IRCLASS
Indian Register of Shipping

RULES AND REGULATIONS FOR THE CONSTRUCTION AND CLASSIFICATION OF **INLAND WATERWAYS VESSELS**

July 2024

General Information

1. This consolidated version of the 'Rules and Regulations for the Construction and Classification of Inland Waterways Vessels' (July 2024) supersedes the July 2023 edition of the Rules and includes the amendments published in the following :

    a) Rules Change Notice No.1 of March 2024

2. For ease of reference by the users, a summary of additions and amendments incorporated in the various Rule Change Notices (issued since July 2023) along with their effective dates are indicated in the respective tables.

3. This edition of the Rules also consists of amendments carried out subsequent to the publication of Rules Change Notice No.1 of March 2024. Such amendments are included in **Table 1**.

4. This Rule Book consists of various parts as follows:

    a) Part 1 – Regulations
    b) Part 2 – Inspection and Testing of Materials
    (This part is same as Part 2 of 'Rules and Regulations for the Construction and Classification of Steel Ships')
    c) Part 3 – General Hull Requirements
    d) Part 4 – Main and Auxiliary Machinery
    e) Part 5 - Special Ship Types

RULES AND REGULATIONS FOR THE CONSTRUCTION AND CLASSIFICATION OF INLAND WATERWAYS VESSELS – July 2023

RULES CHANGE NOTICE No. 1 – March 2024

TABLE – AMENDMENTS INCORPORATED IN THIS NOTICE

These amendments will come into force as indicated in the Table

Section / Clause	Subject/ Amendments
Part 1 Chapter 1: General *The amendments are applicable from 1 July 2024*	
2/ 2.19.1.11	Rule provisions related to laying up of vessels after being suspended are deleted.

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TABLE 1 – AMENDMENTS INCORPORATED IN THIS EDITION

These amendments will come into force as indicated in the Table

Section / Clause	Subject/ Amendments
Part 3 Chapter 13: Anchoring and Mooring Equipment *The amendments are applicable to vessels contracted for construction on or after 1 July 2024*	
3/ Table 3.3.1.1	The coefficient '*c*' is now also specified for vessels with deadweight less than 400 tonnes.
Part 4 Chapter 9: Fire Protection, Detection and Extinction *The amendments are applicable to vessels contracted for construction on or after 1 July 2024*	
3/ 3.2.1.5, 3.2.2.3.1	'Manual call points' are added to specify that both manual call points and fire detectors are to be grouped in fire detection sections.
3/ 3.2.2.2, 4/ 4.2.2, 4.3.2.6	Editorial changes are made for better clarity.
3/ 3.2.2.3.2	The phrase 'activated and indicated' is replaced with 'triggered', clarifying that fire detection systems are solely for fire detection and specific functions like door closing.
3/ 3.2.2.3.3	It is specified that fire detection systems are to be designed such that both manual call points and fire detectors can independently trigger fire alarms.
3/ 3.2.2.4.1	Design requirements for fire detection sections are better elaborated.
3/ 3.2.2.6, 3.2.3	Amendments made to allow 'manual call points' where fire detectors were required.
4/ 4.3.2.2	"K_2CO_3 (potassium carbonate)" is added as an approved extinguishing agent for permanently installed fire-fighting systems.
4/ 4.3.2.8	Amendments specify that in absence of requirements of national/local authorities, requirements of the FSS Code are to be complied with.
4/ 4.3.2.15 (new)	Requirements for fire-fighting systems using K_2CO_3 are specified.

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RULES AND REGULATIONS FOR THE CONSTRUCTION AND CLASSIFICATION OF **INLAND WATERWAYS VESSELS**

PART 1
REGULATIONS

July 2024

Indian Register of Shipping

Part 1

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Section 1

General Information

1.1 Indian Register of Shipping

1.1.1 Indian Register of Shipping (hereinafter referred to as "IRS") was incorporated in 1975 as a Public Limited Company under the Indian Companies Act for the purpose of providing amongst other things a faithful and accurate classification of mercantile shipping classed with it, to approve designs of, to survey and to issue reports on mercantile and non mercantile ships, hovercrafts, hydrofoils etc. all within the scope of classification described in the Rules. This Section contains General Regulations which have been adopted by IRS for its governance. The Classification regulations are given in Section 2.

1.1.2 The management of the affairs of IRS are carried out by the Managing Director (MD) and Jt. Managing Director (JMD), under the direction and control of the Board of Directors (hereinafter referred to as the 'Board'), in accordance with the provisions of its Memorandum and Articles of Association.

1.1.3 The Board of Directors shall consist of representative of the interests of various members of the Company and those concerned with shipping in general as under:

3	Directors representing Indian Shipowners
2	Directors representing Indian Shipbuilders
1	Director representing General Insurance Corporation of India and other Indian underwriters
1	Director being the Director General of Shipping, Ministry of Surface Transport, Govt. of India
1	Director representing Ship Design Research and Development Institutions
1	Director representing Manufacturers of Marine Engines/General Engineering Goods
1	Director representing Indian Navy/Coast Guard
1	Director being a person of eminence from the field of Law
3	Directors being persons of eminence from any industry allied with maritime activities
1	Managing Director being full-time employee appointed by the Board of Directors
1	Jt. Managing Director, where so appointed, being full-time employee, appointed by the Board of Directors.

The composition of the Board as above is to be in accordance with the Articles of

Association of IRS (as may be amended from time to time).

1.1.4 The Board shall consist of not less than six and not more than fifteen Directors. If the actual representation on the Board of Directors exceeds 15 Directors, the provisions of the Indian Companies Act would apply to approve the increase in the sanctioned strength of the Board beyond the limit specified in the Articles of Association of IRS. The Board of Directors shall elect one of its members to be Chairman of the Board of Directors. The reference to Chairman shall include Executive Chairman, where so appointed by the Board of Directors.

1.1.5 The Board is to appoint a Sub-Committee of Classification representing concerned interests.

1.1.6 The Board is to appoint the Chairman of the Sub-Committee of Classification and the Jt. Managing Director, IRS to be 'ex- officio' member of the Sub-Committee of Classification.

1.1.7 The employees of IRS are to be appointed by and be under the direction of the MD, except for Key Managerial Personnel (KMP), who would be appointed by the Board on the recommendation of the Nomination & Remuneration Committee.

1.1.8 The Surveyors of IRS are not to be permitted without the special sanction of the Board of Directors to receive any fee, gratuity or reward whatsoever, for their own use or benefit, for any service performed by them in their capacity as Surveyors to IRS, except on pain of immediate dismissal.

1.1.9 The Funds and Accounts are to be under the authority and control of the Board of Directors.

1.2 Fees

1.2.1 Fees will be charged for all surveys and for other services rendered by IRS or any of its publications in accordance with established scales. Traveling expenses incurred by the Surveyors in connection with such services are also chargeable.

1.3 Technical committee

1.3.1 The Board is to appoint a Technical Committee whose function will be to consider:-

a) Formulation of Technical Rules for Classification Surveys, building of ships, their machinery and equipment.

b) Important alterations to Rules once framed as may be required from time to time.

1.3.2 All decisions of the Technical Committee including amendments and/or additions to the Rules for classification surveys and building of ships' hull, their machinery and equipment to be reported to the Board of Directors.

1.3.3 The Technical Committee to be constituted as follows:

Number of Members of	Nominees/Representatives
3	Board of Directors of IRS
1	Maine Engine Unit of M/s. Garden Reach Ship-builders and Engineers Ltd.
1	Other Marine Engine Builders
6	Shipbuilders
2	Indian Institution of Naval Architects
2	Institute of Marine Engineers (India)
1	Company of Master Mariners
2	Directorate General of Shipping
1	IMU (Earlier NSDRC)
4	Indian National Shipowners Association
1	Institution of Engineers (India)
1	Ex-Officio – Executive Chairman of IRS or his nominee
1	Indian Coastal Conference Shipping Association
1	Oil Industry Safety Directorate

5	Indian Navy
2	Indian Coast Guard
1	Research Institutes
2	Indian Institute of Technology/ National Institute of Technology
2	Maritime Training Institutes
3	Other Flag Administrations
1	Inland Waterways Authority of India.

1.3.4 In addition to the foregoing, the Technical Committee may co-opt to the main body other members of high managerial positions in Shipping, Ship Building, Marine Engineering, Naval Architecture, Marine Insurance, Steel Making, etc.

1.3.5 Nomination of all members to the Technical Committee to be subject to confirmation by the Board.

1.3.6 The Technical Committee can appoint panels from amongst its body to which representatives of any organisation or industry or individuals specialised in relevant disciplines could be co-opted for the purpose of considering any particular Technical problem or area of Rules.

1.3.7 The Board of Directors to appoint biennially, the Chairman of the Technical Committee and the Technical Committee to appoint from their own body biennially a Vice-Chairman. The appointment of Vice-Chairman is to be confirmed by the Board of Directors.

1.3.8 The terms of office of all members is to be not more than four years, one-fourth of all members (including those co-opted) to retire at the end of each calender year. The members so retiring being those who have been longest in office since their last nomination and such members to be eligible for re-nomination for a second term. Unless specially so authorised by the Board of Directors, no member other than Chairman and/or Vice- Chairman, who has served for two periods of nomination, to be eligible for re-nomination. In the event of any vacancy occurring before the expiration of the normal term of office, a representative to be nominated to fill the vacancy from the same group/body/institution and for such nominee the date of his nomination by the respective body is to be considered as date of his joining the Technical Committee for purposes of his retirement by rotation.

1.3.9 The meeting of the Technical Committee is to be convened as often and at such time and place as may appear necessary, but there shall be at least two meetings in each year.

1.3.10 The members desiring to propose alterations in, or additions to the Rules for the classification, survey or building of ship (hull and machinery) shall give notice of such proposals to the Secretary. Every meeting to be convened by notice from the Secretary, if possible one month before the date of the meeting and the Secretary to send to each member an Agenda paper as soon as possible thereafter.
Proposals for changes to rules may also be given by Flag Administrations, shipowners, shipbuilders and other interested parties who may not be represented in the Technical Committee.

1.3.11 The quorum for any meeting of Technical committee will be six members, with at least 50% of the members present being those who do not represent shipowners, shipbuilders or others engaged commercially in the manufacture, equipping, repair or operation of ships.

1.3.12 In the event that any matter is not decided by unanimity, the same may be decided by a majority of votes cast in favor, with each member, including co-opted members, having one vote only. In the event of a parity of votes, the Chairman of the Technical Committee would be entitled to an additional casting vote.

1.3.13 When any discussion relates to an item of interest to those representing shipowners, shipbuilders or others engaged commercially in the manufacture, equipping, repair or operation of ships, such representatives would not be entitled to vote, if such matter is to be decided by voting.

1.3.14 In the event that any member of the Technical Committee absents himself for 3 consecutive meetings of the Technical Committee without seeking leave of absence, he would be deemed to have vacated office and his vacancy would be filled by seeking fresh nomination from concerned interest represented.

1.3.15 In the absence of the Chairman & the Vice Chairman of the Technical Committee, the members of the Technical committee shall elect a Chairman, by majority vote, to preside over that particular meeting only.

1.3.16 The Board of Directors reserves to themselves the right of altering, adding to or rescinding any/or all of the above terms of reference including the dissolution of the Technical Committee.

1.4 Survey reports

1.4.1 All reports of survey are to be made by the Surveyors according to the form prescribed and submitted for consideration of the Board or the Sub-Committee of Classification, but the character and notations assigned by the latter is to be reported to the Board. The Board may, in specified instances, vest in the Managing Director/ Jt. Managing Director discretionary powers to act on its behalf, and all such actions being reported to the Board at its subsequent meeting.

1.4.2 The reports of the Surveyors shall, subject to the approval of the Managing Director/Jt. Managing Director, be open to inspection of the Owner and any other person authorised in writing by the Owner. Copies of the reports will, subject to the approval of the Managing Director/Jt. Managing Director, be supplied to Owners or their representatives.

1.5 Register of Ships

1.5.1 A Register of Ships is available on-line on IRCLASS Website which contains the names of ships, character of class and notations assigned together with other relevant useful information for ships classed with IRS.

1.6 Liability

1.6.1 Whilst Indian Register of Shipping, a Classification Society, along with its subsidiaries and associates (hereinafter referred to as the Society) and its Committees use their best endeavours to ensure that the functions of the Society are properly carried out, in providing services, information or advice neither the Society nor any of its servants or agents warrants the accuracy of any information or advice supplied. Except as set out herein neither the Society nor any of its servants or agents (on behalf of each of whom the Society has agreed this clause) shall be liable for any loss damage or expense whatever sustained by any person due to any act or omission or error of whatsoever nature and howsoever caused of the Society its servants or agents or due to any inaccuracy of whatsoever nature and howsoever caused in any information or advice given in any way whatsoever by or on behalf of the Society, even if held to amount to a breach of warranty. Nevertheless, if any person uses services of the Society, or relies on any information or advice given by or on behalf of the society and suffers loss damage or expenses thereby which is proved to have been due to any negligent act omission or error of the Society its servants or agents or any negligent inaccuracy in information or advice given by or on behalf of the Society then the Society will pay compensation to such person for his proved loss up to but not exceeding the amount of the fee charged by the Society for that particular service, information or advice.

1.6.2 Any notice of claim for loss, damage or expense as referred to in 1.6.1 shall be made in writing to Head Office within six months of the date when the service, information or advice was first provided, failing which all the rights to any such claim shall be forfeited and the Society shall be relieved and discharged from all liabilities.

1.7 Access of Surveyor to vessels, shipyards or works

1.7.1 The Surveyors are to be given free access to vessels classed with IRS as well as to shipyards, works, etc. so as to perform their duties, and are to receive adequate assistance for this purpose.

1.8 Requirements for service suppliers

1.8.1 For requirements of approval of applicable service suppliers, refer to Part 1, Chapter 1, 1.9 of the *IRS Rules and Regulations for the Construction and Classification of Steel Ships*.

Section 2

Classification Regulations

2.1 General

2.1.1 The objective of vessel classification is to verify the structural strength and integrity of essential parts of the vessel's hull and its appendages; stability of the vessel; the reliability and function of the propulsion and steering systems; power generation and those other features and auxiliary systems which have been built into the vessel in order to maintain essential services on board.

2.1.2 These Rules and Regulations apply to vessels operating in inland waterways, i.e. lakes and rivers. Noting that waves are experienced in some large lakes and river mouths, these Rules provide for determination of scantlings based on the Zone Notation requested by the Builder or the Owners considering the wave height prevalent in the intended area of operation. (see 2.4 for definition of Zone Notation).

2.1.3 These Rules and Regulations may also be applied to vessels which are registered at sea ports under the Inland Vessels Acts of various State Governments or similar local Regulations. The scantlings of such vessels will be specially considered in each case but in general will not be less than that required for operation Zone 1.

2.1.4 When a vessel is assigned a specific Character of Class in Indian Register of Shipping, it implies that IRS has been satisfied that the said vessel meets, for this particular class, with these Rules and Regulations or requirements equivalent thereto. The vessel will continue to be classed with IRS so long as she is found, upon examination at the prescribed annual and periodical surveys, to be maintained in a fit and efficient condition and in accordance with the Periodical Survey requirements of these Rules. In general, classification will be conditional upon compliance with IRS requirements and assignment of character of class for both hull and machinery.

2.1.5 The Rules are framed on the understanding that vessels will be properly loaded and handled and that vessels will not be operated in environmental conditions more severe than those agreed for design basis and approval. They do not, unless stated in the class notation, provide for special distributions or concen-trations of loading.

2.1.6 Compliance to applicable Local/National Regulations in respect of the arrangements and equipment is a prerequisite for classification.

2.1.7 Where a vessel holds dual classification with IRS and the periodical survey requirements of the corresponding Society differ from those of the Rules of IRS, IRS may permit the requirements of the other Society being applied, in so far as they are equivalent in purpose or are no less stringent than the IRS rule requirements.

2.1.8 The classification of a vessel with IRS does not exempt the owners from compliance with any additional and/or more stringent requirements of statutory authority of the region where the vessel is registered or operating.

2.1.9 It is the responsibility of the Owners to ensure that the operating and maintenance instructions/manuals for the vessel machinery equipment essential to the safe operation of the vessel are available in a language understandable by those officers and crew members who are required to understand such information/ instructions in the performance of their duties.

2.2 Application of Rules

2.2.1 Unless directed otherwise by IRS, no new Regulations or amendments to the Rules relating to the character of classification or class notation is to be applied to the existing vessels.

2.2.2 Unless directed otherwise by IRS, all new Rules and Regulations or amendments to the existing Rules & Regulations become applicable 6 months after the date of issue. Where it is proposed to use existing previously approved plans for a new contract, written application is to be made to IRS.

2.3 Scope and process of classification

2.3.1 Classification covers vessel's hull, appendages and machinery including electrical systems to the extent as specified in these Rules & Regulations. Classification does not guarantee the design or performance of a vessel except for those aspects covered by the Rule requirements and subject to the conditions of operation of the vessel mentioned in 2.1.5.

2.3.2 The classification process consists of:

- A technical review of the design plans and related documents for a new vessel to verify compliance with the applicable Rules;

- Attendance at the construction of the vessel in the shipyard by IRS surveyor(s) to verify that the vessel is constructed in accordance with the approved design plans and classification Rules;

- Attendance by IRS surveyor(s) at the relevant production facilities that provide key components such as the steel, engine, generators and castings to verify that the component conforms to the applicable Rule requirements;

- Attendance by IRS surveyor(s) at the trials relating to the vessel and its equipment prior to delivery to verify conformance with the applicable Rule requirements;

- Upon satisfactory completion of the above, the builder's/ owner's request for the issuance of a class certificate will be considered by IRS and, if deemed satisfactory, the assignment of class may be approved and a certificate of classification issued;

- Once in service, the owner is to submit the vessel to a clearly specified programme of periodical class surveys, carried out onboard the vessel, to verify that the vessel continues to meet the relevant Rule requirements for continuation of class. A classification survey is a visual examination that normally consists of an overall examination of the items identified in the Rules for survey, detailed check of selected parts on a sampling basis and witnessing tests, measurements and trials where applicable.

- When a Surveyor identifies corrosion, structural defects or damage to hull, machinery and/ or equipment which, based on the Rules and in the opinion of the Surveyor, affects the Ship's class, remedial measures and/ or appropriate conditions of class are specified in order to retain class. Conditions of class are requirements to the effect that specific measures, repairs, surveys etc. are to be carried out within a specified time limit in order to retain class.

2.3.3 On application by Builder or Owner, certain installation, e.g. refrigerating machinery may be classed by IRS.

2.4 Interpretation of the Rules

2.4.1 The correct interpretation of the requirements contained in the Rules and other Regulations is the sole responsibility and at the sole discretion of IRS.

2.5 Definitions

2.5.1 **Type Notation** : A notation indicating that the vessel has been designed and constructed with applicable Rules to that type of vessel, e.g. FERRY, BULK CARRIER , etc.

2.5.2 **Cargo Notation** : A notation indicating that the vessel has been designed, modified or arranged to carry one or more particular cargoes, e.g. "Phosphoric Acid". Vessels with one or more particular cargo notations are not thereby prevented from carrying other cargoes for which they are suitable.

2.5.3 **Zone Notation** : A notation indicating that a vessel has been classed on the understanding that it will be operated in one of the zones described below :

Zone 1 : A zone where the significant wave height does not exceed 2.0 [m].

Zone 2 : A zone where the significant wave height does not exceed 1.2 [m].

Zone 3 : A zone where the significant wave height does not exceed 0.6 [m].

2.5.4 **Description**: A 'description' may be assigned to indicate the purpose or role of a vessel. In general, there would be no specific rule requirements to be complied with for assignment of a description. E.g. "Cutter Suction Dredger" can be assigned to describe the vessel type dredger.

2.6 Character of classification

2.6.1 The following Characters and symbols are assigned by IRS to indicate classification of Inland Waterways Vessels. (For explanation of abbreviations, see Appendix I).

2.6.2 Character **IWL** indicates that the hull and its appendages and equipment (i.e. anchors, chain cable and hawsers) meet the Rule requirements for assignment of this Character of Class.

Guidance Note : Appendages to the hull referred to in 2.6.2, 2.6.3 and 2.6.4 means the rudder & rudder stock, rudder horn, sole pieces, propeller nozzles, shaft brackets, skeg etc. which are covered by the rule requirements.

2.6.3 Character **IW (-)** indicates that the hull and its appendages meet the Rule requirements but equipment (i.e. anchors, chain cable and hawsers) is not supplied or maintained as per the relevant Rules but is considered by IRS to be acceptable for particular service.

2.6.4 Character **IW** indicates that the hull and its appendages meet the Rule requirements but where special consideration has been given for reason of particular purpose of service and normal equipment may be unnecessary. In such cases letter '**L**' is omitted from the Character **IWL**.

2.6.5 Character **IY** assigned to self-propelled vessels indicates that the machinery meets the rule requirements for assignment of this Character of Class.

2.6.6 The distinguishing mark 卐 inserted before Characters of Class (**IWL, IW (-), IW, IY** as appropriate) is assigned to new vessels where the hull and its appendages, equipment and the machinery, as appropriate are constructed under special survey of IRS in compliance with the Rules to the satisfaction of IRS.

2.6.7 The distinguishing mark 卐 inserted before a Character of Class (IWL, IW (-), IW, IY as appropriate), is assigned to vessels admitted into IRS Class during the course of construction and surveyed by an IACS Society.

2.6.8 The distinguishing mark 卐 inserted before a Character of Class (IWL, IW (-), IW, IY as appropriate), is assigned to vessels admitted into IRS Class at the time of delivery of the vessel and constructed under the survey of an IACS Society.

2.7 Class Notations - Hull

2.7.1 When requested by an Owner and agreed to by IRS or when considered necessary by IRS, a class notation will be appended to the character of classification. This class notation will consist of one of, or a combination of - a type notation, a cargo notation and a zone notation or a service restriction notation as given in 2.7.3 below, e.g. 卐 "IWL BULK CARRIER, Zone 1" .

2.7.2 Details of the vessel types and additional class notations are given in Appendix 1 and applicable Chapters in Pt.5 of the Rules.

2.7.3 For vessels described in 2.1.3 a service restriction notation will generally be assigned in the form given below, but this does not preclude the Owners or Vessel builders from requesting special consideration for other forms of restrictions.

SERVICE WITHIN IV LIMITS AT [...NAME OF SEA PORT...]

2.8 Notations and Requirements for High-Speed Vessels in Inland Waters

2.8.1 Requirements for high-speed vessels operating in Inland Waters are specified in this sub-section.

2.8.2 Where such vessels satisfy the high-speed criteria specified in Chapter 1, Section 2.2.27 of the IRS *Rules and Regulations for the Construction and Classification of High Speed Crafts and Light Crafts* (hereinafter referred to as the HSC & LC Rules), the notation '**HSLC**' would be assigned. Other fast crafts of light construction would be assigned '**LC**' notation, as defined in Chapter 1, Section 2.1.1b of the HSC & LC Rules. The vessels would also be assigned service restriction notations RS 2 and RS 3 (as indicated in HSC & LC Rules), as relevant and applicable.

2.8.3 Requirements in the following Chapters of the HSC & LC Rules may be applied to such vessels, as relevant and applicable:

a) Chapter 3: Materials of Construction

b) Chapter 4: Design Loads
c) Chapter 6: Structures: Steel and Aluminium

d) Chapter 7: General Requirements for Fibre Composite and Sandwich Constructions

2.8.4 For multi-hull and mono-hull crafts with 'HSLC' notation, the relevant requirements for stability in Chapter 5 (excluding clause 2.6.9), Annexure 5 and 6 of the HSC & LC Rules are to be complied with. Alternatively, passenger vessels with 'HSLC' notation may comply with the requirements of IRS Classification Notes *"Stability Requirements for Inland waterways Passenger Ships*".

2.8.5 High speed vessels are to comply with the requirements for machinery and electrical installations, as specified in Part 4 of these Rules.

2.8.6 Requirements of the local statutory authorities (if any) are also to be complied with for such vessels operating in inland waters. These include operational requirements to reduce the effects of wake wash (waves produced by the vessel due to its movement through water, especially in shallow waters) on other vessels, coastal users and the shoreline. The vessel's operational instructions are to include considerations based on identification of any areas likely to be affected by wake wash of the vessel and actions taken to reduce it (such as speed reduction, etc.).

2.9 Class notations – Vessel Type and Systems

2.9.1 The class notations that may be assigned by IRS are given in Appendix 1. IRS may prescribe additional notations as found necessary/expedient from time to time.

2.10 Materials

2.10.1 The materials used in the construction of hulls and machinery intended for classification, or in the repair of vessels already classed, are to be of good quality and free from defects and are to be manufactured and tested in accordance with the relevant Rules. The steel is to be manufactured by an approved process at works recognized by IRS. Alternatively, tests to the satisfaction of IRS will be required to demonstrate the suitability of the steel.

Consideration may be given by IRS to accept the works approved by IACS Member Societies with whom IRS currently has Cooperation Agreements for this purpose.

2.10.2 Certification of materials, components, equipment and machinery is carried out on basis of the following:

a) Type approval carried out by IRS.

b) Unit certification by IRS.

c) Alternative Certification Scheme by IRS (see Pt. 1, Ch.1 Sec. 4 of the *Rules and Regulations for the Construction and Classification of Steel Ships*).

2.10.3 Mutual recognition of certificates, if type approved by an IACS Member Society or European Union recognized organization based on commonly agreed design requirements under Mutual Recognition Scheme between IRS and the recognized organization, may also be used as basis for certification of materials, components, equipment and machinery.

2.11 Request for Surveys

2.11.1 It is the responsibility of the Builders or Owners, as applicable, to inform the Surveyors of IRS in the port at which surveys for supervision during new construction of vessels or vessels in service are to be undertaken and to ensure that all surveys necessary for the issue of class certificate for new construction, and maintenance of class are carried out at the proper time.

2.11.2 It is the responsibility of the Owner to ensure that all surveys necessary for the maintenance of class are carried out by due date. IRS will notify an Owner of upcoming surveys and outstanding Conditions of Class before their becoming overdue. The non-receipt of such notification, however, does not absolve the Owner from his responsibility to comply with survey requirements for maintenance of class.

2.12 Repairs

2.12.1 Any repairs to the hull, machinery and equipment either as a result of damage or wear and tear which are required for the maintenance of vessel's class are to be carried out under the inspection of and to the satisfaction of the Surveyors.

2.12.2 Where a vessel is damaged to an extent resulting in towage outside port limits, it shall be the Owners' responsibility to notify IRS at the first practicable opportunity.

2.12.3 Where such repairs are effected at a port where there is no Surveyor of IRS, the vessel is to be surveyed by one of its Surveyors at the earliest opportunity.

2.12.4 Where repairs to hull, machinery or equipment, which affect or may affect classification, are to be carried out by a riding crew, they are to be planned in advance. A complete repair procedure including the extent of proposed repairs and the need for Surveyor's attendance during the voyage is to be submitted to and agreed upon by the Surveyor reasonably in advance. Failure to notify IRS, in advance of the repairs, may result in suspension of the vessel's class.

Where in any emergency circumstance, emergency repairs are to be effected immediately, the repairs should be documented in the vessel’s log and submitted thereafter to IRS for use in determining further survey requirements.

2.13 Alterations

2.13.1 Any alterations proposed to be carried out to approved scantlings and arrangements of the hull, machinery or equipment are to meet with the approval of IRS and for this purpose plans and technical particulars are to be submitted for approval in advance. Such approved alterations are to be carried out under the inspection of, and to the satisfaction of, the Surveyors. If such alterations are carried out on items which may affect the classification of the vessel without informing IRS, the class of the vessel will be liable to be suspended except in the case of emergency repairs.

2.14 Classification of new constructions

2.14.1 The request for classification of new constructions is to be submitted to IRS by the shipyard or owner in the form provided by IRS. The request is to include complete details regarding class notation and statutory certificates required, where applicable. The IRS Rules in force on the date of contract for construction of the vessel (See 2.14) will be applicable for classification, in general. However, statutory requirements coming into force after the date of contract for construction may have to be complied with if they become applicable based on any other criteria such as the date on which vessel is constructed (keel laid).

2.14.2 Where orders for major machinery and equipment are placed on manufacturer or suppliers, IRS will have to be informed. Responsibility for compliance with IRS Rules and Regulations shall be with the manufacturers/suppliers. Where relevant, the date of application for certification of specific major machinery will also be considered in addition to the date of contract for construction of the vessel, for determining the applicable rules for such machinery.

2.14.3 Plans and particulars as specified in the Rules will have to be submitted to IRS sufficiently in advance of commencement of construction. A copy with stamp of approval will be returned. Any deviation from approved drawings will require to be approved by IRS prior to execution of work. IRS reserves the right to request for additional plans, information or particulars to be submitted. Where it is proposed to use existing previously approved plans for a new contract, written application is to be made to IRS. Approval of plans and calculations by IRS does not relieve the Builders of their responsibility for the design, construction and installation of the various parts, nor does it absolve the Builders from their duty of carrying out any alterations or additions to the various parts on board deemed necessary by IRS during construction or installation on board or trials.

2.14.4 IRS will assess the production facilities and procedures of the shipyard and other manufacturers as to whether they meet the requirements of the construction Rules. Review of the construction facilities prior to any steel work or construction shall be carried out under the following circumstances:

a) Where IRS has none or no recent experience of the construction facilities – typically after a one year lapse – or when significant new infrastructure has been added.

b) Where there has been a significant management or personnel re-structuring having an impact on the vessel construction process, or

c) Where the builder contracts to construct a vessel of a different type or substantially different in design.

2.14.5 During construction of a vessel, IRS will ensure by surveys that parts of hull and machinery requiring approval have been constructed in compliance with approved drawings, all required tests and trials are performed satisfactorily, workmanship is in compliance with current engineering practices and welded parts are produced by qualified welders.

2.14.6 All hull, machinery and electrical installations will be subjected to operational trials in the presence of IRS Surveyor.

2.14.7 On completion of the vessel copies of as-fitted plans showing the vessel as built, essential certificates and records, loading manual etc. are to be submitted by the Builder generally prior to issuance of the Interim Certificate of Class.

2.14.8 For each new construction the builder is required to prepare and deliver documents/ plans/ manuals etc. for facilitating the future inspection of survey, repair and maintenance as detailed in Pt.3, Ch.1, Sec.3. Some of these documents may be directly supplied by other parties e.g. owner. The documentation mentioned above are to be maintained onboard each vessel.

2.15 Date of contract for construction

2.15.1 The date of "contract for construction" of a vessel is the date on which the contract to build the vessel is signed between the prospective owner and the builder. This date and the construction numbers (i.e. hull numbers) of all the vessels included in the contract are to be declared to IRS by the party applying for the assignment of class to a new building.

2.15.2 The date of "contract for construction" of a series of vessels, including specified optional vessels for which the option is ultimately exercised, is the date on which the contract to build the series is signed between the prospective owner and the builder

For the purpose of this requirement, vessels built under a single contract for construction are considered a "series of vessels" if they are built to the same approved plans for classification purposes. However, vessels within a series may have design alterations from the original design provided:

a) Such alterations do not affect matters related to classification, or

b) If the alterations are subject to classification requirements, these alterations are to comply with the classification requirements in effect on the date on which the alterations are contracted between the prospective owner and the builder or, in the absence of the alteration contract, comply with the classification requirements in effect on the date on which the alterations are submitted to IRS for approval.

The optional vessels will be considered part of the same series of vessels if the option is exercised not later than 1 year after the contract to build the series was signed.

2.15.3 If a contract for construction is later amended to include additional vessels or additional options, the date of "contract for construction" for such vessels is the date on which the amendment to the contract, is signed between the prospective owner and the builder. The amendment to the contract is to be considered as a "new contract" to which 2.15.1 and 2.15.2 above apply.

2.15.4 If a contract for construction is amended to change the vessel type, the date of "contract for construction" of this modified vessel, or vessels, is the date on which revised contract or new contract is signed between the Owner, or Owners, and the builder.

2.16 Date of Build

2.16.1 The date of completion of the special survey inspection will normally be taken as the date of build to be entered in the Register Book.

Where there is a substantial delay between completion of construction survey and the vessel commencing service, the date of commissioning may be specified on the classification certificate.

When modifications are carried out on a vessel, the initial date of build remains assigned to the vessel.

2.16.2 When a complete replacement or addition of a major portion of the vessel (e.g. fwd. section, midship section or aft section) is involved, the following applies:

- Date of build assigned to each portion of the vessel will be indicated on the classification certificate, and the date of modification will be indicated in the Register Book.

- Survey requirements shall be based on the date of build associated with each major portion of the vessel.

2.17 Appeal from Surveyors' recommendations

2.17.1 If the recommendations of the Surveyors are considered in any case to be unnecessary or unreasonable, appeal may be made to IRS, who may direct a special examination to be held.

2.18 Certificates

2.18.1 Certificates of Class will be issued to Builders or Owners when the required reports on completion of Special Surveys of new vessels or of existing vessels submitted for classification have been received from the Surveyors and approved by IRS.

2.18.2 The Surveyors are permitted to issue Interim Certificates to enable a vessel, classed with IRS, to proceed on her voyage provided that, in their opinion, she is in a fit and efficient condition. Such Certificates will contain Surveyors' recommendations for continuance of Class, but in all cases are subject to confirmation by IRS.

2.18.3 Individual Certificates can also be issued for propelling machinery, boilers, equipments and fittings which have been manufactured under IRS Survey and in accordance with these Regulations.

2.18.4 It is the responsibility of the owner to ensure that the validity of class and statutory certificates is maintained.

2.18.5 IRS may consider requests for new construction vessels of less than 24 m in length for certification of compliance with the Rules without assignment and maintenance of classification. In such cases, IRS may issue a certificate of compliance (valid for one year from the date of issue) with the applicable design and construction requirements of the Rules, instead of a Class certificate. Such vessels would not be subjected to periodical surveys after construction.

2.19 Suspension / withdrawal and deletion of class

2.19.1 Suspension

2.19.1.1 The class of a vessel will be automatically suspended from the expiry date of the Certificate of Class or by the expiry date of any extension granted, if the special survey has not been completed by the due date and an extension has not been agreed to, or the vessel is not under attendance by the Surveyor with a view to complete the surveys prior to resuming service.

2.19.1.2 The class of a vessel will also be automatically suspended if the annual, intermediate survey become overdue unless the vessel is under attendance by the surveyor for completion of survey. (See Ch.2, Table 1.1.1 for due dates and window period). Where any vessel proceeds on trading voyage without having completed Surveyor’s recommendations which were required to be dealt with before leaving port, the ship’s class will be suspended.

2.19.1.3 When the surveys relating to specific additional notations of hull or equipment or machinery have not been complied with and thereby the vessel is not entitled to retain that notation, then the specific notation will be suspended till the related surveys are completed.

2.19.1.4 The class of a vessel will be subject to a suspension procedure if an item of continuous survey is overdue at the time of annual survey, unless the item is dealt with or postponed by agreement.

2.19.1.5 The class of the vessel will also be subject to a suspension procedure if conditions of class are not dealt with by the due date or postponed by agreement, by the due date.

2.19.1.6 The class of a vessel is liable to be withheld or, if already granted, may be withdrawn in case of any non-payment of fees or expenses chargeable for the service rendered.

2.19.1.7 Where any vessel proceeds with less freeboard than that approved by IRS or when the freeboard marks are placed higher on the vessel's sides than the position assigned or approved by IRS, the vessel's class will be suspended.

2.19.1.8 When it is found that a vessel is being operated in a manner contrary to that agreed at the time of classification, or is being operated in conditions or in areas more onerous than those agreed, the class will be suspended.

2.19.1.9 The class of a vessel will be liable to be suspended if the Owner fails to notify IRS of any damage to the vessel‘s hull, machinery or equipment, which may adversely affect classification of the vessel or subsequently fails to arrange for the survey as may be advised by IRS.

2.19.1.10 The class of a vessel will be suspended after a major casualty to the vessel, such as grounding, sinking or breaking up, if the Owner is unable to arrange for the vessel’s survey by IRS and commence repairs within a reasonable period of the occurrence of the casualty, unless otherwise agreed to with IRS. Procedures for withdrawal of class could be initiated unless the Owner is able to arrange for the ship’s survey by IRS and commence repairs within the agreed time period.

2.19.1.11 Vessels laid up in accordance with the Rules prior to surveys becoming overdue will not be suspended when surveys addressed above become overdue.

2.19.1.12 The ships class may be suspended if the owner does not implement the lay-up maintenance program and /or lay-up surveys (Ch.2, Sec. 1.2) are not carried out by due date.

2.19.1.13 Classification will be reinstated upon satisfactory completion of overdue survey. The scope of the overdue surveys will be based on the survey requirements applicable to the vessel at the original due date and not based on the age of the vessel when the survey is carried out. Such surveys will be credited from the date originally due. Such surveys will be credited from the date originally due. However, the vessel will remain dis-classed from the date of suspension until the date class is reinstated.

2.19.1.14 The Owners and the statutory authority, where applicable, would be informed in writing, of the suspension and reinstatement of Classification.

2.19.2 Withdrawal

2.19.2.1 Vessel’s class will be withdrawn, at the end of six months of suspension, if the Owner has not commenced any action to reinstate the vessel’s class. A longer suspension period may be granted in the following cases when the vessel is:

a) not trading and awaiting attendance for reinstatement of class; or

b) laid up; or

c) awaiting disposal, in the event of a casualty.

2.19.2.2 When the class of a vessel holding IRS class, is withdrawn by IRS in consequence of a request from the Owners, the notation "Class withdrawn at Owners' request" (with date) will be made in the Supplement and the notation "Class withdrawn - Owners' request" (with date) will be made in the next reprint of the Register of Ships. After one year, the notation will be altered to "Classed IRS until" (with date).

2.19.2.3 When the Regulations as regards surveys on the hull or equipment or machinery have not been complied with and the vessel thereby is not entitled to retain her class, the class will be withdrawn and the notation "Class withdrawn" (with date) will be made in the Supplement and the notation "IRS Class withdrawn" (with date) will be made in the next reprint of the Register of Ships.. This entry will continue till the vessel’s class is reinstated or deleted.

2.19.2.4 Procedure for withdrawal of class may be initiated if the vessel is found to be in breach of international sanctions or engaged in unlawful trading activities.

2.19.2.5 The withdrawal of a vessel will be confirmed in writing to the Owner and the statutory authority, where applicable.

2.20 Deletion of Class

2.20.1 A vessel will be considered to “cease to exist” when it is destroyed by recycling or by sinking to unsalvageable depths or abandoned by the owner.

2.20.2 A vessel can also be considered to “cease to exist” when it is broken up either by grounding or due to structural failure or due to actions of war or sabotage.

2.20.3 Vessel’s class will be deleted when it ceases to exist.

2.21 Reclassification of vessels

2.21.1 When Owners request for reclassification of a vessel for which the class previously assigned has been withdrawn, IRS will require a Special Survey for Reclassification to be held by the IRS Surveyors. The extent of the survey will depend upon the age of the vessel and the circumstances of each case.

2.21.2 If the vessel is found or placed in good and efficient condition in accordance with the requirements of the Rules and Regulations at the Special Survey for Reclassification, IRS may decide to reinstate her original class or assign such other class as considered appropriate.

2.21.3 The date of reclassification will appear in the supplement to the Register of Ships and the subsequent issue of Register of Ships.

Section 3

Classification of Vessels not built under the Supervision of Indian Register of Shipping

3.1 General procedure for classification of vessels not built under survey of IRS

3.1.1 Plans of hull and machinery, as listed in 3.2.1 to 3.2.5 or equivalent, together with torsional vibration calculations, where applicable, are to be submitted for approval. Alternative technical data in lieu of specific plans or items may be accepted. It is preferable to have the plans approved before the classification survey is commenced. In case of transfer of class from an IACS member society/ adding dual class with an IACS member society, only copies of plans or equivalent (as listed in 3.2.1 to 3.2.5) are to be submitted to IRS

3.1.2 Full special classification surveys would require to be carried out by IRS Surveyors in order to satisfy themselves regarding the workmanship and to verify the approved scantlings and arrangements. The scope of these surveys may, however, be modified in the case of vessels built under the Special Survey and holding valid certificates of class of established classification societies, if prior to commencement of survey by IRS, documentary evidence of all hull and machinery classification surveys held by the other society subsequent to last special survey carried out by them could be produced. In such cases, a special survey notation will not be assigned in conjunction with the classification survey. The next special survey therefore would become due five years from the special survey held by the other society and not five years from classification with IRS.

3.1.3 When the required reports on completion of such surveys have been received from the Surveyors and thereafter approved by IRS, they will be classed. Certificates of Class will be issued and entered in the Register of Ships with the relevant characters of class and notation, but the mark signifying the survey during construction will be omitted.

3.1.4 Once a vessel has been taken into IRS class, periodical surveys are subsequently to be held as per these rules.

3.2 Plans and data to be furnished

3.2.1 Generally following plans of hull and equipment showing the main scantling and arrangements of the actual vessel and any proposed alterations are to be submitted.

For approval

- Loading Manual, where required
- Midship section
- Longitudinal section and decks
- Shell expansion plan
- Transverse Bulkheads
- Sternframe
- Rudder and Rudder Stock
- Hatch Covers
- Fire detection, fighting and extinction and such other plans as may be requested.
- Loading instrument details
- Stability booklet
- Damage stability calculations, where required.

For information

- General arrangement
- Capacity plan
- Hydrostatic Curves.

3.2.2 It would normally be expected that particulars of the process of manufacture and testing of material of construction are furnished. Consideration will however be given to waiving this where such particulars are not readily available, provided it can be established that the relevant vessel has been originally built under special survey of an established classification society and continues to be so classed with an established classification society. In the case of vessels which have been originally built under the special survey of an established classification society but subsequently not maintaining class, it should additionally be possible to reasonably ascertain that no changes that would significantly affect the material specifications have taken place.

3.2.3 Following machinery plans together with the particulars of the materials used in the construction of the boilers, air receivers and important forgings should be furnished:

- Plans to be submitted in case of motorships
- For approval
  - Crank, thrust, intermediate and propeller shafting
  - Pumping and piping arrangements (diagrammatic) including sounding and air pipes
  - Steam pipes, arrangement and dimensions
  - Air receivers
  - Auxiliary boilers
  - Exhaust gas economiser
  - Electrical wiring including main switchboard.
- For information
  - General machinery lay-out

3.2.4 Where remote and/or automatic controls are fitted to propulsion machinery and essential auxiliaries, a description of the scheme is to be submitted, particulars are to be given of the spare gear carried for machinery and control gear.

3.2.5 Calculations of torsional vibration characteristics of the main propelling machinery are to be furnished specially for vessels which have been in service less than about 2 years.

3.2.6 In addition to the requirements of 3.2.1 to 3.2.5, additional plans would require to be submitted in accordance with applicable Chapters of Pt.5 of the Rules for vessels with additional class notations.

3.2.7 In cases where the vessel has been previously classed by IRS or a Classification Society subject to verification of compliance with IACS QSCS, the approval of plans may be specially considered subject to confirmation of no alteration/ modification to the vessel. In such cases, it is to be also verified that the vessel complies with any retroactively applicable classification or statutory requirements which came into effect subsequently.

Appendix 1
Table of Characters Class and Type Notations of IRS, their Expanded Form and Significance

Abbreviation	Significance
Characters Of Class	
IWL	Denotes vessels which are classed with Indian Register of Shipping for operation in Inland Waterways where the hull and its appendages and equipment (i.e. anchors, chain cables, hawsers) meet the Rule requirements.
IW (-)	Denotes vessels which are classed with IRS for operation in Inland Waterways where the hull and its appendages meet the Rule requirements but the equipment of vessel is not supplied or maintained as per the relevant Rules but is considered by IRS to be acceptable for particular service.
IW	Denotes vessels which are classed with IRS for Inland Waterways but where for reason of their particular purpose or service normal equipment may be unnecessary
IY	Denotes that for self-propelled vessels the machinery installation complies with the applicable requirements of Indian Register of Shipping
卐	This distinguishing mark inserted before a Character of Class is assigned to new vessels where the hull and its appendages, equipment and the machinery as appropriate, are constructed under special survey of IRS in compliance with the Rules to the satisfaction of IRS.

