMENT AND FACILITIES FOR PREVENTION OF POLLUTION BY SEWAGE**

5.11.1 The requirements of this Chapter apply to the following ships:

.1 of gross tonnage of 200 and over;

.2 of gross tonnage less than 200 with a number of people on board over 10 persons;

.3 which may carry people on board over 10 persons.

5.11.2 The ships shall be fitted with the following equipment:

.1 a sewage treatment plant and a collecting tank. Collecting tank may be used for collection of non-treated sewage, activated sludge or sludge from the sewage treatment plant; or

.2 collecting tanks.

5.11.3 Provision shall be made to prevent from the discharge of purified and disinfected sewage as well as non-treated sewage in areas where the discharge is forbidden.

5.11.4 Collecting tanks shall comply with the requirements of 3.2.1–3.2.8.

5.11.5 Installations for the treatment of sewage water shall comply with the requirements of 3.4.1–3.4.8.

5.11.6 The equipment for discharge of sewage water shall comply with the requirements of 3.3.7–3.3.10.

5.11.7 The ship shall be supplied with standard discharge connections of international type (see Fig. 5.11.7).

![Fig. 5.11.7 Standard flange discharge connection of international type](image)

The flange of standard discharge connection of international type is intended for pipes with an internal diameter of up to 100 mm and shall be made of steel or an equivalent material with a flat machined surface. The flange together with a gasket shall be designed for a working pressure of 0.6 MPa. Coupling shall be affected by means of four 16-mm screw bolts. Outlet branches shall be fitted with closures.

---

**Table 5.10.5**

<table>
<thead>
<tr>
<th>Deadweight, D, tons</th>
<th>Distance w, m</th>
<th>Height h, m</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 600 to 5000</td>
<td>0.4 + 2.4D/20000, but not less than 0.9*</td>
<td>B/15 but not less than 0.8*</td>
</tr>
<tr>
<td>5000 and over</td>
<td>0.5 + D/20000, but not less than 1.0</td>
<td>B/15, but not less than 1.0</td>
</tr>
</tbody>
</table>

* For separate tanks with oil fuel tonnage of less then 500 m³, the minimum value is taken equal to 0.76.

**Note.** B — breadth of a ship at design waterline.
6 REQUIREMENTS FOR PREVENTION OF AIR POLLUTION FROM SHIPS

6.1 SCOPE OF APPLICATION

6.1.1 The present Section applies to the marine diesel engines and specifies the normative values of harmful substance emission and exhaust gases opacity.

6.1.2 The values of harmful substance emission and exhaust gases opacity from marine spark-ignition engines as well as from marine gas turbines and compressed gas engines shall not exceed the values set by normative documents and/or international agreement of the Russian Federation.

6.2 NORMATIVE VALUES OF HARMFUL SUBSTANCES EMISSION AND EXHAUST GASES OPACITY

6.2.1 The regulated parameter of gas components of harmful substances with exhaust gases is specific average weighted emission in grams per kWh of effective engine operation during the full test cycle imitating typical operating conditions.

6.2.2 Maximum permissible values of regulated parameters if gas components of emissions for new engines during bench tests are listed in Tables 6.2.2-1 and 6.2.2-2.

6.2.3 Maximum permissible values of regulated parameters of emission gas components for engines after thorough repair are taken in accordance with Tables 6.2.2-1 and 6.2.2-2 with multiplication by correction factors listed in Table 6.2.3.

6.2.4 Regulated parameters of exhaust gases opacity are:

<table>
<thead>
<tr>
<th>Engine crankshaft revolution frequency n, min⁻¹</th>
<th>Maximum permissible value of average weighted emission of nitrogen oxides (NOₓ) reduced to NO₂, g/kW·h for engines in production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 19.05.2005</td>
<td>Since 19.05.2005 to 01.01.2011 Since 01.01.2011</td>
</tr>
<tr>
<td>Up to 130</td>
<td>17.0 14.4</td>
</tr>
<tr>
<td>Over 130 to 2000</td>
<td>45n⁰·² 44n⁰·²³</td>
</tr>
<tr>
<td>Over 2000</td>
<td>9.8 7.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Regulated parameter</th>
<th>Maximum permissible value for engines in production</th>
</tr>
</thead>
<tbody>
<tr>
<td>The specific average weighted emission of carbon monoxide (CO), g/kW·h</td>
<td>6.0 3.5 1.5</td>
</tr>
<tr>
<td>The specific average emission of total hydrocarbons (CH) in recalculation of conditional composition of fuel CH₃₋₆, g/kW·h</td>
<td>2.4 1.0 0.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Correction factor values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmful substance</td>
</tr>
<tr>
<td>Nitrogen oxides (NOₓ)</td>
</tr>
<tr>
<td>Carbon monoxide (CO)</td>
</tr>
<tr>
<td>Hydrocarbons (CH)</td>
</tr>
</tbody>
</table>

natural coefficient of luminous flux attenuation;
coefficient of luminous flux attenuation;
Regulated opacity parameters