Appendix 1 – (Contd.)	
Abbreviation	**Significance**
	The distinguishing mark inserted before a Character of Class (IWL, IW (-), IW, IY as appropriate), is assigned to vessels admitted into IRS Class during the course of construction and surveyed by an IACS Society
	The distinguishing mark inserted before a Character of Class (IWL, IW (-), IW, IY as appropriate), is assigned to vessels admitted into IRS Class at the time of delivery of the vessel and constructed under the survey of an IACS Society
[ ]	When a Class Notation is enclosed within brackets, it indicates that applicable arrangements exist on board but the notation has been temporarily suspended.
Class Notations - Hull	
Zone 1	A zone where the significant wave height does not exceed 2.0 [m].
Zone 2	A zone where the significant wave height does not exceed 1.2 [m].
Zone 3	A zone where the significant wave height does not exceed 0.6 [m].
Specified Operating Area Service	Service within one or more geographical area(s) which will form part of the Class Notation.
"Strengthened for heavy cargoes"	This will be entered in the Register of Ships where the scantlings and arrangements have been approved for heavier cargo loadings in any hold filled up to the top of the hatch coaming with bulk cargo of density of at least upto 1.0 [t/m^3].
INWATER SURVEY	Denotes that the examination of the ship's bottom and related items may be carried out while the ship is afloat in accordance with the applicable requirements indicated in Pt.1, Ch.2.
TANK DESIGN 1	This additional class notation will be assigned to a vessel having a class notation “TANKER” and using pressure tank for carrying cargo.
TANK DESIGN 2	This additional class notation will be assigned to a vessel having a class notation “TANKER” and using closed tank for carrying cargo.
TANK DESIGN 3	This additional class notation will be assigned to a vessel having a class notation “TANKER” and using open tank with flame arresters for carrying cargo.
TANK DESIGN 4	This additional class notation will be assigned to a vessel having a class notation “TANKER” and using open tank for carrying cargo.
TANK TYPE 1	This additional class notation will be assigned to a vessel having a class notation “TANKER” and using independent tank for carrying cargo.
TANK TYPE 2	This additional class notation will be assigned to a vessel having a class notation “TANKER” and using integral tank for carrying cargo.
TANK TYPE 3	This additional class notation will be assigned to a vessel having a class notation “TANKER” and using tanks whose walls are distinct from outer hull of the vessel for carrying cargo.
EDD (X)	Denotes that the vessel/ structure complies with the requirements of the IRS Classification Note “*Extended Dry-Docking Scheme*”, and is fit for service with an extended interval of ‘X’ years between successive dry-dockings.

Appendix 1 – (Contd.)	
Abbreviation	**Significance**
Class Notations – Vessel Type and System	
BULK CARRIER	This notation will be assigned to vessels designed for the carriage of dry cargo in bulk and built in accordance with the applicable requirements of Pt.5, Ch.1 of the Rules for carriage of cargoes of density of at least 0.8 [t/m^3].
ORE CARRIER	This notation will be assigned to vessels specially designed for the carriage of Ore and built in accordance with applicable requirements of Pt.5, Ch.1 of the Rules.
TANKER	This notation will be assigned to vessels intended for carriage of bulk cargo in tanks built in accordance with applicable requirements of Pt.5, Ch.2 of the Rules.
TYPE N	This additional class notation will be assigned to a vessel having a class notation “TANKER” complying with the requirements of Part 5 Chapter 2, Section 5, 5.4 and other relevant rule requirements. In general, TYPE N tankers are intended for the carriage of flammable liquid and chemical cargoes in bulk.
TYPE C	This additional class notation will be assigned to a vessel having a class notation “TANKER” complying with the requirements of Part 5 Chapter 2, Section 5, 5.5 and other relevant rule requirements. In general, TYPE C tankers are intended for the carriage of flammable liquid and chemical cargoes in bulk.
TYPE G	This additional class notation will be assigned to a vessel having a class notation “TANKER” complying with the requirements of Part 5 Chapter 2, Section 6 and other relevant rule requirements. In general, TYPE G tankers are intended for the carriage of gases in bulk.
PASSENGER VESSEL	This notation will be assigned to vessels intended for the carry more than 12 passengers and built in accordance with Pt.5, Ch.3 of the Rules.
FERRY	This additional notation will be assigned to vessels on regular scheduled service.
RO-RO PAX	This additional notation will be assigned to a vessel having a class notation “PASSENGER VESSEL” intended for carriage of passengers and vehicles and built in accordance with Pt.5, Ch.3, Sec 6 of the Rules
PRM	This additional notation will be assigned to a vessel having a class notation “PASSENGER VESSEL” in which areas are provided for use by persons with reduced mobility, according to the provisions of Pt.5, Ch.3, Sec 7 of the Rules.
TUG	This notation will be assigned to all vessels built in accordance with applicable requirements of Pt.5, Ch.4 of the Rules.
BARGE	This notation will be assigned to non-self- propelled, manned or unmanned vessels carrying dry cargo in cargo holds and built in accordance with applicable requirements of Pt.5, Ch.5 of the Rules. For special purpose vessels, the Notation will be suitably modified, e.g. Shipborne Barge
PONTOON	This notation will be assigned to non-self- propelled, manned or unmanned vessels designed specifically for the carriage of non-perishable cargo or equipment on deck and built in accordance with the applicable requirements of Pt.5, Ch.5 of the Rules. For special purpose vessels, the Notation will be suitably modified, e.g. Crane Pontoon
LFPF(NG)(SFE) LFPF(NG)(DFE)	This additional class notation would be assigned, where the vessel is designed and constructed primarily for using natural gas as fuel, and complying with the requirements of IRS Classification Note “*Natural Gas Fueled Vessels for Coastal and Inland Waters”*. An additional qualifier will be assigned to identify the engine type used as follows: (SFE) – Single Fuel Engine (DFE) – Dual Fuel Engine

Appendix 1 – (Contd.)	
Abbreviation	**Significance**
LFPF(ML)(SFE) LFPF(ML)(DFE)	This additional class notation would be assigned, where the vessel is designed and constructed primarily for using methanol as fuel, and complying with the requirements of IRS "*Guidelines on Methanol Fueled Vessels"* An additional qualifier will be assigned to identify the engine type used as follows: (SFE) – Single Fuel Engine (DFE) – Dual Fuel Engine
BATTERY PROP	The additional notation BATTERY PROP will be assigned to vessels where the battery systems are used for propulsion and are in accordance with the 'Guidelines on Battery Powered Vessels'.
INDIAN INSHORE TRAFFIC CORRIDOR VESSEL	This notation will be assigned to Inland vessels engaged in operations in fair weather season during the fair weather; within 5 nautical miles from the base line or upto 2 meters of significant wave height condition, whichever is less. Such Inland vessels are to comply with the DGS Order 08 of 2018. The DGS Order 08 of 2018 stipulates minimum compliance criteria for issuance of "Statement of Compliance" (SOC).
INDIAN RIVER SEA VESSEL-TYPE 1	This additional notation will be assigned to vessels engaged in ship-to-shore operations at Indian ports beyond inland water limits of the said port, provided that such operation is carried out in fair weather and against a favorable weather forecast. Vessels falling under this Type, while engaged in ship-to-shore operations at an Indian port, shall operate within territorial waters of India. These vessels are covered by and are to comply with the DGS Order No.18 of 2013.
INDIAN RIVER SEA VESSEL-TYPE 2	This additional notation will be assigned to vessels engaged in operations between Indian ports in which the sea passage does not exceed that can be covered by a fully loaded vessel at the vessel's optimum speed in daylight hours, provided that such operation is carried out in fair weather and against a favorable weather forecast. Vessels falling under this Type shall, at all times, operate within the territorial waters of India. These vessels are covered by and are to comply with the DGS Order No.18 of 2013.
SELF ELEVATING PLATFORM	This notation will be assigned to self-elevating platforms operating in inland water ways, which are normally used for assisting in construction projects. The leg structure and associated items of these platforms are to comply with the requirements for *Rules and Regulations for the Construction and Classification of Mobile Offshore Drilling Units*. Self-elevating platforms that are self-propelled would be assigned additional qualifier 'SELF PROPELLED' and are to comply with the relevant requirements of these Rules.
HOPPER BARGE/ SPLIT HOPPER BARGE	The notation 'Hopper Barge' will be assigned to non-self-propelled vessels operating in Inland Waterways designed and constructed for the carriage and discharge of rocks, sand, spoil in the hopper. The notation 'Split Hopper Barge' will be assigned to vessels which are similar to hopper barges but with arrangements for discharging the spoil through the bottom of the ship by means of split hull, separated at the hinges using actuating devices. Requirements of Pt.5, Ch. 10 of the Rules and Regulations for the Construction and Classification of Steel Ships with appropriate reductions in external loads, as applicable to the vessel operating in Inland Waterways; are to be complied with.

End of Chapter

Chapter 2

Periodical Surveys

Contents

Section

Section 1

General Requirements

1.1 General

1.1.1 All vessels are to be subjected to Periodical Surveys for the purpose of maintenance of class. Survey notations and Survey intervals are given in Table 1.1.1 for main class Surveys.

1.1.2 Vessels with additional class notations for which there are no specific Survey requirements in this Chapter are to have the equipment and/or construction related to this additional class notation examined to the Surveyor's satisfaction at each Special Survey.

1.2 Laid up vessels

1.2.1 General

1.2.1.1 Vessels may be laid up when not carrying any cargo and not engaged in any commercial operation.

1.2.1.2 '*Hot lay-up*' means that the vessel is non-operational, with some of the machinery kept in operation for fast re-activation. This lay-up condition is relatively short term and may extend upto 12 months.

1.2.1.3 '*Cold lay-up*' means that the vessel is non-operational, with the machinery being shut down and the vessel being unable to be reactivated or brought to a state of readiness at short notice. This lay-up condition is relatively long term and may extend over 12 months.

Table 1.1.1 : Periodical Survey intervals for Main class notations

Survey	Main class Survey Notation	Survey interval in years
Special Survey; Hull	SSH	5
Special Survey; Machinery	SSM	5
Intermediate Survey	IS	2.5[1]
Annual Survey	AS	1[2]
Tailshaft Survey	TS	5
Auxiliary boilers	ABS	2.5[1]

1 Survey may be carried out between second and third annual surveys.
2 Survey may be carried out within 3 months on either side of the due date.

1.2.1.4 When a ship is laid-up, the normal survey requirements may no longer apply provided that IRS is notified by the Owner in advance and requirements for lay up as advised by IRS are complied with. The Owner is also to submit a lay-up maintenance program and details to IRS for approval.

1.2.1.5 A record of lay-up preparations, maintenance and preservation actions is to be maintained throughout the vessel's lay-up and re-activation. Humidity levels in machinery spaces are to be recorded on a regular basis during the lay-up period, together with scheduled equipment maintenance and operation.

1.2.1.6 The requirements of flag Administrations and port or maritime authorities regarding lay-up are also to be complied with

1.2.1.7 During lay-up, the vessel is also to comply with the following:

a) The vessel is to be adequately manned in accordance with the statutory requirements prevailing at the location of lay-up.

b) Adequate power is to be available on board to meet the following requirements, as applicable: -

- firefighting;
- bilge pumping;
- lighting;
- communication with shore;
- needs of crew on board, and
- operating anchor and mooring winches within a reasonable time.

The listed items are generally applicable for hot lay-up. For cold lay-up, arrangements may be specially considered.

1.2.2 Surveys during lay-up

1.2.2.1 Lay-up survey

.1 A lay-up survey is to be carried out at the beginning of the lay-up period to verify that the safety conditions, preservation measures, lay-up site and mooring arrangements are in accordance with the lay-up program approved by IRS.

.2 On successful completion of the survey, a lay-up status will be assigned by IRS.

1.2.2.2 Annual lay-up condition surveys

.1 A general examination of the hull and machinery is to be carried out in lieu of annual survey. An underwater examination is to be carried out in lieu of docking survey coinciding with special survey.

The purpose of the annual lay-up condition survey is to ascertain that the lay-up maintenance program is being continuously complied with and recorded in the lay-up record.

.2 The annual lay-up condition survey is to cover examination of hull integrity, firefighting arrangements, mooring arrangements, and other equipment in use depending on the type of lay-up.

1.2.3 Survey at re-activation

1.2.3.1 Vessels are to be surveyed and tested before re-entering service. On completion of the lay-up period, all outstanding class and statutory surveys are to be completed before the vessel returns to normal operation.

1.2.3.2 For vessels in hot lay-up, the scope of the reactivation survey is to include:

- a general examination of the hull, deck fittings, safety systems, machinery installations (including boilers whose survey is not due) and steering gear;

- all periodical surveys due at the date of re-activation or which became overdue during the lay-up period;

- dealing with the Conditions of Class due at the date of re-activation or which became due during the lay-up period.

Function testing of equipment would be specially considered.

1.2.3.3 The extent of the surveys and tests for vessels in cold lay-up will be considered in each case by IRS depending upon the time out of service, the maintenance and preservative measures taken during lay-up and the extent of surveys carried out during this time but, will at least include a sea trial for function testing of the machinery installation.

1.2.3.4 Upon satisfactory completion of the re-activation survey, the Class of the vessel will be revalidated.

1.3 Surveys for damage or alterations

1.3.1 At any time when a ship is undergoing alterations or damage repairs, any exposed parts of the structure normally difficult to access are to be specially examined, e.g. if any part of the propulsion or auxiliary machinery, including boilers, insulation or fittings, and tanks not forming part of the ship's structure, is removed for any reason, the steel structure in way is to be carefully examined by the Surveyor, or when cement in the bottom or covering on decks is removed, the plating in way is to be examined before the cement or covering is relaid.

1.4 Unscheduled Surveys

1.4.1 In the event that IRS has reason to believe that its Rules and Regulations are not being complied with, IRS reserves the right to perform unscheduled surveys of the hull or machinery.

1.5 Provision for surveys

1.5.1 The Surveyors are to be provided with necessary facilities for a safe execution of survey. In order to enable the attending surveyors to carry out the survey, provisions for proper and safe access, are to be agreed between the owner and IRS in accordance with confined space safe entry procedure of IRS and IMO Resolution A1050(27) 'Revised recommendations for entering enclosed spaces abroad ships', as amended. Details of the means of access are to be provided in the survey planning questionnaire. In cases where the provisions of safety and required access are judged by the attending surveyor(s) as not adequate, the survey of the spaces concerned would not be carried out.

1.5.2 Tanks and spaces are to be safe for access, i.e. gas freed, ventilated and illuminated.

1.5.3 In preparation for survey and thickness measurements, all spaces are to be cleaned including removal from surfaces of all loose accumulated corrosion scale. Spaces are to be sufficiently clean and free from water, scale, dirt, oil residues, etc. to reveal corrosion, deformation, fractures, damages or other structural deterioration. However, those areas of structure whose renewal has already been decided by the owner need only be cleaned and descaled to the extent necessary to determine the limits of renewed areas.

1.5.4 Sufficient illumination is to be provided to reveal corrosion, deformation, fractures, damages or other structural deterioration.

1.5.5 Means are to be provided to enable the Surveyor to examine the structure in a safe and practical way.

1.5.6 For surveys, including close-up survey where applicable, in cargo spaces and ballast tanks, one or more of the following means of access is to be provided:

(a) Permanent staging and passages through structures.

(b) Temporary staging and passages through structures.

(c) Lifts and movable platforms.

(d) Boats or rafts.

(e) Portable ladders may be used, at the discretion of the Surveyor.

1.5.7 Where soft coatings have been applied, safe access is to be provided for the Surveyor to verify the effectiveness of the coating and to carry out an assessment of the conditions of internal structures which may include spot removal of the coating. When safe access cannot be provided, the soft coating is to be removed.

1.5.8 A survey planning meeting is to be held prior to the commencement of Intermediate Survey and Special Survey.

1.6 Repairs

1.6.1 Any damage in association with wastage over the allowable limit (including buckling, grooving, detachment or fracture), or extensive areas of wastage over the allowable limits, which affects or, in the opinion of the Surveyor, will affect the ship's structural, watertight or weathertight integrity, is to be promptly and thoroughly repaired. Areas to be considered include (where fitted):

- side shell frames, their end attachments and adjacent shell plating;
- deck structure and deck plating;
- bottom structure and bottom plating;
- side structure and side plating;

- inner bottom structure and inner bottom plating;
- inner side structure and inner side plating;
- watertight or oiltight bulkheads;
- hatch covers and hatch coamings.

For locations where adequate repair facilities are not available, consideration may be given to allow the ship to proceed directly to a repair facility. This may require discharging the cargo and/or temporary repairs for the intended voyage.

1.6.2 Additionally, when a survey results in the identification of structural defects or corrosion, either of which, in the opinion of the Surveyor, will impair the ship's fitness for continued service, remedial measures are to be implemented before the ship continues in service.

1.7 Extension of Special Surveys

1.7.1 Under “exceptional circumstances”, IRS may grant an extension not exceeding 45 days to allow for completion of the special survey provided that the vessel is attended and the attending surveyor(s) so recommend(s) after the following has been carried out:

a) Annual Survey:
b) Re-examination of Condition(s) of Class;
c) In the case where dry docking is due prior to the end of the Class extension, an underwater examination is to be carried out by an approved diving company.

“Exceptional circumstances” means non-availability of dry docking facilities, non-availability of repair facilities, non-availability of essential materials, equipment or spare parts. It is the responsibility of the Owner to sufficiently plan in advance for repairs and/ or dry-docking to avoid occurrences of such “exceptional circumstances”.

Section 2

Hull Surveys

2.1 Special surveys (hull)

2.1.1 All ships classed with IRS are to undergo Special Surveys at 5 yearly intervals. The first Special Survey becomes due five years after the date of build or date of Special Survey for classification and the subsequent Special Surveys become due 5 years after the assigned date of the previous Special Survey.

2.1.2 The interval between the Special Surveys may be reduced at the request of the parties concerned or by IRS if deemed appropriate.

2.1.3 For surveys completed within 3 months before expiry date of Special Survey, the next period of class will start from the expiry date of the Special Survey. For surveys completed more than 3 months before the expiry date of the Special Survey, the period of class will start from the survey completion date.

2.1.4 The Special Survey may be commenced at the 4th Annual Survey and be progressed with a view to completion by the 5th Annual Survey.

2.1.5 Record of Special Survey will not be assigned until the Machinery Survey has been completed.

2.1.6 As part of the preparation for Special Survey, the thickness measurement and Survey Programme should be dealt with, in advance of the Special Survey. The thickness measurement is not to be held before the 4th Annual Survey.

2.1.7 Upon satisfactory completion of a Special Survey a record will be entered in the supplement to the Register of Ships indicating the month and the year in which the Survey is completed. In the case where a Special Survey is spread over a period and is not carried out at one time the date assigned for such a Survey will correspond to the date when the principal part of the Survey has been completed. IRS will decide when the principal part of the Survey is deemed to have been completed. Record of Special Survey will not be assigned until the engine Survey has been completed.

2.1.8 IRS may, at the request of the Owners, accept a Special Survey of hull on a continuous basis spread over a period of 5 years. Proposals for such continuous Surveys are to be submitted for the consideration of IRS. In general, approximately one fifth of the Special Survey is to be completed every year. All compartments of the hull should be opened for survey and testing in rotation such that not more than 5 years elapse between consecutive examination of each part.

2.2 Requirements of special surveys

2.2.1 General

2.2.1.1 Survey requirements

2.2.1.1.1 The requirements of intermediate survey are to be complied with as applicable. The ship is to be placed in drydock or on a slipway, cleaned and be at a sufficient height above the dockfloor or the ground for examination of shell plating, sternframe, rudders, etc. If necessary, proper staging is to be erected for this examination. Each rudder is to be lifted for examination of pintles if considered necessary by the Surveyor.

2.2.1.1.2 The holds, tween decks, deep tanks, peaks, bilges and drain wells, engine and boiler spaces, coal bunkers and other spaces are to be cleared out and cleaned as necessary and examined. Floor plates in engine and boiler spaces are to be lifted as may be necessary for examination of the structure underneath.

Where necessary close and spar ceiling, lining and pipe casings are to be removed for examination of the structure.

2.2.1.1.3 In ships with single bottom, a sufficient amount of close ceiling is to be lifted to enable examination of the structure below. The ceiling to be lifted is to comprise of at least two strakes on each side of centreline fore and aft and one of these strakes is to be in way of the bilges.

2.2.1.1.4 In ships having double bottom, a sufficient amount of ceiling is to be lifted from the tank top and the bilges to enable the condition of plating underneath to be ascertained. If the condition of the plating is found to be satisfactory, lifting of the remainder of the ceiling may be dispensed with. All bilges are to be cleaned for examination.

Where the inner bottom plating is covered with cement or asphalt the removal of such covering may be dispensed with provided it is found to be adhering properly to the plating when carefully examined by hammering and chipping.

2.2.1.1.5 All watertight bulkheads are to be examined.

2.2.1.1.6 The steelwork is to be exposed and cleaned as may be required for its proper examination by the Surveyor and close attention is to be paid to the parts of the structure which are particularly liable to excessive corrosion or to deterioration due to other causes.

2.2.1.1.7 The Surveyor may require to determine thickness of the material where wastage is evident. Any parts of the structure which are found defective or materially reduced in scantlings are to be made good by materials of approved scantlings and quality. Particular attention is to be paid to structure in way of discontinuities. Surfaces are to be re-coated as necessary.

2.2.1.1.8 Double bottom compartments, peak tanks and all other tanks are to be tested hydrostatically by a head sufficient to give the maximum pressure that can be experienced in service.

2.2.1.1.9 Tanks, forming part of the main structure, except as stated below, are to be thoroughly cleaned and examined internally, special attention being paid to the tanks under boiler spaces.

Tanks, other than the peak tanks, which are used exclusively for oil fuel or freshwater or lubricating oil in ships less than 15 years old need not be examined internally provided upon external examination and testing of the tanks, the Surveyor finds their condition to be satisfactory.

2.2.1.1.10 Spaces which are inaccessible for examination, e.g. low double bottom tanks, boxed in web frames, spaces under tanks not forming part of the ship's structure are to be examined externally and gauged as necessary. In case of doubt, openings are to be made in the structure for examination of the interior so that the Surveyor can satisfy himself as to the efficient condition of the structure.

2.2.1.1.11 All decks, casings and superstructures are to be examined. Attention is to be given to the corners of openings and other discontinuities in way of the strength decks and top sides.

Wooden decks or sheathings are to be examined and if decay or rot is found or the wood is excessively worn, the wood is to be renewed.

Attention is to be given to the condition of the plating under wood decks, sheathing or other deck coverings. If it is found that such coverings are broken, or are not adhering closely to the plating, sections are to be removed, as necessary, to ascertain the condition of the plating.

2.2.1.1.12 Where holds are insulated for the carriage of refrigerated cargoes and the hull in way was examined by IRS Surveyors prior to the fitting of the insulation, it will be sufficient to remove the limbers and hatches for examination of the structure in way. In all other cases additional insulation will require to be removed as considered necessary to enable the Surveyor to satisfy himself regarding condition of the structure.

2.2.1.1.13 The masts, standing rigging and anchors are to be examined. Chain cables are to be ranged for examination. Chain cables which are worn to 12 per cent or more of the original rule diameter are to be renewed.

The Surveyor should satisfy himself that there are appropriate mooring ropes on board and also that a towline is provided when this is a Rule requirement.

2.2.1.1.14 The steering gear, and its connections and control systems (main and alternative) are to be examined. The various parts of the auxiliary steering gear are to be assembled, examined and tested. The helm indicator is to be examined and tested.

2.2.1.1.15 The windlass, hand pumps and suctions, watertight doors, air and sounding pipes are to be examined. Whilst examining the tanks internally, the Surveyors are to ensure that striking plates are fitted under the sounding pipes .

2.2.1.1.16 The Surveyor should satisfy himself regarding the efficient condition of the following.

- Means of escape from machinery spaces, crew and passenger spaces and spaces in which crew are normally employed;

- Means of communication between bridge and engine room and between bridge and alternative steering position;

- Fire protection, detection and extinction arrangements.

2.2.1.1.17 When ships which are placed in drydock or on a slipway, the propeller(s), sternbushes, water inlets and outlets and gratings are to be examined. The clearance in each sternbush or the efficiency of each sterngland is to be ascertained.

2.2.1.1.18 Where any alterations are made to a vessel, which materially affect the stability, the vessel is to be re-inclined.

2.2.1.1.19 At special surveys, a lightweight survey is to be carried out on all passenger vessels to verify and record any changes in lightship displacement and longitudinal centre of gravity.

2.2.1.1.20 The vessel is to be re-inclined whenever, in comparison with the approved stability information, a deviation from the lightship displacement exceeding 2% or a deviation of the longitudinal centre of gravity exceeding 1% of the rule length is found, or anticipated.

2.2.1.2 Thickness Measurement

2.2.1.2.1 The general minimum requirements for thickness measurements for all ship types of length 24 [m] and above are given in Table 2.2.1.2.1. The Surveyor may extend the thickness measurements as deemed necessary. For vessels of less than 24 [m] in length locations for thickness measurements will be as decided by the Surveyor.

<table>
<tr><th colspan="4">Table 2.2.1.2.1 : Thickness Measurements – All Ship Types</th></tr>
<tr><th>Special Survey No. I
(Age ≤ 5 years)</th><th>Special Survey No. II
(5 < Age ≤ 10 years)</th><th>Special Survey No. III
(10 < Age ≤ 15 years)</th><th>Special Survey No. IV
(Age > 15 years)</th></tr>
<tr><td>Critical areas, as required by the Surveyors</td><td>Within the cargo area or 0.5L amidships:

- Selected deck plates
- One transverse section
- Selected bottom / inner bottom plates
- Selected side shell plates
- Selected hatch covers and coamings[1]
- Critical areas, as required by the Surveyor</td><td>Within the cargo area or 0.5L amidships:

- Each exposed deck plate
- Two transverse sections
- Selected tank top plates
- Each bottom / inner bottom plates
- All side shell plates
- Selected transverse and longitudinal cargo hold bulkheads[1]
- All hatch covers and coamings[1]
- Critical areas, as required by the Surveyor</td><td>Within the cargo area or 0.5L amidships:

- Each deck plate
- Three transverse sections [3]
- Each bottom / inner bottom / tank top plate
- All side shell plates
- All transverse and longitudinal cargo hold bulkheads[1]
- All hatch covers and coamings[1]
- Critical areas, as required by the Surveyor</td></tr>
<tr><td></td><td></td><td>Outside the cargo area:
- Selected side shell plates
- Selected bottom plates
- Nozzle plating in way of transverse thrust units</td><td>Outside the cargo area:
- Each deck plate
- Each side shell plate
- Each bottom plate
- Nozzle plating in way of transverse thrust units</td></tr>
<tr><td></td><td colspan="2">Collision bulkhead, forward machinery space bulkhead, aft peak bulkhead[1, 2]</td><td>All transverse and longitudinal bulk heads outside cargo area[1, 2]</td></tr>
<tr><td></td><td colspan="3">In engine room[2]
- Sea chests
- Sea water crossover manifold
- Duct keel or pipe tunnel plating and internals</td></tr>
<tr><td></td><td colspan="2"></td><td>Selected internal structure such as ballast tank, floor and longitudinals, transverse frames, web frames, deck beams, girders etc.</td></tr>
<tr><td colspan="4">Notes
1:Including plates and stiffeners.
2: When such bulkheads form the boundaries of dry void spaces or sea chests, etc. and are found in good condition, measurements may be waived or reduced after satisfactory visual examination,.
3: For vessels of length under 40[m], the number of transverse sections may be reduced at the Surveyor’s discretion.
4: In case of original tank coating being in good condition, scope of thickness measurement may be reduced at the Surveyor’s discretion.
5: In case of detected areas with substantial corrosion, extent of corrosion should be verified by means of 5 point pattern over 1 m^2 area.</td></tr>
</table>

2.2.1.2.2 Thickness measurements may be carried out in the 12 months preceding the due date of the Special Survey or when the Special Survey is postponed in the 12 months preceding the revised Special Survey due date.

2.2.1.2.3 In areas where substantial corrosion (defined as wastage of individual plates and stiffeners in excess of 75 per cent of allowable margins, but within acceptable limits) has been noted, additional measurements are to be carried out, as deemed necessary by the attending Surveyor.

2.2.1.2.4 Where substantial corrosion is identified and not rectified, this will be subject to re-examination and gauging as necessary at Intermediate Surveys.

2.2.1.2.5 At each Special Survey, thickness measurements are to be taken in way of critical areas, as considered necessary by the Surveyor. Critical areas are to include locations throughout the ship that show substantial corrosion and/or considered prone to rapid wastage or erosion.

2.2.1.2.6 Where a 10 per cent area reduction of deck plating and longitudinals is exceeded, a check of the buckling capacity of the upper deck is to be carried out for all tankers.

2.2.2 Special survey of ships over 15 years old

2.2.2.1 In addition to the full requirements as stipulated in 2.2.1 the following are to be complied with.

2.2.2.2 In ships having a single bottom, a sufficient amount of ceiling is to be lifted to allow the examination of the structure underneath. The lifting of the ceiling is to comprise of at least three strakes all fore and aft on each side and one such strake on each side to be in way of the bilges. Where the ceiling is fitted in hatches, the whole of the hatches and at least one strake of planks in way of the bilges on each side are to be lifted. If the Surveyor considers it necessary the whole of the ceiling and the limber boards are to be lifted.

2.2.2.3 In ships with double bottom, sufficient amount of ceiling is to be lifted for the examination of the inner bottom plating, pillar feet bottom plating of bulkheads, tunnel side plating and the structure in way of the bilges. If the Surveyor considers it necessary the whole of the ceiling is to be lifted.

2.2.2.4 Chain locker is to be cleaned and examined internally.

2.2.2.5 The thickness of bottom plating in way of cement is to be ascertained unless the Surveyor, after an internal and external examination, is entirely satisfied that this is unnecessary. Selected portions of cement are to be removed from the bottom and bilge if required by the Surveyor.

2.2.3 Tankers

2.2.3.1 The requirements of 2.2.1 and 2.2.2 are to be complied with as applicable.

2.2.3.2 The survey is to include the inspection of pump-rooms, cargo, bunker and vent piping systems on deck and in pumprooms, and also pressure/vacuum valves and flame arresters

2.2.3.3 All cargo tanks and cofferdams are to be thoroughly cleaned and cleared of gas at each Special Survey before inspection and every precaution is to be taken to ensure safety during inspection. Access is to be arranged to any part of the tank as considered necessary by the Surveyor to enable him to ascertain the condition of the structure within the tanks.

2.2.3.4 Attention is to be given to the inside of the bottom plating for excessive pitting and where extensive pitting is found requisite renewals or repairs are to be carried out to preserve the longitudinal strength of the bottom.

2.2.3.5 The strums of the cargo suction pipes are to be removed to facilitate examination of the shell plating and bulkheads in that vicinity, unless other means for visual inspection of these parts are provided.

2.2.3.6 Where fitted, anodes in tanks and cofferdams within the cargo tank spaces are to be examined together with their attachments to the structure. The condition of internal coatings, if applied, is to be examined.

2.2.3.7 All cargo tanks are to be tested at Special Surveys by filling the tanks with liquid to the top of the hatch coaming. Tanks may be tested when the ship is afloat provided the internal examination of the bottom is also carried out afloat.

2.2.3.8 Where extensive repairs have been effected to the shell plating or bulkheads, the tanks should be tested to Surveyor's satisfaction.

2.2.3.9 Where corrosion control arrangements have been adopted, satisfactory evidence of continued effectiveness is to be verified.

2.2.4 Tankers with cargo tanks independent from the ship's structure

2.2.4.1 The requirements of 2.2.1, 2.2.2, 2.2.3.3, 2.2.3.6 and 2.2.3.7 are to be complied with so far as applicable.

2.2.4.2 Special attention is to be paid to the ship's structure underneath the cargo tanks and the supports, securing arrangements, etc. of these tanks.

2.2.4.3 All cargo tanks are to be tested by filling the tanks with liquid to the top of the hatch coaming. Cofferdams and cargo tanks of tankers of Type G, C and N, are to be pressure tested with liquid to the top of the hatch coaming.

2.2.4.4 The requirements of 2.2.1.2 are to be complied with for the hull structure at Special Survey II (ships 10 years old) and at each Special Survey thereafter. In order to determine the general diminution in thickness, cargo tanks independent from the ship's structure are to be gauged.

The gauging is to be done in at least one place on each tank (in two places on each tank over 20 [m] in length) in each strake of bottom, forward and aft, side and top plating. The remainder of the plating is to be gauged as deemed necessary by the Surveyor, taking into account the results of gauging already carried out.

2.3 Intermediate surveys

2.3.1 Preparations for Survey

2.3.1.1 The ship is to be brought in to light condition for internal and external examination afloat. All ships operating at sea ports and other ships over 20 years of age are to be examined in drydock or on a slipway. In the case of ships over 20 years old and not operating at sea ports this requirement may be waived, if following an internal examination, the Surveyor is satisfied as to the efficient condition of the underwater part of the shell.

2.3.1.2 When the ship is in dry dock or on a slipway, it is to be at a sufficient height above the dock floor or the ground for examination of shell plating, sternframe, rudder(s), etc. If necessary proper staging is to be erected for this examination. Each rudder is to be lifted for examination of pintles if considered necessary by the Surveyor.

2.3.1.3 The decks, hatchways with beams and covers are to be cleared for examination.

2.3.1.4 The steering gear and auxiliary steering gear are to be prepared for examination and testing.

2.3.1.5 Tankers of Type G, C and N, when submitted for the survey are to be thoroughly cleared of gas.

2.3.1.6 Stream anchor, when provided, is to be prepared for examination and testing.

2.3.1.7 Alternatively, in-water survey in lieu of surveys in dry dock or on a slipway may be considered for ships operating at sea ports. Eligibility conditions and survey requirements for assignment of INWATER SURVEY class notation would be in accordance with Part 1, Chapter 2, Section 7, 7.2 of the *Rules and Regulations for the Construction and Classification of Steel Ships.*

2.3.2 Survey Requirements

2.3.2.1 The Surveyor is to examine the ship afloat in light condition internally and externally, for so far as necessary in order to satisfy himself as to the efficient condition of the hull structure.

2.3.2.2 It may be necessary for the Surveyor to require the ship to be dry-docked or placed on a slipway for a more detailed inspection, if the afloat examination gives rise to doubts about the condition of the underwater structure or of tanks and cofferdam spaces.

2.3.2.3 When the ship is placed in dry dock or on a slipway, the Surveyor is to examine the shell plating, the sternframe, rudder(s), etc. and attention is to be given to those underwater parts of the ship particularly liable to deterioration due to excessive corrosion or to damage by contact with other vessels, quay walls or from causes such as chafing, touching or lying on the ground and to any undue unfairness of bottom plating, especially in transversely framed ships.

2.3.2.4 The Surveyor is to thoroughly examine the following parts and also ensure the efficient condition of their respective closing appliances:-

a) Inert gas plant overboard discharge when passing through the shell, so far as practicable.

b) Vent piping, including that of inert gas installation, where applicable, within cargo tank area together with associated flame arresters and pressure/vacuum valves and cargo and bunker deck piping of tankers.

c) Watertight bulkhead penetrations as far as practicable.

d) Hatchways with beams and covers, deck houses and companionways together with any closing appliances.

e) Scuppers and sanitary discharges so far as practicable, bulwarks and guard rails.

f) Wheelhouse elevation arrangements (if provided).

2.3.2.5 Gasketted steel hatch covers to be tested or alternatively proven tight.

2.3.2.6 All watertight doors in watertight bulkheads, to be examined and tested (locally and remotely) as far as practicable.

2.3.2.7 Surveyor is to satisfy himself regarding the efficient condition of the fire protection, detection and extinction arrangements.

2.3.2.8 Anchoring and mooring equipment is to be examined as far as is practicable. When chain cables are ranged, the anchors and cables are to be examined by the Surveyors.

2.3.2.9 All main and auxiliary steering arrangements and their associated equipment and control systems are to be examined and tested.

2.3.2.10 The various parts of the auxiliary steering gear are to be assembled to ascertain that the gear is in good and workable condition. Auxiliary steering gear of the mechanically driven type is to be examined and tested to demonstrate that, if the power for the main steering gear fails, the auxiliary gear can be put into operation immediately.

2.3.2.11 The Surveyor is to examine and test bow rudder installations when they are an essential part of the steering arrangement. Opening up the gear may be required if deemed necessary by the Surveyor in view of the condition or the testing of the gear.

2.3.2.12 Where rod and chain steering gear is fitted, attention is to be paid to all parts of rod and chain gears. All pins are to be examined and the chain in the vicinity of the blocks is to be cleaned and examined for wear and tear. Any length of chain so worn that its mean diameter at its most worn part is reduced by 12 per cent or more from its Rule diameter, is to be renewed. All replacements of chains are to be subjected, at approved Works, to the proof tests required for short link cables by the Rules and the certificates are to be produced. It is recommended that, in addition, a breaking test be applied to these chains.

2.3.2.13 It is recommended that repaired chains be tested by the repairers and a certificate to that effect produced.

2.3.2.14 All the means of communication between the navigating bridge and the machinery control positions, as well as the bridge and the alternative steering position, if fitted, are to be tested.

2.3.2.15 On tankers of type G, C and N Closed and N Open with flame arrestors, pump rooms, cargo, bunker and vent piping systems on deck and in pump rooms, pressure/vavuum valves and flame arresters and electrical installations are also to be inspected including verification of:

a) The efficiency of any safe type equipment fitted;

b) Insulation resistance.

c) Tests are to be carried out to demonstrate the effectiveness of earth bonding straps, where fitted.

d) Inert gas system including alarms and safety devices, is to be tested to demonstrate that it is in good working condition.

2.4 Annual surveys

2.4.1 General

2.4.1.1 The Surveyor is to satisfy himself regarding the efficient condition of the following :

a) Hatchways on freeboard and superstructure decks, ventilator and air pipe coamings, exposed casings, skylights, deckhouses and companionways, superstructure bulkheads, side scuttles and deadlights, together with all closing appliances.

b) Means of ensuring weathertightness of steel hatch covers by hose test if deemed necessary.

c) Scuppers and sanitary discharges with valves; guard rails and bulkwarks; freeing ports, gangways and lifelines.

d) Freeboard marks.

e) General examination of machinery and steering gear.

f) Vent piping, including that of inert gas installations, where applicable, within cargo tank area, together with associated flame arresters and pressure/vacuum valves, also cargo and bunker deck piping of tankers.

2.4.1.2 Additionally, following is to be examined in case of tankers :

a) The efficiency of any safe type equipment fiited.

b) The insulation resistance.

c) Effectiveness of earth bonding straps, where fitted.

d) General examination of inert gas system; flame arresters, pressure/vacuum valves; cargo and bunker piping.

2.4.2 Passenger Ships

2.4.2.1 The ship is to be examined afloat in light condition internally and externally, as far as practicable.

2.4.2.2 It may be necessary to dry-dock the ship or place it on a slipway for a more detailed examination, if the afloat examination gives rise to doubts as to the condition of the underwater structure or of tanks and cofferdam spaces.

2.4.2.3 Where the ship is placed in dry dock or on a slipway, the shell plating, the stern frame, rudder(s), etc. are to be examined and attention is to be given to those underwater parts of the ship particularly liable to deterioration due to excessive corrosion or to damage by contact with other vessels, quay walls or from causes such as chafing, touching or lying on the ground and to any undue unfairness of bottom plating especially in transversely framed ships.

2.4.2.4 The efficient condition of the following is to be confirmed, where applicable:

(a) Hatchways with beams and covers, deck-houses and companionways together with any closing appliances.

(b) Scuppers and sanitary discharges so far as practicable, bulwarks and guard rails.

2.4.2.5 Steering arrangements are to be generally examined. The various parts of the auxiliary steering gear are to be assembled to ascertain that the gear is in good and workable condition. Auxiliary steering gear of the mechanically driven type is to be examined and tested to demonstrate that, if the power for the main steering gear fails, the auxiliary gear can be put into operation immediately.

2.4.2.6 Bow rudder installations are to be examined and tested when they are an essential part of the steering arrangement. Opening up the gear may be required if deemed necessary by Surveyors in view of the condition or the testing of the gear.

2.4.2.7 When chain cables are ranged, the anchors and cables are to be examined.

2.4.2.8 The efficient condition of the fire protection, detection and extinguishing arrangements is to be confirmed, as far as practicable.

Section 3

Machinery Surveys

3.1 Special Surveys

3.1.1 General

3.1.1.1 The Machinery Special Survey becomes due five years from the date of build or from the last Machinery Special Survey (SSM).

3.1.2 Requirements of survey

3.1.2.1 Main engines of internal combustion type

3.1.2.1.1 The following parts are to be opened out and examined. These should include all cylinders, cylinder heads, covers valves and valve gear, pistons, piston rods, cross heads, guides, connecting rods, crankshafts, vibration dampers and all bearings, bedplates, camshafts and driving gear, fuel pumps and fittings, scavenge pumps, scavenge blowers and their prime movers, superchargers, air compressors, intercoolers, clutches, reverse gears, crankcase door fastenings and explosion relief devices and such other parts of the machinery as may be considered necessary. Integral piping systems are to be examined. The manoeuvring of engines is to be tested under working condition. In case of multi-engine installations, alternative survey proposals may be considered by IRS.

3.1.2.2 Reduction gears, flexible couplings and clutch arrangements

3.1.2.2.1 Reduction gears, flexible couplings and clutch arrangements are to be opened as considered necessary by the Surveyor in order to permit the examination of the gears, gear teeth, spiders, pinions, shafts and bearings, reversing gears, etc.

3.1.2.3 Shafting

3.1.2.3.1 All shafts, thrust block(s) and all bearings and their seating are to be examined. The lower halves of bearings need not be exposed if alignment and wear are found acceptable.

3.1.2.4 Auxiliary machinery

3.1.2.4.1 All auxiliary machinery for essential services is to be examined as considered necessary by the Surveyor. Opening of machinery may be required if considered necessary by the Surveyor. Alarms and safety devices fitted on these units are to be included in this Survey. The machinery is to include the following :

- Auxiliary engines, air compressors together with all attached coolers, filters and/or oil separators and safety devices, and all pumps and components used for essential services.;
- Steering machinery;
- Windlass(es) and associated driving equipment, where fitted. Opening up may be required by surveyor depending upon the trial results or the condition of certain components.

3.1.2.5 Securing arrangements

3.1.2.5.1 Holding down bolts and chocks of main and auxiliary engines, gear cases, thrust blocks and tunnel bearings are to be checked.

3.1.2.6 Boiler surveys

3.1.2.6.1 At each Survey, the boilers are to be examined internally (water/steam side) and externally (fire side) as considered necessary.

3.1.2.6.2 Principal boiler mountings and safety valves are to be examined at each Survey. The remaining mountings are to be opened if considered necessary by the Surveyor. Manhole and handhole doors, are to be examined to ensure that the joining faces are in good condition and that the clearances at the spigot are satisfactory.

3.1.2.6.3 In case where it is considered necessary, the parts subjected to pressure are to be hydraulically tested and the thickness of plates and size of stays ascertained to determine the safe working pressure. Collision chocks, rolling stays and boiler stools are to be examined and maintained in efficient condition. The shell plating in way of welded lugs or fabricated feet are to be carefully examined at each Survey. Insulation and sheathing in way are to be removed as considered necessary for this purpose.

In fired boilers employing forced circulation the pumps used for this purpose are to be opened and examined at each boiler Survey.

3.1.2.6.4 The proper operation of the water level indicators and safety devices are to be confirmed at each Survey and the boiler is to be examined under steam and its safety valves are to be adjusted to a pressure not greater than 3 per cent of the approved working pressure. The oil fuel burning system is to be examined under working conditions and a general examination made of the fuel tank valves, pipe, deck control gear and oil discharge pipes between pumps and burners.

3.1.2.7 Survey of steam pipes

3.1.2.7.1 Steam pipes are to be surveyed as part of special surveys of machinery or continuous surveys of machinery.

3.1.2.7.2 At each Survey a selected number of steam pipes over 75 [mm] external diameter and with bolted joints are to be removed for internal examination and are to be tested hydraulically to 1.5 times the working pressure. If these are found satisfactory, the remaining need not be tested. As far as practicable, the pipes are to be selected for examination and hydraulic test in rotation so that in the course of surveys all sections of the pipeline will be tested. In cases of pipes having welded joints, the lagging in way of the welds is to be removed and the welds examined and if considered necessary crack detected.

3.1.2.7.3 Any copper or copper alloy pipes, such as those having expansion or other bends, which may be subjected to bending and/or vibration, are to be annealed before being tested.

3.1.2.8 Air receivers and starting air pipes

3.1.2.8.1 All air receivers and other pressure vessels for essential services together with their mountings and safety devices are to be cleaned internally and examined internally and externally. If an internal examination of an air receiver is not practicable it is to be tested hydraulically to 1.3 times the working pressure.

3.1.2.8.2 Selected pipes in the starting air systems are to be removed for internal examination and hammer tested. If an appreciable amount of lubricating oil is found in the pipes the starting air system is to be thoroughly cleaned by steaming or other suitable means. Some of the pipes selected are to be those adjacent to the starting air valves at the cylinders and to the discharges from the air compressors.

3.1.2.9 Pumping and piping system

3.1.2.9.1 The valves, cocks and strainers of the bilge system including bilge injection are to be opened up as considered necessary by the Surveyor and, together with pipes, are to be examined and tested under working conditions. Non-metallic flexible expansion pieces in the main salt water circulating system are to be examined. If non-return valves are fitted in hold bilges, these be opened up for examination. The fuel oil, feed, lubricating oil and cooling water systems, also the ballast connections and blanking arrangements to deep tanks which may carry liquid or dry cargoes, together with all pressure filters, heaters and coolers used for essential services, are to be opened up and examined or tested, as considered necessary by the Surveyor. All safety devices for the foregoing items are to be examined.

3.1.2.9.2 The upper deck cargo loading and discharge pipe lines in tankers are to be subjected to a pressure test of 1.1 times the approved maximum working pressure with a minimum of 10 Bar.

3.1.2.10 Control systems

3.1.2.10.1 Where remote controls such as bridge controls, bilge controls and bilge level alarms, local hand controls, fire detection and prevention, alarms warning systems and shut-offs, electric supply, main controls station, are fitted for essential machinery, they are to be examined and tested to demonstrate that they are in good working order.

3.1.2.10.2 During such trials the proper operation of the safety devices will be checked, in particular, such as emergency stops, emergency astern movement, standby control of the propelling gear, fire alarm.

3.1.2.10.3 The cargo vapour detection and alarm systems in tankers are to be examined, calibrated and tested to demonstrate that they are in good working order.

3.1.2.10.4 On vessels fitted with a dynamic positioning system, the control system and associated machinery items are to be examined and tested under working conditions.

3.1.2.11 Electrical equipment survey

3.1.2.11.1 Electrical installations including auxiliary and emergency equipment are to be examined in accordance with the following during each Survey cycle.

3.1.2.11.2 Switch boards (including for emergency use) and their accessories including section-boards and sub-division fuse boards are to be examined as far as possible and over current protective devices and fuses inspected to verify that they provide suitable protection for their respective circuits.

3.1.2.11.3 All generator circuit breakers are to be tested, as far as practicable, to verify that the protective devices including preference tripping relays, if fitted, operate satisfactorily. The generators are to be run under load either separately or in parallel, and the governing of the engines to be tested.

3.1.2.11.4 The insulation resistance of cables, switch gear, generators, motors, heaters, lighting and other fittings is to be tested and should not be less than 100,000 ohms between all insulated circuits and earth. The installation may be subdivided to any desired extent by opening switches, removing fuses or disconnecting appliances for the purpose of this test.

The electric cables are to be examined as far as possible without undue disturbance of fixtures or casings unless deemed necessary by the Surveyor.

3.1.2.11.5 Transformers are to be examined. Samples of oil are to be taken and tested for breakdown voltage, acidity and moisture in case of oil immersed transformers or electrical apparatus associated with supplies to essential services. The testing is to be carried out by a competent testing authority and a certificate giving the test results is to be furnished to the Surveyor.

3.1.2.11.6 Motors used for essential services including their starters are to be examined under working conditions.

3.1.2.11.7 Generators and steering gear motors are to be examined under working conditions. Air gaps are to be checked for excessive wear down.

3.1.2.11.8 The emergency source of power and its associated circuits are to be tested. In the case of passenger ships, the temporary source of power and its automatic arrangements (if fitted) are also to be tested.

3.1.2.12 Fuel tanks

3.1.2.12.1 Fuel tanks which do not form part of the ship's structure are to be examined internally and externally and, if considered necessary by the Surveyor, they are to be tested to the pressure specified for new tanks. These need not be examined before the ship is 15 years old if they are found satisfactory on external examination. All mountings, fittings and remote control devices are to be examined as far as practicable.

3.1.2.13 Examination in drydock

3.1.2.13.1 When the ship is in drydock or on a slipway, the propeller(s), stern bush(es) water inlets and outlets and gratings are to be examined. Propellers are to be examined for erosion, pitting, cracking of blades or possible contact damage. The clearance in each stern bush is to be ascertained. In the case of oil glands, this requirement may be waived if an approved oil gland is fitted so that the oil gland is not disturbed provided the sealing arrangements appear satisfactory. If poker gauges or other devices are provided for ascertaining the wear in an oil lubricated stern bush, the clearance in the bush should be measured. Exposed parts of side thrusters are to be examined. Directional propellers are to be examined externally with focus on the condition of gear housing, propeller blades, bolt locking and other fastening arrangements.

3.1.2.13.2 All openings to the sea including sanitary and other overboard discharges in the machinery spaces and pump rooms together with valves and cocks are to be examined internally and externally. The fastenings of valves and cocks to the hull are to be examined and are to be renewed when considered necessary by the Surveyor.

3.1.2.14 Propeller shafts

3.1.2.14.1 Propeller shafts are to be drawn periodically for examination by the Surveyors. All propeller shafts become due for Surveys at intervals of 5 years.

3.2 Intermediate Surveys

3.2.1 In ships which are placed in dry dock or on a slipway for this survey, the propeller(s), stern bush(es), water inlets and outlets and gratings are to be examined. The clearance in each stern bush or the efficiency of each stern gland is to be ascertained. Exposed parts of side thrusters are to be examined. Directional propellers are to be examined externally with focus on the condition of gear housing, propeller blades, bolt locking and other fastening arrangements.

3.3 Annual Surveys

3.3.1 In ships which are placed in dry dock or on a slipway, the propeller(s), stern bush(es), water inlets and outlets and gratings are to be examined. The clearance in each stern bush or the efficiency of each stern gland is to be ascertained. Exposed parts of side thrusters are to be examined. Directional propellers are to be examined externally with focus on the condition of gear housing, propeller blades, bolt locking and other fastening arrangements.

3.3.2 The Surveyor is to inspect machinery spaces generally, with particular attention being given to the following:

(a) Propulsion system, auxiliary machinery and to the existence of any fire and explosion hazards.

(b) Emergency escape routes are to be checked to ensure that they are free of obstruction.

(c) The bilge pumping system, including operation of extended spindles and level alarms, where fitted. Satisfactory operation of the bilge pumps is to be proven.

(d) Verification, so far as is practicable, that the remote controls for stopping fans and machinery and shutting off fuel oil supplies in machinery spaces and, where fitted, the remote controls for stopping fans in accommodation spaces and the means of cutting off power to the galley are in good working order.

3.3.3 The main propulsion, essential auxiliary and emergency generators including safety arrangements, controls and foundations are to be generally examined. Surveyors are to confirm that Periodical Surveys of engines have been carried out as required by the Rules and that safety devices have been tested.

3.3.4 For ships fitted with automation equipment for main propulsion, essential auxiliary and emergency machinery, a general examination of the equipment and arrangements is to be carried out. Records of changes to the hardware and software used for control and monitoring systems for propelling and essential auxiliary machinery since the original issue (and their identification) are to be reviewed by the attending Surveyor. Satisfactory operation of the safety devices and control systems is to be verified.

Section 4

Surveys - Dredgers

4.1 General

4.1.1 This section provides additional survey requirements for dredgers. Where surveys are required on dredging or hopper equipment such as gantries, bottom doors and their operating gear, positioning spuds and suction pipe attachments, these will be limited to the extent considered necessary by the Surveyor to be satisfied that their condition or malfunction will not adversely affect the ship's structure.

4.1.2 When the ship is placed in dry dock or on a slipway, the Surveyor is to examine the hopper doors or hopper valves, ladders, spud wells, and their fittings where applicable.

4.2 Special Surveys

4.2.1 On ships less than 10 years old:

(a) Hoppers are to be cleared and cleaned as necessary and examined.

(b) Where applicable, hopper doors or valves are to be opened and closed, so far as practicable, but keel blocks need not normally be moved specially to permit this to be done.

(c) The integrity of hopper overflows and diluting water inlet and distribution structures is to be confirmed. Weir valves and sluices are to be tested to ensure proper operation, particular attention being paid to the lower weir, when weirs are fitted at more than one level.

(d) Attention is to be given to shell plating in way of hopper overflows.

(e) The attachment to the ship's structure of all main items of dredging equipment, including gantries, 'A' frames and spud control gear supports, is to be carefully examined to ensure that no fracture is present.

4.2.2 On ships over 10 years old:

(a) Attention is to be given by the Surveyor to the structure in way of dredging pumps.

(b) Hopper doors and valves are to be checked for proper operation, and their hinges, control gear and other fittings are to be examined for wear or distortion. All seals and wear down strips are to be replaced if necessary, but a watertight seal is not normally required. Attention is to be paid to areas likely to be suffering from excessive erosion.

(c) Those items of dredging gear and equipment whose efficiency is not part of classification but whose failure or malfunctioning is, nevertheless, likely to affect the ship's structure adversely, are to be examined to ensure that the structural integrity of the ship is maintained.

Section 5

Surveys – Liquefied Gas Carriers

5.1 General

5.1.1 This section provides additional survey requirements for ships carrying liquefied gas as cargo.

5.2 Special Surveys

5.2.1 General

5.2.1.1 All cargo tanks are to be examined internally and externally as far as practicable. Particular attention is to be paid to the plating in way of supports and of securing arrangements and pipe connections.

5.2.1.2 For insulated cargo tanks with the insulation accessible, the insulation is to be examined externally and sections removed for examination of the tank if considered necessary by the Surveyor.

5.2.1.3. Non-destructive testing is to supplement cargo tank inspection with special attention to be given to the integrity of the main structural members, tank shell and highly stressed parts, including welded connections as deemed necessary by the Surveyor.

5.2.1.4 Cargo tank internal pipes and fittings are to be examined, and all valves and cocks in direct communication with the interiors of tanks are to be opened out for inspection and connection pipes are to be examined internally, so far as practicable.

5.2.1.5 Pressure relief valves and vacuum relief valves are to be opened out for inspection and are to be adjusted afterwards. Valves may be removed from tanks, cargo gas and liquid pipelines for this purpose.

5.2.1.6 All cargo pumps, cargo booster pumps and cargo vapour pumps, where applicable, are to be opened out for examination.

5.2.1.7 Where considered necessary by the Surveyor, insulated cargo gas and liquid pipelines are to have sections of insulation removed to ascertain the condition of the pipes.

5.2.1.8 Where equipment for the production of inert gas is fitted, it is to be examined and tested to show it to be operating satisfactorily within the gas specification limits. Pipelines, valves, etc. for the distribution of the inert gas are to be generally examined. Pressure vessels for the storage of inert gas are to be examined internally together with their fastenings. Pressure relief valves are to be demonstrated to be satisfactorily operational. Liquid nitrogen storage vessels are to be examined as far as practicable and all control equipment, alarms and safety devices are to be verified as operational.

5.2.2 Refrigerating equipment

5.2.2.1 Each reciprocating compressor is to be opened out. Cylinder bores, pistons, piston rods, connecting rods, valves and seats, glands, relief devices, suction filters and lubricating arrangements are to be examined. Crankshafts are to be examined but crankcase glands and the lower half of main bearings need not be exposed if the Surveyor is satisfied with the alignment and wear.

5.2.2.2 Where other than reciprocating type compressors are fitted, or where there is a program of replacement instead of surveys on board, alternative survey arrangements will be considered. Each case will be given individual consideration.

5.2.2.3 The water end covers of condensers are to be removed for examination of the tubes, tube plates and covers.

5.2.2.4 Refrigerant condenser cooling water pumps, including standby pump(s) which may be used on other services, are to be opened out for examination.

5.2.2.5 Where a pressure vessel is insulated, sufficient insulation is to be removed, especially in way of connections and supports, to enable the vessel's condition to be ascertained.

5.2.2.6 Insulated pipes are to have sufficient insulation removed to enable their condition to be ascertained. Vapour seals are to be specially examined for condition.

5.2.2.7 The Surveyor is to satisfy himself that all pressure relief valves and/or safety discs throughout the system are satisfactorily operational. Primary refrigerant pressure relief valves are not to be tested onboard ship.

5.2.3 Special Survey of Ships over 10 years old

5.2.3.1 All pressure vessels of inert gas installations are to be examined internally and externally and tested.

5.2.3.2 Cargo tanks are to be pressure tested to a pressure of 1.25 times the working pressure.

5.3 Intermediate Surveys

5.3.1 General

5.3.1.1 Cargo liquid level indicating devices are to be generally examined. The low level, high level and overfill alarms are to be examined and tested to ascertain that they are operational. Consideration will be given to the acceptance of simulated tests provided that they are carried out at the cargo temperature and/or pressure.

5.3.1.2 Where applicable, gas leakage systems are to be examined and tested to ascertain that they are in working order and calibrated using sample gas.

5.3.1.3 Where applicable, the correct functioning of the cargo containment system temperature indicating equipment, together with any associated alarms, is to be verified.

5.3.1.4 Where applicable, the ventilation system for the spaces surrounding the cargo tanks and in working spaces is to be examined and checked for satisfactory operation.

5.3.1.5 Where applicable, inert gas systems for the environmental control of cargo tanks and/or spaces surrounding the cargo tanks are to be generally examined.

5.3.1.6 Where applicable, control devices for the cargo containment system and cargo handling equipment, together with any associated shut-down and/or interlock, are to be checked under simulated working conditions, and if required, recalibrated.

5.3.1.7 The arrangements for manually operated emergency shut-down are to be checked to ascertain they are in working order.

5.3.1.8 Cargo pipelines, valves and fittings are to be generally examined, with special reference to expansion bellows, supports and vapour seals on insulated pipes.

5.3.1.9 Portable and/or fixed drip trays, or insulation for deck protection in the event of cargo leakage are to be examined for their condition.

5.3.2 Refrigerating equipment

5.3.2.1 Where refrigerating equipment for cargo temperature and pressure control is fitted the following are to be examined so far as practicable:

(a)The machinery under working condition.

(b) Shells of all pressure vessels in the system including primary refrigerant gas and liquid pipes, cargo vapour and liquid condensate pipes and condenser cooling arrangements. Insulation need not be removed, but any deterioration or evidence of dampness is to be investigated.

End of Chapter

IRCLASS
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RULES AND REGULATIONS FOR THE CONSTRUCTION AND CLASSIFICATION OF **INLAND WATERWAYS VESSELS**

PART 2
INSPECTION AND TESTING OF MATERIALS

July 2024

Indian Register of Shipping

Part 2

Inspection and Testing of Materials

(This part is same as Part 2 of Rules and Regulations for the Construction and Classification of Steel Ships)

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IRCLASS
Indian Register of Shipping

CELEBRATING 50 YEARS OF EXCELLENCE

RULES AND REGULATIONS FOR THE CONSTRUCTION AND CLASSIFICATION OF **INLAND WATERWAYS VESSELS**

PART 3
GENERAL HULL REQUIREMENTS

July 2024

Indian Register of Shipping

Part 3

General Hull Requirements

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Chapter 1

General, Definitions, Documentation

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Section 1

General

1.1 Scope

1.1.1 The Rules in this part apply to all-welded, single hull steel ships of normal form, proportions and speed for operation in inland waterways.

1.1.2 For additional class notations relating to various ship types, requirements as per Pt.5 are to be complied with.

1.1.3 Ships of unconventional forms and proportions or intended for carriage of cargoes not covered by the Rules or to be engaged in special service will receive individual consideration based on the general principles of the Rules. In these cases, however, additional calculations and/or model testing may be required to be carried out and submitted for approval.

1.1.4 Proposals for use of alternative materials e.g. aluminium, wood, etc. for some parts of the ship shall receive special consideration.

1.2 Equivalence

1.2.1 Alternative arrangements, scantlings and equipment may be accepted provided they can be shown to be equivalent to the overall safety and strength standard of the Rules. Direct calculations for the derivation of the scantlings as an alternative to those derived by the Rule formulae, may be accepted on special consideration. The calculation procedure and the assumptions made are to be submitted for approval.

1.3 National regulations

1.3.1 While the Rules cover requirements for the classification of ships, the attention of all concerned is drawn to requirements of various local or national Regulations, Codes and Recommendations which the vessel may also have to comply with.

1.4 Loadline and stability

1.4.1 All ships will be assigned class only after it has been demonstrated that their intact/damage stability and loadline requirements (where applicable) are in compliance with the standards laid down by the local or National statutory authority.

1.4.2 For stability of passenger ships, the requirements specified in IRS Classification Note*: "Stability Requirements for Inland Waterways' Passenger Ships"* are to be complied with.

1.5 Assumptions

1.5.1 It is assumed that significant dynamic excitation of major orders from propellers and machinery do not fall close to any natural frequency of the hull.

1.5.2 It is assumed that the ships will be competently handled and loaded as per the approved loading manuals.

Section 2

Definitions

2.1 Principal particulars

2.1.1 The forward perpendicular, F.P., is the perpendicular drawn at the intersection of the maximum load water line with the fore side of the stem.

In ships with unusual bow arrangement the position of the F.P. will be specially considered.

2.1.2 The after perpendicular, A.P., is the perpendicular drawn at the intersection of the maximum load waterline with the after side of the rudder post or the centreline of the rudder stock if there is no rudder post.

In ships with unusual stern arrangement the position of the A.P. will be specially considered.

2.1.3 Rule length, L, is the distance, [m], between the forward and after perpendiculars. However L is to be not less than 96 per cent, and need not be greater than 97 per cent of the extreme length on the maximum load waterline.

In ships with unusual bow and/or stern arrangement the Rule length, L, will be specially considered.

2.1.4 "Amidship" is at 0.5L aft of the F.P.

2.1.5 Breadth, B, is the greatest moulded breadth [m].

2.1.6 Depth, D, is the moulded depth [m], measured amidships from top of the keel to the moulded deck line of the uppermost continuous deck at side. When a rounded gunwale is arranged the depth is to be measured to the continuation of the moulded deck line.

2.1.7 Draught, T, is the moulded draught amidships corresponding to the maximum load waterline, [m].

2.1.8 The block co-efficient, C_b, is the moulded block co-efficient calculated as follows :-

$$C_b = \frac{\text{moulded displacement } [m^3] \text{ at draught T}}{\text{LBT}}$$

2.1.9 Speed, V, is the maximum service speed in knots on draught T.

2.2 Structural terms

2.2.1 The general terms used in the Rules for various structural parts of the ships are defined as under:

- *Strength Deck* : In general the uppermost continuous deck. Where a superstructure deck has within 0.4L amidships, a continuous length equal to or greater than (1.5B + 3H), it is to be regarded as the strength deck instead of the covered part of the uppermost continuous deck. (H is the height of the superstructure, [m]).

- *Superstructure* : A decked structure on freeboard deck extending from side to side of the ship or with the side plating not inboard of shell plating by more than 4 per cent of the breadth B.

- *Deckhouse* : A decked structure above the freeboard deck with the side plating being inboard of the shell plating by more than 4 per cent of the breadth B.

- *Bottom Structure* : Shell plating with stiffeners and girders below the upper turn of bilge and all other elements below and including the inner bottom plating in case of the double bottom. Sloping hopper tank top is to be regarded as a bulkhead.

- *Side Structure* : Shell plating with stiffeners and girders between the upper turn of bilge and the uppermost continuous deck at side. A rounded gunwale is included in the side structure.

- *Deck Structure* : Deck plating with stiffeners, girders, and supporting pillars.

- *Girder* : A collective term for the primary supporting members, other terms include :

- Transverses - transverse girders under the deck.
- Web frames - side vertical girders.
- Hatch end beams - transverse deck girders at the ends of the hatch.
- Stringers - horizontal girders.
- Cross-ties - girders connecting two vertical girders in a deep tank.
- Floor - bottom transverse girders.

– *Stiffener* : A collective term for secondary supporting members; other terms being :

- Frames.
- Bottom, inner bottom, side or deck longitudinals.
- Reverse frame - transverse stiffener on the inner bottom.
- Horizontal or vertical bulkhead stiffeners.
- Other terms are defined in the appropriate Chapters.

2.3 Material factor

2.3.1 Material factor, k, a factor depending on material strength is defined in Ch.2.

Section 3

Documentation

3.1 General

3.1.1 Documentation is to be submitted as per the following paragraphs. In case of certain ship types additional documentation may be required as per Pt.5.

3.1.2 The documents should be submitted in triplicate, one copy of which shall be returned.

3.2 Plans for information

3.2.1 The following supporting plans and calculations are to be submitted for information:

- General arrangement.
- Tank plan.
- Capacity plan.
- Lines plan and Hydrostatic curves or tables.
- Docking plan.

3.3 Additional information

3.3.1 The following additional information is to be submitted as necessary for strength calculations:

- Maximum values of still water bending moments and shear forces.
- Lightship weight and its longitudinal distribution.
- Bonjeans data.
- Stowage factor and angle of repose of bulk cargoes to be carried.
- Masses and unbalanced moments of heavy machinery components e.g. engines, cranes, winches etc.

3.4 Plans for approval

3.4.1 Plans as relevant are to be submitted for approval as indicated in Table 3.4.1. These should as far as practicable be complete in all necessary details.

3.5 Plans to be kept on board

3.5.1 A copy of the final approved loading manual and suitable scantlings plans including details of corrosion control system; if any, are to be placed on board the ship.

3.5.2 To facilitate the ordering of materials for repairs, plans showing the disposition and extent of high tensile steel and steel of grades other than Grade A, along with the information relating to their physical and mechanical properties, recommended working, treatment and welding procedures etc. are to be placed on board.

Table 3.4.1 : Plans for approval

Plan	Including Information On
Loading manual [1]	details of loading in all contemplated loading conditions and resulting SWBM, SF & Torsional Moments (TM) design values of SWBM, SF & TM
Midship section Other transverse sections Longitudinal sections & decks Shell expansion & framing plan	main particulars (L,B,D,T,C_b,V) equipment specification complete class notation applied for spacing of stiffeners deck Loads, if other than those specified in the Rules openings on the deck openings on the shell material grades
Double bottom	indication of access height and location of overflows loading on inner bottom
Watertight subdivision bulkheads & watertight tunnels	openings and their closing appliances
Aft-end structure Sternframe or sternpost Propeller shaft brackets Aft peak tank	propeller outline propeller thrust structural details in way of rudder and propeller bearings height and location of overflow
Engine room structure Engine and thrust block seatings	type, power and r.p.m. of propulsion machinery weight of machinery, boilers, etc.
Fore-end construction Fore peak tank	openings on non-watertight bulkheads and diaphragm plates height and location of overflows
Oil tight/water tight and partition bulkheads in cargo tanks, ballast tanks and deep tanks	intended tank contents & their densities height and location of overflow/air pipes tanks intended to be partially filled corrosion protection; if any
Superstructures, deckhouses and machinery casings	height of sills from deck and closing appliances for companion ways
Hatchways Hatch covers	position and type loads if different from those specified in the rules sealing and securing arrangement, spacing of bolts or wedges
Rudder, stock and tiller Steering gear arrangement	speed of the ship (ahead & astern) material of bearings, coupling bolts, stock and the locking device rudder carrier.
Masts & derrick posts Support structure for masts, derrick posts & cranes	derrick length and loading dimensions and positions of stays and shrouds quality of material
Testing plan of tanks & bulkheads	
Welding details	
Notes: 1) See Chapter 5, Section 6. 2) One drawing may contain more than one of the items from each group	

End of Chapter

Chapter 2

Materials of Construction

Contents

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Section 1

General

1.1 Scope

1.1.1 The Rules relate, in general, to the construction of steel ships. Consideration will however be given to the use of other materials also.

1.1.2 The materials used in the construction of the ship are to be manufactured and tested in accordance with the requirements of Pt.2. 'Materials' of the Rules and Regulations for the Construction and Classification of Steel Ships (Main Rules). Materials for which provision is not made may be accepted, provided that they comply with an approved specification and such tests as may be considered necessary.

1.2 Steel

1.2.1 Ordinary hull structural steel is a hull structural steel with a minimum yield stress of 235 [N/mm^2] and a tensile strength generally in the range of 400-490 [N/mm^2].

For ordinary hull structural steel, the **material factor `k'** is to be taken as 1.0.

1.2.2 Steels having a yield stress of 265 [N/mm^2] and higher, are regarded as higher tensile steels. Where higher tensile steel is used, the hull girder section modulus and the local scantlings may be reduced in accordance with the relevant requirement of the Rules. For this purpose, a material factor 'k', is to be taken as follows:

k = 0.78 for steel with a minimum yield stress of 315 [N/mm^2]

k = 0.72 for steel with minimum yield stress of 355 [N/mm^2]

1.2.3 Where steel castings or forgings are used for sternframes, rudderframes, rudder stocks, propeller shaft brackets and other major structural items, they are to comply with Pt.2 'Materials' of Main Rules as appropriate.

1.3 Grades of steel

1.3.1 The ships covered by these Rules are generally to be constructed of Grade 'A' steel. However, for materials of over 20 [mm] in thickness used in highly stressed areas, grades of steel with higher levels of notch toughness (Grades 'B', 'D' or 'E') may be required dependent on the stress pattern associated with its location.

1.4 Aluminium

1.4.1 Where seawater resisting aluminium alloys manufactured and tested in accordance with the requirements of Pt.2 of the main rules are used for superstructures, deckhouses, hatch covers or other structural components, scantlings equivalent to steel are to be derived as follows:

plating thickness, $t_a = t_s \sqrt{k_a}$

section modulus of stiffeners, $Z_a = Z_s \cdot k_a$

where,

t_a, t_s = plating thickness of aluminium and mild steel respectively.

Z_a, Z_s = section modulus of aluminium and mild steel stiffeners respectively.

$$k_a = \frac{235}{\sigma_a}$$

σ_a = 0.2% proof stress or 70% of the ultimate strength of the aluminium material, whichever is lesser [N/mm^2].

1.4.2 The smaller modulus of elasticity of aluminium is to be taken into account, when determining the buckling strength of structural elements subjected to compression and the deflections, where relevant.

Section 2

Corrosion Protection

2.1 General

2.1.1 All steelwork, except inside tanks intended for the carriage of oil or bitumen, is to be protected against corrosion by application of suitable coating.

For protection required in salt water ballast spaces, See 2.5.

For protection required in holds of dry bulk cargo carriers, see Pt.5, Ch.1.

For the protection required in tanks carrying chemicals or other special cargoes, see Pt.5, Ch.3.

2.1.2 Where bimetallic connections are made, measures are to be incorporated to preclude galvanic corrosion.

2.2 Surface preparation, prefabrication primers, and paints or coatings

2.2.1 Steelwork is to be cleared of millscale and suitably cleaned before the application of surface paints and coatings. It is recommended that blast cleaning or other equally effective means be employed for this purpose.

2.2.2 Where a primer is used to coat steel after surface preparation and prior to fabrication, the composition of the coating is to be such that it will have no significant deleterious effect on subsequent welding work and that it is compatible with the paints or other coatings subsequently applied. Unless the primer used is type approved by IRS for this purpose, tests as detailed in Pt.3, Ch.2, Sec.3 of the Main Rules are to be made to determine the influence of the primer coating on the characteristics of the weld.

2.2.3 Paints or other coatings are to be suitable for the intended purpose in the locations where they are to be used. Unless previously agreed, at least two coats are to be applied.

2.2.4 The paint or coating is to be compatible with any previously applied primer, See 2.2.2.

2.2.5 Paints, varnishes and similar preparations having a nitrocellulose or other highly flammable base, are not to be used in accommodation or machinery spaces.

2.2.6 In ships intended for the carriage of oil cargoes having a flash point below 60°C (closed cup test), paint containing aluminium should not in general be used in cargo tanks, adjacent ballast tanks, cofferdams, pump rooms as well as on deck above the mentioned spaces, nor in any other areas where cargo vapours may accumulate, unless it has been shown by appropriate tests that the paint to be used does not increase the incendive sparking hazard.

2.3 Internal cathodic protection

2.3.1 Impressed current cathodic protection systems are not permitted in any tank.

When a cathodic protection system is to be fitted in tanks for the carriage of liquid cargo with flash point not exceeding 60°C, a plan showing details of the locations and attachment of anodes is to be submitted. The arrangements will be considered for safety against fire and explosion aspects only.

2.3.2 Particular attention is to be given to the locations of anodes in relation to the structural arrangements and openings of the tank.

2.3.3 Anodes are to be of approved design and sufficiently rigid to avoid resonance in the anode support. Weldable steel cores are to be fitted, and these are to be so designed as to retain the anode even when the anode is wasted.

2.3.4 Anodes are to be attached to the structure in such a way that they remain secure both initially and during service. The following methods of attachment would be acceptable :

a) Steel core connected to the structure by continuous welding of adequate section.

b) Steel core bolted to separate supports, provided that a minimum of two bolts with lock nuts are used at each support. The separate supports are to be connected to the structure by continuous welding of adequate section.

c) Approved means of mechanical clamping.

2.3.5 Anodes are to be attached to stiffeners, or may be aligned in way of stiffeners on plane bulkhead plating, but they are not to be attached to the shell. The two ends are not to be attached to separate members which are capable of relative movement.

2.3.6 Where cores or supports are welded to the main structure, they are to be kept clear of the toes of brackets and similar stress raisers. Where they are welded to asymmetrical stiffeners, they are to be connected to the web with the welding kept at least 25 [mm] away from the edge of the web. In the case of stiffeners or girders with symmetrical face plates, the connection may be made to the web or to the centreline of the face plate but well clear of the free edges. However, it is recommended that anodes are not fitted to face plates of high tensile steel longitudinals.

2.4 Aluminium and magnesium anodes

2.4.1 Aluminium and aluminium alloy anodes are permitted in tanks used for the carriage of oil, but only at locations where the potential energy does not exceed 275 [J] (i.e. 28 [kgf m]). The weight of the anode is to be taken as the weight at the time of fitting, including any inserts and fitting devices.

2.4.2 The height of the anode is, in general, to be measured from the bottom of the tank to the centre of the anode. Where the anode is located on or closely above a horizontal surface (such as a bulkhead girder) not less than 1 [m] wide, provided with an upstanding flange or face plate projecting not less than 75 [mm] above the horizontal surface, the height of the anode may be measured above that surface.

2.4.3 Aluminium anodes are not to be located under tank hatches or tank cleaning openings unless protected by adjacent structure.

2.4.4 Magnesium or magnesium alloy anodes are permitted only in tanks intended solely for water ballast.

2.5 Corrosion protection coatings for salt water ballast spaces

2.5.1 In case of ships which normally carry salt water for ballast purposes, all ballast spaces, having boundaries formed by the hull envelope, are to have a suitable corrosion protection coating applied in accordance with the manufacturer's requirements.

Section 3

Deck Covering

3.1 General

3.1.1 Where plated decks are sheathed with wood or an approved composition, reductions in plate thickness may be allowed.

3.1.2 The steel deck is to be coated with a suitable material in order to prevent corrosive action, and the sheathing or composition is to be effectively secured to the deck.

3.1.3 Deck coverings in the following positions are to be of a type which will not readily ignite where used on decks :

a) forming the crown of machinery or cargo spaces within accommodation spaces of cargo ships

b) within accommodation spaces, control stations, stairways and corridors of passenger ships.

End of Chapter

Chapter 3

Principles for Scantlings and Structural Details

Contents

Section 1

General

1.1 Application

1.1.1 Scantlings of various platings, stiffeners and girders to meet the local strength requirements are to be determined in accordance with the general principles given in this Chapter.

The design values of loads are given in chapters relevant to the structures under consideration.

1.1.2 Scantlings of hull members contributing to the longitudinal strength are also to comply with the requirements of Ch.4.

1.1.3 Scantlings of hull members subjected to compressive stresses are also to comply with the requirements of Sec.6.

1.2 Symbols

p = design pressure [kN/m^2] as given in the relevant chapters calculated at the loadpoint as given below:

Loadpoint for plates:

- midpoint of horizontally stiffened plate field
- half the stiffener spacing above the lower support of vertically stiffened plate field, or at the lower edge of plate when the thickness is changed within the plate field.

Loadpoint for stiffeners:

- midpoint of span.

Loadpoint for girders

- midpoint of load area supported by the girder.

s = stiffener spacing [mm], measured along the plating.

l = span of the stiffener, [m], in accordance with 4.1.1.

r = radius of curvature [mm].

S = span of the girder [m], in accordance with 4.1.2.

b = mean breadth [m], of the load area supported by the girder.

h_w = height of web, [mm].

b_f = width of flange, [mm].

σ = allowable bending stress, [N/mm^2] as given in the relevant Chapters.

σ_y = minimum yield stress of material, [N/mm^2], may be taken as 235 [N/mm^2] for normal strength steel.

k = material factor as defined in Ch.2, Sec.1.2.

E = modulus of elasticity, 2.06 x 10^5 [N/mm^2] for steel.

1.3 Frame spacing

1.3.1 The normal frame spacing between aft peak and 0.2L from F.P. may be taken as:

450 + 2L [mm] for transverse framing

550 + 2L [mm] for longitudinal framing.

1.3.2 In aft peak and fore peak the frame spacing is not to exceed 600 [mm] or that given in 1.3.1, whichever is less.

1.3.3 Where the actual frame spacing is higher than that mentioned above, the minimum thicknesses of various structural members as given in the Rules may require to be increased.

Section 2

Corrosion Additions

2.1 General

2.1.1 The thickness of plates, stiffeners and girders in tanks for water ballast and/or cargo oil and in holds of dry bulk cargo carriers is to be increased by a corrosion addition 't_c' as given in Table 2.1.1.

2.1.2 The required corrosion addition 'Z_c' to the section modulus of stiffeners and girders due to the thickness addition 't_c' mentioned above may be approximated as:

$$Z_c = \frac{t_c\, h_w\, (b_f + 0.3\, h_w)}{1000}\ [\mathrm{cm}^3]$$

Table 2.1.1 : Corrosion addition t_c [mm]

Item	Space Category	t_c
Internal members within and plate boundary between spaces of the given category	Ballast tank	1.5 $^{1)}$
	Cargo oil tank	1.5
	Hold of dry bulk cargo carriers	2
Plate boundary between the two given space categories	Ballast tank/Cargo oil tank	1.5 $^{1)}$
	Ballast tank/Hold of dry bulk cargo carrier	2
	Ballast tank/Other category space	1.0
	Cargo oil tank/Other category space	1.0
	Hold of dry bulk cargo carrier/Other category space	1.0

Notes:

1) Where the relevant ballast or liquid cargo tanks extend upto the exposed weather deck the minimum corrosion addition in the region extending upto 1.5 [m] below the weather deck corrosion addition is to be increased by 0.5 [mm].

2) Hold of dry bulk cargo carriers refers to the cargo holds of vessels with class notation **Bulk Carrier** and **Ore Carrier**.

3) Other category space denotes the hull exterior and all spaces other than water ballast and cargo oil tanks and holds of dry bulk cargo carriers.

Section 3

Plating

3.1 General

3.1.1 Minimum requirements of thickness of various platings are given in relevant chapters.

3.1.2 The thickness 't' of plating subjected to lateral pressure is not to be less than

$$t = \frac{15.8\,s\sqrt{p}}{\sqrt{\sigma}} \,x\, 10^{-3} + t_c \ \ [mm]$$

3.1.3 Any tapering of thickness of platings contributing to the longitudinal strength is to be based upon linear variation of stress s allowed at specified regions.

Section 4

Stiffeners and Girders

4.1 Determination of span

4.1.1 For stiffeners, the span 'l' [m] is to be taken as the length of the stiffener between the two supporting members less the depth of stiffener on crossing panel if any. Where brackets larger than those required in 5.1.2 are fitted, the span may be determined as shown in Fig.4.1.1.

For curved stiffeners, 'l' may be based on the chord length.

4.1.2 For girders, the span 'S' [m] is to be taken as the length of the girder between the two supporting members, less the web height of in-plane girder if any, and the correction for bracket 'b_c', as shown in Fig.4.1.2.

4.2 Effective width of attached plating

4.2.1 The area of the attached plating, to be used in the calculation of sectional properties of the stiffeners and girders, is to be taken as the cross-sectional area within the effective width of the attached plating.

4.2.2 The effective width of plating attached to a stiffener may be taken as the mean of spacings on either side of the stiffener.

4.2.3 The effective width of plating attached to a girder, 'b_e' is to be taken as per the following:

$$b_e = c \cdot b$$

where,

c = c_1, for girders with uniformly distributed loads or with six or more evenly spaced point loads

= c_2, for girders with three or less evenly spaced point loads.

Table 4.2.3 : Values of "c"

a/b	0.5	1.0	2.0	3.0	4.0	5.0	6.0	≥ 7.0
c_1	0.19	0.38	0.67	0.84	0.93	0.97	0.99	1.00
c_2	0.11	0.22	0.40	0.52	0.65	0.73	0.78	0.80

For intermediate values of a/b and number of point loads, values of 'c' may be obtained by interpolation.

a = span of the girder, for simply supported girders, [m].

= 60 per cent of span of the girder, for girders fixed at both ends, [m].

4.2.4 In case of girders on corrugated bulkheads which run across the corrugations, the effective width of attached plating is to be taken as 10% of that obtained from 4.2.3.

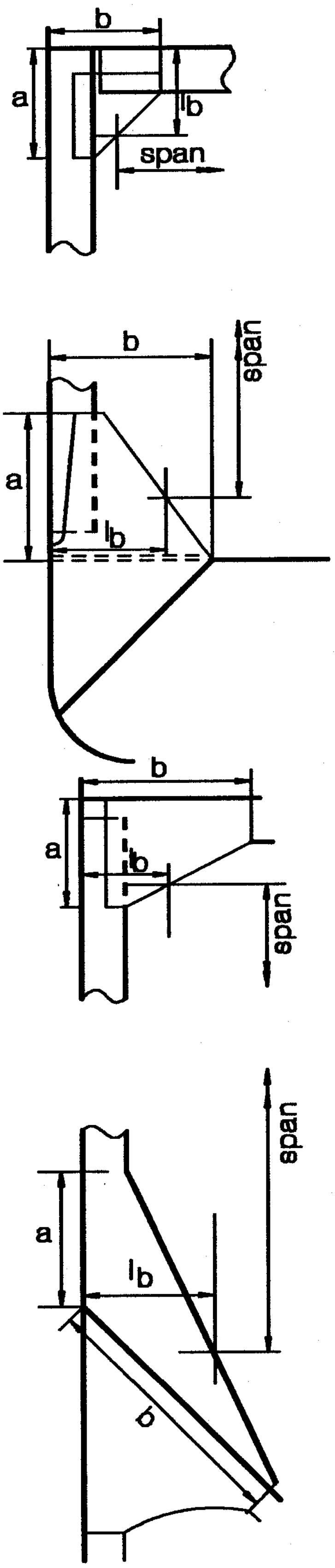
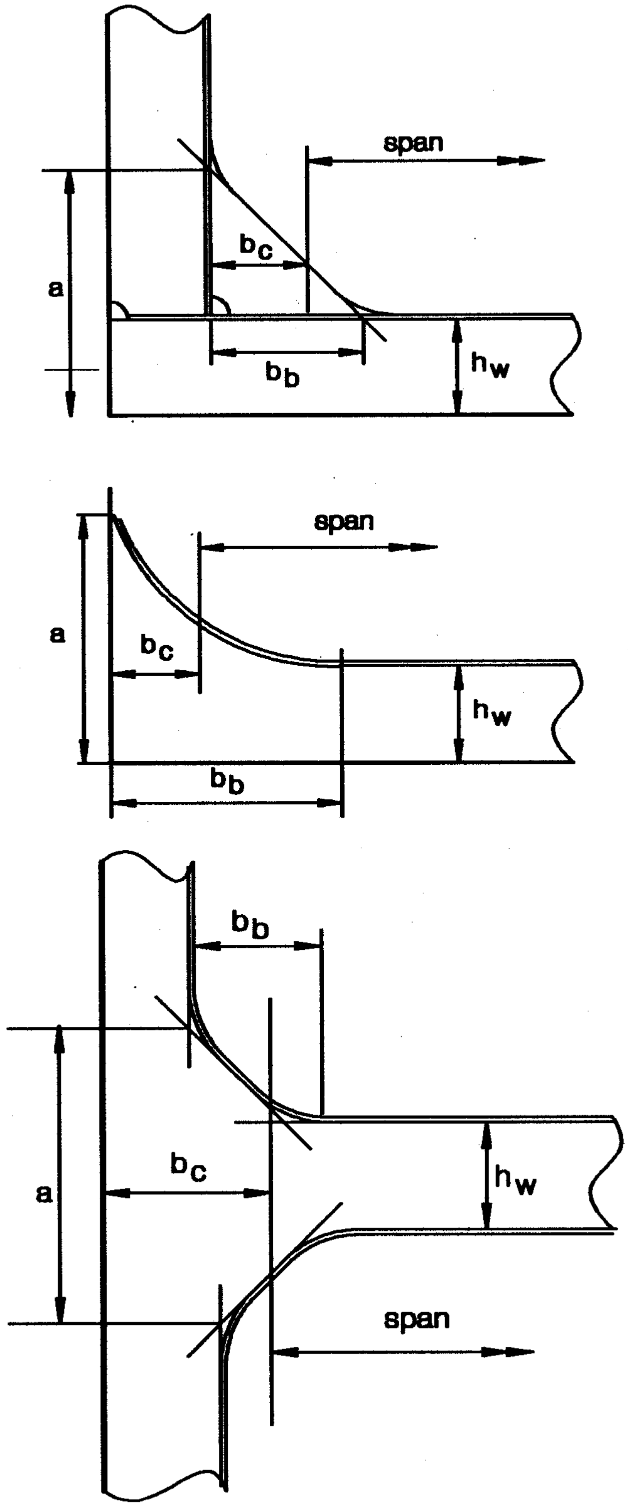


Fig.4.1.1



$$b_c = b_b\,(1 - h_w/a)$$

Fig.4.1.2

4.2.5 The effective cross sectional area of the attached plating is not to be less than that of the face plate.

4.3 Scantlings of stiffeners

4.3.1 The section modulus 'Z' of stiffeners subjected to lateral pressure is not to be less than:

$$Z = \frac{s.p.l^2}{m\sigma} + Z_c \ [cm^3]$$

where,

m = bending moment factor depending on the arrangement at the supports and variation of lateral pressure as given in the relevant chapters. Where not stated, the `m' value may generally be taken as:

= 12 for continuous longitudinal stiffeners

= 10 for transverse, vertical and non-continuous longitudinal stiffeners fixed at both ends.

= 8 for stiffeners simply supported at both ends.

4.3.2 Where stiffeners are not perpendicular to the plating, the section modulus as obtained from 4.3.1 is to be increased by the factor (1/cos α), α being the angle between the stiffener web and the plane perpendicular to the plating.

4.4 Scantlings of girders

4.4.1 The scantlings of simple girders subjected to lateral pressure which can be considered as conforming to the general beam theory are to satisfy the requirement given in 4.4.2.

4.4.2 The section modulus 'Z' of girders subjected to lateral pressure is not to be less than:

$$Z = \frac{b.p.S^2.10^3}{m\sigma} + Z_c \ [cm^3]$$

where,

m = bending moment factor depending upon the arrangement at supports and variation of lateral pressure as given in the relevant chapters. Where not stated, the 'm' value may generally be taken as 12 for continuous longitudinal girders and 10 for all other girders.

4.4.3 Where openings are cut in the girder web, they are to be away from the girder ends and scallops for stiffeners; with their centre located as near to the neutral axis of the girder as practicable. Openings of depth exceeding 25% of the girder depth or 300 [mm] and, of length exceeding the depth of the girder or 60% of the secondary stiffener spacing, are to be reinforced all around at the edge; or alternatively by providing horizontal and vertical stiffeners.

4.4.4 Girders are to be provided with adequate lateral stability by tripping brackets fitted generally at every fourth stiffener. Tripping brackets are also to be fitted at the toes of end brackets and in way of concentrated loads such as heels of pillars or cross ties.

Section 5

End Attachments

5.1 End attachments of stiffeners

5.1.1 Continuity of all stiffeners participating in longitudinal strength is to be maintained over transverse members within 0.5L amidships. Longitudinals abutting at transverse members may be accepted provided the brackets connecting the ends of the longitudinals are of adequate size and are either continuous or properly aligned.