<table>
<thead>
<tr>
<th>Exhausted gas flow $V_{exh}^{103}$ reduced to the normal conditions (temperature 273 K, pressure 101.3 kPa), m$^3$/s</th>
<th>Natural coefficient $K$ of luminous flux attenuation, m$^{-1}$</th>
<th>Coefficient $N$ of luminous flux attenuation adjusted to smoke density indicator scale of optical type ($L = 0.43$ m), %</th>
<th>Filter smoke index adjusted to the scale of smoke density indicator of filtration type ($L_s = 0.405$ m), nominal units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 75</td>
<td>1.36</td>
<td>1.01</td>
<td>44</td>
</tr>
<tr>
<td>Over 75 to 95</td>
<td>1.23</td>
<td>0.90</td>
<td>41</td>
</tr>
<tr>
<td>&gt; 95 to 140</td>
<td>1.07</td>
<td>0.80</td>
<td>37</td>
</tr>
<tr>
<td>&gt; 140 to 210</td>
<td>0.90</td>
<td>0.70</td>
<td>32</td>
</tr>
<tr>
<td>&gt; 210 to 350</td>
<td>0.73</td>
<td>0.58</td>
<td>27</td>
</tr>
<tr>
<td>&gt; 350 to 600</td>
<td>0.58</td>
<td>0.46</td>
<td>22</td>
</tr>
<tr>
<td>&gt; 600 to 1150</td>
<td>0.46</td>
<td>0.35</td>
<td>18</td>
</tr>
<tr>
<td>&gt; 1150 to 3000</td>
<td>0.32</td>
<td>0.25</td>
<td>13</td>
</tr>
<tr>
<td>&gt; 3000</td>
<td>0.23</td>
<td>0.19</td>
<td>10</td>
</tr>
</tbody>
</table>

Note. For radial cylinder engines, the standard values of exhaust gas opacity are to be set as required by the customer.

6.2.5 Exhausted gas flow $V_{exh}$ reduced to the normal conditions, depending on which the Table 6.2.4 establishes the opacity values, is determined by direct measurement or calculated by the formula (6.2.5-1), m$^3$/h:

$$V_{exh} = \dot{B}_T F_T$$  \hspace{1cm} (6.2.5-1)

where $\dot{V}_a$ is air flow rate reduced to the normal atmospheric conditions ($T_a = 273$ K, $p_a = 101.3$ kPa, density = 1.293 kg/m$^3$), m$^3$/h;

$F_T$ is fuel mass flow per hour, kg/h;

$T$ is coefficient of reducing the flow of undiluted combustion products of different fuels (mixture ratio) to the normal atmospheric conditions, m$^3$/kg, taken according to Table 6.2.5 for dry and wet conditions of exhaust gases.

For wet exhaust gases, which density is equal to 1.293 kg/m$^3$, $V_{exh}$ is calculated by the formula (6.2.5-2), m$^3$/s:

$$V_{exh} = 0.214810^{-3} (B_T + \dot{B}_T)$$  \hspace{1cm} (6.2.5-2)

where $B_T$ is hourly fuel rate calculated by the formula (6.2.5-3), kg/h,

$$B_T = \dot{h} P_{out}$$  \hspace{1cm} (6.2.5-3)

where $\dot{h}$ is specific effective fuel rate of the engine at the rated power (as per engine specification), kg/kWh;

$P_{out}$ is engine's rated power (as per engine specification), kW.

$$\dot{B}_T = \phi \alpha L_s B_T$$  \hspace{1cm} (6.2.5-4)

where $\phi = 1.05 - 1.2$ is blowing factor,

$\alpha$ is total excess air factor, minimum value as per engine specification. The $\alpha$ values depend on mixture formation type.
28 Rules for Prevention of Environmental Pollution from Ships (RPPS)