5.1.2 Scantlings of brackets fitted on stiffeners not participating in the longitudinal strength are not to be less than the following:

- The arm lengths, 'a and b' (See Fig.4.1.1) are to be such that:

i) a, b $\geq$ 0.8 l_b

and

ii) $a+b \geq 2.0\ l_b$.

where,

$l_b = 24\sqrt{Z} + 75$ [mm]

– Thickness of unflanged bracket is to be not less than:

$t = (4.0 + 0.3\sqrt{Z}) + t_c$ [mm]

– Thickness of flanged bracket is to be not less than:

$t = (3.0 + 0.25\sqrt{Z}) + t_c$ [mm]

– Width of flange, $w \geq 40 + Z/25$ [mm], but not to be less than 50 [mm].

where,

Z is the section modulus [cm3], of the smaller stiffener, being connected.

5.2 End attachments of girders

5.2.1 The end attachments and supporting structure of the girders are to provide adequate resistance against rotation and displacement of the joint and effective distribution of the load from the member. Supporting members to which the girders are being connected, may require additional strengthening to provide adequate stiffness to resist rotation of the joint. Where the end attachment provides only a low degree of restraint against rotation, the girder is generally to be extended beyond the point of support by at least two frame spaces before being gradually tapered.

Connections between girders forming a ring system are to be such as to minimize stress concentrations at the junctions. Integral brackets are generally to be radiused or well rounded at the toes.

Where the face plate of the girder is not continuous over the bracket, the free edge of the bracket is to be stiffened and the face plate of the girder is to be extended well beyond the toe of the bracket.

5.2.2 The thickness 't' of brackets on girder is not to be less than that of the girder web.

The arm length 'a' including the depth of girder is not to be less than:

$a = 83\sqrt{(Z/t)}$ [mm];

where,

Z = the section modulus [cm^3], of the girder to which the bracket is connected.

The cross sectional area 'A_f' of the face plate on the girder bracket is not to be less than:

$$A_f = 0.001\ l_f\ t\ [\mathrm{cm}^2]$$

where, l_f is the length [mm], of the free edge of the bracket.

Additional stiffeners parallel to the bracket face plate are to be fitted on webs of large brackets. The arm length of an unstiffened triangular end panel of bracket is generally not to exceed 100 t [mm].

Section 6

Buckling

6.1 General

6.1.1 The critical buckling stress 'σ_{cr}' of plate panels and other members subjected to compressive loads is to be such that:

$$\sigma_{cr} \geq \frac{\sigma_c}{\eta}$$

where,

σ_c = applied compressive stress

η = 1.0 for deck, longitudinally stiffened side shell and single bottom plating

= 0.9 for bottom, inner bottom plating in double bottom and transversely stiffened side shell plating

$= \frac{0.7}{1 + l_m / i}$ (need not be taken smaller than 0.3);

– for axially loaded members such as pillars, cross-ties, panting beams etc., in general. - to be reduced by 15 per cent where the loads are primarily dynamic in nature.

– for 'l_m' and 'i' See 6.2.2.

6.1.2 The critical compressive buckling stress 'σ_{cr}' determined as follows is not to be less than the maximum compressive stress developed in the members under consideration.

$\sigma_{cr} = \sigma_E$ when $\sigma_E \leq 0.5\ \sigma_y$

$$= \sigma_y \left(1 - \frac{\sigma_y}{4\sigma_E}\right) \text{ when } \sigma_E > 0.5\,\sigma_y$$

where,

σ_E = ideal elastic buckling stress as per Sec.6.2.

6.2 Ideal elastic buckling stress

6.2.1 The σ_E value for platings may be taken as:

$$\sigma_E = 0.9\,K\,E\left[(t - t_c)/s\right]^2 \quad [\text{N/mm}^2]$$

where,

$$K = \frac{8.4}{\psi + 1.1}$$

– for plating with stiffeners in the direction of the compressive stress

$$= C\left[1 + \left(\frac{s}{1000\,\text{x}\,l}\right)^2\right]^2 \frac{2.1}{\psi + 1.1}$$

– for platings with stiffeners in the direction perpendicular to the compressive stress

ψ = ratio between the smaller and the larger values of the compressive stress assuming a linear variation (See Fig.6.2.1)

C = 1.30 when plating is stiffened by floors or deep girders

= 1.21 when stiffeners are angles or T sections

= 1.10 when stiffeners are bulb flats

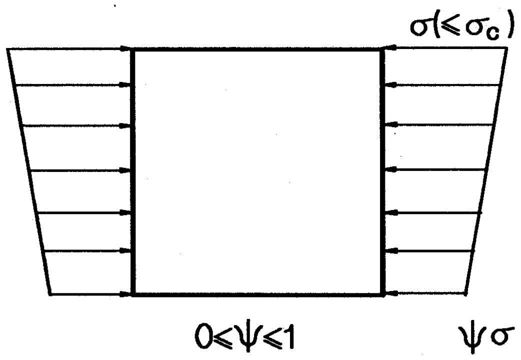


Fig. 6.2.1

= 1.05 when stiffeners are flat bars

s = shorter side of plate panel, [mm]

l = longer side of plate panel, [m]

6.2.2 The value for axially loaded members may be taken as:

$\sigma_E = 0.001\ C\ E\ (i/l_m)^2$ [N/mm^2]

C = 1.0 for both ends hinged

= 2.0 for one end fixed

= 4.0 for both ends fixed

i = radius of gyration of the member, [cm].

= $\sqrt{(I/a)}$

I = moment of inertia of the member, [cm^4], about the axis perpendicular to the direction of buckling being considered

a = cross sectional area of the member, [cm^2]

l_m = length of the member, [m].

Where end connections of a member are different with respect to the two principal axes, σ_E is to be found out for both cases using appropriate values of 'C' and 'I'.

End of Chapter

Chapter 4

Longitudinal Strength

Contents

Section 1

General

1.1 Application

1.1.1 Scantlings of hull members contributing to longitudinal strength are to comply with the requirements given in this Chapter. These members are also to comply with the requirements of buckling strength given in Ch.3, Sec.6 and of local strength given in relevant chapters of Pt.3.

1.1.2 Still water bending moments are to be calculated for all ships with unusual or non-uniform weight or cargo distribution and for other ships of $L \geq 60$ m.

Such ships are to be provided with an approved loading manual which describes the loading conditions on which the design is based and also gives the values of still water bending moments and permissible limits.

1.2 Symbols

L, B, T, k as defined in Ch.1, Sec.2.

I_n = moment of inertia of hull girder, [cm^4], about the transverse neutral axis at the section under consideration.

Z_n = vertical distance [m] of the horizontal neutral axis above base line.

M_s = design still water bending moment [kN-m] as given in 2.1.2.

M_w = rule wave bending moment [kN-m] as given in 2.2.1.

Section 2

Vertical Bending Moments

2.1 Still water bending moment

2.1.1 Still water bending moments are to be calculated for the following loading conditions as a minimum:

a) Fully loaded condition with design cargo distribution(s)

b) Light condition with full consumables, stores, crew and ballast, if any.

In addition other loading conditions which may be more onerous, e.g. intermediate conditions of special loading or discharging sequences, are to be investigated.

2.1.2 The design value of still water bending moment Ms at 0.4L amidships is to be taken as the greater of the following:

a) The maximum of sagging or hogging still water bending moments obtained for the loading conditions specified in Sec.2.1.1, and

b) 0.375 L^2B [kN-m]

At locations outside 0.4L amidships the design value of still water bending moment Ms may be linerally reduced to zero at perpendiculars.

2.2 Wave load conditions

2.2.1 The rule vertical wave bending moment M_w for 0.4L amidships is to be taken as

$$M_w = C\,L^2 B\ [\mathrm{kN-m}]$$

where,

C = coefficient as per Table 2.2.1.

Table 2.2.1

Zone	Coefficient C
1	0.30 for L ≤ 20 m 0.3 + 0.005 (L-20) for 20 < L < 60 0.5 for L ≥ 60 m
2	0.3
3	0.15

At locations outside 0.4L amidships, the value of rule wave bending moment Mw is to be linerally reduced to zero at perpendiculars.

Section 3

Hull Section Modulus and Moment of Inertia

3.1 Calculation of section properties

3.1.1 When calculating the moment of inertia and section moduli, the net sectional area (after deduction for openings) of all continuous longitudinal strength members is to be taken into account. Small isolated lightening holes in girders need not be deducted.

Superstructures not forming strength deck (See Ch.1, Sec.2.2), deckhouses, bulwarks and non-continuous longitudinal hatch coamings are not to be included in the above calculations.

In case of ships with continuous trunks or longitudinal hatch coamings, their net sectional area may be included in the calculations provided they are effectively supported by longitudinal bulkheads or deep girders. The section modulus at deck however, is then to be calculated as given in 3.1.3.

3.1.2 The main strength members included in the calculation of hull moment of inertia and section modulus are to extend continuously through the cargo region and sufficiently far towards the ends of the ship. Longitudinal bulkheads are to terminate at effective transverse bulkheads and large transition brackets are to be fitted in line with the longitudinal bulkheads.

3.1.3 The midship section modulus 'Z' at deck or bottom about the transverse neutral axis is to be obtained as follows:

$$Z = I_n / (100.z) \quad [\mathrm{cm}^3]$$

where,

z = the vertical distance [m] from the horizontal neutral axis upto the strength deck at side or the base line, as relevant.

However, in case of ships where continuous trunks or longitudinal hatch coamings are to be included in the section modulus calculation as per Sec.3.1.1, the distance z for calculation of modulus at deck is to be taken as the greater of the following:

z = z as above
$z = z_n$ [0.9 + 0.2 y/B]

where,

z_n = the vertical distance from the horizontal neutral axis to top of continuous strength number.

y = athwartship distance from the centreline of the ship to the side of the strength member.

z_n and y are to be measured to the point giving the largest value of z.

3.2 Extent of high tensile steel

3.2.1 Where high tensile steels are used in the main hull structure in order to reduce the section modulus requirement, the vertical and longitudinal extent of its use is to be such that adjacent structure made of ordinary hull structural steel is not stressed beyond the stress level permissible for ordinary steel.

3.3 Section modulus requirement

3.3.1 At any transverse section, the hull section modulus Z, about the transverse neutral axis for the still water bending moments M_s given in 2.1 and wave bending moments M_w given in 2.2, is not to be less than:

$$Z = \left(\frac{M_s + M_w}{\sigma_L} \right) \text{ x } 10^3 \quad [\text{cm}^3]$$

where,

σ_L = 175/k [N/mm^2] within 0.4L amidships

= 125/k [N/mm^2] within 0.1L from A.P. and F.P.

Between the specified regions σ_L is to be obtained by linear interpolation.

3.3.2 Scantlings of all continuous longitudinal members of hull girder based on the section modulus requirement in 3.3.1 are to be maintained within 0.4L amidships.

In the region outside 0.4L amidships, the scantlings are to be gradually tapered to the local requirements at ends.

3.4 Moment of inertia requirement

3.4.1 The moment of inertia I_n of the hull section about the transverse neutral axis, at midship, is not to be less than:

$$I_n = 3 \text{ L . Z} \quad [\text{cm}^4]$$

where,

Z = Hull section modulus amidships as required by 3.3.1.

Section 4

Openings in Longitudinal Strength Members

4.1 Locations

4.1.1 As far as practicable, openings are to be avoided in the keel plate and in the bilge plate within 0.6L amidships.

4.1.2 Openings in the strength deck within 0.6L amidships are as far as practicable to be located inside the line of large hatch openings. Necessary openings outside this line are to be kept well clear of the ship's side and hatch corners.

4.1.3 Small openings are generally to be kept well clear of other openings in the longitudinal strength members.

4.2 Reinforcements

4.2.1 All openings are to be adequately framed and arrangements in way of corners and openings are to be such as to maintain structural continuity and minimize the creation of stress concentrations.

Corners of hatchways are to be reinforced as given in Ch.8, Sec.2. Smaller openings in the strength deck and outer bottom within 0.6L amidships are to be reinforced as given in 4.2.2 to 4.2.5 below. The area of these reinforcements is not to be included in the sectional areas used in the section modulus calculation.

4.2.2 Circular openings with diameter equal to or greater than 0.325 [m] are to have edge reinforcement having sectional area A not to less than:

$$A = 2.5 \text{ b.t.} \quad [\text{cm}^2]$$

where,

b = diameter of the opening [m]

t = thickness of the plating [mm].

4.2.3 Elliptical openings are to have their major axis in the fore and aft direction. Where the ratio of the major axis to minor axis is less than 2, the openings are to be reinforced as given in 4.2.2 taking b as the breadth of the opening (minor axis).

4.2.4 Rectangular openings are to have their corners well rounded. Where corners are of circular shape the radius is not to be less than 20 per cent of the breadth of the opening and the edges are to be reinforced as given in 4.2.2 taking b as the breadth of the opening.

Where corners are of elliptical shape as given in 4.2.3 or of streamlined shape as given in 4.3, the reinforcement will generally not be required provided that the transverse extension of the curvature, a, shown in Fig. 4.3.2 is not less than:

a = 0.15b [m]

4.2.5 Openings in side shell subjected to large shear stresses are to be of circular shape and are to be reinforced as given in 4.2.2 irrespective of the size of opening.

4.3 Hatchway corners

4.3.1 Where corners are of circular shape, the radius r within 0.6L amidships is not to be less than

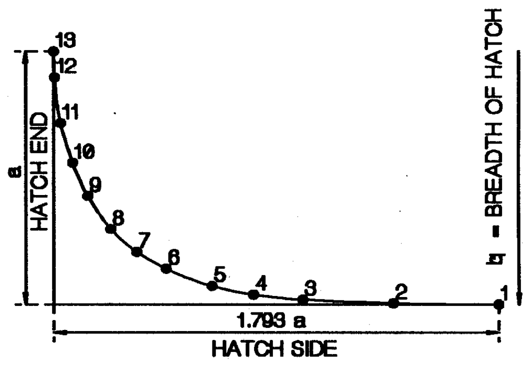
r = 0.05 b [m], minimum 0.3 [m]

where,

b = breadth of the hatchway [m]

4.3.2 Where corners are of streamlined shape, as given by Fig. 4.3.2, the transverse extension of the curvature, a, is not to be less than

a = 0.05 b [m], minimum 0.3 [m]



Ordinates of steamlined corner		
Point	**Abscissa, x**	**Ordinate, y**
1	1.793a	0.0
2	1.381a	0.002a
3	0.987a	0.021a
4	0.802a	0.044a
5	0.631a	0.079a
6	0.467a	0.131a
7	0.339a	0.201a
8	0.224a	0.293a
9	0.132a	0.408a
10	0.065a	0.548a
11	0.022a	0.712a
12	0.002a	0.899a
13	0.0	1.000a

Fig.4.3.2 : Streamlined deck corner

End of Chapter

Chapter 5

Bar Keel, Stem and Sternframes

Contents

Section

Section 1

General

1.1 Scope

1.1.1 This chapter provides requirements for bar keel, bar stem, stern frames and shaft brackets.

1.2 Material

1.2.1 All steel plates and sections, castings and forgings used in the constructions are to be tested and approved in accordance with the requirements of Ch.3, Ch.4 and Ch.5 of Pt.2 'Materials' of the Rules & Regulations for the Construction and Classification of Steel Ships (Main Rules), respectively. Material grades for plates and sections are to be selected as per Pt.3, Ch.2.

1.2.2 Bar keels and stems may either be steel castings or forgings or rolled plates or bars.

1.2.3 Sternframes, rudder horns and shaft brackets may be constructed of cast or forged steel or may be fabricated from plates.

1.3 Symbols

1.3.1 L, T as defined in Ch.1, Sec.2.

Section 2

Bar Keel

2.1 Scantlings

2.1.1 The scantlings of bar keel are not to be less than :

Depth = 75 + 0.75 L [mm]

Thickness = 10 + 0.4 L [mm]

Minor deviations from the above values may be accepted provided the required sectional area is maintained.

Section 3

Stem

3.1 Bar stem

3.1.1 The cross sectional area 'A' of a bar stem, below the summer load waterline, is not to be less than

$A = 0.6L$ [cm^2]; or 12 [cm^2]

- whichever is greater.

3.2 Plate stem

3.2.1 The thickness 't' of the plate stem below the summer load waterline is not to be less than:

$t = (0.08 L + 5.0)$ [mm]

3.2.2 The thickness of the plate stem may be gradually reduced to that of the side shell at the stem head.

3.2.3 The plate stems are to be supported by horizontal diaphragms spaced not more than 1.0 [m] apart. Where the stem plate radius is large, a centreline stiffener or web is to be provided.

Section 4

Stern Frames

4.1 General

4.1.1 Sternframes, shaft brackets etc. are to be designed such that they are effectively integrated into the ship's structure.

4.1.2 In castings, sudden changes of section or possible constrictions to the flow of metal during castings are to be avoided. All fillets are to have adequate radii, which in general should not be less than 50 to 75 [mm], depending on the size of the casting.

4.1.3 Fabricated and cast steel sternframes are to be strengthened at intervals by webs spaced not more than 700 [mm] apart. In way of the upper part of the sternframe arch, these webs are to line up with the floors.

4.1.4 Rudder posts and propeller posts are to be connected to floors of increased thickness.

4.1.5 It is recommended that the after body of the ship be so shaped as to ensure adequate flow of water to the propeller so as to prevent uneven formation of eddies, as far as possible.

4.2 Sternframes

4.2.1 The scantlings of the propeller posts are not to be less than the following:
Forged propeller posts (see Fig. 4.2.1 (a))

$A = (8 + 0.4L)\, T$ [cm^2] for $L < 60$ [m]

$= 32\, T$ [cm^2] for $L > 60$ [m]

Fabricated propeller posts (see Fig. 4.2.1 (b))

$l = 150 \sqrt{T}$ [mm]

$w = 100 \sqrt{T}$ [mm]

$r = 18 \sqrt{T}$ [mm]

$t_1 = 11 \sqrt{T}$ [mm]

$t_w = 5 \sqrt{T}$ [mm]

Cast steel propeller posts (see Fig. 4.2.1 (c))

$l = 125 \sqrt{T}$ [mm]

$w = 85 \sqrt{T}$ [mm]

$r = 20 \sqrt{T}$ [mm]

$t_1 = 12 \sqrt{T}$ [mm]

$t_2 = 14 \sqrt{T}$ [mm]

$t_w = 7 \sqrt{T}$ [mm].

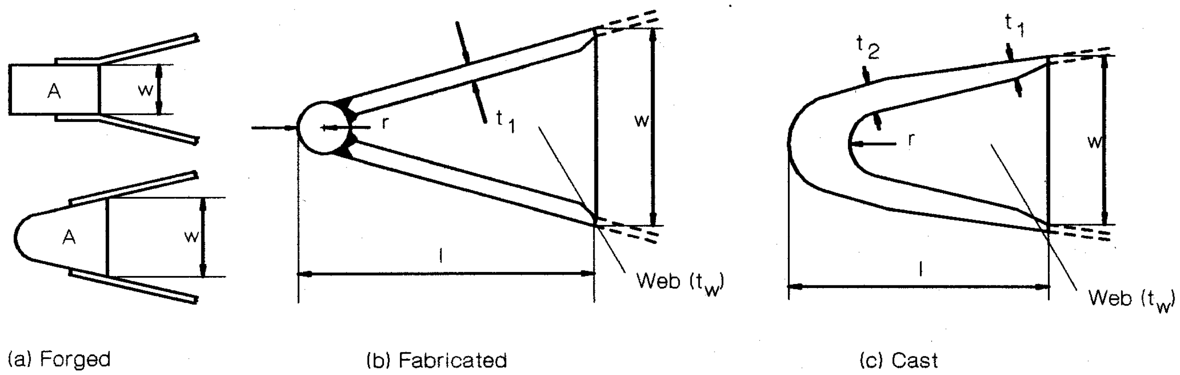


Fig.4.2.1 : Types of propeller posts

Where the sections adopted differ from the above, the section modulus about the longitudinal axis is to be equivalent to that with the Rule scantlings.

On sternframes without solepieces, the modulus of the propeller post, about the longitudinal axis, may be gradually reduced by 15 per cent below the propeller boss, provided the thicknesses are maintained as above.

4.2.2 The wall thickness of the boss 't_b' in the propeller post is not to be less than :

$$t_b = 0.25\, d_{ts} + 12 \text{ [mm]}$$

where,

d_{ts} = Rule diameter of tail shaft, [mm].

In fabricated stern frames the connection of the propeller post to the boss is to be by full penetration welds.

4.3 Sole piece

4.3.1 The section modulus 'ZT' of the sole piece against transverse bending is not to be less than

$$Z_T = \frac{1}{90}\ \frac{c\,F_r\,x}{b}\ [\text{cm}^3]$$

where,

F_r = Rudder force [N] as defined in Pt.3, Ch.12, Sec. 3

x = distance of the cross section under consideration from the centre line of rudder stock, [m]. 'x' is not to be taken as less than a/2.

a, b, c = as shown in Figures 4.3.1 (a) and (b) [m].

The above requirement of Z_T is to be increased by 15 per cent for cast steel solepieces.

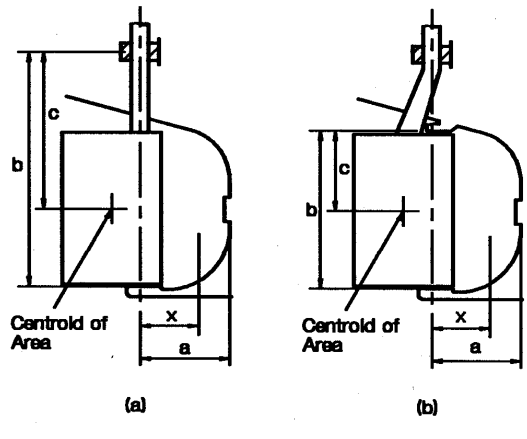


Fig.4.3.1 : Open stern frame

4.3.2 The section modulus 'Z_v' of the sole piece against vertical bending is not to be less than :

$$Z_v = \frac{Z_T}{2}\ [\text{cm}^3]$$

4.3.3 The sectional area of sole piece is not to be less than:

$$A_s = \frac{1}{5400} \cdot \frac{c \cdot F_r}{b} \ [cm^2]$$

4.3.4 The sole piece is to extend at least two frame spaces forward of the forward edge of the propeller boss and beyond this, the cross section of the extension is to be gradually reduced to that necessary for an efficient connection to the keel plate. Fabricated solepieces are to have adequate internal stiffening.

4.4 Shaft brackets

4.4.1 Where the propeller shafting is exposed to the sea for some distance clear of the main hull, it is generally to be supported adjacent to the propeller by independent brackets having two arms. It is recommended that the angle included between the arms differs from the angle included between the propeller blades. In very small ships the use of single arm brackets will be considered.

4.4.2 Fabricated brackets are to be designed to avoid or reduce the effects of hard spots and ensure a satisfactory connection to the hull structure. The connection of the arms to the bearing boss is to be by full penetration welding.

4.4.3 Generally, bracket arms are to be carried through the shell plating and attached to floors or girders of increased thickness. The shell plating in way of shaft brackets is to be increased in thickness to a minimum of 1.5 times the Rule bottom shell plating thickness amidships.

The connection of the bracket arms to the shell plating is to be by full penetration welding.

4.4.4 The scantlings of solid or built-up shaft brackets are to comply with the following:

$t = 0.4\ d_{ts}$ [mm]

$A = 4.5\ d_{ts}^2 \cdot 10^{-3}$ [cm^2]

$Z_T = 30\ d_{ts}^3 \cdot 10^{-6}$ [cm^3]

where,

t = thickness of the bracket arms

A = cross sectional area of the bracket arms

Z_T = Section modulus of the bracket arms against transverse bending

End of Chapter

Chapter 6

Bottom Structure

Contents

Section

Section 1

General

1.1 Scope

1.1.1 The scantlings and arrangement of bottom structure as defined in Ch.1, Sec.2 are to comply with the requirements given in this Chapter.

1.2 Symbols

L,B,T,C_b,k as defined in Ch.1, Sec.2.

s = spacing of stiffeners, [mm]

l = span of stiffeners, [m]

b = spacing of girders, [m]

S = span of girders, [m]

t_c, Z_c are corrosion additions to the thickness and section modulus respectively, as given in Ch.3, Sec.2.1.

$$f_B = \frac{Z_R}{Z_B}$$

where,

Z_R = Rule midship section modulus [cm^3] as required by Ch.4.

Z_B = Actual midship section modulus [cm^3] provided at bottom.

Section 2

Structural Arrangement and Details

2.1 General

2.1.1 Depth of wells constructed in the double bottom, in connection with the drainage arrangement of holds, is to be kept in the minimum.

2.1.2 The continuity of the bottom, bilge and inner bottom longitudinals is to be maintained in accordance with Ch.3, Sec.5.1.1.

2.1.3 The bilge keel and the ground bar to which it is attached, are to be gradually tapered at ends and arranged to finish in way of suitable internal stiffening.

Butt welds in the bilge keel and the ground bar are to be well clear of each other and those in the shell plating.

2.1.4 The weld connections are to comply with the requirements of Ch.16.

2.2 Access, ventilation and drainage

2.2.1 Adequate access is to be provided to all parts of the double bottom. Where the vertical dimension of the lightening hole exceeds 50 percent of the web height adequate reinforcements are to be provided. The diameter of lightening holes in the bracket floors is not to exceed 1/3 of the breadth of the brackets. Lightening holes or manholes are normally not to be cut in floors or girders towards their ends and under large pillars or supporting structures. Manholes in innerbottom are to have reinforcement rings, and the man hole covers in the inner bottom plating in cargo holds are to be effectively protected. The edges of all holes are to be smooth.

2.2.2 To ensure the free passage of air and water from all parts of the tanks to air pipes and suctions, air and drain holes are to be provided in all non-watertight members. The air holes are to be placed as near to the inner bottom as possible and their total area is to be greater than the area of the filling pipes. The drain holes are to be placed as near to the bottom as possible.

2.2.3 The access opening to pipe tunnel is to be visible above the floor plates and is to be fitted with a rigid watertight closing device. A notice board stating that the access opening to the pipe tunnel is to be kept closed, is to be fitted near the opening. The opening is to be regarded as an opening in watertight bulkhead.

Section 3

Design Loads

3.1 Bottom shell

3.1.1 The design pressure 'p' [kN/m^2] on outer bottom is to be taken as

$p = 10\ T_1$ [kN/m^2]

T_1 to be obtained from Table 3.1.1.

Table 3.1.1 : Values of T_1

Zone	T_1
1	T+1.0 [m] for L > 60 [m] T+0.6 [m] for L < 20 [m]
2	T+0.6 [m]
3	T+0.3 [m]
For intermediate values of L in Zone 1, T_1 to be linearly interpolated	

In way of tanks, the design pressure is not to be taken less than internal pressure 'p' given in 3.2.1.

3.2 Watertight floors and girders

3.2.1 The design pressure 'p' on watertight floors and girders in double bottom tanks is to be taken as the greater of:

$p = 6.7\ h_p$ [kN/m^2]

$p = 10\ (h_s + 1)$ [kN/m^2]

where,

h_p = vertical distance [m], from the load point to the top of air pipe.

h_s = vertical distance [m], from the load point to top of the tank.

3.3 Inner bottom

3.3.1 The design pressure 'p' on the inner bottom is to be taken as the greater of that given in 3.2.1 and the following:

In way of cargo holds, the design pressure 'p' is not to be taken as less than:

$$p = 12.5\ \rho H \quad [\text{kN/m}^2]$$

where,

ρ = cargo density [t/m^3] normally not to be taken as less than 0.7 [t/m^3]

H = height [m], to deck or top of hatchway coaming.

Section 4

Bottom and Inner Bottom Plating

4.1 Keel plate

4.1.1 The width of the plate keel is not to be less than (400+10L) [mm]. The thickness is to be 1 [mm] greater than that required for the adjacent bottom plating.

4.2 Bottom, bilge and inner bottom plating

4.2.1 The thickness of the bottom and inner bottom plating is to be not less than:

- for bottom plating

$t = (t_o+0.04L)\ \sqrt{k} + t_c$ [mm]

- for inner bottom plating.

$t = (t_o+0.03L)\ \sqrt{k} + t_c$ [mm] but not less than 6.0 [mm]

where,

t_o = 4.0 [mm], in general.

= 6.0 [mm], for inner bottom plating where ceiling is not fitted.

= 4.0 [mm] for inner bottom plating where wooden ceiling of 50 [mm] thickness is fitted.

4.2.2 The bottom, bilge and innerbottom plating is also to comply with the requirements of buckling strength given in Ch.3, Sec.6.

4.2.3 For ships discharged by grabs and where no ceiling is fitted, the plating thickness 't' of the inner bottom and exposed parts of sloping bulkheads is not to be less than:

$$t_1 = 0.62\sqrt{s.k}\left(\frac{M_{GRAB}}{20}\right)^{0.25} + t_c\ [mm]$$

s = spacing of stiffeners [mm]

M_{GRAB} = Mass of unladen grab [t]; M_{GRAB} is not to be taken less than 7 tonnes

4.2.4 Where the inner bottom is subjected to wheel loads from cargo handling vehicles, the scantlings are also to comply with the requirements given in Ch.8, Sec.6.

Section 5

Single Bottom

5.1 Transverse framing

5.1.1 Plate floors of following scantlings are to be fitted at every frame

depth at centreline d = 40B [mm] in general

thickness of web, t = d/100 + 2.5 [mm]

Section modulus

$Z = 0.006\ s.l_f^2\ .\ T_1$ [cm^3] in cargo holds

$= 0.0072\ s.l_f^2\ .\ T_1$ [cm^3] in machinery and other spaces

where,

l_f = span of floor, measured on the top of floor plate from side to side

= longitudinal bulkheads are provided the span, l_f not to be taken less than 0.4B.

T_1 is as defined in 3.1.1.

The thickness of face plate is not to be less than 1/15 of the face width.

The top of floors, in general, is to be level from side to side. However, in ships having considerable rise of floor, the depth of web at 10 per cent of the span from ends, is not to be less than half the depth at centreline.

If the height of floors between engine girders is reduced in way of crankcase, the face plate area is to be suitably increased, however the reduced height is normally not to be less than 2/3 of 'd' as given above.

5.1.2 On all ships one centre girder is to be fitted and in addition side girders are to be fitted such that the spacing of girders does not exceed 3.0 [m]. The girders are to extend as far forward and aft as practicable and where they are cut at transverse bulkheads the longitudinal continuity is to be maintained. Where the bottom structure changes into a double bottom structure, the bottom girders are to extend at least 3 frame spaces into double bottom structures.

The scantlings of the centre girders and side girders are to be not less than that of the floors.

The thickness of face plates is not to be less than 1/15 of the face width.

5.1.3 In the after peak of single screw ships, the height of the floors is to be increased such that their upper edge is well above the stern tube.

5.1.4 Where single bottom in the cargo region is stiffened by transverse frames supported by longitudinal girders, the scantlings of the frames and longitudinal girders are to be determined in accordance with 6.2.3 and 5.2.3, 5.2.4 respectively.

5.2 Longitudinal framing

5.2.1 The spacing of bottom transverses is normally not to exceed 3.0 [m]. The bottom transverses are to be supported by primary girders or longitudinal bulkheads. Where the design does not incorporate a centreline bulkhead, at least a docking girder is to be provided. The scantlings of simple girders and transverses are to be obtained in accordance with 5.2.3. The scantlings of a complex girder system are to be based on a direct stress analysis.

5.2.2 The section modulus 'Z' of the bottom longitudinals is not to be less than:

$$Z = \frac{s\,p\,l^2}{12\,\sigma} + Z_c\ [\mathrm{cm}^3]$$

where,

p = applicable design pressure [kN/m^2], as given in 3.1.1.

$\sigma = (215 - 140\ f_B)/k$, max.160/k [N/mm^2] within 0.4L amidships

= 160/k [N/mm^2] within 0.1L from ends.

Elsewhere σ may be obtained by linear interpolation.

5.2.3 The section modulus 'Z' of bottom girders is not to be less than:

$$Z = \frac{10^3 \, b \, p \, S^2}{m \, \sigma} + Z_c \quad [cm^3]$$

where,

m = 10 in general

p = applicable design pressure [kN/m^2], as given in 3.1.1.

σ = (190 - 130 f_B)/k, max160/k [N/mm^2]

for continuous longitudinal girders within 0.4L amidships.

= 160/k [N/mm^2]

for longitudinal girder within 0.1L from ends and for transverse girders in general.

Elsewhere σ may be obtained by linear interpolation.

5.2.4 Tripping brackets are to be fitted in accordance with the requirements given in Ch.3, Sec.4.4.4.

Section 6

Double Bottom

6.1 General

6.1.1 Where double bottom spaces are used as tanks, the centre girder is to be watertight unless the double bottom is divided by watertight side girders or the tanks are narrow.

The depth 'd' of the centre girder is not to be less than:

d = 250 + 20B + 50T [mm],
with a minimum of 650 [mm].

In case of ships with considerable rise of floors the depth 'd' may have to be increased.

6.1.2 The thickness 't' of the bottom girders and floors is not to be less than

t = (0.007d + 3) $\sqrt{k}$ [mm].

6.1.3 The section modulus 'Z' of the stiffeners on girders and floors forming boundaries of double bottom tanks is not to be less than:

$$Z = \frac{s \, p \, l^2}{10 \, \sigma} + Z_c \; [cm^3]$$

where,

p = design pressure [kN/m^2], as given in 3.2.1;

σ = (210 - 130 f_B)/k, max. 160/k [N/mm^2]
for longitudinal stiffeners within 0.4L amidships

= 160/k [N/mm^2]

for longitudinal stiffeners within 0.1L from ends and for transverse or vertical stiffeners in general.

Between the regions specified above σ for longitudinal stiffeners may be obtained by linear interpolation.

Longitudinal stiffeners are to have end connections, other stiffeners may be sniped at ends provided the section modulus Z is increased by 40 per cent.

6.1.4 The longitudinal girders are to be satisfactorily stiffened against buckling in accordance with the requirements given in Ch.3, Sec.6.

6.2 Transverse framing

6.2.1 The side girders are normally to be fitted at a spacing not exceeding 4.0 [m] and are to be extended as far forward and aft as practicable. The girders are to be stiffened at every bracket floor by a vertical stiffener of depth same as that of reverse frame and thickness that of the girder.

6.2.2 Plate floors are to be fitted under bulkheads, pillars, thrust seating, boiler bearers and in way of change of depth of double bottom. In engine room, plate floors are to be fitted at every frame. Elsewhere plate floors are to be fitted at least every fifth frame, the spacing not exceeding 3.0 [m].

6.2.3 Where bracket floors are fitted the section modulus 'Z' of the bottom frames and reverse frames is not to be less than:

$$Z = \frac{s\,p\,l^2 k}{1.6} \times 10^{-3} + Z_c \quad [cm^3]$$

where,

p = applicable design pressure [kN/m^2], as given in 3.1.1 and 3.3.1 for bottom frames and reverse frames respectively.

l = span of frames [m] measured between girder or brackets.

Where vertical struts according to 6.2.4 are fitted, the section modulus of bottom and reverse frames may be reduced by 35 per cent.

6.2.4 The cross sectional area 'A' of the struts is not to be less than

A = c . k . l . s . T . [cm^2]

where,

c = 7x10^{-4} in way of ballast tanks

= 6x10^{-4} elsewhere

l = actual span [m], without considering the strut.

The moment of inertia I of the struts is not to be less than:

I = 2.5 A . d^2 x 10^{-6} [cm^4]

where,

d = depth of double bottom, [mm].

6.2.5 The bottom frames and reverse frames are to be attached to the centre girder and margin plate by means of brackets of same thickness as that of the plate floors. The breadth of the brackets is not to be less than 0.75 times the depth of the centre girder and the brackets are to be flanged 75 [mm] at their free edges.

6.3 Longitudinal framing

6.3.1 The side girders are normally to be fitted at a spacing not exceeding 5.0 [m] and are to be extended as far forward and aft as practicable.

6.3.2 The plate floors are to be fitted under bulkheads, pillars, thrust seating and boiler bearers. In engine room, plate floors are to be fitted at every second side frames. Additionally, under the main engine seatings, floors extending to the first side girder outside the engine seating, are to be fitted at intermediate frames. The spacing of floors is normally not to exceed 3.0 [m].

6.3.3 The plate floors are to be stiffened at every longitudinal by a vertical stiffener of depth same as that of the inner bottom longitudinal and thickness as that of the floor. Between plate floors, transverse brackets are to be fitted at every frame at the margin plate and at a spacing not exceeding 1.25 [m] on either side of the centre girder. The thickness of brackets is to be same as that of the plate floors. The brackets are to extend upto the adjacent longitudinal and are to be flanged 75 [mm] at their free edges.

6.3.4 The section modulus 'Z' of the bottom and inner bottom longitudinals is not to be less than:

$$Z = \frac{s\,p\,l^2}{12\sigma} + Z_c \,[cm^3]$$

where,

p = applicable design pressure [kN/m^2], as given in 3.1.1 and 3.3.1 for bottom longitudinals and inner bottom longitudinals respectively;
l = span of longitudinals [m], measured between the plate floors

σ = (210 - 140 f_B)/k [N/mm^2], maximum 160/k [N/mm^2] for bottom longitudinals within 0.4L amidships

= (210 - 100 f_B)/k [N/mm^2], maximum 160/k [N/mm^2] for inner bottom longitudinals within 0.4L amidships

σ = 160/k [N/mm^2] within 0.1L from ends.

Between the regions specified above, σ may be obtained by linear interpolation.

Where vertical struts according to 6.2.4 are fitted, the section modulus of the bottom and inner bottom longitudinals may be reduced by 35 per cent.

Section 7

Engine Seatings

7.1 General

7.1.1 It is recommended that the depth of the floors or double bottom in way of engine foundations be increased.

7.1.2 Sufficient fore and aft girders are to be arranged in way of the main machinery to effectively distribute its weight and to ensure adequate rigidity of the structure. The girders are generally to extend over the full length of the engine room and are to be suitably scarphed into the bottom structure beyond.

7.1.3 The scantlings of engine seatings are to be adequate to resist gravitational, thrust, torque, dynamic and vibratory forces which may be imposed on them. The recommendations given by the engine manufacturer are also to be taken into account.

7.1.4 Where the top plate of the engine seating is situated above the floors or the inner bottom, adequate transverse strength by means of brackets in line with the floors is to be ensured. In way of the recess for crankcase, brackets as large as practicable are to be fitted.

7.1.5 Lightening holes in engine foundations are to be kept as small as practicable and the edges are to be suitably reinforced.

7.2 Recommended scantlings

7.2.1 For engines of power less than 1500 kW and RPM greater than 1200, the scantlings of engine girder face plate, web and floors in way of engine seatings may be calculated as given below. Scantlings for other engines will be specially considered.

Top plate area; $A = 20 + 120 \left(\frac{P}{R}\right)$ [cm^2]

Thickness of top plate; $t_p = 0.1A + 14$ [mm]

Girder web thickness; $t_g = 0.043A + 7$ [mm]

Floor web thickness; $t_f = 0.02A + 6$ [mm]

where,

P = maximum power of the engine [kW]

R = rpm of engine at maximum power

End of Chapter

Chapter 7

Side Structure

Contents

Section

Section 1

General

1.1 Scope

1.1.1 The scantlings and arrangement of side structure as defined in Ch.1, Sec.2 and also those of sides of the superstructures are to comply with the requirements of this Chapter.

1.2 Symbols

L, B, T, C_b, k as defined in Ch.1, Sec.2.

s = spacing of stiffeners, [mm].

l = span of stiffeners, [m].

b = spacing of girders, [m].

S = span of girders, [m].

t_c, Z_c = corrosion additions to thickness and section modulus respectively, as given in Ch.3, Sec.2.1

$$f_D = \frac{Z_R}{Z_D}$$

$$f_B = \frac{Z_R}{Z_B}$$

f_S = f_D for side shell area above neutral axis

= f_B for side shell area below neutral axis

where,

Z_R = Rule midship section modulus [cm^3] as required by Ch.4.

Z_D, Z_B = Actual midship section moduli [cm^3] provided at deck and bottom respectively.

Section 2

Structural Arrangement and Details

2.1 General

2.1.1 The ship's side shell may be stiffened longitudinally or vertically.

2.1.2 Where the side shell is stiffened longitudinally, the continuity of the side longitudinals within a distance of 0.15D from bottom or from strength deck is to be maintained in accordance with Ch.3, Sec.5.1.1. The web frames are to be fitted in line with the bottom transverses or plate floors.

2.1.3 The position, shape and reinforcement of sea inlets or other openings in side shell are to be in accordance with the requirements of Ch.4.

2.1.4 In the case of superstructures exceeding 0.15L in length and ending within 0.5L amidships, the side plating of the superstructures is to be increased by 25 per cent in way of the break.

2.1.5 The thickness of the shell plating is to be increased locally by 50 per cent in way of sternframe, propeller brackets and rudder horn. For reinforcements in way of anchor pockets, hawse pipes etc. refer to Ch.13.

2.1.6 The weld connections are to comply with the requirements of Ch.14.

2.2 Sheer strake

2.2.1 The thickness of sheer strake as obtained from 4.1.1 is to be increased by 30 per cent on each side of a superstructure end bulkhead located within 0.5L amidships if the superstructure deck is a partial strength deck.

2.2.2 Where a rounded sheer strake is adopted, the radius in general, is not to be less than 15 times the plate thickness.

2.2.3 Bulwarks are generally not to be welded to the top of the sheer strake within 0.6L amidships.

2.2.4 Where the sheer strake extends above the deck stringer plate, the top edge of the sheer strake is to be kept free from notches and drainage openings if any, are to have smooth transition in the longitudinal direction.

Section 3

Design Loads

3.1 External pressure

3.1.1 The design pressure 'p' on side shell is to be taken as per Table 3.1.1.

3.2 Internal tank pressure

3.2.1 Where the side shell forms a boundary of a tank, the design pressure 'p' is to be taken as the greater of external pressure given by 3.1.1 and the internal tank pressure 'p_i' given by 3.2.2.

3.2.2 The internal tank pressure 'p_i' is to be taken as the greater of:

$$p_i = 10\,(h_s + 1) \quad [\text{kN/m}^2]\text{, or}$$

$$= 6.7\,h_p \quad [\text{kN/m}^2]$$

Table 3.1.1

Zone		Design pressure 'p' [kN/m²] a)	
		For load points below the max. load waterline	**For load points above the max. load waterline**
1	$L \geq 60$ [m]	$10 h_o + \left(15 - 5\frac{h_o}{T}\right)$	$15 - 10 h_o$
	$L \leq 20$ [m] b)	$10 h_o + \left(9 - 3\frac{h_o}{T}\right)$	$9 - 10 h_o$
2		$10 h_o + \left(9 - 3\frac{h_o}{T}\right)$	$9 - 10 h_o$
3		$10 h_o + \left(5 - 2\frac{h_o}{T}\right)$	5

a) 'p' is not to be taken as less than 5 [kN/m^2]

b) For intermediate lengths (L) in Zone 1, the value of 'p' is to be linearly interpolated

h_o = vertical distance [m], from the maximum load waterline to the loadpoint.

where,

h_s = The vertical distance [m] from the load point to the top of tank

h_p = vertical distance [m], from the load point to the top of air pipe.

For very large tanks which may be partially filled, sloshing pressures may have to be considered.

Section 4

Side Shell Plating and Stiffeners

4.1 Side shell plating

4.1.1 The thickness 't' of side shell is not to be less than:

$$t = (4 + 0.04L)\sqrt{k} + t_c \quad \text{[mm]}$$

4.1.2 The side shell plating is also to comply with the requirements of buckling strength given in Ch.3, Sec.6.

4.1.3 The breadth of the sheer strake is not to be less than 100 D [mm].

Where the thickness of the strength deck plating is greater than that required for side plating, the sheer strake thickness is not to be less than the mean of the two values.

4.2 Side shell longitudinals

4.2.1 The section modulus 'Z' of side longitudinals is not to be less than

$$Z = \frac{s p l^2}{12\sigma} + Z_c \ [\mathrm{cm}^3]$$

where,

p = applicable design pressure at midpoint of the span [kN/m^2].

$\sigma = (215 - 145 f_S)/k$, maximum 160/k [N/mm^2] for side longitudinals at deck/bottom level within 0.4L amidships.

= 160/k [N/mm^2] at neutral axis within 0.4L amidships

= 160/k [N/mm^2] within 0.1L from ends and at the level of short superstructure decks.

Between the regions specified above `σ' may be obtained by linear interpolation.

4.3 Main frames

4.3.1 The section modulus 'Z' of the main frames bracketed at both ends as per 4.3.2 is not to be less than :

$$Z = \frac{spl^2k}{2400} + Z_c \ [cm^3] \ and$$

$$= 5.5\sqrt{Lk} \ [cm^3]$$

where,

p = applicable design pressure at midpoint of the span or mean of the pressures at two ends, whichever is greater, [kN/m^2].

4.3.2 Main frame brackets are to be as follows:

length of the bracket :

- for upper bracket : 70 l [mm]
- for lower bracket : 120 l [mm]

section modulus at end (including bracket) :

- for upper bracket : 1.7 Z [cm^3]
- for lower bracket : 2.0 Z [cm^3]

where,

Z = section modulus of main frame as given in 4.3.1

Where the free edge of the bracket exceeds 40 times the bracket thickness, the brackets are to be flanged. The flange width is to be at least 1/15 of the length of the free edge.

4.3.3 Brackets at ends of the main frame may be omitted provided the frame is carried through the supporting members and the section modulus obtained as per 4.3.1 is increased by 75 per cent.

4.4 Superstructure frames

4.4.1 Superstructure frames located between the collision bulkhead and the after peak bulkhead are to have section modulus 'Z' not less than:

$$Z = 0.005 \ s \ l^2 \ k \quad [cm^3]$$

4.4.2 The lower end of the superstructure frame is to be connected to the bracket or frame below or else it is to be bracketed above the deck. The upper end is to be bracketed to the deck beam or longitudinal.

4.5 Peak frames

4.5.1 Vertical peak frames forward of the collision bulkhead and aft of the after peak bulkhead are to have section modulus 'Z' not less than

$$Z = \frac{s p l^2 k}{1600} + Z_c \ [cm^3] \ and$$

$$= 5.5\sqrt{(L.k)} \ [cm^3]$$

where,

p = applicable design pressure [kN/m^2], as given in Sec.3.

4.5.2 Peak frames are to be bracketed at top and bottom and in way of side stringers, the connection is to provide adequate shear strength.

Section 5

Girders

5.1 General

5.1.1 Web frames are to be fitted in way of hatch end beams and deck transverses.

5.1.2 In the engine room, web frames are to be fitted at the forward and aft end of the engine and every 5th frame in general. The section modulus `Z' of the web frames and side stringers is to be obtained as per 5.1.5 taking 'b' as the mean of the web frame or stringer spacings respectively, on either side. The depth of the webs and stringers are not to be less than 2.5 times the depth of the ordinary frames.

Adequate deep beams are to be provided in line with the web frames.

5.1.3 In peak spaces, side stringers supporting vertical peak frames are normally to be fitted at every 2.6 [m]. The section modulus `Z' of the stringers is to be obtained as per Sec.5.1.5. The stringers are to be supported by web frames.

5.1.4 The scantlings of simple girders and web frames supporting frames and longitudinals are to be in accordance with 5.1.5. The scantlings of webs supporting fully effective side stringers are to based on point loadings and 'σ' values given in 5.1.5. The scantlings of the complex girder system are to be based on a direct stress analysis. The buckling strength of the cross ties, where fitted, is to comply with the requirements given in Ch.3, Sec.6.

5.1.5 The section modulus 'Z' of simple girders and web frames is not to be less than :

$$Z = \frac{b\,p\,S^2\,.10^3}{m\sigma} + Z_c \ [\mathrm{cm}^3]$$

where,

p = applicable design pressure [kN/m^2], as given in Sec 3.

m = 12 for continuous longitudinal girders with end attachments in accordance with Ch.3, Sec.5.

= 10 for other girders with end attachments in accordance with Ch.3, Sec.5.

σ = (190 - 145 f_S)/k, max 160/k [N/mm^2], for continuous longitudinal girders within 0.4L amidships.

= 160/k [N/mm^2] for longitudinal girders within 0.1L from ends and for web frames in general.

Between the regions specified above, s may be obtained by linear interpolation.

5.1.6 The net cross sectional area 'A' of the girder web at ends is not to be less than

A = 0.06 Sbpk + 0.01 h t_c [cm^2] for stringers and upper ends of the web frames.

= 0.08 Sbpk + 0.01 h t_c [cm^2] for lower ends of the web frames.

where,

h = girder height [mm].

5.1.7 Tripping brackets are to be fitted in accordance with the requirements given in Ch.3, Sec.4.4.4.

End of Chapter

Chapter 8

Deck Structure

Contents

Section 1

General

1.1 Scope

1.1.1 The scantlings and arrangement of deck structure as defined in Ch.1, Sec.2 are to comply with the requirements given in this Chapter.

1.2 Symbols

L,B,T,C_b,k as defined in Ch.1, Sec.2.

s = spacing of stiffeners, [mm].

l = span of stiffeners, [m].

b = spacing of girders, [m].

S = span of girders, [m].
t_c, Z_c = corrosion additions to thickness and section modulus respectively as given in Ch.3, Sec.2.1.

$$f_D = \frac{Z_R}{Z_D}$$

where,

Z_R = Rule midship section modulus [cm^3], as required by Ch.4.

Z_D = actual midship section modulus [cm^3], provided at deck calculated as per Ch.4.

$$f_z = \frac{z}{z_n}$$

where,

z_n = vertical distance [m], from the neutral axis of the hull girder to the strength deck, in general. For ships with continuous trunks refer to Ch.4, Sec.3.1.3.

z = vertical distance [m], from the neutral axis of the hull girder to the deck under consideration or to the free flange of the deck longitudinal or girder as relevant.

Section 2

Structural Arrangement and Details

2.1 General

2.1.1 In tankers, the deck is normally to be stiffened longitudinally in the cargo tank region, however, where L does not exceed 75 [m], consideration may be given to transversely stiffened decks.

2.1.2 The continuity of the deck longitudinals is to be maintained in accordance with Ch.3, Sec.5.1.1.

2.1.3 The deck within the line of hatchway openings is preferably to be stiffened transversely or alternatively the arrangements are to provide adequate transverse buckling strength. Where the deck outside the line of hatchway openings is framed longitudinally, the transverse beams or buckling stiffeners between the hatchways are to extend at least upto the second longitudinal from the hatch side or equivalent.

2.1.4 In ships with large hatch openings, the effective cross-sectional area of the deck between the hatchways is to be sufficient to withstand the transverse load acting on the ship's sides.

2.1.5 The weld connections are to comply with the requirements of Ch.14.

2.1.6 Hatchway corners are to be of streamlined, elliptical or circular shape as given in Ch.4. Where shapes other than the streamlined shape or equivalent are adopted, insert plates are to be fitted at the hatch corners in strength deck. The insert plates are to be 25 per cent thicker than the deck plating outside the line of hatchways and are to extend as shown in Fig.2.1.6. The butts of insert plates are to be well clear of those in coaming.

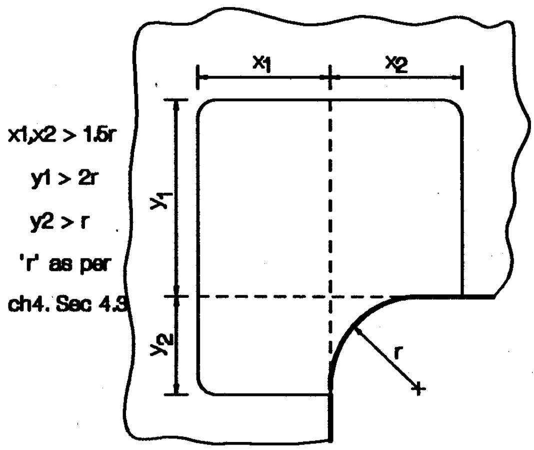


Fig.2.1.6 : Extent of insert plate

Section 3

Design Loads

3.1 Weather deck

3.1.1 The design pressure 'p' on exposed decks is to be taken as:

$$p = H_1 - 10\, h_o \ \ [kN/m^2], \text{ minimum } 5\ [kN/m^2]$$

where,

h_o = vertical distance [m], from the maximum load waterline to the deck.
H_1 = as given in Table 3.1.1.

Table 3.1.1

Zone	H_1
1	9 for $L \le 20$ [m] 9 + 0.15 (L-20) for $20 < L < 60$ 15 for $L \ge 60$ [m]
2	9
3	5

3.1.2 For decks subjected to cargo loading the design pressure is to be taken as:

p = 12.5 q [kN/m^2]

where 'q' is deck cargo loading [t/m^2].

3.1.3 For weather decks forming crowns of tanks, the design pressure 'p' is to be taken as the greater of that given by 3.1.1 and 3.3.1.

3.2 Accommodation decks

3.2.1 The design pressure 'p' on accommodation decks is to be taken as :

p = 4.5 [kN/m^2]

3.2.2 For decks forming crowns of tanks the design pressure 'p' is to be taken as the greater of that given by 3.2.1 and 3.3.1.

3.3 Decks forming tank boundaries

3.3.1 The design pressure 'p' for decks forming the bottom or crown of a tank may be taken as the greater of the following:

p = 6.7 h_p [kN/m^2] or

= 10 (h_s + 1) [kN/m^2]

where,

h_p = vertical distance [m], from the deck to the top of air pipe

h_s = vertical distance [m], from the deck to the top of the tank.

Section 4

Deck Platings and Stiffeners

4.1 Deck platings

4.1.1 The thickness of the strength deck plating outside the line of hatchway openings is to be adequate to give the necessary hull section modulus and moment of inertia required by Ch.4.

4.1.2 The thickness 't' of deck platings is not to be less than:

t = (t_o+0.02L) $\sqrt{k}$ + t_c [mm]

where,

t_o = 5 for strength decks and forecastle decks

= 4.0 for other decks.

4.1.3 The strength deck plating outside the line of hatchways is also to comply with the requirements of buckling strength given in Ch.3, Sec.6.

4.1.4 In way of ends of bridges, poops and forecastles, the thickness of the strength deck stringer strake is to be increased by 20 per cent over four frame spaces fore and also aft of the end bulkheads.

4.2 Deck stiffeners

4.2.1 The section modulus 'Z' of deck longitudinals is not to be less than:

$$Z = \frac{s\,p\,l^2}{12\sigma} + Z_c \ [\mathrm{cm}^3]$$

where,

p = applicable design pressure [kN/m^2] as given in Sec.3.

σ = (215 - 145f_D.f_z)/k, max. 160/k [N/mm^2] for strength deck and decks of long super-structures/deckhouses within 0.4L amidships.

= (225 - 145f_D.f_z)/k, max. 160/k [N/mm^2] for continuous decks below strength deck within 0.4L amidships.

= 160/k [N/mm^2] within 0.1L from ends and for short decks.

Elsewhere, σ may be obtained by linear interpolation.

The longitudinals are also to comply with the requirements of buckling strength given in Ch.3, Sec.6.

4.2.2 The section modulus 'Z' of transverse beams is not to be less than:

$$Z = \frac{spl^2k}{1600} + Z_c\ [cm^3]$$

where,

p = applicable design pressure [kN/m^2] as given in Sec.3.

Section 5

Deck Girders and Pillars

5.1 Girders

5.1.1 Deck girders and transverses are to be arranged in line with vertical members of scantlings sufficient to provide adequate support.

5.1.2 The scantlings of simple girders and transverses are to be in accordance with 5.1.3. The scantlings of a complex girder system are to be based on a direct stress analysis.

5.1.3 The section modulus 'Z' of deck girders is not to be less than:

$$Z = \frac{b\,p\,S^2\,.10^3}{m\sigma} + Z_c\ [cm^3]$$

where,

p = applicable design pressure [kN/m^2] as given in Sec.3.

m = 12 for continuous longitudinal girders with end attachments in accordance with Ch.3.

= 10 for other girders with end attachments in accordance with Ch.3.

σ = (190 - 145$f_D f_z$)/k, max. 160/k [N/mm^2] for continuous longitudinal girders within 0.4L amidships.

= 160/k [N/mm^2] for longitudinal girders within 0.1L from ends and for transverse girders in general.

Elsewhere, `σ' may be obtained by linear interpolation.

5.1.4 The net cross sectional area 'A' of the girder web at ends is not to be less than:

$$A = 0.07\ .\ S.b.p\ k + 0.01h\ t_c\ [cm^2]$$

where,

h = girder height [mm].

5.1.5 The girders are to be satisfactorily stiffened against buckling in accordance with the requirements given in Ch.3, Sec.6. Tripping brackets are to be fitted in accordance with the requirements given in Ch.3, Sec.4.4.4.

5.2 Cantilevers

5.2.1 The scantlings of cantilever beams and supporting frames will be specially considered.

5.3 Pillars

5.3.1 The scantlings of the pillars are to be in accordance with the requirements of Ch.3, Sec.6. Axial load, if any, from pillars above is to be added to the load from deck girders.

The minimum wall thickness 't' [mm], of the tubular pillars is not to be less than:

t = 4.5 + 0.015 d for d < 300 [mm]

= 0.03d for d $\geq$ 300 [mm]

where,

d = diameter of the pillar [mm].

5.3.2 Pillars are to be fitted in the same vertical line wherever possible, and arrangements are to be made to effectively distribute the load at the heads and heels. Where pillars support eccentric loads, they are to be strengthened for the additional bending moments imposed upon them. Doubling or insert plates are generally to be fitted at the head and heel of hollow pillars.

5.3.3 The pillars are to have a bearing fit and are to be attached to the head and heel plates by continuous welding.

5.3.4 Where the heels of hold pillars are not directly above the intersection of plate floors and girders, partial floors and intercostal girders are to be fitted as necessary to support the pillars. Lightening holes or manholes are not to be cut in the floors and girders below the heels of pillars.

5.3.5 Inside tanks, hollow pillars are not to be used and strengthening at the heads and heels of pillars is not to be obtained by means of doubling plates. Where hydrostatic pressure may give rise to tensile stresses in the pillars, their sectional area 'A' is not to be less than

$$A = 0.07 \cdot A_L . p \ [cm^2]$$

where,

p = design pressure as given in Sec.3, causing the tensile stress in pillar

A_L = load area of deck [m^2], being supported by the pillar.

Section 6

Decks for Wheel Loading

6.1 General

6.1.1 Where it is proposed either to stow wheeled vehicles on the deck or to use wheeled vehicles for cargo handling, the requirements of this section are to be complied with in addition to those given in the preceding sections.

6.1.2 The requirements given below are based on the assumption that the considered element (Deck plating and/or stiffener) is subjected to one load area only, and that the element is continuous over several evenly spaced supports. The requirements for other loads and/or boundary conditions will be specially considered.

A "load area" is the tyre print area of individual wheels; for closely spaced wheels it may be taken as the enveloped area of the wheel group.

6.1.3 The details of wheel loadings are to be forwarded by the shipbuilder. These details are to include the proposed arrangement and dimensions of tyre prints, axle and wheel spacings, maximum axle load and tyre pressure.

6.2 Wheel loads

6.2.1 The pressure 'p' from the wheels on deck is to be taken as:

$$p = \frac{12.5W}{n.a.b} \times 10^6 \ [kN/m^2]$$

– for stowed vehicles in sailing condition; and

$$p = \frac{W}{n.a.b}\left(9.81 + \frac{3}{\sqrt{W}}\right) 10^6 \ [kN/m^2]$$

– for cargo handling vehicles in harbour condition

where,

W = maximum axle load, [t]. For fork lift trucks, the total weight is to be taken as the axle load.

n = number of "load areas" per axle

a = extent [mm], of the load area parallel to the stiffener (see Fig. 6.2.1)

b = extent [mm], of the load area perpendicular to the stiffener (see Fig.6.2.1)

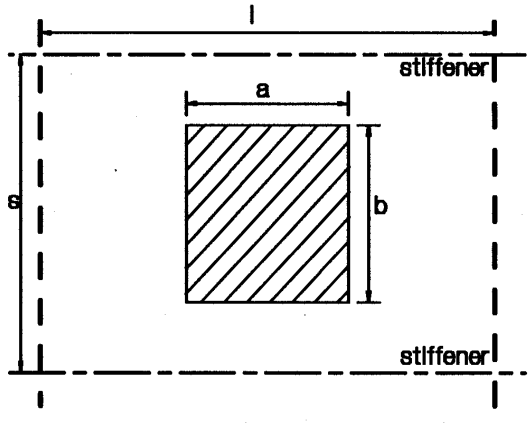


Fig.6.2.1 : Plate panel and load area dimensions

6.3 Deck plating

6.3.1 The thickness 't' of deck plating subjected to wheel loadings is not to be less than:

$$t = c_1 f_a \sqrt{\frac{c_2 b s p k .10^{-3}}{m}} + t_c \ [mm]$$

where,

f_a = (1.1 - 0.25 s/l) for s ≤ l, however need not be taken as greater than 1.0

a,b,s,l = deck panel dimensions [mm] (see Fig.6.2.1)

c_1 = 0.137 in general for sailing conditions

= 0.127 in general for harbour conditions

= As per Table 6.3.1 for upper deck within 0.4L amidships.

Table 6.3.1 : c_1 values for upper deck plating within 0.4L amidships

Framing system	Sailing conditions	Harbour conditions
Longitudinal	0.145	0.130
Transverse	0.180	0.145

For upper deck plating between 0.4L amidships and 0.1L from ends, c_1 is to be varied linearly.

$$c_2 = 1.3 - \frac{4.2}{(a/s + 1.8)^2},$$

however, need not be taken as greater than 1.0

$$m = \frac{38}{(b/s)^2 - 4.7(b/s) + 6.5} \quad \text{for } b \le s$$

6.4 Deck stiffeners

6.4.1 The section modulus 'Z' of deck beams and longitudinals subjected to wheel loadings is not to be less than:

$$Z = \frac{c_3 .a.b.l.p \ 10^{-6}}{m\sigma} + Z_c \ [cm^3]$$

where,

c_3 = (1.15 - 0.25 b/s) for b ≤ s, however need not be taken as greater than 1.0

$$m = \frac{r}{(a/l)^2 - 4.7\, a/l + 6.5}$$

r = 29 for continuous stiffeners supported at girders

= 38 when the continuous stiffeners can be considered as rigidly supported at girders against rotation.

σ = 160/k [N/mm^2] in general, for sailing conditions

= 180/k [N/mm^2] in general, for harbour conditions

= As per Table 6.4.1 for deck longitudinals within 0.4L amidships, but not exceeding the above general values.

For deck longitudinals between 0.4L amidships and 0.1L from ends, σ is to be varied linearly.

Table 6.4.1 - σ Values for longitudinals within 0.4L amidships

Condition	[N/mm^2]
Sailing	(215 - 145f_D.f_z)/k
Harbour	(225 - 90 f_D.f_z)/k

6.5 Deck girders

6.5.1 The scantlings of girders will be specially considered based on the most severe condition of moving or stowed vehicles. Also see Sec.6.1.3.

End of Chapter

Chapter 9

Bulkheads

Contents

Section 1

General

1.1 Scope

1.1.1 The requirements of this chapter cover the arrangement and scantlings of watertight and deep tank bulkheads.

1.1.2 The requirements also cover the non-watertight bulkheads and shaft tunnels.

1.2 Statutory requirements

1.2.1 Where applicable, the number and disposition of bulkheads are to be arranged to meet the requirements for subdivision, floodability and damage stability in accordance with the requirements of the local or National Statutory Authority of the country in which the ship is registered.

1.3 Symbols

L, B, T, C_b, k as defined in Ch.1, Sec.2.

s = spacing of stiffeners [mm]

l = span of stiffeners [m]

b = spacing of girders [m]

S = span of girders [m]

t_c, Z_c = corrosion additions to thickness and section modulus respectively as given in Ch.3, Sec.2.1

$$f_D = \frac{Z_R}{Z_D}$$

$$f_D = \frac{Z_R}{Z_D}$$

where,

Z_R = Rule midship section modulus [cm^3] as required by Ch.4.

Z_D, Z = Actual midship section moduli in [cm^3] provided at deck and bottom respectively calculated as per Ch.4.

f_s =f_D for side shell area above neutral axis

f_s = f_B for side shell area below neutral axis.

Section 2

Subdivision and Arrangement

2.1 Number of bulkheads

2.1.1 The following transverse watertight bulkheads are to be fitted in all ships:

- A collision bulkhead;
- An aftpeak bulkhead;
- A bulkhead at each end of the machinery space.

In ships with machinery aft, the aftpeak bulkhead may form the aft boundary of the machinery space.

Additional transverse watertight bulkheads are to be fitted to ensure adequate transverse strength.

2.1.2 The ordinary transverse watertight bulkheads in the holds should be spaced at reasonably uniform intervals. Where non-uniform spacing is unavoidable and the length of a hold is unusually large, the transverse strength of the ship is to be maintained by providing additional web frames, increased framing etc.

2.2 Position and height of bulkheads

2.2.1 The collision bulkhead is to be fitted at a distance of 0.04L to 0.1L from the F.P. Any recesses or steps in collision bulkheads are to fall within the limits.

2.2.2 Consideration will however be given to proposals for the collision bulkhead positioned aft of the limits given in 2.2.1, provided that the application is accompanied by calculations showing that with the ship fully loaded to maximum draught on even keel, flooding of space forward of the collision bulkhead will not result in any part of the main deck becoming submerged, nor result in any unacceptable loss of stability.

2.2.3 All ships are to have an after peak bulkhead generally enclosing the sterntube and rudder trunk in a watertight compartment. In twin screw ships where the bossing ends forward of the after peak bulkhead, the sterntubes are to be enclosed in suitable watertight spaces.

2.2.4 The watertight bulkheads are in general to extend to the uppermost continuous deck.

2.2.5 For passenger ships the number and position of the bulkheads will normally be governed by the requirements of Pt.5, Ch.3, Sec 2.

2.3 Openings in watertight bulkheads and closing appliances

2.3.1 Doors, manholes, permanent access openings or ventilation ducts are not to be cut in the collision bulkhead below the uppermost continuous deck.

2.3.2 Openings may be accepted in other watertight bulkheads provided the number and the size of openings is kept to a minimum compatible with the design and proper working of the ship. Where penetrations of watertight bulkheads are necessary for access, piping, ventilation, electrical cables, etc., arrangements are to be made to maintain the watertight integrity. In way of openings, suitable reinforcements are to be provided to ensure that the strength is at least equal to that of the unpierced bulkhead.

2.4 Cofferdams

2.4.1 Cofferdams are to be provided between the following spaces to separate them from each other:

- tanks for fuel oil or lubricating oil
- tanks for edible oil
- tanks for fresh water and feed water.

2.4.2 Tanks for lubricating oil are also to be separated by cofferdams from those carrying fuel oil. However, these cofferdams need not be fitted provided that the common boundaries have full penetration welds and the head of oil is generally not in excess of that in the adjacent lubricating oil tanks.

Section 3

Structural Arrangement and Details

3.1 General

3.1.1 Oil fuel or oil carried as cargo in the deep tanks is to have a flash point of 60°C and above in closed cup test. Where tanks are intended for other liquid cargoes of a special nature the scantlings and arrangements will be considered in relation to the nature of the cargo.

3.1.2 The continuity of bulkhead longitudinals within a distance of 0.15D from the bottom or the strength deck is to be maintained in accordance with Ch.3, Sec.5.1.1.

3.1.3 Carlings, girders or floors are to be fitted below the corrugated bulkheads at their supports. These supporting members are to be aligned to the face plate strips of the corrugations.

3.1.4 The weld connections are to comply with the requirements of Ch.16.

3.2 Wash bulkheads

3.2.1 A centreline wash bulkhead is to be fitted in peak spaces used as tanks, where the breadth of the tank exceeds 0.5B and also in deep tanks used for fuel oil extending from side to side.

3.2.2 The area of perforations is generally to be between 5% to 10% of the total area of bulkhead. The plating is to be suitably stiffened in way of the openings.

3.3 Supporting bulkheads

3.3.1 Bulkheads or parts thereof supporting deck structure are also to be designed as pillars. The permissible axial loads and buckling strength are to be calculated in accordance with Ch.3, Sec.6. In calculating sectional properties the width of attached plating is not to be taken in excess of 40 times the plate thickness. Also see Ch.8, Sec.5.1.1.

Section 4

Design Loads

4.1 Watertight bulkhead loads

4.1.1 The design pressure 'p', for ordinary watertight bulkheads is given by:

$$p = 10\,h \quad [kN/m^2]$$

where,

h = the vertical distance [m] from the loadpoint to the uppermost continuous deck.

4.1.2 For bulkheads bounding cargo spaces intended to carry dry bulk cargoes, the design pressure 'p' is to be taken as the higher of that given in 4.1.1 and the pressure due to bulk cargo as given below:

$$p = 12.5\,C\,\rho\,h_c \quad [kN/m^2]$$

where,

$$C = \sin^2\alpha\,\tan^2(45 - \delta/2) + \cos^2\alpha$$

α = angle made by the panel under consideration with the horizontal plane [deg.]

δ = angle of repose of cargo [deg.] not to be taken greater than the following

- 20° for light bulk cargo (e.g. coal, grain)
- 25° for bulk cement cargo
- 35° for heavy bulk cargo (e.g. ore)

h_c = vertical distance [m], from the loadpoint to the mean horizontal plane corresponding to actual volume of cargo being considered

ρ = density of cargo [t/m^3].

For vessels designed to carry heavy bulk cargoes which are also required to carry lighter cargoes, the pressure 'p' based on maximum mass of cargo to be carried in the hold and filled up to the top of hatch coaming would also require to be considered.

4.2 Tank bulkhead loads

4.2.1 The design pressure 'p' for tank bulkheads are normally to be taken as the greater of

$p = 12.5\ h_s$ [kN/m^2]

$= 6.7\ h_p$ [kN/m^2]

$= 10\ (h_s + 1)$ [kN/m^2]

where,

h_p = vertical distance [m] from the loadpoint to the top of the air pipe.

h_s = vertical distance [m] from the loadpoint to the top of the tank or hatchway.

For very large tanks which may be partially filled, sloshing pressures may have to be considered.

4.2.2 The pressure 'p' on girder web panels in cargo tanks or ballast tanks is not to be taken as less than 20 [kN/m^2].

4.3 Wash bulkheads loads

4.3.1 The design pressure 'p' for wash bulk-heads may be taken as 50% of that for boundary bulkhead in the same location.

Section 5

Plating and Stiffeners

5.1 Bulkhead plating

5.1.1 The thickness 't' of the bulkhead plating is not to be less than the minimum thickness given in 5.1.2 nor less than

$$t = 15.8 s \sqrt{p/\sigma}\ \text{x}\ 10^{-3} + t_c\ \ [\text{mm}]$$

where,

p = applicable design pressure as given in Sec.4.

σ = as per Table 5.1.1 for longitudinal bulkheads.

= 160/k for transverse tank bulkheads and collision bulkhead;

= 220/k for ordinary transverse watertight bulkheads.

= 190/k for transverse dry bulk cargo bulkheads

5.1.2 The minimum thickness requirement of the bulkhead plating is given by

$$t = (4.0 + 0.01L) + t_c\ \ [\text{mm}]$$

5.1.3 The plate thickness of corrugated bulkheads is not to be less than that required according to 5.1.1 and 5.1.2. The spacing 's' to be used in the calculation of the plating thickness is to be taken as the greater of 'b' or 'c' where 'b' and 'c' are indicated in Fig. 5.1.3.

For built up corrugation bulkheads, where the thickness of the flange and web are different, the thickness of the wider plating is also not to be less than :

Table 5.1.1 : 'σ' values for longitudinal bulkhead plating				
Region	Framing system	At neutral axis	At strength deck or at bottom	Between neutral axis and strength deck or bottom
0.4L amidships	Vertical	140/k	(175-130 f_s)/k max. 120/k	To be obtained by linear interpolation
	Longitudinal	160/k	(185-105 f_s)/k max. 120/k	To be obtained by linear interpolation
Within 0.1L from ends	160/k	160/k	160/k	
Elsewhere	to be obtained by linear interpolation between allowable values at regions specified above.			

$$t = \sqrt{\frac{s^2.p}{2\sigma} - (t_a - t_c)^2} + t_c \ \text{[mm]}$$

where,

t_a = thickness of adjacent plating [mm] not to be taken greater than t.

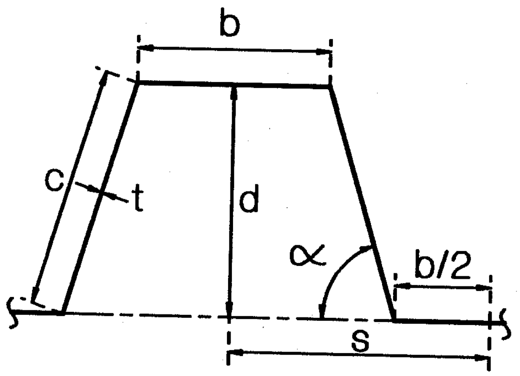


Fig.5.1.3 : Corrugated bulkhead

5.1.4 The longitudinal bulkhead plating within 0.1D from bottom or strength deck is also to comply with the requirements of buckling strength given in Ch.3, Sec.6.

5.1.5 In way of stern tubes, doubling plate of same thickness as the corresponding strake is to be fitted, or the strake thickness is to be increased by at least 60 per cent.

5.2 Longitudinals

5.2.1 The section modulus of continuous longitudinal stiffeners and corrugations is not to be less than:

$$Z = \frac{spl^2}{m\sigma} + Z_c \ [\text{cm}^3]$$

where,

p = applicable design pressure given in Sec.4.

m = 12

σ = (215 - 145 f_s)/k, max. 160/k [N/mm^2] at deck/bottom level within 0.4L amidships

= 160/k at neutral axis within 0.4L amidships

= 160/k for longitudinals within 0.1L from ends.

For longitudinals between the regions specified above σ may be obtained by linear interpolation.

5.2.2 The thickness of the web and flange is not to be less than the minimum plating thickness requirements stipulated in 5.1.2.

5.2.3 The rule section modulus of a corrugated bulkhead element is to be obtained according to 5.2.1 taking 's' as shown in Fig. 5.1.3.

5.2.4 The actual section modulus of a corrugated bulkhead element may be obtained in accordance with the following:

$$Z_{actual} = \frac{t.d(b + c/3)}{2000} \ [\text{cm}^3]$$

where, t,d,b and c [mm], are as shown in Fig. 5.1.3.

5.3 Vertical and transverse stiffeners on tank bulkheads, collision bulkheads, dry bulk cargo bulkheads and wash bulkheads

5.3.1 The section modulus of bulkhead stiffeners is not to be less than:

$$Z = \frac{spl^2}{m\sigma} + Z_c \ [cm^3]$$

where,

p = applicable design pressure [kN/m2] given in Sec.4.

m = 10 for transverse stiffeners and vertical stiffeners which may be considered fixed at both ends

= 7.5 for vertical stiffeners simply supported at one or both ends

= 10 for horizontal corrugation fixed at ends

= 13 for fixed upper end of vertical corrugation

= 20 for non-fixed upper end of vertical corrugation

= 10 for lower end of vertical corrugation

σ = 160/k for tank bulkhead and collision bulkhead

= 210/k for dry bulk cargo bulkheads.

5.3.2 The thickness of web and flange is to be as required in 5.1.2.

5.3.3 Actual section modulus of corrugations is to be obtained as per 5.2.4.

5.3.4 Brackets are normally to be fitted at the ends of non-continuous stiffeners. Where stiffeners are sniped at the ends, the thickness of the plating supported by the stiffeners is not to be less than:

$t = 0.0395 \sqrt{[(l - 0.0005s)\, s.p.k]} + t_c$ [mm]

5.4 Vertical and transverse stiffeners on ordinary watertight bulkheads

5.4.1 The section modulus of bulkhead stiffeners is not be less than

$$Z = \frac{spl^2}{m\sigma}$$

where,

p = applicable design pressure given in Sec.4.

m = 16 for stiffeners fixed at both ends

= 12 for stiffeners fixed at one end (lower end in case of vertical stiffeners) and simply supported at the other end.

= 8 for stiffeners simply supported at both ends.

σ = 220/k

5.4.2 The thickness of web and flange is to be as required in 5.1.2. For sniped ends, the thickness of bulkhead plating is to be as per 5.3.4.

5.4.3 Actual section modulus of corrugations is to be obtained as per 5.2.4.

Section 6

Girders

6.1 General

6.1.1 Bulkhead stringers and deep transverses are to be arranged in line with other primary supporting structure to the adjoining deck, side shell and bottom so as to facilitate the formation of continuous ring structures. Otherwise equivalent scarphing arrangement is to be provided.

6.1.2 The section modulus requirement 'Z' of simple girders is not to be less than:

$$Z = \frac{b.p.S^2 \ x\,10^3}{m\sigma} + Z_c \ [cm^3]$$

where,

m = 12 for continuous longitudinal girders with end attachments in accordance with Ch.3, Sec.5.

= 10 for other girders with end attachments in accordance with Ch.3, Sec.5.

σ = (190 - 45f_S), max 160/k [N/mm^2], for continuous longitudinal girders within 0.4L amidships.

= 160/k [N/mm^2] for continuous longitudinal girders within 0.1L from ends and for vertical or transverse girders on tank and collision bulkheads.

= 210/k for vertical and transverse girders, in general.

For continuous longitudinal girders between the regions specified above, 'σ' may be obtained by linear interpolation.

6.1.3 The depth of the girders should not be less than 2.5 times the depth of the cutout (if any) for the passage of continuous stiffeners. The net cross sectional area 'A' of the girder web at ends is not to be less than

$$A = CkSbp + 0.01\ d_w\ t_c\ [cm^2]$$

where,

C = 0.060 for tank and collision bulkheads

C = 0.045 for other watertight bulkheads

d_w = depth of web [mm].

However, for lower end of vertical girders value of C to be taken as 0.08 and 0.06 respectively.

6.1.4 Tripping brackets are to be fitted in accordance with the requirements given in Ch.3, Sec.4.

End of Chapter

Chapter 10

Superstructures, Deckhouses and Bulwarks

Contents

Section 1

General

1.1 Scope

1.1.1 The scantlings of the bulwarks and of the exposed bulkheads of the superstructures and deckhouses are to comply with the requirements of this chapter. The scantlings of the decks of the superstructures and deckhouses are to be in accordance with the requirements of Ch.8, and those of the sides of the superstructures are to be in accordance with the requirements of Ch.7.

1.2 Definitions

1.2.1 For definitions of the terms 'Superstructure' and 'Deckhouse' refer to Ch.1.

1.2.2 The lowest tier is normally the tier that is directly situated on the deck to which the rule depth 'D' is measured or on superstructures which are less than 1.8 [m] in height.

1.3 Symbols

1.3.1 L and k as defined in Ch.1, Sec.2.

s = spacing of stiffeners [mm].

l = span of stiffener [m].

Section 2

Scantlings

2.1 End bulkheads and exposed sides of deckhouses

2.1.1 The thickness 't' of steel plating of the fronts, sides and aft ends of deckhouses and the front and aft ends of superstructures is not to be less than:

$t = (0.004\ s + 2.5)\sqrt{k}$ - for lowest tier

$= (0.004\ s + 1.5)\sqrt{k}$ - for upper tiers

2.1.2 The section modulus Z of stiffeners on fronts, sides and aft ends of deck houses and the front and aft ends of superstructures is not to be less than:

$Z = 3.6\ sl^2 \times 10^{-3} \cdot k$ [cm^3] - for uppermost tier

l is not to be taken less than 2.0 [m].

When a multiple tier erection is fitted, the section modulus of stiffeners on lower tiers is to be increased at the rate of 15% per tier fitted above the tier under consideration.

2.1.3 The upper end of stiffeners on all erections are to be bracketed to the deck beams or longitudinals and the lower end is to be welded to the deck below.

2.2 Protected machinery casings

2.2.1 The thickness of plating is not to be less than:

$t = (0.003\ s + 1.5)\ \sqrt{k}$ [mm]

2.2.2 The section modulus 'Z' of stiffeners is not to be less than:

$Z = 0.003\ sl^2\ \sqrt{k}$ [cm^3]

where, l is not to be taken less than 2.0 [m].

2.2.3 Casings supporting one or more decks above are to be adequately strengthened.

Section 3

Structural Arrangement and Details

3.1 Structural continuity

3.1.1 Adequate transverse strength is to be provided to the deckhouses and superstructures by means of transverse bulkheads, girders and web frames.

3.1.2 The front and the after end bulkheads of large superstructures and deckhouses are to be effectively supported below by a transverse bulkhead or by a combination of partial bulkheads, girders and pillars. Similarly, the exposed sides of various tiers of erections are to be supported by bulkheads, girders or carlings below.

3.1.3 All openings cut on the sides are to be substantially framed and have well rounded corners.

3.1.4 At the ends of superstructures, which have no set-in from the ships' side, the side plating is to extend beyond the ends of the superstructure, and is to be gradually reduced in height down to the sheer strake. The extended plating is to be adequately stiffened, particularly at its upper edge.

Section 4

Bulwarks and Guard Rails

4.1 General requirements

4.1.1 Bulwarks or guard rails are to be provided on the exposed parts of the freeboard and superstructure decks and also on all upper deck spaces normally accessible to crew and passengers. The height of the bulwarks or guard rails measured above the sheathing, if any, should not be less than the following:

For all passenger ships :

- For all Zones : 900 [mm]

For all other ships :

- For Zone 1 : 900 [mm]
- For Zone 2 : 600 [mm]
- For Zone 3 : 300 [mm].

Consideration will be given to cases where this height would interfere with the normal operation of the ship.

4.1.2 Bulwarks or guard rails as required by 4.1.1 may be dispensed with in way of hatch side coamings fitted with suitable handrails.

4.1.3 Where bulwarks on the weather portion of freeboard or superstructure decks form wells, provision is to be made for rapidly freeing the decks of water.

4.2 Bulwark construction

4.2.1 Bulwarks are to be stiffened at the upper edge by a strong rail section and supported by stays from the deck, spaced not more than 2.0 [m] apart. Where bulwarks are cut in way of a gangway or other openings, stays of increased strength are to be fitted at the ends of the openings.

Bulwark stays are to be supported by, or are to be in line with, suitable underdeck stiffening, which is to be connected by double continuous fillet welds in way of the bulwark stay connection.

Bulwarks are to be adequately strengthened in way of the eyeplates for cargo gear. In way of the mooring pipes, the plating is to be increased in thickness and also adequately stiffened.

4.2.2 Bulwarks are generally not to be welded to the top of the sheerstrake within 0.6L amidships and so arranged as to ensure their freedom from main structural stresses.

4.3 Bulwark scantlings

4.3.1 The thickness of the bulwark plating is not to be less than 4.0 [mm].

4.3.2 The section modulus 'Z' at the bottom of the bulwark stay is not to be less than:

$Z = (33 + 0.44\ L)\ h^2\ s\quad [cm^3]$

where,

h = height of the bulwark [m].

s = spacing of bulwark stays [m].

In the calculation of section modulus 'Z', only the material connected to the deck is to be included. The contribution from bulwark plating and/or stay flange may be considered depending upon the construction details.

4.4 Guard rails

4.4.1 The guard rails are to be supported by stanchions fitted not more than 3.0 [m] apart;

At least every third stanchion is to be supported by a bracket or stay.

4.4.2 Lengths of chain may be accepted in lieu of guard rails if they are fitted between two fixed stanchions and/or bulwarks.

4.4.3 The clear opening below the lowest course of the guard rails is not to exceed 230 [mm].

End of Chapter

Chapter 11

Openings and Closing Appliances, Ventilators, Air Pipes and Discharges

Contents

Section 1

General

1.1 Scope

1.1.1 This Chapter applies to all ship types in general. Additional requirements pertaining to special ship types are given in Pt.5.

1.1.2 The requirements of National or local authorities should also be applied, where relevant.

1.1.3 For the purpose of this section, weathertightness of hatch covers means that closing appliances do not permit entry of water into the ship which may prejudice the safety of the vessel under the navigational conditions envisaged.

Section 2

Hatch Coamings

2.1 Coaming heights

2.1.1 The height of cargo hatchcoamings above deck is to be not less than 300 [mm] for Zones 1 and 2 and 200 [mm] for Zone 3.

In addition, the distance of coaming top above load water line is to be not less than given in Table 2.1.1.

2.2 Hatch coaming construction

2.2.1 Hatchside coamings are to extend to the lower edge of the deck beams. Side coamings not forming a part of continuous girders, are to extend two frame spaces beyond the hatch ends below the deck.

Table 2.1.1 : Height of hatch coamings [mm]

	Zone 1	Zone 2	Zone 3
With weathertight hatch cover [1)]	1000	600	300
Without weathertight hatch cover	1700	1000	500
Note 1) See 1.1.3			

2.2.2 Hatch end coamings when not in line with the deck transverses are to extend below the deck, at least three longitudinal frame spaces beyond the side coaming.

2.2.3 Continuous hatchway coamings or coamings forming an effective part of the deck girder system are to be made from steel of same tensile strength as that of the deck plating.

2.2.4 If the junction of hatch coamings forms a sharp corner, the side and end coamings are to be extended in the form of tapered brackets in longitudinal and transverse directions respectively.

2.2.5 Extension brackets or rails arranged approximately in line with the cargo hatch side coamings and intended for the stowage of steel hatch covers are not to be welded to deckhouse, masthouse or to each other unless they form a part of the longitudinal strength members. The ends of supporting structures of hatch cover stowage rails are not to end abruptly and are to be tapered by suitable end brackets.

2.3 Coaming scantlings

2.3.1 The scantlings of hatch coaming plating and stiffeners are to be not less than that required for the adjacent deck.

2.3.2 Hatchway coamings 300 [mm] and above are to be stiffened in their upper edge.

Coaming stays are to be fitted at spacing of not more than 3.0 [m]. The stays are to end on stiffened plating. The coamings are to be satisfactorily stiffened against buckling.

Section 3

Hatch Covers

3.1 General

3.1.1 Hatch covers, where fitted, may be of the types a) to e) as described below.

Hatch Cover Types :

'**a**' : Steel plated cargo hatch covers stiffened by webs or stiffeners and secured by clamping devices. Weathertightness is to be ensured by means of gaskets. Hatch covers used for holds containing liquid cargoes are also included in this category.

'**b**' : Steel plated pontoon type cargo hatch covers with internal webs and stiffeners extending over the full width of the hatchway. Weather- tightness is to be achieved by tarpaulins.

'**c**' : Wood or steel hatch covers used in conjunction with the portable beams. Weathertightness to be obtained by tarpaulins.

'**d**' : Access hatch covers for cargo oil tanks and adjacent spaces. The hatch covers are to be of steel and gasketed.

'**e**' : Access hatch covers other than 'd'. The covers are to be of steel or wood and weathertight. Escape hatches are to be operable from both sides.

3.1.2 Materials for steel hatch covers are to satisfy the requirements of hull structural steel. Where other approved materials are used, equivalent strength and stiffness are to be provided.

3.2 Design loads

3.2.1 The design weather load on the weather deck hatchcovers is to be taken as:

$p = H_1 - 10\, h_o$ [kN/m^2], minimum 3 [kN/m^2]

where,

h_o = Vertical distance [m] from the maximum load waterline to the top of hatch covers.

H_1 = as given in Table 3.2.1.

Table 3.2.1

Zone	H_1
1	9 for $L \le 20$ [m] 9 + 0.15 (L-20) for 20 < l < 60 15 for $L \ge 60$ m
2	0
3	5

3.2.2 For hatch covers subjected to cargo loading the design pressure is to be taken as:

$$p = 12.5\ q\ [kN/m^2]$$

where,

q = specified cargo loading [t/m^2] on the hatch cover.

3.2.3 The design internal pressure on hatch covers above tanks are to be determined as per the design pressure on deck structure given in Ch.8.

3.3 Hatchcover plating

3.3.1 The thickness of steel hatch cover plating is not to be less than:

$$t = 15.8\,s\sqrt{p/\sigma}\ \ x10^{-3} + t_c\ \ [mm], \text{ or}$$

3 [mm] whichever is greater

where,

p = design pressure as per 3.2

= 160/k [N/mm^2]

Hatch covers of G.I. sheet and other material will be specially considered.

3.3.2 The plating of hatch covers acting as compression flanges for the hatch cover stiffeners and girders is to be effectively stiffened against buckling.

In the middle part of the simply supported span the critical buckling stress s_c is to be such that:

$\sigma_c \geq 1.15\ \sigma_b$ [N/mm^2]

where,

σ_b = calculated bending stress in the compression flange corresponding to the design load as given in 3.2.

σ_c = the critical buckling stress as per Ch.3, Sec.6.

3.4 Stiffeners and girders

3.4.1 The section modulus of the stiffeners and girders is not to be less than the following:

$$Z = \frac{6.25\,spl^2}{m}\ [cm^3]$$

where,

l = the member span between effective supports [m]

s = the member spacing [m]

m = 8 for members simply supported at ends

= 12 for members which can be considered as fixed at both ends.

The moment of inertia of stiffeners and girders is not to be less than:

$$I = 2.1\ Zl\ \ [cm^4]$$

For other materials the requirement will be specially considered.