For engines

- with film mixture formation: $\alpha = 1.2$ to $1.5$
- with spray mixture formation: $\alpha = 1.9$ to $2.2$
- with spray-film mixture formation: $\alpha = 1.7$ to $2.0$
- for swirl-chamber diesel engines: $\alpha = 1.5$ to $1.9$
- for prechamber diesel engines: $\alpha = 1.3$ to $1.6$

$L_0'$ is stoichiometric ratio, i.e. amount of air in kg theoretically required for burning 1 kg of fuel, kg/kg. For diesel fuel of average elementary composition (C = 0.87, H = 0.126, O = 0.004) $L_0' = 14.33$ kg/kg.

6.2.6 Permissible values of regulated opacity parameters for engines after thorough repair shall not exceed the values specified in Table 6.2.4 by more than 29%.
7 PREVENTION OF USE OF OZONE-DEPLETING SUBSTANCES

7.1 OZONE-DEPLETING SUBSTANCES AND THE MONTREAL PROTOCOL

7.1.1 The ozone-depleting substances listed in the Montreal Protocol are prohibited except hydrochlorofluorocarbons (HCFC) stated in Appendix C to the Montreal Protocol which can be used till January 1, 2020.

7.1.2 The ozone-depleting substances listed in the Montreal Protocol and equipment containing ozone-depleting substances when removing from ships shall be disposed according to the procedure established by normative documents of the Russian Federation.
CALCULATION METHOD OF SHIP’S NAVIGATION ENDURANCE DUE TO ENVIRONMENTAL SAFETY CONDITIONS

1. The navigation endurance is calculated for each ship. Navigation endurance may be calculated for a series of ships of the same design provided that the equipment and facilities installed in those ships, which may influence the ship’s environmental safety, are identical.

2. Navigation endurance is determined for the following pollutants:
   - oil-containing water (OCW);
   - sewage water (SW);
   - refuse (R).

3. For ships fitted with filtering equipment and sewage treatment plant complying with the requirements of the Rules, navigation endurance is taken as non-limited for those pollutants.

4. Navigation endurance for oil-containing water $T_{ocw}$ is calculated by the formula, in days:
   \[ T_{ocw} = 0.9 \frac{V_{ocw}}{Q_{ocw}}, \]  
   (A1.4)
   where $V_{ocw}$ is the volume of collecting tank for OCW, m$^3$. If no special tank for oil-containing water is provided, $V_{ocw}$ is determined as the volume of bilge space of the machinery spaces considering the requirements of 2.1.4 of the Rules or volume of portable tanks;
   $Q_{ocw}$ is the design daily accumulation of OCW, m$^3$/day, which depends upon the type of a ship and the power of main engines and is taken according to norms stated in Table A1.4.

\begin{table}
\centering
\caption{Design daily accumulation of oil-containing water $Q_{ocw}$, m$^3$/days}
\begin{tabular}{|c|c|c|}
\hline
Output of the main engines, kW & $Q_{ocw}$, m$^3$/days & \\
\hline
Transport vessels & & \\
\hline
Coast ships, auxiliary ships, crew boats, technical fleet vessels & & \\
\hline
Over 55 to 220 & 0.03 to 0.12 & 0.02 to 0.08 \\
\hline
$\leq 440$ & 0.12 to 0.18 & 0.08 to 0.14 \\
\hline
$> 440$ & 0.18 to 0.24 & 0.14 to 0.20 \\
\hline
$> 890$ & 0.24 to 0.30 & 0.20 to 0.25 \\
\hline
\end{tabular}
\end{table}

Notes. 1. For ships not older than 5 years an adjusting factor 0.8 may be applied.
2. For dynamically supported ships and high speed craft, $Q_{ocw}$ is taken for 0.07 m$^3$/day irrespective of the output and number of main engines.
3. For dredges, output of engines working on a soil pump or a scoop drive shall be taken as output of main engines.
4. In specific operating conditions along with $Q_{ocw}$ values stated in the Table other methods may be used which take into consideration specific character of operating conditions in a basin or at a shipowner.
5. For a ship for which the main engine output is within one of the intervals stated in the table, $Q_{ocw}$ is determined by linear interpolation of the tabulated data.