3.4.2 For covers above cargo and ballast tanks, fillet welds on tank side are to be double continuous.

3.5 Hatch cover edges

3.5.1 The cover edges are to be adequately stiffened to withstand the forces imposed upon them during opening and closing of the hatches.

3.6 Wooden hatch covers

3.6.1 Wooden hatch cover planks are to have a finished thickness not less than 1/24th of the unsupported span, with a minimum of 20 [mm]. The planks of wood covers are to be connected at their underside by cross planks spaced not more than 1.5 [m].

3.6.2 The ends of all wooden hatch covers are to be protected by encircling with galvanized steel bands.

3.7 Portable hatch beams

3.7.1 The section modulus and the moment of inertia of the portable hatch beams stiffened at their upper and lower edges by continuous flat bars are to satisfy the requirements of 3.4.

3.7.2 Carriers or sockets, or other suitable arrangements are to be provided as means of the efficient fitting and securing of portable hatch beams.

3.7.3 Sliding hatch beams are to be provided with an efficient device for locking them in their correct fore and aft positions when the hatchway is closed.

3.8 Direct calculations

3.8.1 Hatchcovers of special construction and arrangement e.g. covers designed and constructed as a grillage, covers supported along more than two opposite edges and covers supporting other covers, may require submission of direct strength calculation taking into account the arrangement of stiffeners and the supporting members.

3.9 Hatch cover securing arrangement

3.9.1 The gaskets and the securing arrangements are to be designed for the expected relative movement between cover and coaming or special devices are to be fitted to restrict such movement.

3.9.2 Securing arrangements together with suitable gasketting material are to ensure weathertightness of the covers to the satisfaction of the surveyors.

3.9.3 The gasket material is to be of satisfactory air, seawater and if necessary oil resistant quality. It is to be effectively secured along the edges of the cover in a manner as to ensure that the forces from the hatch covers or cargo stowed on top of the hatchcovers are transferred to the coaming or to the deck by direct contact without the load coaming on the gaskets. The sealing is to be achieved by relatively soft packing. The hatch coaming or steel parts on the adjacent covers in contact with the packing are to be well rounded where necessary.

A metallic contact is to be kept between the hatchcover and the hull to effect electrical earthing.

3.9.4 Where tarpaulins are fitted to make hatch covers weathertight. They are to be free from jute, and are to be waterproof and of ample strength. At least two layers of tarpaulins are to be provided and these are to be secured by battens and wedges or equivalent arrangements.

Section 4

Miscellaneous Openings

4.1 Manholes

4.1.1 Manholes on the weather decks are to be closed by substantial covers capable of closing them watertight.

4.2 Companionways, doors and accesses on weather decks

4.2.1 Companionways on exposed deck are to be equivalent in strength and weathertightness to a deckhouse in the same portion. The height of the doorway sills above deck is not to be less than 100 [mm] for Zone 3 and 150 [mm] for Zone 1 & 2 on exposed locations.

For doorways directly leading to engine room the sill height above deck is to be not less than 400 [mm].

In addition the sill heights above load waterline should not be less than the values mentioned below:

Zone 1	1000 [mm]
Zone 2	600 [mm]
Zone 3	300 [mm]

4.3 Openings on engine casing

4.3.1 Machinery space openings are to have efficient closing appliances. The openings and coamings for fiddley, funnel and machinery space ventilators in the casing in those positions are to be provided with strong covers of steel or other equivalent material permanently attached in their proper positions and capable of being secured weathertight.

4.3.2 Skylights are to be of substantial construction and secured firmly to the deck. For skylights the coaming height is not to be less than that required for the hatch coamings. Efficient means are to be provided for closing and securing the hinged scuttles, if any. The thickness of glasses in fixed or opening skylights is to be appropriate to their position and size as required for side scuttles. Glasses are to be protected against mechanical damage, and are to be fitted with deadlights or storm covers permanently attached.

4.3.3 Side scuttles in the engine casings are to be provided with fireproof glass.

4.4 Windows and side scuttles

4.4.1 Side scuttles and windows are to be made and tested according to Standards. The glass thickness of side scuttles below main deck is to be not less than 8.0 [mm].

The glass thickness of windows above deck is not to be less than:

$$t = \frac{w}{70} \text{ [mm], minimum 6.0 [mm]}$$

where,

w = the height or the width of the window, whichever is smaller, [mm].

4.4.2 Side scuttles in the shell below main deck are to be non opening type with deadlights and the lower edge of glass is to be atleast 500 [mm] above the load waterline in any condition of list or trim. Further, the scuttles are to be adequately protected against damage by direct contact.

4.4.3 Side scuttles and windows above deck may be fitted without deadlight/portable covers provided the height of lower edge of glass above waterline is not less than specified in Table 4.4.3.

Table 4.4.3 : Height of side scuttles [mm]

Zone	**h_t [mm]**
1	1700
2	1000
3	500

Section 5

Ventilators

5.1 General

5.1.1 The scantlings of exposed ventilator coamings are to be equivalent to the scantlings of deckhouses in the same position. In cargo spaces and other areas where mechanical damage is likely, the ventilator trunks are to be well protected.

5.2 Coaming heights

5.2.1 Ventilators on exposed decks are to have the lower edge of openings at a height of not less than 300 [mm] above deck.

In addition the heights of lower edge of openings above waterline are to be not less than specified in Table 5.2.1.

Table 5.2.1 : Ventilator coaming heights [mm]

	With closing appliances	Without closing appliances
Zone 1	1000	1700
Zone 2	600	1000
Zone 3	300	500

5.3 Closing appliances

5.3.1 Ventilator openings are to be fitted with efficient weathertight closing appliances if applicable as specified in Table 5.2.1.

Section 6

Air and Sounding Pipes

6.1 General

6.1.1 Air and sounding pipes are to comply with the requirements of Pt.4, Ch.2.

6.1.2 Striking plates of suitable thickness, or their equivalent, are to be fitted under all sounding pipes.

6.1.3 Air and sounding pipes leading through cargo containment areas or other spaces where mechanical damage is likely to occur, are to be well protected.

6.2 Height of air pipes

6.2.1 The height of air pipes from the upper surface of decks exposed to the weather, to the point from where water may have access below, is not normally to be less than 300 [mm].

The heights above load waterline of air pipes with and without closing appliances are not to be less than as specified in Table 5.2.1 for ventilators.

6.2.2 Lower heights may be approved in cases where these are essential for the working of the ship, provided closing appliances are of an approved automatic type.

6.3 Closing appliances

6.3.1 Permanently attached closing appliances to prevent free entry of water are to be fitted to all sounding pipes and for air pipes where required as per 6.2.1.

6.3.2 Where the closing appliances are not of an automatic type, provision is to be made for relieving vacuum when the tanks are being pumped out.

Section 7

Scuppers and Sanitary Discharges

7.1 General

7.1.1 Scuppers sufficient in number and size to provide effective drainage are to be fitted in all decks.

7.1.2 Scuppers draining weather decks and spaces within superstructures or deckhouses not fitted with efficient weathertight doors are to be led overboard.

7.1.3 Scuppers and discharges which drain spaces below the main deck, or spaces within intact superstructures or deckhouses on the main deck fitted with efficient weathertight doors, may be led to the bilges in the case of scuppers, or to suitable sanitary tanks in the case of sanitary discharges. Alternatively, they may be led overboard provided that the spaces drained are above the load waterline, and the pipes are fitted with efficient and accessible means of preventing water from passing inboard as required in 7.2.1.

7.1.4 Scuppers and discharge pipes should not normally pass through fuel oil or cargo oil tanks. Where scuppers and discharge pipes pass, un-avoidably, through fuel oil or cargo oil tanks, and are led through the shell within the tanks, the thickness of the piping should be at least the same thickness as Rule shell plating in way, derived from the appropriate chapters.

Piping within tanks is to be tested in accordance with Pt.4, Ch.2 and Ch.3.

7.1.5 All piping is to be adequately supported.

7.2 Closing appliances

7.2.1 Where the inboard end of scuppers and discharges are below main deck, normally a screw down non-return value in an accessible location is to be fitted to prevent water from passing inboard.

Where the inboard end is above the main deck, a non-return valve is to be fitted at the shell, if the height of the inboard end above waterline is lower than the following:

Zone 1 - 1000 [mm]

Zone 2 - 600 [mm]

Zone 3 - 300 [mm].

7.3 Materials for valves, fittings and pipes

7.3.1 All shell fittings and valves required by 7.2 are to be of steel, bronze or other approved ductile material; ordinary cast iron or similar material is not acceptable.

7.3.2 All these items, if made of steel or other approved material with low corrosion resistance, are to be suitably protected against wastage.

7.3.3 The lengths of pipe attached to the shell fittings, elbow pieces or valves are to be of galvanized steel or other equivalent approved material.

End of Chapter

Chapter 12

Rudders

Contents

Section 1

General

1.1 Scope

1.1.1 The requirements of this Chapter apply to arrangement and scantlings of normal streamlined or plate rudders and their supporting structure. Rudders fitted with special features e.g. special profiles, fins, flaps, steering propellers etc. to increase the lift force will be specially considered.

1.2 Material

1.2.1 All materials used in the construction of the rudder are to be tested and approved in accordance with Pt.2. 'Materials' of the Rules and Regulations for the Construction and Classification Steel Ships (Main Rules).

1.2.2 Material grades for plates and sections for the rudder blade are to be selected as per Pt.3, Ch.2, Sec.1.3.

1.2.3 Bearing materials for bushings are to be stainless steel, bronze, white metal, synthetic material or lignum vitae. If stainless steel is proposed to be used for liners or bushes for the rudder stocks and pintles, the chemical composition is to be submitted for approval.

Hardness of the material of the bushing is to be at least 65 Brinell lower than that of the liner or the rudder stock or pintle.

Synthetic bush materials are to be of approved type. Arrangement is to be provided for adequate supply of sea-water to these bearings.

1.3 Testing

1.3.1 Bodies of the rudders are to be tested in accordance with the requirements given in Ch.15.

Section 2

Arrangement and Details

2.1 General

2.1.1 Various types of rudder arrangement are shown in Fig. 2.1.1; other combinations of couplings and bearings may, however, be proposed.

2.1.2 Effective means are to be provided for supporting the weight of the rudder. Where the support is provided by a carrier bearing attached to the rudder head, the structure in way of the bearing is to be adequately strengthened. The plating under all rudder head bearings or rudder carriers is to be increased in thickness.

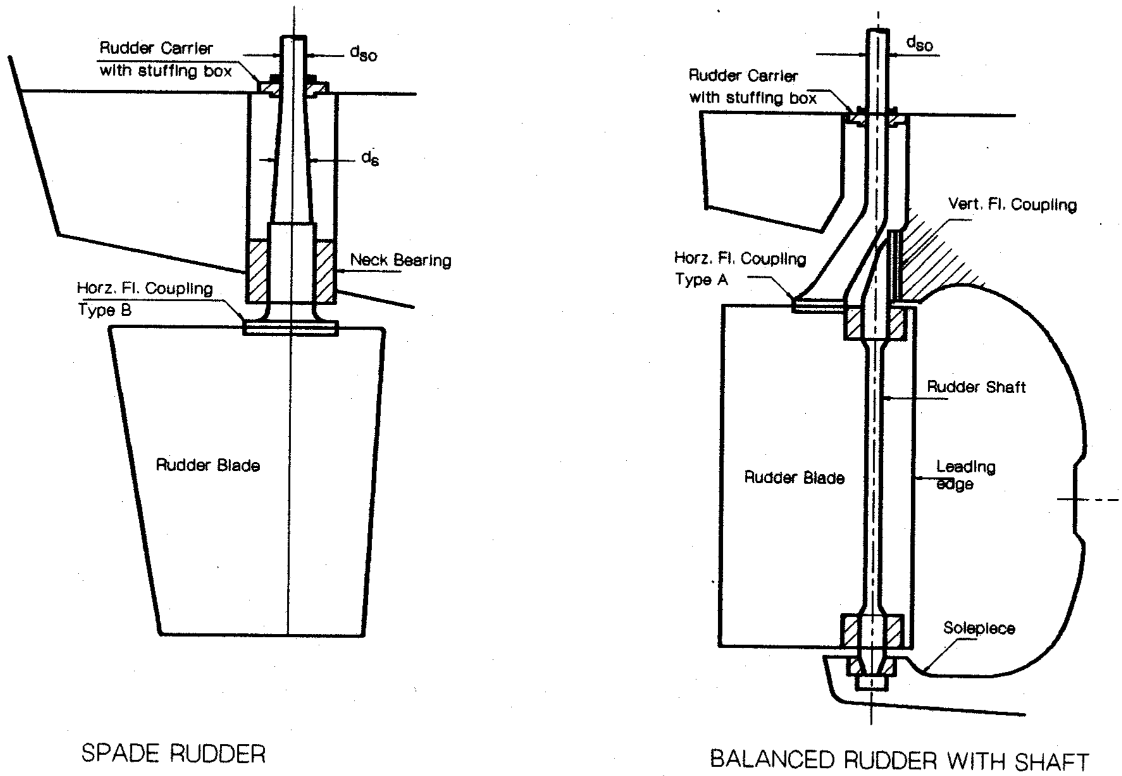


Fig.2.1.1 : Types of rudders

2.1.3 All rudder bearings are to be accessible for measuring wear without lifting or unshipping the rudder.

2.1.4 Satisfactory arrangement is to be provided to prevent water from entering the steering gear compartment and lubricant from being washed away from the rudder carrier. A seal or stuffing box is to be fitted above the deepest load water line for this purpose unless the top of the rudder trunk (steering gear flat) is more than 300 [mm] above the deepest waterline in way trimmed condition. When the rudder carrier is fitted below the deepest load water line, two separate seals or stuffing boxes are to be provided.

2.1.5 Suitable arrangement is to be provided to prevent the rudder from lifting and accidental unshipping.

Section 3

Design Loads

3.1 Rudder force

3.1.1 The rudder force, upon which rudder scantlings are to be based, is to be determined from the following formula:

$$F_r = 132 \,.\, K_1 \,.\, K_2 \,.\, K_3 \,.\, A \,.\, V^2 \text{ [N]}$$

where,

F_r = rudder force [N]

A = area of rudder blade [m^2]

V = maximum achievable ship speed (knots) in the lightest operating condition in which the rudder is fully immersed. V is not to be taken as less than 6 knots.

For astern condition, the maximum astern speed is to be used, but in no case less than:

V_{astern} = 0.5V

$K_1 = (\lambda + 2)/3$; with λ not to be taken greater than 2.

$\lambda = b^2/A_t$; where b is the mean height of the rudder area [m] and A_t, the sum of rudder blade area and area of rudder post or rudder horn, if any, within the height b [m^2]

Mean breadth C [m] and mean height b [m] of rudder are calculated according to the co-ordinate system in Fig.3.1.1.

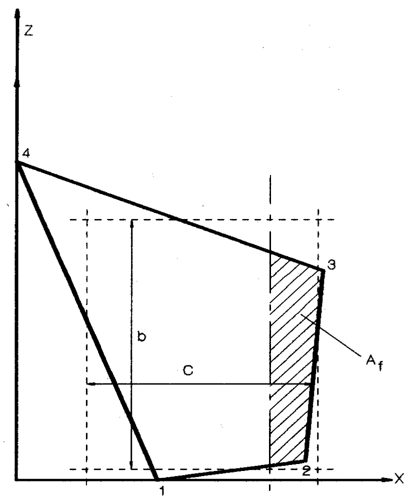


Fig.3.1.1 : Rudder dimensions

K_2 = Factor depending on the kind of rudder profile as per Table 3.1.1.

K_3 = 0.80 for rudders outside the propeller jet

= 1.15 for rudders behind a fixed propeller nozzle

= 1.0 otherwise.

Table 3.1.1

Profile type	K_2 ahead	K_2 astern
NACA:00 Gottingen profiles	1.1	0.80
Hollow profiles	1.35	0.90
Flat side profiles	1.1	0.90

3.2 Rudder torque

3.2.1 The rudder torque on regular shaped rudders in both the ahead and astern conditions of travel is to be calculated as follows:

$$Q_r = F_r \,.\, r \text{ [N-m]};$$

where,

$r = x_c - f$ [m]; but not to be taken less than 0.1C.

x_c = the distance of the point of application of the design force Fr from the leading edge

= 0.33 C in ahead condition

= 0.66 C in astern condition.

C = Mean breadth of rudder area [m] See Fig. 3.1.1.

$f = C \,.\, A_f/A$ where A_f is the portion of the rudder blade area situated ahead of the centre line of the rudder stock.

3.2.2 In case of rudder blades with stepped contours the total rudder torque is to be obtained as follows:

$$Q_r = \Sigma Q_{ri} \quad \text{for } i = 1,2,3,.....$$

where,

Q_{ri} = $F_{ri}.r_i$; individual torque component from each part Ai of the total rudder area.

$F_{ri} = F_r. A_i/A$

$r_i = x_{ci}$ f_i; but not to be taken less than 0.1 C_i.

x_{ci}, f_i and C_i are to be taken as x_c, f and C as in 3.2.1 for each discrete part except that for those rudder parts immediately aft of rudder horn x_{ci} is to be taken as $0.25C_i$ and $0.55C_i$ in ahead and astern conditions respectively.

3.3 Bending moments, shear forces and reactions

3.3.1 The bending moment (BM) and shear force (SF) distributions along the entire height of the rudder blade and rudder stock as well as the bearing reactions (R) may be obtained by direct calculation. The rudder is to be assumed as simply supported at the centres of the upper bearing and the neck bearing. In case of rudders supported by the sole piece or rudder horn the flexibility of the sole piece or rudder horn, and rudder and rudder stock is to be taken into consideration.

3.3.2 For common types of rudders, the following approximate values may be used:

- **For balanced rudders with heel support:**

$$BM = \frac{F_r . b}{8} \; [N - m]$$

at mid-height of the rudder blade;

$$= \frac{F_r . b}{7} \; [N - m]$$

at centre of neck bearing.

SF = 0.6 F_r [N]

at top and bottom ends of the rudder blade;

= 0.1 F_r [N]

at mid-height of the rudder blade.

R = 0.6 F_r [N]

at the heel pintle bearing;

= 0.7 F_r [N]

at the neck bearing/stern pintle;

= 0.1 F_r [N]

at the upper bearing.

- For spade rudders :

$$BM = \frac{F_r . A_1 . b_1}{A} \; [N - m]$$

at any cross section below and including the neck bearing.

$$SF = \frac{F_r . A_1}{A} \; [N]$$

at any cross section upto the centre of the neck bearing.

$$R = \frac{b_2 + b_3}{b_3} . \, F_r \quad [N - m]$$

at the neck bearing;

$$= \frac{b_2}{b_3} \; . \; F_r \; [N]$$

at upper bearing;

where,

A_1 = rudder area below the cross section under consideration;

b_1 = vertical distance from the centroid of A_1 to the cross section;

b_2 = vertical distance from the centroid of rudder area A to the centre of the neck bearing, and

b_3 = vertical distance between the centres of the upper and lower bearings.

3.3.3 At upper bearings the bending moments are to be taken as zero and between the upper bearing and the neck bearing the bending moments may be varied linearly.

Section 4

Rudder Blades

4.1 Construction details

4.1.1 Care is to be taken to avoid notch effects and to maintain continuity of strength around cut-outs and openings in the side plating. The plating thickness is to be increased suitably and corners are to be well rounded and ground smooth.

4.1.2 Side plating and vertical webs transmitting the torque are to be welded to the coupling flange by full penetration welds.

4.1.3 In general, welds between plates and heavy pieces are to be made as full penetration welds. Where back welding is not practicable, welding is to be performed against backing bar or equivalent.

4.1.4 Webs are to be connected to the side plating in accordance with Ch.14. Where fillet welding is not practicable, side plating is to be connected by means of slot welding to flat bars welded to the webs. Normally slots of length 75 [mm], breadth at least twice the side plating thickness and spaced 200 [mm] centre to centre will be accepted. The ends of the slots are to be well rounded. In areas subjected to large bending stresses, horizontal slots may require to be replaced by continuous weld.

4.1.5 Arrangement is to be provided to drain the rudders completely. Drain plugs are to be provided with efficient packing.

4.1.6 Internal surfaces of rudders are to be efficiently coated for corrosion resistance after completion of fabrication and testing. Where it is intended to fill the rudder with plastic foam, details of the foam material are to be submitted.

4.2 Double plated rudders

4.2.1 Thickness 't' of the rudder side, top and bottom plating is not to be less than:

$$t = 5.5 s f_a \sqrt{k\left(T + \frac{F_r}{A} 10^{-4}\right)} \quad 10^{-3} + 2.5\ [mm]$$

where,

$$f_a = \sqrt{1.1 - 0.5\,(s/1000.l)^2}\ ;\ \max .1.00$$

s = the smaller of the distances between the horizontal or the vertical web plates [mm].

l = the larger of the distances between the horizontal or the vertical web plates [m].

The thickness 't' is however not to be less than the minimum side shell thickness as per Pt.3, Ch.7.

For nose plates the thickness is to be increased to 1.25 t.

4.2.2 The thickness of the vertical and horizontal webs is not to be less than 70 per cent of the requirement given in 4.2.1 with a minimum of 7 [mm].

4.2.3 The thickness of side plating and vertical webs forming the main piece may have to be increased locally in way of the coupling and cut-outs or openings, if any.

4.3 Single plated rudders

4.3.1 Rudder blade thickness is not to be less than:

$t = 1.5 . y. V \sqrt{k}. 10^{-3} + 2.5$ [mm]

where y is the spacing of horizontal arms, [mm]; and V, the speed in knots as per 3.1.1.

4.3.2 Rudder blade is to be stiffened by horizontal arms spaced not more than 1000 [mm] apart. The arms are to be efficiently attached to the main piece. The thickness of the arms is not to be less than the blade thickness. The section modulus of the arms in way of main piece is not to be less than:

$Z = 0.5 . y . x^2 V^2 k. 10^{-3}$ [cm^3]

where,

x is the distance from the centre line of the stock to the after end of the rudder [m].

4.3.3 The diameter of the mainpiece at top end is not to be less than that of the lower rudder stock, and it may be gradually reduced towards lower end.

Section 5

Rudder Stock and Pintles

5.1 Rudder stock

5.1.1 Diameter of the rudder stocks, when obtained by direct calculation, are normally to give an equivalent stress se not exceeding 138 [N/mm^2] i.e.

$$\sigma_e = \sqrt{\sigma^2 + 3\tau_t^2} \leq 138 \text{ [N/mm}^2\text{]}$$

where,

σ is the bending stress [N/mm^2],

τ_t is the torsional shear stress [N/mm^2].

This requirement is regardless of the liners; and both ahead and astern conditions are to be considered.

5.1.2 The diameter of the rudder stock at and above rudder carrier is given by

$$d_u = 4.0\sqrt[3]{(Q_r)} \text{ [mm]}$$

5.1.3 The diameter of rudder stock at any other cross section is given by

$$d_s = d_u \cdot \sqrt[6]{\left[1 + \frac{4}{3} \cdot \frac{BM^2}{Q_r^2}\right]} \text{[mm]}$$

where BM is the bending moment at the cross section under consideration obtained as per 3.3.

5.1.4 The diameter of the rudder stock at neck bearing is to be maintained to a point as far as practicable above the top of the neck bearing and may subsequently be tapered to that required at the rudder carrier. The length of the taper is to be at least three times the reduction in diameter. Particular care is to be taken to avoid the formation of a notch at the upper end of the taper.

5.1.5 Sudden changes of section or sharp corners in way of the rudder coupling, jumping collars and shoulders for rudder carriers are to be avoided. Jumping collars are not to be welded to the rudder stock. Keyways in the rudder stock are to have rounded ends and the corners at the base of the keyway are to be adequately radiused.

5.2 Pintles and bearings

5.2.1 The diameter d_p of the pintles, measured on the inside of liners where fitted, is not to be less than:

$$d_p = 0.35 \sqrt{R} \text{ [mm]}$$

where,

R = Reaction force [N] at the pintle bearing, obtained as per Sec.3.3.

5.2.2 Pintles are to have a conical attachment to the gudgeons and the taper on diameter is generally to range between 1:8 to 1:12. The slugging nut is to be efficiently secured. An effective sealing against sea water is to be provided at both ends of the cone.

5.2.3 The length of pintle housing in the gudgeon is not to be less than the pintle diameter d_p. The thickness of the pintle housing is not to be less than 0.25 d_p.

5.2.4 Where liners are fitted to pintles, they are to be shrunk on or otherwise efficiently secured. If liners are to be shrunk on, the shrinkage allowance is to be indicated on the plans. Where liners are formed by stainless steel weld deposit, the pintles are to be of weldable quality steel, and details of the procedure are to be submitted. Bushing is to be effectively secured against movement.

5.2.5 Pintle clearances are normally to be as given in Table 5.2.5.

Attention is to be paid to the manufacturer's recommendations particularly where bush material requires pre-soaking.

Table 5.2.5 : Pintle Clearances	
- For metal bearing material	$0.001\ d_p + 1.0$ [mm]
- For synthetic bearing material	To be specially determined considering the swelling and thermal expansion properties of the material, but not less than 1.5 [mm].

5.2.6 The bearing pressure 'p', due to reaction 'R' on projected bearing area is not to exceed the values given in Table 5.2.6. For the purpose of this calculation, the bearing length is not to be taken greater than 1.2 times the rudder stock or pintle diameter measured outside of liners, if fitted. Higher values than given in the table may be taken on verification by tests.

Table 5.2.6 : Bearing pressure

Bearing Materials	P [N/mm^2]
Steel or bronze against lignum vitae	2.5
Steels against white metal, oil lubricated	4.5
Steel against synthetic material with hardness between 60 and 70 shore D(1)	5.5
Steel against stainless steel, bronze and hot pressed bronze-graphite materials	7.0

Note : (1) Indentation hardness test at 23°C and with 50% moisture, according to a recognised standard. Synthetic bearing materials to be of approved type.

Section 6

Rudder Couplings

6.1 Horizontal bolted couplings

6.1.1 The diameter of the coupling bolts is not to be less than:

$$d_b = 0.62 \left[\frac{d_s^3\ k_b}{ne_m\ k_s}\right]^{1/2}\ [mm]$$

where,

d_s = Rule stock diameter [mm] in way of the coupling flange;

k_s = material factor for the rudder stock material;

k_b = material factor for the bolt material

n = total number of bolts;

e_m = mean distance of the bolt axis from the centre of the bolt system [mm].

6.1.2 Coupling bolts are to be fitted bolts and a minimum of six (6) bolts are to be provided. Their nuts are to be effectively locked.

6.1.3 Mean distance em from the centre of the bolts to the centre of the bolt system is not to be less than 0.9 d_s [mm]. In addition, where the coupling is subjected to bending stress the mean athwartship distance from the centre of bolts to the longitudinal centreline of the coupling is not to be less than 0.6 d_s [mm].

6.1.4 The thickness of coupling flanges is not to be less than the diameter of the coupling bolts.

6.1.5 The width of material outside the bolt holes is not to be less than 0.67 d_b [mm].

6.2 Vertical flange couplings

6.2.1 The diameter of the coupling bolts is not to be less than:

$$d_b = 0.81 \left[\frac{d_s^3\ k_b}{n\ k_s}\right]^{1/2}\ [mm]$$

where,

d_s = Rule stock diameter [mm] in way of the coupling flange

k_s = material factor for the rudder stock material;

k_b = material factor for the bolt material

n = total number of bolts, not to be less than 8.

6.2.2 The first moment of area of the bolts about the centre of the coupling to be not less than:

$$m = 0.00043\ d_s^3\ [cm^3]$$

6.2.3 The thickness of the coupling flanges must be at least equal to the bolt diameter; and the width of the flange material outside the bolt holes must be greater than or equal to 0.67 d_b.

End of Chapter

Chapter 13

Anchoring and Mooring Equipment

Contents

Section 1

General

1.1 Introduction

1.1.1 To entitle a vessel to the letter 'L' in her character of classification, anchoring and mooring equipment is to be provided in accordance with the requirements of this Chapter.

These requirements are based on maximum current of 8 [km/hr], water depth of 5-7 [m] and good holding ground conditions. Where environmental conditions are different from those specified above, the anchoring and mooring equipment would be specially considered based on actual conditions.

1.1.2 Except in case of tugs, towlines are not subject of classification. However, for tugs intended for towing other ships, having onboard suitable lines for the same purpose, the requirement of towline may be waived with written concurrence from the Owners.

1.1.3 Attention is drawn to any relevant requirements of the local Authorities with which the ship is to be registered.

1.1.4 The requirements for anchoring and mooring equipment specified in this Section are intended for vessels operating purely in Inland Waterways. For Indian River-Sea vessels and vessels assigned notation INDIAN INSHORE TRAFFIC CORRIDOR VESSEL, the requirements in Part 3, Chapter 15 of the *Rules and Regulations for the Construction and Classification of Steel Ships* are to be complied with, as relevant and applicable.

1.2 Documentation

1.2.1 The arrangement of anchoring and mooring equipment and Equipment calculations are to be submitted for information.

1.2.2 Following details of the proposed equipment are to be submitted for approval:-

1) Number, weight, type and design of anchors.

2) Length, diameter, grade and type of chain cables.

3) Type and breaking load of steel and fibre ropes.

1.3 Symbols

1.3.1 L,B,T as defined in Ch.1, Sec.2.

Section 2

Structural Arrangement for Anchoring Equipment

2.1 General

2.1.1 The fore end of the vessel is to be arranged in such a way that the anchors do not protrude beyond the side shell. The anchors are normally to be housed in hawse pipes and anchor pockets of adequate size, scantlings and suitable form to prevent movement of anchor and chain due to wave action.

The arrangements are to provide an easy lead of chain cable from windlass to the anchors. Upon release of the brake, the anchors are to immediately start falling by their own weight. Substantial chafing lips are to be provided at shell and deck. These are to have sufficiently large, radiused faces to minimise the probability of cable links being subjected to large bending stresses. Alternatively, roller fairleads of suitable design may be fitted.

Alternative arrangements for housing of anchors will be specially considered.

2.1.2 The shell plating and framing in way of the hawse pipes are to be reinforced as necessary.

2.1.3 When two chain cables are used, the chain locker is to be divided into two compartments, each capable of housing the full length of one line. The chain locker is to have adequate capacity and depth to provide an easy direct lead for the cable into the chain pipes, when the cable is fully stowed. The chain pipes are to be of suitable size and provided with chafing lips. The chain lockers boundaries are to be watertight. Provisions are to be made to minimize the ingress of water to the chain locker in bad weather. Adequate arrangement for drainage of chain lockers is to be provided.

Provisions are to be made for securing the inboard ends of the chains to the structure. The strength of this attachment should be between 15 per cent to 30 per cent of the breaking strength of the chain cable. It is recommended that suitable arrangements be provided so that in an emergency the chain can be readily made to slip from an accessible position outside the chain locker.

2.1.4 The windlass and chain stoppers are to be efficiently bedded and secured to deck. The thickness of deck plating is to be increased in way of the windlass and chain stoppers and adequate stiffening underneath is to be provided.

2.1.5 Hawse pipe scantlings

.1 The gross thickness of the hawse pipes is not to be less than:

— for $t_0 < 10$ mm; $t = \min(t_0 + 2; 10)$

— for $t_0 \geq 10$ mm; $t = t_0$

Where t_0 = gross thickness of adjacent shell plating [mm]

Section 3

Anchors

3.1 General

3.1.1 Anchors are to be of an approved design and of a type suitable for the intended service. Cast iron anchors are not permitted to be used.

3.1.2 The mass of each bower anchor as required in this Section is for anchors of equal mass. The masses of individual anchors may vary by ± 7 per cent of the calculated masses, provided that the total mass of the anchors is not less than would have been required for anchors of equal mass.

3.1.3 Where the maximum current expected in service differs considerably from 8 [km/hr], the anchor weight is to be suitably modified. Where the maximum current expected in service considerably exceeds 8 [km/hr] or 4.32 [knots], the calculated anchor mass is to be increased by the factor:

$$\left(\frac{\text{Curent speed in km/hr}}{8}\right)^{1.875}$$

$$\left(\frac{\text{Curent speed in knots}}{4.32}\right)^{1.875}$$

Where the maximum current expected in service is less than 8 [km/hr] or 4.32 [knots], the calculated anchor mass may be reduced by the factor:

$$\left(\frac{\text{Current speed in km/hr}}{8}\right)^{0.5}$$

$$\left(\frac{\text{Current speed in knots}}{4.32}\right)^{0.5}$$

3.1.4 The mass of the head, including pins and fittings, of an ordinary stockless anchor is not to be less than 60 per cent of the total mass of the anchor.

3.1.5 The mass 'ex stock' of stocked bower or stream anchors is not to be less than 80 per cent of the tabular mass of ordinary stockless bower anchors. The mass of the stock is to be 25 per cent of the total mass of the anchor including the shackle etc. but excluding the stock.

3.1.6 When anchors of a design approved for the designation 'High Holding Power' are used as bower anchors, the mass of each such anchor may be reduced as indicated in 3.5.1. For approval of other HHP anchors, see Pt.3, Ch.15, Cl.4.2 of the *Rules and Regulations for the Construction and Classification of Steel Ships*.

3.1.7 Anchor shackles are to be of a design and material suitable to the service for which the anchor is intended.

3.2 Manufacture and testing

3.2.1 Anchors and anchor shackles are to be manufactured and tested in accordance with the requirements of Pt.2, Ch.10 of the *Rules and Regulations for the Construction and Classification of Steel Ships.*

3.3 Bow Anchors

3.3.1 Cargo Vessels

3.3.1.1 The total mass ‘P’ of the bow anchors of cargo carriers is to be calculated in accordance with the following:

$$P = kBT$$

Where, $k = c\left(\frac{Loa}{8B}\right)^{0.5}$

L_{oa} is the length overall

c is a coefficient defined in Table 3.3.1.1

For pushed barges, k = c

The breath B, to be considered for the application of these requirements to multi-hull vessels is to be determined using the following formula:

$$B = \sum Bi$$

where Bi is the individual breadth of each hull.

Table 3.3.1.1 : Value of Coefficient 'c'

Deadweight [tonnes]	c
≤ 50	20
> 50 ≤ 100	25
> 100 ≤ 200	30
>200 ≤ 400	45
> 400 ≤ 650	55
> 650 ≤ 1000	65
> 1000	70

3.3.2 Passenger vessels and vessels not intended for carriage of goods (e.g. launches)

3.3.2.1 Passenger vessels and vessels not intended for the carriage of goods, apart from pushers, are to be fitted with bow anchors whose total mass 'P' is obtained from the formula in 3.3.1.1 where:

k: Coefficient corresponding to 3.3.1.1 but, where, in order to obtain the value of the empirical coefficient c, the maximum displacement, in m^3, is to be taken instead of the deadweight tonnage.

3.3.3 Increased bower anchor mass

3.3.3.1 For passenger vessels, and for vessels having a large windage area (such as container vessels), the bow anchor mass is to be increased as follows:

$$P_i = P + 4\,A_f$$

where, A_f is the Transverse profile view (windage area) of the hull above waterline at the draught T, in m^2.

For calculating the area A_f, all superstructures, deckhouses and cargoes (e.g. containers) having a breadth greater than B/4 are to be taken into account.

Parts of windscreens or bulwarks which are more than 0.8 [m] in height are to be regarded as parts of houses when determining A_f.

3.4 Stern Anchors

3.4.1 Stern anchors are to be fitted in compliance with the requirements of 3.4.4 to 3.4.8.

3.4.2 The requirement for stern anchors may be specially considered in certain cases depending on specified operating conditions regarding, for instance, current speed or vessel positioning.

3.4.3 Self-propelled vessels are to be fitted with stern anchors whose total weight is equal to 25% of the mass P calculated in accordance with 3.3.

3.4.4 Vessels whose maximum length L_{oa} exceeds 86 [m] are to, however, be fitted with stern anchors whose total mass is equal to 50% of the mass P or Pi calculated in accordance with 3.3.

3.4.5 Pushers

Vessels intended to propel rigid convoys not more than 86 [m] in length are to be fitted with stern anchors whose total mass is equal to 25% of the maximum mass P calculated in accordance with 3.3.1.1 for the largest formation considered as a nautical unit.

3.4.6 Vessels intended to propel downstream rigid convoys that are longer than 86 [m] are to be fitted with stern anchors whose total mass equals 50% of the greatest mass P calculated in accordance with 4.3.1.1 for the largest formation considered as a nautical unit.

3.4.7 Stern anchors requirements are not applicable to the following:

- vessels for which the calculated stern anchor mass will be less than 150 [kg]
- vessels intended to operate on reservoirs, lakes;
- pushed barges and pontoons;
- tugs intended for towing operations only.

3.5 Mass Reduction

3.5.1 The anchor masses calculated in accordance with 3.3 and 3.4 may be reduced for certain special anchors, such as high holding power anchors. Examples of such anchors and the permissible mass reduction is specified in Table 3.5.1

Table 3.5.1 : High Holding Power Anchors	
Anchor Type	Mass Reduction
HA-DU	30%
D'Hone Special	30%
Pool 1 (hol)	35%
Pool 2 (massief)	40%
De Biesbosch-Danforth	50%
Vicinay-Danforth	50%
Vicinay AC 14	25%
Vicinay Typ 1	45%
Vicinay Typ 2	45%
Vicinay Typ 3	40%
Stockes	35%
D'Hone-Danforth	50%
Schmitt high holding anchor	40%
SHI high holding anchor, type ST (standard)	30%
SHI high holding anchor, type FB (fully balanced)	30%
Klinsmann anchor	30%
HA-DU-POWER anchor	50%

3.6 Number of Anchors

3.6.1 The total mass P specified for bow anchors may be distributed among one or two anchors. It may be reduced by 15% where the vessel is equipped with only a single bow anchor.

3.6.2 The required total weight of stern anchors for pushers and vessels whose maximum length exceeds 86 [m] may be distributed between one or two anchors.

3.6.3 The mass of the lightest anchor is not to be less than 45% of that total mass.

Section 4

Anchor Chain Cables

4.1 General

4.1.1 Chain cables may be either short link or stud link and of mild steel or special quality steel meeting the requirements of breaking strength and the length as given in 4.3. The required chain diameter is to be obtained by using tables of chain breaking strength given in Pt.2, Ch.10 of the *Rules and Regulations for the Construction and Classification of Steel Ships.*

4.1.2 In conjunction with HHP anchors, only Grade CC2 or ISO Grade 40 chain cable is to be used, however, for HHP anchors having a mass of 300 [kg] or less, Grade CC1 chain cable may be accepted provided the diameter of Grade CC1 cable required is increased by ten per cent.

4.1.3 When desired by the Owners, steel wire ropes may be used instead of chain cables. Steel wire ropes are to have a breaking strength not less than that required for chain cables and their length is to be not less than 20 per cent in excess of the length required for chain cable.

In such cases it is recommended that a short length of chain or a swivel is fitted between the anchor and the wire rope, having a length equal at least the distance from the anchor in the stowed position to the winch.

4.1.4 Where wire rope is used in lieu of chain cable for anchoring, galvanised wire rope with an independent wire core in accordance with Part 2, Chapter 10 *of the Rules and Regulations for the Construction and Classification of Steel Ships* is to be used. Wire rope terminal fittings are to comply with a recognised standard.

4.2 Manufacture and testing

4.2.1 Chain cables, steel wire ropes and shackles are to be manufactured and tested in accordance with the requirements of Pt.2, Ch.10 of the *Rules and Regulations for the Construction and Classification of Steel Ships.*

4.3 Minimum Breaking Strength

4.3.1 The minimum breaking load of chain cables is to be calculated by the formulae given in Table 4.3.1.

The breaking loads of short-link chains and stud-link chains may be determined in accordance with Part 2 Chapter 10 of the *Rules and Regulations for the Construction and Classification of Steel Ships.*

4.3.2 Where the anchors have a mass greater than that required in 3.3.1 to 3.3.3, the breaking load of the anchor chain cable is to be determined as a function of that highest anchor mass.

4.3.3 The attachments between anchor and chain are to withstand a tensile load 20% higher than the tensile strength of the corresponding chain.

Table 4.3.1: Breaking load R of chain cable

Anchor Mass [kg]	R [kN]
≤ 500	0.35 P’
> 500 and ≤ 2000	$R = \left(0.35 - \frac{P' - 500}{15000}\right) P'$
> 2000	0.25P’

Note: P’ is the theoretical mass of the anchor as established in accordance with 3.3 and 3.4

Where the actual anchor mass is greater than required, P ’ is to be taken as the actual anchor mass

Where the actual anchor is an anchor of the High Holding Power type, the equivalent mass of a normal anchor is to be used for *P*’

Table 4.4.1 Minimum length of chain cable per anchor

*L*oa [m]	Minimum length of chain cable [m]	
	Zones 2 & 3	Zone 1
< 30	40	*L*oa + 10 with a minimum of 40 [m] and need not be greater than 100 [m].
≥ 30 and ≤ 50	Loa + 10	
> 50	60	

4.4 Length of Chain Cables

4.4.1 Bow anchor chain cables

Refer to Table 4.4.1 for the minimum length of bow anchor chain cables.

4.4.2 Stern anchor chain cables

The length of stern anchor chain cables is not to be less than 40 [m]. However, where vessels need to stop facing downstream they are to be equipped with a stern anchor chain of not less than 60 [m] in length.

Section 5

Towlines and Mooring Lines

5.1 General

5.1.1 Towlines and mooring lines may be of steel wire, natural fibre or synthetic fibre and are to be made by an approved manufacturer. During loading and unloading of tank vessels carrying inflammable liquids, steel wire ropes only are to be used for mooring purposes.

5.1.2 Vessels are to be equipped with three mooring lines. The length and breaking strength of mooring lines are to be as required by Table 5.1.2 and Table 5.1.3 respectively. Also see Sec.1.1.2.

Ropes and lines should preferably be of the following type:

— 6 × 24 wires + 7 fibre cores for towing ropes and mooring lines.

5.1.3 The diameter of a fibre rope is not to be less than 20 [mm]

Table 5.1.2 : Mooring Lines

Mooring line	Minimum length [m]
1st line	$l' = \min(l_1, l_2)$ $l_1 = L_{oa} + 20$ $l_2 = l_{max}$[1]
2nd line	$l'' = 2/3 * l'$
3rd line[2]	$l'' = 1/3 * l'$

1. l_{max} = 100 [m]

2. This line is not required on vessels with L_{oa} < 20 [m].

Table 5.1.3 : Minimum breaking strength of mooring lines, Rs

Loa *B * T	Rs [kN]
≤ 1000 [m^3]	$Rs = 60 + \frac{Loa * B * T}{10}$
> 1000 [m^3]	$Rs = 150 + \frac{Loa * B * T}{100}$

5.1.4 Pushed barges may be equipped with atleast least four wire ropes having a theoretical breaking strength of 440 [kN] instead of the towing ropes.

5.2 Manufacture and testing

5.2.1 Steel wire ropes are to be manufactured and tested in accordance with the requirements of Pt.2, Ch.10 of the *Rules and Regulations for the Construction and Classification of Steel Ships.*

5.3 Mooring arrangement

5.3.1 Means are to be provided to enable mooring lines to be efficiently secured on board ship by an adequate number of suitably placed bollards on either side of the ship.

5.3.2 Every vessel is to be equipped with one double bollard each on the fore and after body on port and starboard side. In between, depending on the vessel's size, one to three single bollards are to be arranged on either side of the vessel.

5.3.3 Mooring winches should be fitted with drum brakes of sufficient strength to prevent unreeling of the mooring lines.

5.3.4 Adequate stiffening is to be provided in way of Bollards, Mooring winches etc.

5.4 Towing lines

5.4.1 Tugs are to be equipped with a number of lines that are suitable for their operation. However, the main cable is to be at least 100 [m] long and have a breaking strength, in [kN], not less than one third of the total power, in [kW], of the main engine(s).

5.4.2 Self-propelled vessels and pushers that are also intended to tow are to be equipped with an at least 100 [m] long towing line whose breaking strength in [kN], is not less than one quarter of the total power, in [kW], of the main engine(s).

Section 6

Windlass

6.1 General

6.1.1 The requirements of 6.1.2 to 6.1.5 apply equally to bow and stern anchor winches.

6.1.2 On ships equipped with anchors having a mass of over 50 [kg], windlass(es) of sufficient power and suitable for the type and size of chain cable are to be fitted. Arrangements for anchor davits will be specially considered.

6.1.3 The windlasses may be hand or power operated. Hand operated windlasses are acceptable only if the effort required at the handle does not exceed 15 [kgf] for raising one anchor at a speed of not less than 2 [m/min] and making about 30 turns of the handle per minute.

6.1.4 A power operated windlass is to be capable of exerting, for a period not less than 30 minutes, a continuous duty pull of 28 d_c^2 [N] and to raise one anchor with chain cable at a mean speed of not less than 9 [m/min], d_c [mm] being the diameter required for Grade CC1 chain cable.

6.1.5 Winches suitable for operation by hand as well as by external power are to be so constructed that the power drive cannot activate the hand drive.

6.2 Testing

6.2.1 After installation on board, anchoring tests are to be carried out to demonstrate satisfactory working.

End of Chapter

Chapter 14

Welding

Contents

Section 1

General

1.1 Scope

1.1.1 Welding in steel hull construction of all types of ships is to comply with the requirements of this Chapter.

Welding in aluminium structures will be specially considered.

1.2 Documentation

1.2.1 Connection details of the welded structural members, including type and size of welds are to be clearly indicated on the plans submitted for approval. An explanation of all symbols or abbreviations used in detailing the weld connections should be included on the plans.

Details of proposed welding procedure is to be submitted indicating preheating temperature and any postwelding heat treatment, if employed. Extent to which automatic welding, including deep penetration welding, is to be employed should also be indicated.

Section 2

Welding

2.1 Welders and supervision

2.1.1 Welders are to be proficient in the type of work on which they are to be engaged. The records of their tests and qualifications are to be kept by the builders and made available to the Surveyors. A sufficient number of skilled supervisors are to be employed to ensure effective control at all stages of assembly and welding operations.

2.2 Welding electrodes

2.2.1 Electrodes and welding consumables approved by IRS in accordance with the requirements of Pt.2, Ch.11 and suitable for the type of joint and grade of steel, are to be used.

2.2.2 For the connection of two different grades of steel of the same tensile strength properties, electrodes suitable for the lower grade will be generally acceptable except at structural discontinuities or other points of stress concentration.

2.2.3 For the connection of steel of different tensile strengths, the electrodes are to be suitable for the tensile strength of the component, on the basis of which the weld fillet size has been determined in Sec.3.

2.3 Preparation for welding

2.3.1 The parts to be welded are to be fitted in accordance with the approved joint detail. The edge preparation is to be accurate and uniform. Means are to be provided for maintaining the parts to be welded, in correct position during the welding operations. Excessive force is not to be employed in aligning the parts before welding and the means employed in maintaining the alignment are to be so arranged as to allow for expansion and contraction during the welding operation. All methods employed in correcting improper alignment are to be to the satisfaction of the Surveyor.

2.3.2 All surfaces to be welded are to be clean, dry and free from rust, scale and grease. The surface and boundaries of each run of deposit are to be thoroughly cleaned and freed from slag before the next run is applied. Before a manual sealing run is applied to the back of a weld, the original root material is to be gouged out to sound metal.

2.3.3 Tack welding is to be kept to a minimum, and where used, should be equal in quality to that of the finished welds. Any defective tack weld is to be cut out before completing the finished welds. Care is to be taken in removing the tack welds to ensure that the structure is not damaged in doing so.

2.4 Welding procedure

2.4.1 Only approved welding procedures are to be used, See 2.5.

2.4.2 Structural arrangements are to be such as to allow adequate access for satisfactory completion of all welding operations. Welded joints are to be so arranged so as to facilitate downhand welding wherever possible.

2.4.3 The sequence of welding is to be so planned that any restraint during welding operations is reduced to a minimum. The ends of the frames and stiffeners should be left unattached to the plating at the subassembly stage until connecting welds are made, in the intersecting systems of plating, framing and stiffeners, at the erection stage.

Where a butt meets a seam, the welding of the seam should be interrupted well clear of the junction and not be continued until the butt is completed. Welding of the butt should continue past the open seam and the weld be chipped out for the seam to be welded straight through.

2.4.4 Adequate precautions are to be taken to ensure that the welding site is protected from the deleterious effects of high moisture, severe wind and extreme cold.

2.5 Approval of procedures

2.5.1 Unless previously approved, welding procedures are to be established by the yard and forwarded to IRS for approval. The welding procedure specifications are to include detailed description of the base material, primer, plate thickness range, joint/groove design, welding consumable, welding position, welding techniques, welding parameters, preheating/ interpass temperature and post heat treatment if any.

The welding for procedure qualification and subsequent testing, are to be witnessed by the IRS Surveyor.

2.6 Inspection of welds

2.6.1 Effective arrangements are to be provided for the inspection of finished welds to ensure that all welding has been satisfactorily completed.

2.6.2 All finished welds are to be visually inspected and are to be sound, uniform and substantially free from slag inclusions, porosity, undercutting or other defects. Welds and adjacent base metal are to be free from injurious arc strikes.

2.6.3 For the examination of important structural welds, visual inspection is to be supplemented by radiography or other acceptable non- destructive crack or flaw detection methods. The extent of such examination is to be to the Surveyors' satisfaction, but particular attention is to be given to the following locations:

a) Junction and crossings of seams and butts in strength deck, sheer strake, side and bottom shell within 0.4L amidships.

b) Butts of keel plating and rounded sheerstrake within 0.4L amidships.

c) Insert plates in way of hatch openings on the strength deck.

d) Butts of longitudinal framing and longitudinal bulkhead stiffeners within 0.4L amidships.

2.6.4 Defective sections of welds as found by visual or non- destructive examination or leakages under hydrostatic tests, are to be gouged out as necessary and carefully rewelded.

Section 3

Welded Connections

3.1 Butt welds

3.1.1 Plates of equal thickness may be manually butt welded as per Fig.3.1.1. For automatic welding procedures and special welding techniques, the welding procedure will be specially considered.

3.1.2 For joints of plates with difference in thickness of more than 4 [mm], the thicker plate is to be tapered. The taper is not to exceed 1:3. Edge preparation after the tapering is to be as indicated in Sec.3.1.1.

3.1.3 All manual butt welds are normally to be welded from both sides. Where a back ceiling run is not practicable or in certain cases when the stress level in the members is very low, welding on one side may be permitted provided the welding process is found satisfactory.

3.1.4 Where stiffening members, attached by continuous fillet welds, cross the finished butt or seam welds, these welds are to be made flush in way of the faying surface. Similarly for butt welds in webs of stiffening members, the butt weld is to be first completed and made flush with the stiffening member before the stiffener is connected to the plating by fillet weld. The ends of the flush portion are to run out smoothly without notches or any sudden change of section. Where such conditions can not be complied with, a scallop is to be arranged in the web of the stiffening member. Scallops are to be of such size and in such a position, that a satisfactory weld can be made.

3.2 'T' connections

3.2.1 The throat thickness (See Fig.3.2.1) of the fillet welds is given by:

throat thickness = t_p . weld factor . d/s

where,

t_p = thickness [mm], of the thinner of the two parts being connected.

d = distance [mm], between the successive weld fillets.

s = length [mm], of the correctly proportioned weld fillets, clear of end caterss is not to be less than 75 [mm].

The weld factors for various connections are generally to be as given in Table - 3.2.1.

Where an approved automatic deep penetration procedure is used, the weld factors may be reduced by 15 per cent

3.2.2 The throat thickness is not to be less than 3.0 [mm] and generally not to be greater than 0.44 t_p for double continuous welds and the greater of 0.44 t_p or 4.5 [mm] for intermittent welds.

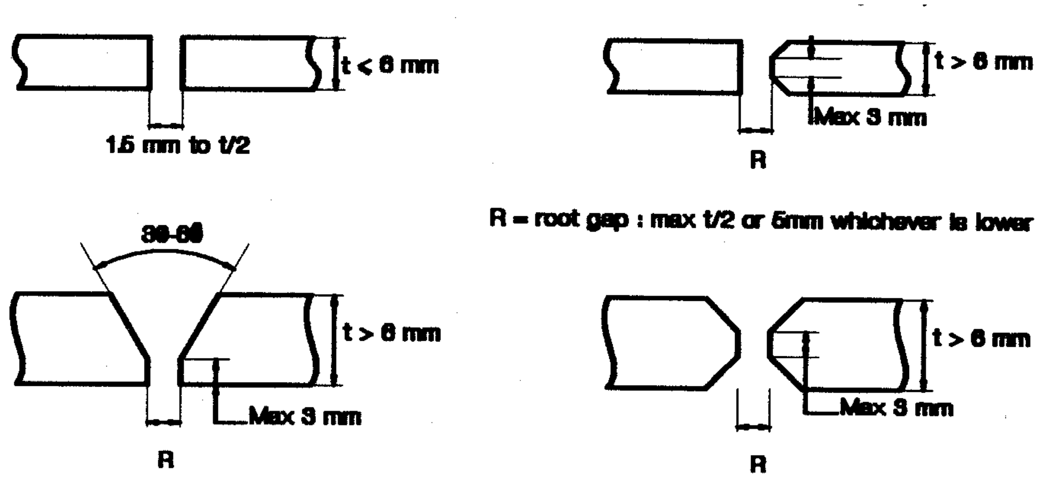


Fig.3.1.1 : Manually welded butt joints

Table 3.2.1 : Weld factors for fillet welds

	Structural items	Weld Factors	d.c.	Int.weld	Remarks
Single Bottom					
Centre girder	to keel plate or bar keel	0.3	*		
	to face plate	0.15		*	
Side girder	to bottom shell	0.15		*	
	to face plate	0.13		*	
	to floors	0.20		*	
Floors	to keel plate	0.15	*		
	to shell plating	0.15		*	
	to centre girder	0.35	*		
	to longitudinal bulkheads	0.35	*		
	to face plate	0.15		*	
	sterntube covering	0.15	*		
Bottom longitudinal	to shell plating	0.13		*	
Double Bottom, See Note 1					
Centre girder or duct keel	to keel plate	0.3	*		
	to inner bottom	0.25		*	
Side girder	to bottom shell	0.15		*	
	to inner bottom	0.15		*	
	to floors	0.15		*	
Floors	to shell plating	0.15		*	
	to inner bottom/margin plate	0.15		*	
	to centre girder/keel plate	0.20		*	
Margin plate	to shell plating	0.4	*		
	to inner bottom	0.4	*		
Inner bottom	to side shell	0.4	*		
Tank side brackets	to shell plating	0.3		*	
	to margin plate	0.3,		*	
Bracket floor	to inner bottom/bottom shell	0.15		*	
	to centre girder	0.25		*	
	to side shell/margin plate	0.25		*	
Bottom frames	to shell plating	0.13		*	
Reverse frames	to inner bottom	0.13		*	
Longitudinals	to shell plating	0.13		*	
	to inner bottom	0.13		*	
Tank boundaries and bilge wells		0.40	*		
Stiffeners	to floors and girders	0.13		*	

	Structural items	Weld Factors	d.c.	Int.weld	Remarks
Structure in Machinery Space					
Floors and girders	to shell & inner bottom	0.3	*		
	to face plate	0.2		*	
Transverse & longitudinal frames	to shell plating	0.15		*	
Floors	to centre girder in way of engine, thrust blocks & boiler seatings				
	– in single bottom	0.50	*		
	– in double bottom	0.30	*		
Main engine foundation girders	to top plate	0.5	*		See Note 2
	to hull structure	0.4	*		
Floors	to engine girder	0.4	*		
Brackets etc.	to engine girders	0.3	*		
Side Structure					
Transverse frames	to side shell				
	– in tanks	0.13		*	
	– elsewhere	0.11		*	
Side longitudinals	to shell plating	0.13		*	
Web frames & side stringers	to shell plating				
	– within 0.2 x span from ends	0.35	*		
	– elsewhere	0.20		*	
	to face plate and tripping bracket	0.15		*	
Web frames	to side stringers	0.3	*		
Bilge keel	to ground bars	0.2	*		
Bilge keel ground bar	to side shell	0.35	*		Single cont.
Deck Structure					
Strength deck	to shell	F.P.			See Note 3
Other decks	to shell and bulkheads	0.3	*		Generally
Deck beams	to deck plating				
	– in tanks	0.13		*	
	– elsewhere	0.11		*	
Deck longitudinals	to decks	0.13		*	
Deck girders	to deck plating				
	– within 0.2 x span from ends	0.35	*		
	– elsewhere	0.20		*	
	to face plating and tripping brackets	0.15		*	
Cantilever webs	to shell, decks, face plates and longitudinal girders at ends	0.35	*		
Pillars	to deck, inner bottom and pillar brackets	0.40	*		

	Structural items	Weld Factors	d.c.	Int.weld	Remarks
Construction in 0.25L from F.P.					
Floors & girders	to shell	0.25	*		
	to inner bottom	0.25		*	
Bottom longitudinals	to shell	0.15		*	
Shell	to transverse & longitudinal side framing	0.15		*	
Panting stringers	to shell & frames	0.30	*		
All internal structure	in fore peak (unless a higher factor is specified)	0.13		*	
Aft Peak Construction					
All internal structure	on bottom, side shell & aft peak bulkhead	0.3	*		See 3.2.5
Bulkheads and Partitions					
Boundaries of	watertight, oiltight & wash bulkheads and shaft tunnels	0.4	*		To be specially considered for chemical cargo tanks
Stiffeners	on tank & wash bulkheads	0.13		*	
	on pillar bulkheads	0.13		*	
	on ordinary bulkheads	0.11		*	
Vertical & horizontal girders in tanks & wash bulkheads	to bulkhead plating				
	– within 0.2 x span from ends	0.40	*		
	– elsewhere	0.40		*	
	– to faceplate	0.30		*	
	– to tripping brackets	0.30		*	
Vertical & horizontal girders elsewhere	to bulkhead plating	0.15			
	– within 0.2 x span from ends	0.35	*		
	– elsewhere	0.20		*	
	to faceplate & tripping brackets	0.15		*	
Primary Structures in Cargo Tanks					
Webs	to shell, deck & bulkheads				
	– within 0.2 x span from ends	0.4	*		
	– elsewhere	0.3	*	*	
Webs	to face plates	0.3	*		
Webs	to webs of other primary members	0.3	*		
Boundaries	of tripping brackets	0.15		*	
Superstructures & deckhouses					
External bulkheads	to deck				
	– on 1st and 2nd tiers	0.40	*		
	– elsewhere	0.25	*		
Internal bulkheads	boundaries	0.13		*	
Stiffeners	to external bulkheads	0.10		*	

	Structural items	Weld Factors	d.c.	Int.weld	Remarks
Hatchways and closing appliances					
Hatch coaming	to deck at corners	0.5	*		
	to deck elsewhere	0.4	*		
	to face plate	0.4	*		
	to hatch cover rest bar	0.16	*		
Hatch cover	to stiffeners	0.12		*	
Rudders & Nozzles					
Rudders					See Note 4
Main piece members	to coupling flange	F.P.	*		
	to each other	0.44	*		
Rudder plating	to rudder webs, elsewhere	0.20	*		
Nozzles	generally as for rudders				
Miscellaneous fittings & equipment					
Framing ring for manhole type covers	to deck & bulkhead	0.4	*		
Framing around ports and W.T./oiltight doors	to plating	0.4	*		
Sea-chest boundary welds	exposed to sea	0.5	*		
	elsewhere	0.4	*		
Ventilators, air pipes etc.	to deck	0.4	*		
Bulwark stays	to deck	0.4	*		
	to bulwark plating	0.2		*	
Fabricated anchors		F.P.			
Masts, derrick posts, crane pedestals, deck machinery & mooring equipment seating - to deck etc.		To be considered in each individual case			

d.c double continuous

F.P. Full penetration weld

Note 1 For tank boundaries see 3.2.5.

Note 2 Preferably to be deep penetration or full penetration weld depending on the thickness of the engine girders.

Note 3 Generally full penetration, but alternative proposals may be considered.

Note 4 See Chapter 12, Section 4.1.

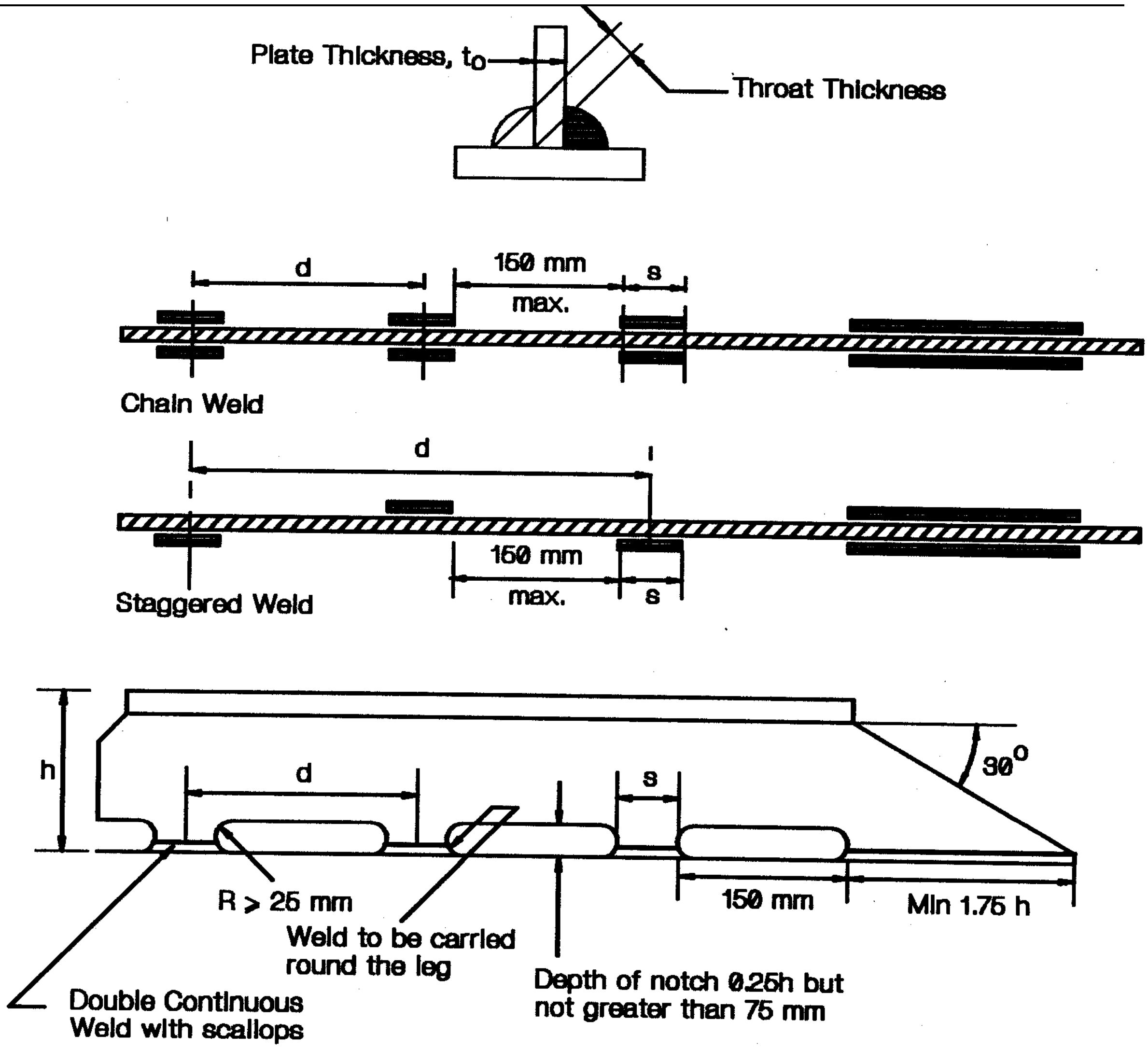


Fig.3.2.1 : Fillet welds

3.2.3 The leg length is not to be less than √2 times the specified throat thickness.

3.2.4 Where the connection is highly stressed, deep penetration or full penetration welding may be required. Where full penetration welding s required, the abutting plate may require to be beveled.

3.2.5 Continuous welding is to be adopted in the following locations and in any other region of high dynamic loading:-

a) Boundaries of weathertight decks and erections, including hatch coamings, companionways and other openings.

b) Boundaries of tanks and watertight compartments.

c) All structures in the afterpeak and the afterpeak bulkhead stiffeners.

d) All framing within holds of bulk carriers intended for carriage of coal.

e) All welding inside tanks intended for chemicals or edible liquid cargoes.

f) All lap welds in tanks.

g) Primary and secondary members to plating in way of end connections and end brackets to plating in the case of lap connection.

h) Other connections as given in Table - 3.2.1.

3.2.6 Where intermittent welding is used, the welding is to be made continuous around the ends of brackets, lugs, scallops and at other orthogonal connections with other members. In tanks for water ballast, cargo oil or fresh water, only scalloped welding is to be used.

3.2.7 Where structural members pass through the boundary of a tank, and leakage into the adjacent space could be hazardous or undesirable, full penetration welding is to be adopted for the members for at least 150 [mm] on each side of the boundary. Alternatively, a small scallop of suitable shape may be cut in the member close to the boundary outside the compartment, and carefully welded all round.

3.3 Lap connections

3.3.1 Overlaps are not to be used to connect plates which may be subjected to high tensile or compressive loading. However, where they are adopted, the width of overlap is to be adequate to ensure a good weld, the surfaces are to be in close contact and the joints should be closed all round by continuous fillet weld.

3.4 Slot weld

3.4.1 For the connection of plating to internal webs, where access for welding is not practicable, the closing plating is to be attached by continuous full penetration or slot welds to flat bars fitted to the webs. Slots are to be well rounded at ends, to have a minimum length of 75 [mm] and in general, a minimum width of twice the plating thickness. The distance between the slots is not to exceed 150 [mm]. Complete filling of the slots is normally not permitted.

3.5 End connection

3.5.1 In way of the end connections of girders double continuous welding is to be used all around. The weld area is not to be less than the cross-sectional area of the member, and the throat thickness not less than that given by Table 3.2.1 for girder ends.

3.5.2 Where stiffeners have bracketed end connections, bracket arms are to be welded all around and the throat thickness is not to be less than 0.35 times the thickness of bracket.

3.5.3 Where stiffeners are continuous at girder, they are to be connected to the webs, either directly and/or by means of lugs. The weld area is to be such that the shear stress does not exceed 80/k [N/mm^2]. Where the shear forces are high, a double sided connection to the web and/or a web stiffener welded on top of the continuous stiffener may be required.

End of Chapter

Chapter 15

Hull Inspection, Workmanship and Testing

Contents

Section

Section 1

Hull Inspection

1.1 Approval of works

1.1.1 The builders, intending to class vessels to be built at their yard with IRS, are to demonstrate their capability to carry out the fabrication to acceptable quality standards before the commencement of the fabrication. Similar approval procedure shall apply to subcontractor's works also. Previous experience in the building and repair of relevant structures and equipment can be considered favourably in this regard.

1.2 Inspection facilities

1.2.1 Adequate facilities are to be provided to enable the Surveyor to carry out a satisfactory inspection of all components during each stage of prefabrication and construction.

Section 2

Workmanship

2.1 General

2.1.1 All workmanship is to be of good quality and in accordance with good shipbuilding practice. Any defect is to be rectified to the satisfaction of the Surveyor before being covered with paint, cement or other composition.

2.1.2 The assembly sequence and welding sequence are to be agreed prior to construction and are to be to the satisfaction of the Surveyor.

2.2 Plate edges and cut-outs

2.2.1 Openings, holes and other cut-outs in the main structural components are to be rounded off by adequately large radii. The free edges of cut-outs, hatch corners etc. are to be properly prepared and are to be free from notches. All edges should be faired.

2.3 Cold forming

2.3.1 Flanging and bending of plates while cold forming are not to have an average bending radius less than three times the plating thickness. The minimum radius is not to be less than twice the plating thickness.

2.3.2 During joggling of plates and profiles, the depth of joggle is not to be less than four times and the bending radius not less than twice the web thickness.

2.4 Hammering, bending and straightening

2.4.1 Steel being worked on when hot, is not to be overheated, and it is to be hammered and bent in the appropriate heat condition. Steel which is burnt, is not to be used.

2.4.2 Flame heating may be employed to straighten buckled plating when the buckling is not severe.

Section 3

Testing

3.1 Definitions

3.1.1 Shop primer is a thin coating applied after surface preparation and prior to fabrication as a protection against corrosion during fabrication.

Protective coating is a final coating protecting the structure from corrosion.

3.1.2 Structural testing is a hydrostatic test carried out to demonstrate the tightness of the tanks and the structural adequacy of the design. Where practical limitations prevail and hydrostatic testing is not feasible (for example when it is difficult, in practice, to apply the required head at the top of the tank), hydropneumatic testing may be carried out instead. When a hydropneumatic testing is performed, the conditions should simulate, as far as practicable, the actual loading of the tank.

3.1.3 Hydropneumatic testing is a combination of hydrostatic and air testing, consisting of filling the tank with water up to its top and applying an additional air pressure. The value of the additional air pressure is to be at least as given in Sec.3.4.

3.1.4 Leak testing is an air or other medium test carried out to demonstrate the tightness of the structure.

3.1.5 Hose testing is carried out to demonstrate the tightness of structural items not subjected to hydrostatic or leak testing and to other components which contribute to the watertight or weathertight integrity of the hull.

3.2 Application

The requirements of this Section apply to:

- tanks, including independent tanks
- watertight or weathertight structures.

The purpose of these tests is to check the tightness and/or the strength of structural elements.

Tests are to be carried out in the presence of the Surveyor at a stage sufficiently close to completion so that any subsequent work would not impair the strength and tightness of the structure.

For the general testing requirements, See Sec.3.8 and Sec.3.9.

3.3 Structural testing

3.3.1 Structural testing as required in Table 3.3.1 may be carried out before or after launching.

Shop primer may be applied before carrying out the structural testing.

3.3.2 Structural testing may be carried out after the protective coating has been applied, provided that one of the following two conditions is satisfied:

a) all the welds are completed and carefully inspected visually to the satisfaction of the Surveyor, prior to the application of the protective coating,

b) leak testing is carried out prior to the application of the protective coating.

However, when leak testing is not carried out, protective coating in way of the following welds should be applied only after the structural testing has been satisfactorily completed:

- all erection welds, both manual and automatic
- all manual fillet weld connections on tank boundaries and manual penetration welds.

3.4 Leak testing

3.4.1 Where leak testing is carried out in accordance with Table 3.3.1, an air pressure of 7 [KN/m^2] is to be applied during the test.

Prior to inspection, it is recommended that the air pressure in the tank is raised to 10 [KN/m^2] and kept at this level for about 1 hour to reach a stabilized state, with a minimum number of personnel in the vicinity of the tank, and then lowered to the test pressure.

3.4.2 Welds are to be coated with an efficient indicating liquid.

3.4.3 A U-tube filled with water up to a height corresponding to the test pressure is to be fitted to avoid overpressure of the compartment tested and to verify the test pressure. The U-tube should have a cross section larger than that of the pipe supplying air.

In addition, the test pressure is also to be verified by means of one master pressure gauge. Alternative means which are considered to be equally reliable, may be accepted.

3.4.4 Where leak testing is carried out it should be prior to the application of a protective coating, on all fillet weld connections on tank boundaries, penetrations and erection welds on tank boundaries excepting welds made by automatic processes. Selected locations of automatic erection welds and pre-erection manual or automatic welds may require to be similarly tested at the discretion of the Surveyor, taking account of the quality control procedures operating in the shipyard. For other welds, leak testing may be carried out after the protective coating has been applied, provided that these welds were carefully inspected visually to the satisfaction of the Surveyor.

Any other recognized method may be accepted to the satisfaction of the Surveyor.

3.5 Hose testing

When hose testing is required to verify the tightness of the structures, as defined in Table 3.3.1, a minimum pressure in the hose of at least 200 [KN/m^2] is to be applied at a maximum distance of 1.5 [m]. The nozzle diameter is not to be less than 12 [mm].

3.6 Hydropneumatic testing

When hydropneumatic testing is performed, the same safety precautions as for leak testing (See Sec.3.4) are to be adopted.

3.7 Other testing methods

Other testing methods may be accepted, at the discretion of IRS, based upon equivalency considerations.

3.8 General testing requirements

General requirements for testing are given in Table 3.3.1.

3.9 Additional requirements for special type vessels/tanks

In addition to the requirements of Table 3.3.1, particular requirements for testing of certain spaces within the cargo area of following types of vessels are given in Table 3.9.1.

- edible liquid carriers
- chemical carriers

These requirements intend generally to verify the adequacy of the structural design of the tank, based on the loading conditions on which the scantlings of the tank structure were determined.

Table 3.3.1 : General testing requirements

Item number	Structure to be tested	Type of testing	Structural test pressure	Remarks
1	Double bottom tanks	Structural testing[a]	The greater of the following: – head of water up to the top of overflow – head of water up to the uppermost continuous deck	Tank boundaries tested from at least one side
2	Double side tanks	Structural testing[a]	The greater of the following: – head of water upto the top of overflow – 1.0 [m] head of water above highest point of tank	Tank boundaries tested from at least one side
3	Tank bulkheads, deep tanks	Structural testing[a]	The greater of the following[b]: – head of water up to the top of overflow – 1.0 [m] head of water above highest point of tank – setting pressure of the safety relief valves, where relevant	Tank boundaries tested from at least one side
	Fuel oil bunkers	Structural testing		
4	Fore peak and after peak used as tank	Structural testing	The greater of the following: – head of water up to the top of overflow – 1.0 [m] head of water above highest point of tank	Test of the after peak carried out after the stern tube has been fitted
	Fore peak not used as tank	Structural testing	– head of water upto the uppermost continuous deck for cargo ships and bulkhead deck for passenger ships	
	After peak not used as tank	Leak testing		
5	Watertight bulkheads	Hose testing[c]		Thorough inspection of bulkhead to be carried out
6	Watertight doors below uppermost continuous deck or bulkhead deck	Structural testing[d]	– Water pressure head upto the uppermost continuous deck for cargo ships and bulkhead deck for passenger ships	
7	Double plate rudders	Leak testing		
8	Shaft tunnel clear of deep tanks	Hose testing		
9	Shell doors	Hose testing		
10	Weathertight hatchcovers and closing appliances	Hose testing		
11	Chain locker (if aft of collision bulkhead),	Structural testing	Head of water up to the top	
12	Independent tanks	Structural testing	Head of water upto the top of overflow, but not less than 0.9 [m],	
13	Ballast ducts	Structural testing	Ballast pump maximum pressure	

Notes:

[a] Leak or hydropneumatic testing may be accepted under the conditions specified in 3.4, provided that at least one tank for each type is structurally tested. This however does not apply to cargo space boundaries in tankers and tanks for segregated cargoes or pollutants. If the structural test reveals weakness or severe faults not detected by the leak test, all tanks are to be structurally tested.

[b] Where applicable, the highest point of tank is to be measured to the deck and excluding hatches.

[c] When hose test cannot be performed without damaging possible outfitting (machinery, cables, switchboards, insulation, etc.) already installed, it may be replaced, at the discretion of IRS by a careful visual inspection of all the crossings and welded joints; where necessary, dye penetrant test or ultrasonic leak test may be required.

[d] The test may be made before or after the door is fitted. In case test is done before, hose testing is to be carried out in place after the door is fitted.

Table 3.9.1 : Additional testing requirements for spaces within the cargo area of certain types of ships					
Item No.	**Types of ships**	**Structure to be tested**	**Testing requirements**	**Structural test pressure**	**Remarks**
1	Edible liquid carriers	Independent tanks	Structural testing	Head of water up to the top of overflow without being less than 0.9 [m]	
2	Chemical carriers	Integral or independent tanks	Structural testing of cargo tanks boundaries from at least one side	The greater of the following: – 1.0 [m] head of water above highest point of tank – setting pressure of the safety relief valves, where relevant	

End of Chapter

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RULES AND REGULATIONS FOR THE CONSTRUCTION AND CLASSIFICATION OF **INLAND WATERWAYS VESSELS**

PART 4
MAIN AND AUXILIARY MACHINERY

July 2024

Indian Register of Shipping

Part 4

Main and Auxiliary Machinery

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Chapter 1

General Requirements for the Design and Construction of Machinery

Contents

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Section 1

General

1.1 Scope

1.1.1 The requirements of this Chapter and those given in Ch.2 to 10 apply to the construction and installation of main propulsion and auxiliary machinery systems, together with their associated equipment, boilers, pressure vessels and pumping and piping arrangements fitted in vessels intended to be classed with IRS.

1.2 Machinery to be constructed under survey

1.2.1 In ships intended to be built under Special Survey, all important units of equipment are to be surveyed at the manufacturer's works. The workmanship is to be to the Surveyor's satisfaction and the Surveyor is to be satisfied that the components are suitable for the intended purpose and duty. Examples of such units are :

– Main propulsion engines, including their associated gearing, flexible couplings, scavenge blowers and superchargers;

– Boilers supplying steam for propulsion or for services essential for the safety or the operation of the ship at sea, including superheaters, economisers, desuperheaters, steam receivers. All other boilers having working pressures exceeding 3.5 bar, and having heating surfaces greater than 4.65 [m^2];

– Auxiliary engines of 110 [kW] (150 shp) and over which are the source of power for services essential for safety or for the operation of the ship.

– Steering machinery;

– Athwartship thrust units, their prime movers and control mechanisms;

– All pumps necessary for the safety of vessel, e.g. bilge, ballast, fire pumps, etc.;

– Air compressors, air receivers and other pressure vessels necessary for the operation of main propulsion and essential machinery.

– Alarm and control equipment as detailed in Ch.7; and

– Electrical equipment and electrical propelling machinery as detailed in Ch.8.

1.3 Extent of survey

1.3.1 The Surveyors are to examine and test the materials and workmanship from the commencement of work until the final test of the machinery under full power working conditions.

Any defects, etc., are to be indicated as early as possible. On completion, the Surveyors will submit a report and, if this is found to be satisfactory by IRS, a certificate of class will be granted and an appropriate notation assigned in accordance with Pt.1.

1.4 Departures from the rules

1.4.1 Where it is proposed to depart from the requirements of the Rules, IRS will be prepared to give due consideration to the circumstances of any special case.

1.5 Plans and particulars

1.5.1 Before the work is commenced, plans in triplicate of all machinery items, as detailed in the Ch.2 to 9 giving the requirements for individual systems, are to be submitted for approval. The particulars of the machinery, including power ratings and design calculations, where applicable, necessary to verify the design, are also to be submitted. Any subsequent modifications are subject to approval before being put in to operation.

1.5.2 The strength requirements for rotating parts of the machinery, as specified in Ch.4 to 8, are based upon strength consideration only and their application does not relieve the manufacturer from the responsibility for the presence of dangerous vibrations in the installation at speeds within the operating range.

1.6 Availability of machinery for operation

1.6.1 The design and arrangement is to be such that the machinery can be started and controlled on board ship without external aid, so that operating conditions can be maintained under all circumstances.

1.7 Ambient reference conditions

1.7.1 The rating of the main and auxiliary machinery is to be suitable for the temperature conditions associated with the geographical limits of the restricted service.

1.7.2 Machinery installations are to be designed such as to ensure proper operations under the conditions as under:

- Permanent list of 10°
- Permanent trim of 5°

1.8 Power ratings

1.8.1 In the following Chapters, where the dimensions of any particular component are determined from shaft power, P in [kW] (H, in shp), and revolutions per minute, R, the values to be used are to be derived from the following:

- For main propelling machinery, the maximum shaft power and corresponding revolutions per minute giving the maximum torque for which the machinery is to be classed; and
- For auxiliary machinery, the maximum continuous shaft power and corresponding revolutions per minute which will be used in service.

1.9 Units

1.9.1 Units and formulae included in the Rules are shown in SI units followed by metric units in brackets, where appropriate.

1.9.2 Where the metric version of shaft power, i.e. (shp), appears in the Rules, 1 shp is equivalent to 75 [kgf metre/sec] or 0.735 [kW].

1.9.3 Pressure gauges may be calibrated in bar,

where,

1 bar = 0.1 [N/mm^2] = 1.02 [kgf/cm^2]

1.10 Power conditions for generator sets

1.10.1 Auxiliary engines coupled to electrical generators are to be capable under service conditions of developing continuously the power to drive the generators at full rated output and, if developing for a short period (15 minutes) an overload power of not less than 10 per cent.

1.10.2 Engine builders are to satisfy the Surveyors by tests on individual engines that the above requirements, as applicable, can be complied with, due account being taken of the deference between the temperature under test conditions and those specified in 1.7.1. Alternatively, where it is not practicable to test the engine/generator set as a unit, type tests (e.g. against a brake) representing a particular size and range of engines may be accepted. With oil engines any fuel stop fitted is to be set to permit the short period overload power of not less than 10 per cent above full rated output being developed.

1.11 Fuel

1.11.1 The flash point (closed cup test) of oil fuel is to be not less than 55°C, unless specially approved. 1.11.2 Fuels with flash points lower than 55°C, but not less than 43°C, unless specially approved, may be used in ships intended for service restricted to certain geographical limits, where it can be ensured that the temperature of the machinery spaces will always be 10°C below the flash point of the fuel. In such cases, safety precautions and the arrangements for storage and pumping will be specially considered.

1.12 Astern power

1.12.1 Sufficient astern power is to be provided to maintain control of the ship in all normal circumstances.

Section 2

Machinery Room Arrangements

2.1 General

2.1.1 The machinery is to be so designed, installed and protected that risks of fire, explosions, accidental pollution, leakages and accidents thereof, and accidents to personnel working in machinery spaces will be minimised.

2.1.2 The design and arrangement of machinery foundations, shaft connections, piping and ducting is to take into account the effects of thermal expansion, vibrations, misalignment and hull interaction to ensure operation within safe limits. Bolts and nuts exposed to dynamic forces and vibrations are to be properly secured.

2.2 Accessibility

2.2.1 Accessibility, for attendance and maintenance purposes, is to be provided for machinery plants.

2.3 Fire protection

2.3.1 All surfaces of machinery where the surface temperature may exceed 220°C and where impingement of flammable liquids may occur are to be effectively shielded to prevent ignition. Where insulation covering these surfaces is oil absorbing or may permit penetration of oil, the insulation is to be encased in steel or equivalent.

2.3.2 Flammable or oil absorbing materials are not to be used in floors, gratings, etc. in boiler and engine rooms, shaft tunnels or in compartments where settling tanks are installed.

2.4 Ventilation

2.4.1 All spaces, including engine and cargo pump spaces, where flammable or toxic gases or vapours may accumulate, are to be provided with adequate ventilation under all conditions.

2.5 Communications

2.5.1 At least one independent means of communication is to be provided between the bridge and engine room control station.

Section 3

Trials

3.1 General

3.1.1 Tests of components and trials of machinery, as detailed in the Chapters giving the requirements for individual systems are to be carried out to the satisfaction of the Surveyors.

3.2 Trials

3.2.1 For all types of installations, the trials are to be of sufficient duration, and carried out under normal maneuvering conditions, to prove the machinery under power. The trials are also to demonstrate that any vibration which may occur within the operating speed range is acceptable.

3.2.2 The trials are to include demonstrations of the following :

– The adequacy of the starting arrangements to provide the required number of starts of the main engines;

– The ability of the machinery to reverse the direction of thrust of the propeller in sufficient time, under normal maneuvering conditions, and so bring the ship to rest from maximum ahead rated speeds

3.2.3 Where controllable pitch propellers are fitted, the free route astern trial is to be carried out with the propeller blades set in full pitch astern position. Where emergency manual pitch setting facilities are provided, their operation is to be demonstrated to the satisfaction of the Surveyors.

3.2.4 All trials are to be to Surveyor's satisfaction.

Section 4

Certification of Machinery and Components based upon Quality Management Systems

4.1 General

4.1.1 This certification scheme is applicable to works where the employment of quality control procedures is well established. IRS will have to be satisfied that the practices employed will ensure that the quality of finished products is to the standards which would be demanded when using traditional survey procedures.

4.1.2 IRS will consider proposed designs for compliance with the Rules, or other appropriate requirements, and the extent to which the manufacturing processes and control procedures ensure conformity of the product to the design. A comprehensive survey will be made by the Surveyors of the actual operation of the quality control programme and of the adequacy and competence of the staff to implement it.

4.1.3 Where IRS considers that the requirements of 4.1.2 can be satisfactorily complied with, the manufacturers will, in general, be approved and authorised to inspect and certify their products.

4.1.4 The procedures and practices of manufacturer which have been granted approval will be kept under continuous review.

4.1.5 Approval by another organization will not normally be acceptable as sufficient evidence that a manufacturer's arrangements comply with IRS requirements.

4.2 Requirements for approval

4.2.1 The manufacturer is required to have adequate equipment and facilities for those operations appropriate to the level of design, development and manufacture being undertaken.

4.2.2 The manufacturer shall demonstrate that the firm has experience consistent with technology and complexity of the product for which approval is sought and that firm's products have been of a consistently high standard.

4.2.3 The manufacturer should have implemented quality management systems generally in accordance with the ISO 9000 series of standards.

4.2.4 The manufacturer shall establish and maintain procedures and controls to ensure that IRS requirements for certification of materials and components at sub-contractor's works are complied with to the satisfaction of IRS.

4.3 Information required for approval

4.3.1 Manufacturers applying for approval under this scheme are to submit the following information :

- Description of the products for which certification is required including, where applicable, model or type number;
- Applicable plans and details of materials used;
- An outline description of all important manufacturing plant and equipment;
- A summary of equipment used for measuring and testing during manufacturing and completion;
- The quality manual;
- The system used for identification and traceability;
- Number and qualification of personnel engaged in quality control and quality assurance; and
- A list of suppliers of materials and components and proposed arrangements to ensure compliance with IRS requirements for certification.

4.4 Approval and maintenance of approval

4.4.1 After receipt and appraisal of the information required by 4.3, an assessment of the Works would be carried out by the Surveyors to ensure compliance with the quality manual.

4.4.2 If the initial assessment of the Works confirms that the implementation of the quality management systems is satisfactory, IRS will issue to the manufacturer a Quality Assurance Approval Certificate which will include details of the products for which approval has been given.

4.4.3 An extension of approval in respect of product type may be given at the discretion of IRS without any additional assessment.

4.4.4 The certificate will be valid for 3 years subject to surveillance assessments being carried out every 6 months.

4.4.5 When significant faults or deficiencies are found during surveillance assessments or surveillance assessments are not carried out, the certificate of approval may be withdrawn/suspended at the discretion of IRS.

4.5 Certification of products

4.5.1 After issue of the Quality Assurance Approval Certificate, the manufacturer would be authorized to issue certificate for products on behalf of IRS subject to the certificates being countersigned by IRS Surveyors. Arrangements for this will be specially advised by IRS.

End of Chapter

Chapter 2

Piping Design Requirements

Contents

Section

Section 1

General

1.1 Scope

1.1.1 The requirements of this Chapter apply to the design and construction of piping systems, including pipe fittings forming parts of such systems but excluding steam piping systems and systems where the temperature exceeds 300°C.

1.1.2 For steam piping systems and systems having temperatures greater than 300°C, the Rules and Regulations for the Construction & Classification of Steel Ships will be applicable.

1.2 Classes of pipes

1.2.1 For the purpose of testing, type of joints to be adopted, heat treatment and welding procedure, piping systems are divided into three classes, as given in Table 1.2.1.

1.2.2 For Class I piping, the *Rules and Regulations for the Construction & Classification of Steel Ships* will be applicable.

1.2.3 In addition to the pressure piping systems in Table 1.2.1, Class III pipes may be used for open ended piping, e.g. overflows, vents, boiler waste steam pipes, open ended drains etc.

1.3 Design pressure

1.3.1 The design pressure, P, is the maximum permissible working pressure and is to be not less than the highest set pressure of the safety valve or relief valve.

1.3.2 The design pressure of feed piping and other piping on the discharge from pumps is to be taken as the pump pressure at full rated speed against a shut valve. Where a safety valve or other protective device is fitted to restrict the pressure to a lower value than the shut valve load, the design pressure is to be the highest set pressure of the protective device.

Table 1.2.1 : Classes of piping systems

Piping system	Class I	Class II	Class III
Fuel oil	P > 16 or T > 150	P ≤ 16 and T ≤ 150	P ≤ 7 and T ≤ 60
Other media	P > 49 or T > 300	P ≤ 40 and T ≤ 300	P ≤ 16 and T ≤ 200

1.4 Design temperature

1.4.1 The design temperature is to be taken as the maximum temperature of the internal fluid, but in no case is it to be less than 50°C.