5. Navigation endurance for sewage water $T_{sw}$ is determined for all types of ships by the formula, in days:
   \[ T_{sw} = 0.9 \frac{V_{sw}}{Q_{sw}}, \]  
   (A1.5)
   where $V_{sw}$ is the volume of collecting tank for SW, m$^3$. 

\( Q_{sw} \) is the specific accumulation of sewage water for different types of vessels, m\(^3\)/person-day; it is stated in Table A1.5; 
\( n \) is a number of persons onboard.

**Table A1.5**

<table>
<thead>
<tr>
<th>Type of a ship</th>
<th>( Q_{sw} ), m(^3)/person-day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cruise and passenger vessels with all utilities in cabins</td>
<td>0.18</td>
</tr>
<tr>
<td>Passenger vessels with wash-stands in cabins and common shower-baths</td>
<td>0.14</td>
</tr>
<tr>
<td>Passenger vessels with wash-stands in cabins</td>
<td>0.12</td>
</tr>
<tr>
<td>Cargo vessels and tugboats with main engine power of 900 kW and above</td>
<td>0.12</td>
</tr>
<tr>
<td>Cargo vessels and tugboats with main engine power from 400 to 900 kW</td>
<td>0.09</td>
</tr>
<tr>
<td>Cargo vessels and tugboats with main engine power of below 400 kW</td>
<td>0.07</td>
</tr>
<tr>
<td>Passenger intracity fleet and high speed craft</td>
<td>0.09</td>
</tr>
<tr>
<td>Worksite craft and non-self-propelled manned vessels*</td>
<td>0.003</td>
</tr>
</tbody>
</table>

* For a dredge convoy the accumulation shall be calculated proceeding from a number of persons on board of all ships of the convoy.

Navigation endurance for sewage water shall not exceed six days with gradual filling the collecting tanks.

6 Navigation endurance for refuse \( T_r \) calculated by the formula, in days:

\[
T_r = 0.9 V_r/(Q_r n),
\]  
(A1.6)

where \( V_r \) is the volume for collecting facilities of dry refuse and food wastes, m\(^3\);

\( Q_r \) is the design daily accumulation of dry refuse and food wastes, m\(^3\)/person-day); it is stated in Table A1.6;

\( n \) is a number of persons onboard.

**Table A1.6**

(for reference)

<table>
<thead>
<tr>
<th>Type of pollutant</th>
<th>( Q_r ), m(^3)/person-day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry refuse</td>
<td>0.002</td>
</tr>
<tr>
<td>Solid food remains</td>
<td>0.0004</td>
</tr>
</tbody>
</table>

Notes: 1. \( Q_r \) is taken according to SanPin 2.5.2-703-98.
2. For technical fleet the daily accumulation shall be calculated proceeding from a number of persons on board of all ships of the dredge convoy.

7 For ships fitted with incinerators complying with the requirements of the Rules, navigation endurance for refuse is taken as non-limited for kinds of refuse to be destroyed in the incinerator.
APPENDIX 2
(normative)

NORMATIVE VALUES OF OIL-CONTAINING AND SEWAGE WATER TREATMENT ON INLAND AND RIVER-SEA NAVIGATION SHIPS OPERATED IN INLAND WATERWAYS

Table A2.1
Normative values of oil-containing water treatment

<table>
<thead>
<tr>
<th>Regulated parameters</th>
<th>TOW stations in passenger, transport vessels and technical fleet, installed</th>
<th>TOW stations in specialised waste treatment vessels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration of oil products, mg/l</td>
<td>10.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Table A2.2
Normative values of sewage water treatment

<table>
<thead>
<tr>
<th>Regulated parameters</th>
<th>TDSW stations in passenger, transport vessels and technical fleet, installed</th>
<th>TDSW stations on specialised waste treatment vessels, installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended particles, mg/l</td>
<td>max. 50</td>
<td>max. 40</td>
</tr>
<tr>
<td></td>
<td>» » 50</td>
<td>» » 40</td>
</tr>
<tr>
<td>BOD₅, mg/l</td>
<td>» » 1000</td>
<td>» » 1000</td>
</tr>
<tr>
<td>Coli index</td>
<td>1.5 to 3.0</td>
<td>1.5 to 3.0</td>
</tr>
<tr>
<td>Residual chlorine (for chlorine disinfection), mg/l</td>
<td>1.5 to 3.0</td>
<td>1.5 to 3.0</td>
</tr>
</tbody>
</table>