1.5 Design symbols

1.5.1 The symbols used in this Chapter are defined as follows :

a = percentage negative manufacturing tolerance on thickness;

b = bending allowance [mm];

c = corrosion allowance [mm];

D = outside diameter of pipe [mm] (see 1.5.2);

d = inside diameter of pipe [mm] (see 1.5.3);

e = weld efficiency factor (see 1.5.4);

P = design pressure, in [N/mm^2];

Pt = hydraulic test pressure, in [N/mm^2];

R = radius of curvature of a pipe bend at the centreline of the pipe [mm];

T = design temperature, in C°;

t = the minimum thickness of a straight pipe [mm] including corrosion allowance and negative tolerance, where applicable;

t_b = the minimum thickness of a straight pipe to be used for a pipe bend [mm] including bending allowance, corrosion allowance and negative tolerance, where applicable;

σ = maximum permissible design stress, in [N/mm^2].

1.5.2 The outside diameter, D, is subject to manufacturing tolerance, but these are not to be used in the evaluation of formulae.

1.5.3 The inside diameter, d, is not to be confused with nominal size, which is an accepted designation associated with outside diameters of standard rolling sizes.

1.5.4 The weld efficiency factor, e, is to be taken as1.0 for seamless and electric resistance and induction welded steel pipes. Where other methods of pipe manufacture are proposed, the value of e will be specially considered.

1.6 Heat treatment

1.6.1 Method of heat treatment and means of temperature control and recording are to be to the satisfaction of Surveyors.

Section 2

Carbon and Low Alloy Steel Pipes and Fittings

2.1 Materials

2.1.1 Materials for Class I and Class II piping systems, also for ship-side valves and fittings and valves on the collision bulkhead, are to be manufactured and tested in accordance with the appropriate requirements of *Ch.8, Pt.2, Inspection and Testing of Materials, of Rules & Regulations for the Construction and Classification of Steel Ships.*

2.1.2 Materials for Class III piping systems may be manufactured and tested in accordance with the requirements of acceptable national /international specifications. Pipes having forge butt welded longitudinal seams are not to be used for oil fuel systems, for heating coils in oil tanks, or for pressures exceeding 0.4 [N/mm^2].

The manufacturer's test certificate will be acceptable and is to be provided for each consignment of material.

2.2 Minimum thickness of steel pipes and bends

2.2.1 The maximum permissible design stress, σ, is to be taken as the lowest of the following values :-

$$\sigma = \frac{\mathrm{Et}}{1.6} \; or \; \sigma = \frac{\mathrm{R}_{20}}{2.7} \text{ or } \sigma = \frac{\mathrm{S_R}}{1.6}$$

where,

E_t = specified minimum lower yield or 0.2 per cent proof stress at the design temperature,

R_{20} = specified minimum tensile strength at ambient temperature,

S_R = average stress to produce rupture in 100,000 hours at the design temperature.

Table 2.2.1 : Carbon and carbon-manganese steel pies : Maximum permissible stress [N/mm²]

Design temp.°C	Specified minimum tensile strength [N/mm²]				
	320	**360**	**410**	**460**	**490**
50	107	120	136	151	160
100	105	117	131	146	156
150	99	110	124	139	148
200	92	103	117	132	141
250	78	91	106	122	131
300	62	76	93	111	121

2.2.2 The minimum thickness, t, of straight steel pipes is to be determined by the following formula :-

$$t = \left(\frac{PD}{2\sigma e + P} + c \right) \frac{100}{100 - a} \ \text{[mm]}$$

where,

P, D, e and a are defined in Sec.1, Cl.1.5.1

σ is defined in 2.2.1 and also obtained from Tables 2.2.1.

c is obtained from Table 2.2.2.

Table 2.2.2 : Values of c for steel pipes

Piping service	C [mm] (See Note)
Compressed air systems	1.0
Hydraulic/Lubricating oil systems	0.3
Fuel oil systems	1.0
Cargo oil systems	2.0
Refrigerating plants	0.3
Fresh water systems	0.8

Note:

For pipes passing through tanks an additional corrosion allowance is to be considered according to the figures given in Table and depending upon the external medium in order to account for the external corrosion.

2.2.3 The minimum thickness, t_b, of a straight steel pipe to be used for a pipe bend is to be determined by the following formula, except where it can be demonstrated that the use of a thickness less than t_b would not reduce the thickness below 't' at any point after bending :-

$$t_b = \left(\frac{PD}{2\sigma e + P} + b + c \right) \frac{100}{100 - a} \ \text{[mm]}$$

where,

P, D, R, e, b and a are defined in Sec.1, Cl.1.5.1;

σ and c are defined in tables 2.2.1 and 2.2.2 respectively;

$$b = \frac{D}{2.5R} \left(\frac{PD}{2\sigma e + P} \right) \ \text{[mm]}$$

In general, R, is to be not less than 3D.

2.2.4 The minimum thickness calculated in accordance with 2.2.2 and 2.2.3 is not to be less than that given in Table 2.2.4. Where the pipes are efficiently protected against corrosion, the thickness may be reduced by not more than 1.0 [mm]. For threaded pipes, where permitted, the thickness is to be measured at the bottom of the threads.

Table 2.2.4 : Minimum pipe thicknesses, t [mm] (see note)

External diameter D [mm]	Pipes in general	Venting overflow & sounding pipes for structural tanks
10.2 - 12	1.6	-
13.5 - 19.3	1.8	-
20	2	-
21.3 - 25	2	-
26.9 - 33.7	2	-
38 - 44.5	2	4.5
48.3	2.3	4.5
51 - 63.5	2.3	4.5
70	2.6	4.5
76.1 - 82.5	2.6	4.5
88.9 - 108	2.9	4.5
114.3 - 127	3.2	4.5
133 - 139.7	3.6	4.5
152.4 - 168.3	4	4.5
177.8	4.5	5
193.7	4.5	5.4
219.1	4.5	5.9
244.5 - 273	5	6.3
298.5 - 368	5.6	6.3
406.4 - 457.2	6.3	6.3

2.3 Flange connections

2.3.1 Flanges with their pressure-temperature ratings in accordance with recognized national/international standards will normally be accepted.

2.3.2 Flanges may be cut from plates or may be forged or cast. The material is to be suitable for the design temperature. Flanges may be attached to the branches by screwing and expanding or by welding. Alternative methods of flange attachment may be accepted provided details are submitted for consideration.

2.3.3 Examples of accepted flanged connections and their uses are given in Fig. 2.3.1 and Table 2.3.1 respectively.

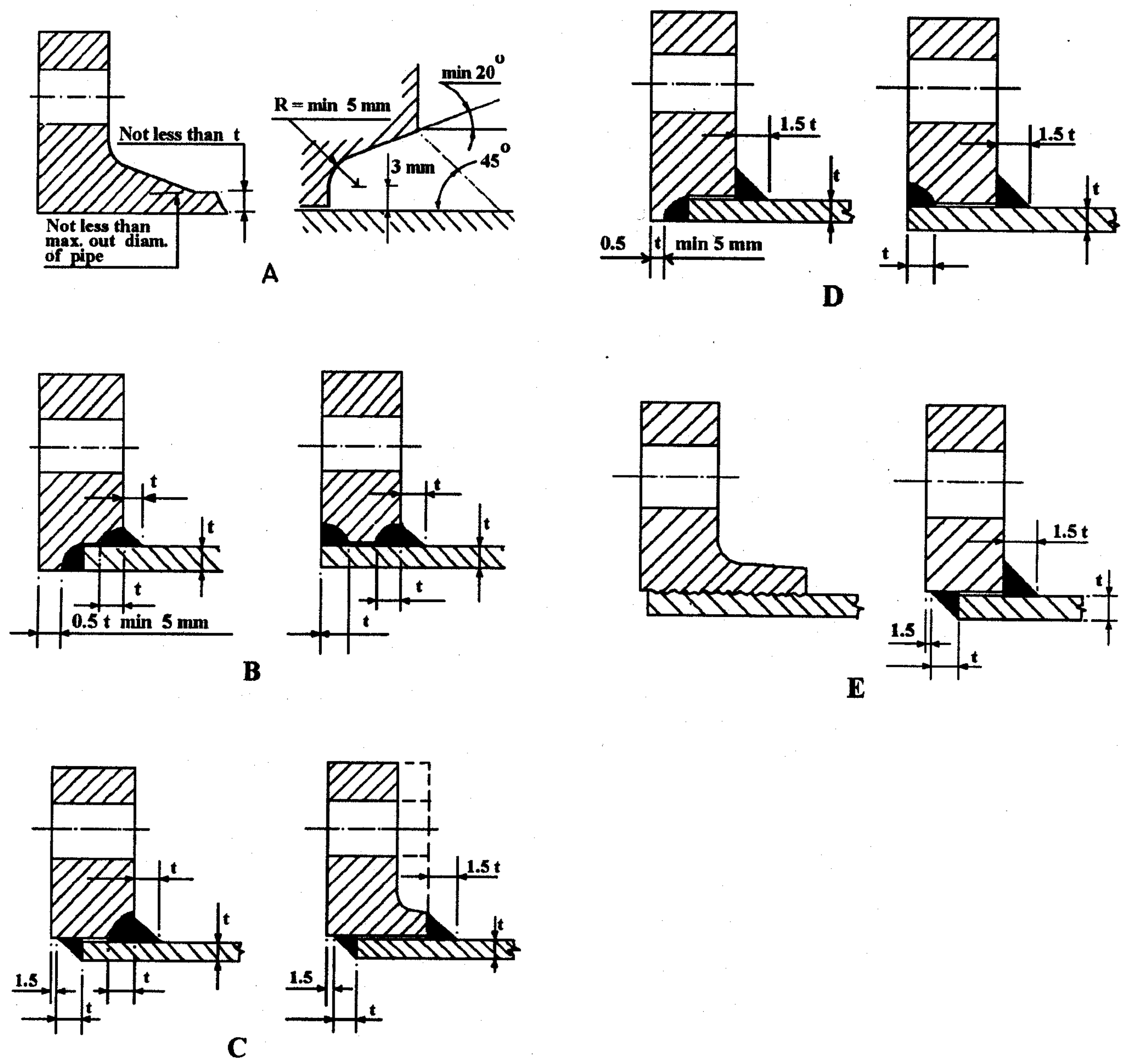

Fig. 2.3.1

Table 2.3.1 : Type of flange connections			
Class of piping	Lub. and fuel oil	Other media	
	Typical flange application	t°C	Typical flange application
II	A - B - C	> 250 ≤ 250	A - B - C A - B - C - D - E
III	A - B - C - E		A - B - C -D - E

2.3.4 Where flanges are secured by screwing, as indicated in Fig.2.3.1, the pipe and flange are to be screwed with a vanishing thread and the diameter of the screwed position of pipe over the thread is not to be appreciably less than the outside diameters of the unscrewed pipe. After the flange has been screwed hard home, the pipe is to be expanded into the flange. The vanishing thread on a pipe is to be not less than three pitches in length, and the diameter at the root of the thread is to increase uniformly from the standard root diameter to the diameter at the top of the thread. This may be produced by suitably grinding the dies, and the flange should be tapered out to the same formation.

2.4 Threaded sleeve joints

2.4.1 Threaded sleeve joints, in accordance with national or other established standards, may be used with carbon steel pipes within the limits given in Table 2.4.1 and for services other than pipe systems conveying combustible fluids.

Table 2.4.1 : Limiting design conditions for threaded sleeve joints

Nominal bore [mm]	Maximum pressure [N/mm^2]	Maximum temperature °C
≤ 25	1.2	260
> 25 ≤ 40	1.0	260
> 40 ≤ 80	0.85	260
> 80 ≤ 100	0.7	260

2.5 Non-destructive examination of welded pipes

2.5.1 In addition to visual examination of pipe welds by the Surveyors, non-destructive examination of butt and fillet welds is to be carried out in accordance with 2.5.2 to 2.5.4 to the satisfaction of the Surveyors.

2.5.2 Selected butt welds of pipes of outside diameter of 101.6 [mm] and over in Class II piping systems are to be radiographed at Surveyor's discretion. Use of ultrasonic examination in lieu of radiography will be specially considered.

2.5.3 Selected fillet welds in pipes of 101.6 [mm] outside diameter and over in Class II piping systems are to be examined by magnetic particle or liquid penetrant flaw testing at Surveyor's discretion.

2.5.4 Defects in welds are to be rectified and re-examined by the appropriate test method, all to the satisfaction of the Surveyors.

2.6 Post-weld heat treatment

2.6.1 Carbon and carbon-manganese steel pipes and fabricated branch pieces, manufactured from material having a carbon content not exceeding 0.25 per cent and having a thickness exceeding 30 [mm], are to be given a stress relieving heat treatment on completion of welding. All pipes and branches having a carbon content in excess of 0.25 per cent are to be given a stress relieving heat treatment. Where oxy-acetylene welding has been employed, however, all the pipes and branch pieces are to be normalised on completion of welding.

Section 3

Copper and Copper Alloys Pipes and Fittings

3.1 Materials

3.1.1 Materials for Class II piping systems and shipside valves and fittings and valves on the collision bulkhead are to be manufactured and tested in accordance with the requirements of *Ch.8, Pt.2, Inspection and Testing of Materials, of Rules & Regulations for the Construction and Classification of Steel Ships*.

3.1.2 Materials for Class III piping systems are to be manufactured and tested in accordance with the requirements of acceptable national/ international specifications. The manufacturer's test certificate will be acceptable and is to be provided for each consignment of material.

3.1.3 Pipes are to be seamless and branches are to be provided by cast or stamped fittings, pipe pressings or other approved fabrications.

3.1.4 Brazing and welding materials are to be suitable for the operating temperature and for the medium being carried. All brazing and welding are to be carried out to the satisfaction of the Surveyors.

3.1.5 In general, the maximum permissible service temperature of copper and copper alloy pipes, valves and fittings is not to exceed 200°C for copper and aluminium brass, and 300°C for copper nickel. Cast bronze valves and fittings complying with the requirements of *Ch.8, Pt.2,* *Inspection and Testing of Materials, of Rules & Regulations for the Construction and Classification of Steel Ships* may be accepted up to 260°C.

3.2 Minimum thickness of pipes

3.2.1 The minimum thickness, t, of straight copper and copper alloy pipes is to be determined by the following formula :-

$$t = \left(\frac{PD}{2\sigma e + P} + c \right) \frac{100}{100 - a} \quad [mm]$$

where P, D and a are as defined in Sec.1, Cl.1.5.1;

σ = maximum permissible design stress, in [N/mm^2], from Table 3.2.1; Intermediate values of stresses may be obtained by linear interpolation;

c = corrosion allowance;

= 0.8 [mm] for copper, aluminium brass and copper-nickel alloys where the nickel content is less than 10 per cent;

= 0.5 [mm] for copper-nickel alloys where the nickel content is 10 per cent or greater;

= 0 where the media are non-corrosive relative to the pipe material.

Table 3.2.1 : Copper and copper alloy pipes

Pipe material	Condition of supply	Specified min. tensile strength [N/mm^2]	Permissible stress [N/mm^2]					
			Maximum design temperature °C					
			50	75	100	125	150	175
Copper	Annealed	220	41.2	41.2	40.2	40.2	34.3	27.5
Aluminium brass	Annealed	320	78.5	78.5	78.5	78.5	78.5	51.0
90/10 copper nickel iron	Annealed	270	68.6	68.6	67.7	65.7	63.7	61.8
70/30 copper nickel	Annealed	360	81.4	79.4	77.5	75.5	73.5	71.6
			Maximum design temperature °C					
			200	225	250	275	300	
Copper	Annealed	220	18.6	-	-	-	-	
Aluminium brass	Annealed	320	24.5	-	-	-	-	
90/10 copper nickel iron	Annealed	270	58.8	55.9	52.0	48.1	44.1	
70/30 copper nickel	Annealed	360	69.6	67.7	65.7	63.7	61.8	

3.2.2 The minimum thickness, t_b, of a straight seamless copper or copper alloy pipe to be used for a pipe bend is to be determined by the formula below, except where it can be demonstrated that the use of a thickness less than t_b would not reduce the thickness below `t` at any point after bending :

$$t_b = \left(\frac{PD}{2\sigma e + P} + b + c \right) \frac{100}{100 - a} \quad [mm]$$

where P, D, b and c are defined in Sec.1, Cl.1.5.1, and e and c are defined in 3.2.1

$$b = \frac{D}{2.5R} \left(\frac{PD}{2\sigma e + P} \right) \quad [mm]$$

In general, R is to be not less than 3D.

Table 3.2.2 : Limiting design conditions for threaded sleeve joints

Standard pipe sizes (outside diameter) [mm]	Minimum overriding nominal thickness [mm]	
	Copper	Copper alloy
8 to 10	1.0	0.8
12 to 20	1.2	1.0
25 to 44.5	1.5	1.2
50 to 76.1	2.0	1.5
88.9 to 108	2.5	2.0
133 to 159	3.0	2.5
193.7 to 267	3.5	3.0
273 to 457.2	4.0	3.5
508	4.5	4.0

3.2.3 Where the minimum thickness calculated by 3.2.1 or 3.2.2 is less than shown in Table 3.2.2, the minimum nominal thickness for the appropriate standard pipe size shown in the Table is to be used. No allowance is required for negative tolerance or reduction in thickness due to bending on this nominal thickness. For threaded pipes, where permitted, the minimum thickness is to be measured at the bottom of the thread.

3.3 Heat treatment

3.3.1 Pipes which have been hardened by cold bending are to be suitably heat treated on completion of fabrication and prior to being tested by hydraulic pressure. Copper pipes are to be annealed and copper alloy pipes are to be either annealed or stress relief heat treated.

Section 4

Cast Iron Pipes and Fittings

4.1 Spheroidal or nodular graphite cast iron

4.1.1 Spheroidal or nodular graphite iron castings for pipes, valves and fittings in Class II and III piping systems are to be made in a grade having a specified minimum elongation not less than 12 per cent on gauge length of $5.65\sqrt{So}$, where So is the actual cross-sectional area of the test piece.

4.1.2 Castings for Class II and III systems, also for ship-side valves and fittings and valves on collision bulkhead, are to be manufactured and tested in accordance with the requirements of acceptable national specifications. A manufacturer's test certificate will be accepted and is to be provided for each consignment of material.

4.1.3 Where the elongation is less than the minimum required by 4.1.1, the material is, in general, to be subject to the same limitations as grey cast iron.

4.2 Grey cast iron

4.2.1 Grey cast iron pipes, valves and fittings will, in general, be accepted in Class III piping systems except as stated in 4.2.2.

4.2.2 Grey cast iron is not to be used for the following:

a) Pipes for steam systems and fire extinguishing systems;

b) Pipes, valves and fittings for boiler blow down systems and other piping systems subject to shock or vibration;

c) Ship-side valves and fittings;

d) Valves fitted on collision bulkhead;

e) Clean ballast lines through cargo oil tanks to forward ballast tanks;

f) Bilge lines in tanks;

g) Outlet valves of fuel tanks with static head.

4.2.3 Grey iron castings for piping systems are to comply with acceptable national/international specifications.

Section 5

Plastic Pipes

5.1 General

5.1.1 Proposals to use plastics material in shipboard piping systems will be considered in relation to the properties of the materials, the operating conditions of temperature and pressure, and the intended service. Any proposed service for plastics pipe not mentioned in these Rules is to be submitted for special consideration.

5.1.2 The specification of the plastics material, including mechanical and thermal properties and chemical resistance data, is to be submitted for consideration.

5.1.3 These requirements are applicable to thermo-plastic pipes but, where appropriate, may also be applied to pipes manufactured in fibre-reinforced thermosetting resins.

5.1.4 Plastics pipes are not to be used where they will be subjected to temperatures above 60°C or below 0°C. Special consideration will be given to particular materials in appropriate applications at higher temperatures.

5.2 Applications

5.2.1 Plastics pipes of approved type may be used for the following
services:

a) Air and sounding pipes to tanks used exclusively for carrying water ballast or fresh water, with the exception of the portion above deck;

b) Sounding pipes to cargo holds;

c) Water ballast and fresh water pipes situated inside tanks used exclusively for carrying water ballast or fresh water; and

d) Scupper pipes draining inboard provided they are not led within the boundaries of refrigerated chambers. The first two items (a and b) are not applicable to passenger ships.

5.2.2 Plastics pipes may be used for domestic and similar services for which there are no Rule requirements, such as for the following:

a) Domestic cold sea and fresh water systems;

b) Sanitary systems;

c) Sanitary and domestic waste pipes wholly situated above the freeboard deck; and

d) Water pipes associated with air conditioning plants.

Not withstanding the foregoing, plastics pipes are not to be used in sea water systems where leakage or failure of the pipes could give rise to the danger of flooding.

5.2.3 Since plastics materials are generally heat sensitive and very susceptible to fire damage, plastics pipes will not be acceptable for service essential to safety, such as the following :

a) Fire extinguishing pipes;

b) Bilge pipes in cargo holds;

c) Bilge and ballast pipes in the machinery space;

d) Main and auxiliary water circulating pipes;

e) Feed and condensate pipes; and

f) Pipes carrying oil or other flammable liquids.

5.3 Intactness of bulkheads and decks

5.3.1 Where plastics pipes are arranged to pass through watertight or fire- resisting bulkheads or decks, provision is to be made for maintaining the integrity of the bulkhead or deck in the event of pipe failure. Details of the arrangements are to be submitted for approval.

5.4 Design and construction

5.4.1 Pipes and fittings are to be of robust construction and are to comply with the requirements of such national/international standards as may be consistent with their intended use. Particulars of scantlings and joints are to be submitted for consideration.

5.4.2 All pipes are to be adequately but freely supported. Suitable provision for expansion and contraction is to be made in each range of pipes to allow for large movements between plastics pipe and steel structure, the coefficient of thermal expansion for plastics being eight or more times that of steel.

5.4.3 All fittings and branches are to be suitable for the intended service and are to have joints of cemented, flanged or other approved types.

5.4.4 The strength of the pipes and fittings and the acceptability of any jointing system employed is to be check tested at the Surveyor's discretion. The strength of pipes, fittings, joints between pipes and joints between pipes and fittings, as appropriate, is to be determined by hydraulic pressure tests to destruction of sample assemblies. The pressure is to be so applied that failure of the test sample assembly occurs in not less than 5 minutes. Deformation of the pipes and fittings during tests is acceptable.

Section 6

Flexible Hoses

6.1 General

6.1.1 Short joining lengths of flexible hoses of approved type may be used, where necessary to accommodate relative movement between various items of machinery connected to permanent piping systems.

6.1.2 For the purpose of approval for the applications in 6.2, details of the materials and construction of the hoses, and the method of attaching the end fittings, are to be submitted for consideration.

6.1.3 In general, the use of hose clips as a means of securing the ends of hoses is to be restricted to the engine cooling water system, where the hose consists of a short, straight length joining two metal pipes, between two fixed points on the engine.

6.1.4 Prototype pressure tests are to be carried out on each new type of hose, complete with end fittings, and in no case is the bursting pressure to be less than five times the maximum working pressure in service.

6.1.5 Attention is to be given to any statutory requirements of the National Authority of the country in which the ship is to be registered. Such requirements may include a fire test for hoses that are intended to be used in systems conveying flammable fluids or sea water.

6.2 Applications

6.2.1 Synthetic rubber hoses, with integral cotton or similar braid reinforcement, may be used in fresh and sea water cooling systems. In the case of sea water systems, where failure of the hoses could give rise to the danger of flooding, the hoses are to be suitably enclosed.

6.2.2 Synthetic rubber hoses, with single or double closely woven integral wire braid reinforcement, or convoluted metal pipes with wire braid protection, may be used in bilge, ballast, compressed air, fresh water, sea water, fuel oil and lubricating oil systems. Where synthetic rubber hoses are used for fuel oil supply to burners, the hoses are to have external wire braid protection in addition to the integral wire braid.

Section 7

Hydraulic Tests on Pipes and Fittings

7.1 Hydraulic tests before installation on board

7.1.1 All Class II pipes and their associated fittings are to be tested by hydraulic pressure to the Surveyor's satisfaction. Further, all steam, feed, compressed air and fuel oil pipes, together with their fittings, are to be similarly tested where the design pressure is greater than 0.35 [N/mm^2]. The test is to be carried out after completion of manufacture and before installation on board and, where applicable, before insulating and coating.

7.1.2 The test pressure is to be 1.5 times the design pressure.

7.1.3 All valve bodies are to be tested by hydraulic pressure to 1.5 times the nominal pressure rating at ambient temperature. However, the test pressure need not be more than 7 [N/mm^2] above the design pressure specified for the design temperature.

7.2 Testing after assembly on board

7.2.1 Heating coils in tanks and fuel oil piping are to be tested by hydraulic pressure, after installation on board, to 1.5 times the design pressure but in no case to less than 0.35 [N/mm^2].

7.2.2 Where bilge pipes are accepted in way of double bottom tanks or deep tanks, the pipes after fitting are to be tested by hydraulic pressure to the same pressure as the tanks through which they pass.

End of Chapter

Chapter 3

Pumping and Piping

Contents

Section

Section 1

General

1.1 Scope

1.1.1 The requirements of this Chapter are applicable to all ships except where otherwise stated.

1.1.2 Piping systems layouts, for which no requirements are given herein, will be specially considered.

1.2 Plans

1.2.1 The following plans in diagrammatic form are to be submitted for consideration before proceeding with the work.

a) General arrangement of pumps and piping systems;

b) Fuel oil filling, transfer and service piping systems;

c) Bilge and ballast piping systems;

d) Lubricating-oil piping systems;

e) Liquid cargo pumping systems;

f) Hydraulic power piping systems for essential services;

g) Compressed air piping systems;

h) Steering gear piping systems;

i) Sea water and fresh water service piping systems;

j) Air and sounding piping systems;

k) Steam and feed water piping systems

l) Sanitary piping systems;

m) Fire main and fire extinguishing piping systems.

1.2.2 The plans are to include the information like, wall thickness, maximum working pressure temperature and material of all pipes and type, size and material of the valves and fittings.

1.3 Materials

1.3.1 The materials to be used in piping systems are to be suitable for the service intended. In general, except where otherwise stated, pipes, valves and fittings are to be made of steel, cast iron, copper, copper alloy or other approved material.

1.3.2 Cast iron is not to be used for:

a) Shipside and collision bulkhead fittings;

b) Outlet valves of fuel tanks with static head;

c) Bilge and ballast lines passing through double bottom tanks, pipe tunnel and cargo oil tanks;

d) Any piping which can be subjected to shock such as water hammer.

1.3.3 Materials sensitive to heat such as aluminium, lead or plastics, are not to be used in systems essential to the safe operation of the ship.

1.4 Design pressure

1.4.1 The design pressure is considered to be, the most severe condition of co-incident pressure and temperature expected in normal operation. For this purpose the maximum difference in pressure between inside and outside of the part is to be considered.

1.5 Design temperature

1.5.1 Unless otherwise specified the temperature used in design is to be not less than the mean metal temperature (through the thickness) expected under operating conditions for the part considered.

1.5.2 When sudden cyclic changes in temperature are apt to occur in normal operation with only minor pressure fluctuations, the design is to be governed by the highest probable operating temperature and corresponding pressure.

1.6 Redundancy

1.6.1 Redundancy is the ability of a system or a component thereof to maintain or restore its function when one failure has occurred. This can be achieved for instance by installation of more units or alternative means for performing the function.

1.7 Valves and cocks

1.7.1 All the valves and cocks are to be so designed and constructed so that the valve covers or glands will not slacken up when the valves are operated.

1.7.2 All the valves are to be designed to close with right hand (clockwise when facing the end of the stem) motion of the wheel of the valve.

1.7.3 All the valves and cocks are to be fitted in places where they are easily accessible at all times and are to be fitted with legible nameplates indicating their function in the system and their installation is to be such that it can be readily observed that they are open or closed.

1.7.4 All the valves and cocks fitted with remote control are to be provided with local manual control independent of the remote operating mechanism. The operation of the local control is not to render the remote control system inoperable.

1.7.5 The valves, cocks and other fittings which are attached directly to plating, which is required to be of watertight construction, are to be secured to the plating by means of studs screwed into the plating and not by bolts passing through clearance holes. Alternatively the studs may be welded to the plating.

1.8 Shipside fittings (other than sanitary discharges and scuppers)

1.8.1 All sea inlet and overboard discharge valves are to be fitted in either of the following ways:

a) directly on the shell plating;

b) to the plating of fabricated steel water boxes of rigid construction integral with the ship's plating;

c) to short, rigid distance pieces welded to the shell plating.

1.8.2 Valves for ship-side applications are to be installed such that the section of piping immediately inboard of the valve can be removed without affecting the watertight integrity of the hull.

1.8.3 All valves and cocks fitted directly to the shell plating are to have spigots extending through the plating. These spigot on valves may however be omitted, if valves are fitted on pads which themselves form spigots in way of plating.

1.8.4 Valves and cocks are to be attached to the shell plating by bolts tapped into the plating and fitted with countersunk heads, or by studs screwed into heavy steel pads fitted to the plating. The stud holes are not to penetrate the pad plating.

1.8.5 Ship side valves and fittings, if made of steel or material with low corrosion resistance, are to be suitably protected against wastage.

1.8.6 Gratings are to be fitted at all openings in ship's side for inlet of seawater. The net area through the gratings is to be at least twice the area of the valves connected to the opening.

1.8.7 The scantlings of valves and valve stools fitted with steam, or compressed air clearing connections are to be suitable for the maximum pressure to which the valves and stools may be subjected.

1.9 Piping installation

1.9.1 Heavy pipes and valves are to be so supported that their weight is not taken up by connected pumps and fittings.

1.9.2 Support of the pipes is to be such that detrimental vibrations do not arise in the system.

1.9.3 Where pipes are carried through watertight bulkheads or tank tops, means are to be made to ensure the integrity of the watertightness of the compartment.

1.9.4 As far as possible, installation of pipes for water, oil, or steam, is to be avoided near electric switchboards. If this is impracticable, all the joints in pipe line and valves are to be at a safe distance from the switchboards and shielded to prevent damage to switchboard.

1.9.5 Provision is to be made to take care of expansion or contraction stresses in pipes due to temperature stresses or working of the hull.

1.9.6 Expansion pieces of approved type, made of oil resistant re-inforced rubber or other approved material may be used in circulating water systems in machinery spaces.

1.9.7 All piping systems, where a pressure greater than the designed pressure could be developed, are to be protected by suitable relief valves.

1.9.8 All pipes, situated in cargo spaces, fish holds or other spaces, where they can be damaged mechanically, are to be suitably protected.

1.9.9 All pipes which pass through chambers intended for the carriage or storage of refrigerated cargo are to be well insulated. In case the temperature of the chamber is below 0C the pipes are to be insulated from the ship's structure also, except at positions where the temperature of the ship's structure is always above 0°C and is controlled by outside temperature.

Air refreshing pipes leading to and from refrigerated chambers need not be insulated from the ship's structure.

Section 2

Bilge and Ballast Piping Systems

2.1 General

2.1.1 All ships are to be provided with necessary pumps, suction and discharge piping and means of drainage so arranged that any compartment can be pumped out effectively, when the ship is on an even keel and is either upright or has a list of not more than 5 degrees, through at least one suction, except from machinery spaces where at least two suctions are required, one of which is to be a branch bilge suction and the other is to be a direct bilge suction. Wing suctions will, generally, be necessary for this purpose, except for short narrow compartments, where a single suction may be sufficient.

2.1.2 All passenger ships are to be provided with an efficient bilge pumping plant capable of pumping from and draining any watertight compartment under all practicable conditions after a casualty whether the ship is upright or listed.

2.1.3 Attention is drawn to any relevant statutory requirements of the National Authority of the country in which the ship is to be registered.

2.2 Drainage of cargo holds

2.2.1 In ships having only one hold, and this over 30 [m] in length, bilge suctions are to be provided in the fore and after sections of the hold.

2.2.2 In ships having a flat bottom with breadth exceeding 5 [m], bilge suctions are to be fitted at the wings.

2.2.3 Where close ceilings or continuous gusset plates are fitted over the bilges, arrangements are to be made whereby the water in the hold may find its way to the suction pipes.

2.2.4 In ships fitted with double bottoms, suitably located bilge wells are to be provided.

2.3 Drainage from fore and aft peaks

2.3.1 Where the peaks are used as tanks, a power pump suction is to be led to each tank, except in case of small tanks (generally not exceeding 2 [m^3] used for the carriage of domestic fresh water where hand pumps may be used.

2.3.2 The peaks may be drained by hand pumps provided the peaks are not used as tanks and they are not connected to bilge main. The suction lift is to be well within the capacity of the hand pumps and is not to exceed 7.3 [m].

The after peak may be drained by means of a self closing cock situated in a well lighted and accessible position, and draining into engine room or tunnel.

2.3.3 The collision bulkhead is not to be pierced below the bulkhead deck by more than one pipe for dealing with the contents inside the fore peak tank except as permitted in 2.3.4. The pipe is to be provided with a screw down valve capable of being operated from above the bulkhead deck and the chest of the valve is to be secured to the collision bulkhead inside the tank except as permitted by 2.3.5. An indicator is to be provided to indicate whether the valve is open or shut.

2.3.4 In ships, other than passenger vessels, where the forepeak is divided into two compartments, the collision bulkhead may be pierced by two pipes, i.e. one for each compartment and fitted as in 2.3.3.

2.3.5 In ships other than passenger ships, the valve required by 2.3.3 may be fitted on the after side of the collision bulkhead, provided the valve is readily accessible at all time and is not subject to mechanical damage.

2.4 Drainage from tanks, cofferdams and void spaces

2.4.1 All the tanks except self-draining tanks, whether for water ballast, oil fuel, liquid cargoes, etc. are to be provided with suction pipes led to suitable power pumps. The pumping plant is to be so arranged that any water or liquid within any compartment of the ship can be pumped out through at least one suction, when the ship is on an even keel and is either upright or has a list of not more than 5 degrees.

2.4.2 Where the length of the ballast tank exceeds 30 [m], an additional suction is to be provided at the forward end of the tank. Where the width of the tank is unusually large, suctions near the centreline in addition to wing suctions may be required.

2.4.3 Suction pipes from the cofferdams and void spaces are to be led to the main bilge line.

2.4.4 In ships where deep tanks may be used for either water ballast or dry cargo, provision is to be made for blanking the water ballast suction and filling when the tank is being used for carrying cargo and for blanking the bilge line when the tank is being used for carriage of water ballast.

2.5 Drainage from spaces above fore and after peaks and above machinery spaces

2.5.1 Provision is to be made for the drainage of chain locker and watertight compartments above the fore peak tank by hand or power pump suctions.

2.5.2 Steering gear compartments or other small enclosed spaces situated above the after peak tank are to be provided with suitable means of drainage, either by hand or power bilge suctions.

2.5.3 If the compartments referred to in 2.5.2 are adequately isolated from the adjacent 'tween decks, they may be drained by scuppers of not less than 38 [mm] bore, discharging into the tunnel (or machinery spaces in case of ships with machinery aft) and fitted with self-closing cocks situated in well lighted and visible positions. These arrangements are not applicable to passenger ships unless they are specially approved in relation to subdivision considerations.

2.5.4 Accommodation spaces which overhang machinery spaces may also be drained as in 2.5.3.

2.6 Drainage from machinery spaces

2.6.1 The bilge drainage arrangements for machinery spaces are to be in accordance with the requirements of 2.1.

2.6.2 In ships in which the propelling machinery is situated at the after end of the ship, it will generally be necessary for the bilge suctions to be fitted in the forward wings as well as in the after end of the machinery space, but each case will be dealt with according to the size and structural arrangements of the compartment.

2.6.3 Where the machinery space is divided into watertight compartments, the drainage system for all compartments except for main engine room is to be same as for cargo holds except that one direct bilge suction from each watertight compartment would also be required.

2.7 Sizes of bilge suctions

2.7.1 The internal diameter of the bilge pipes is not to be less than that found by the following formula to the nearest 5 [mm] commercial size available:

a) $d_m = 1.5\sqrt{L(B+D)} + 25$ [mm]

b) $d_m = 2.0\sqrt{C(B+D)} + 25$ [mm]

where,

d_m = internal diameter of bilge main [mm];

d_b = internal diameter of branch bilge [mm];

L = Rule length of ship [m];

B = Moulded breadth of ship [m];

C = Length of the compartment [m];

D = Moulded depth to bulkhead deck [m].

2.7.2 In any case, bilge main suction line and branch bilge suction line diameters are not to be less than 40 [mm] and the diameter of the main bilge line is not be less than that of the branch bilge line.

2.7.3 The internal diameter of the direct bilge suction is not to have less than the main bilge line when connected to a power pump and not less than branch bilge suction when connected to a hand pump.

2.7.4 In oil tankers and similar ships, where the engine room pumps do not deal with bilge drainage outside the machinery spaces, the rule diameter of the bilge main may be reduced provided the proposed cross-sectional area of the bilge main is not less than twice that required for the branch bilge suction in machinery spaces.

2.7.5 The area of each branch pipe connecting the bilge main to a distribution chest is to be not less than the sum of the areas required by the rules for the two largest branch bilge suction pipes connected to that chest, but need not be greater than that required for the main bilge line.

2.8 Bilge pumps and ejectors

2.8.1 In ships with main propulsion engines up to 220 [kW] (300 shp), at least one power bilge is to be provided which may be driven by the main engines. In addition hand pump suctions are to be fitted. In ships where the main propulsion engines power exceeds 220 [kW] (300 shp), at least two power bilge pumps are to be provided and at least one of which is to be independently driven. See Part 5, Chapter 3 for requirements regarding passenger ships.

2.8.2 The capacity of the bilge pump may be found by the following formula:

$$Q = 5.75 \times 10^{-3} \times d^2 \ \ [m^3/hour]$$

where,

Q = capacity of pump [m^3/hour]

d = rule diameter of bilge main [mm].

2.8.3 In ships, other than passenger ships, where one bilge pump is of slightly less than rule capacity, the deficiency may be made good by an excess capacity of the other pump. In general this deficiency is to be limited to 30 percent.

2.8.4 An ejector in conjunction with a sea water pump may be accepted as a substitute for independent power bilge pump. This however, is not acceptable on passenger ships.

2.9 Pump types

2.9.1 The bilge pumps required by the rules are to be of self-priming type, unless an approved priming system is provided for these ships.

2.9.2 General service pumps and ballast pumps may be accepted as independent power bilge pumps provided:

a) Their capacity is adequate and in accordance with 2.8.2;

b) These pumps, together with the pipelines to which they are connected, are fitted with necessary devices to ensure that there is no risk of entry of water or oil fuel in the holds or machinery spaces.

2.10 Bilge piping arrangements and fittings

2.10.1 Bilge pipes are not, as far as possible, to pass through double bottom tanks. If un-avoidable, such bilge pipes are to be of heavy gauge, with welded joints or heavy flanged joints and are to be tested after fitting to the same pressure as the tanks through which they pass.

2.10.2 The parts of bilge pipes passing through deep tanks, intended to carry water ballast, fresh water, liquid cargo or fuel oil are normally to be contained in a pipe tunnel, but where this is not done, the pipes are to be of heavy gauge with welded or heavy flange joints. The open ends of such pipes are to be fitted with non-return valves. The pipes are to be tested, after fitting, to a pressure of not less than the maximum head to which the tanks may be subjected.

2.10.3 Expansion bends, not glands, are to be fitted to pipes passing through double bottom tanks or deep tanks.

2.10.4 The intactness of the machinery spaces, bulkheads and of tunnel plating is not to be impaired by fitting of scuppers discharging into machinery spaces or tunnel from adjacent compartments which are situated below the bulkhead deck. These scuppers may, however, be led into a strongly built scupper drain tank situated in the machinery space or tunnel but closed to these spaces and drained by means of a suction of appropriate size led from the main bilge line through a screw-down non-return valve.

a) The scupper tank air pipe is to be led above the bulkhead deck and provision is to be made for ascertaining the level of the water in the tank;

b) Where one tank is used for the drainage of several watertight compartments, the scupper pipes are to be provided with screw-down non-return valves.

2.10.5 No drain valve or cock is to be fitted to the collision bulkhead. Drain valves or cocks are not to be fitted to other watertight bulkheads if alternative means of drainage are practicable. These arrangements are not permissible in passenger ships.

2.10.6 Where drain valves or cocks are fitted to bulkheads other, than collision bulkhead, as permitted by 2.10.5, the drain valves or cocks are to be at all times readily accessible and are to be capable of being shut off from positions above the bulkhead deck. Indicators are to be provided to show whether the drains are open or shut.

2.10.7 Bilge pipes which are required for draining cargo or machinery spaces are to be entirely distinct from sea inlet pipes or from pipes which may be used for filling or emptying spaces where water or oil is carried. This does not, however, exclude a bilge ejection connection, a connecting pipe from a pump to its suction valve chest, or a deep tank suction pipe suitably connected through a change-over device to bilge, ballast or oil line.

2.10.8 The arrangement of pumps, valves and piping is to be such that any pump could be opened up for overhaul and repairs without affecting the operation of the other pumps.

2.10.9 The arrangement of valves, pumps, cocks and their pipe connections is to be such as to prevent the possibility of placing one watertight compartment in communication with another, or of cargo spaces, machinery spaces or other dry spaces coming in communication with the sea or the tanks. For this purpose the bilge suction, pipe of any pump also having sea suction is to be fitted with a non-return valve which cannot permit communication between the bilges and the sea or the compartments in use as tanks.

2.10.10 Screw-down non-return valves are to be provided in the following fittings:

a) Bilge distribution chest valves;

b) Direct bilge suction and bilge pump connection to main line;

c) Bilge suction hose connections on the pumps or on the main line;

d) Emergency bilge suctions.

2.10.11 Bilge suction pipes from machinery spaces and shaft tunnel, except emergency bilge suction, are to be led from easily accessible mud boxes fitted with straight tail pipes to the bilges. The open ends of the tail pipes are not to be fitted with strum boxes. The mud boxes are to be provided with covers which can be easily opened and closed for cleaning purposes.

2.10.12 Strum boxes are to be fitted to the open ends of bilge suction pipes from the cargo holds. The diameter of holes from these strum boxes is not to be more than 10 [mm] and the total area of the holes is not to be less than twice the area of the pipes.

2.10.13 Where access manholes to bilge wells are necessary, they are to be fitted as near to the suction strums as practicable.

2.10.14 Adequate distance is to be provided between the open ends of suction pipes and bilge well bottom to permit adequate and easy flow of water and to facilitate cleaning.

2.10.15 All the valves, cocks and mud boxes are to be located in easily accessible positions above or at the same level as the floor plates. Where this is unavoidable, they may be fitted immediately below the floor plates provided the floor plates are capable of being opened and closed easily and suitable name plates are fitted indicating the fittings below.

2.10.16 Where relief valves are fitted to pumps having sea connections, these valves are to be fitted in readily visible positions above the platform. The arrangement is to be such that any discharge from the relief valves will also be readily visible.

2.10.17 Where non-return valves are fitted to the open ends of bilge suction pipes in cargo holds in order to decrease the risk of flooding, they are to be of an approved type which does not offer undue obstruction to the flow of water.

2.11 Ballast system

2.11.1 Provision is to be made for ballasting and deballasting all the ballast tanks by pipe lines which are entirely separate and distinct from pipe lines used for bilging.

2.11.2 Where the length of the ballast tanks exceeds 30 [m], an additional suction is to be provided at the forward end of the tanks. Where the width of the tank is unusually large, suction near the centreline in addition to wing suctions may be required.

Section 3

Air and Sounding Piping Systems

3.1 General

3.1.1 Reference to oil in this Section is to be taken to mean oil which has a flash point of 60°C or above (closed cup test).

3.1.2 The portions of vent, overflow and sounding pipes fitted above the weather deck are to be of steel.

3.1.3 Name plates are to be affixed to the upper ends of all vent and sounding pipes.

3.2 Air pipes

3.2.1 Vent pipes are to be fitted to all tanks, cofferdams, tunnels and other compartments which are not fitted with alternative ventilation arrangements.

3.2.2 The vent pipes are to be fitted at the opposite end of the tank to which the filling pipes are placed and/or at the highest part of the tank and are to be of the self draining type. Where the tank top is of unusual or irregular profile, special consideration will be given to the number and positions of the vent pipes.

3.2.3 Tanks provided with anodes for cathodic protection are to be provided with vent pipes at forward and aft ends.

3.2.4 Vent pipes to double bottom tanks, deep tanks extending to the shell plating or tanks which can be run up from the sea and sea chests are to be run up from the sea and sea chests are to be led above the bulkhead deck.

3.2.5 Vent pipes to oil fuel and cargo oil tanks, cofferdams, all tanks which can be pumped up, shaft tunnels and pipe tunnels are to be led above the bulkhead deck and to open air.

3.2.6 Vent pipes from lubricating oil storage tanks may terminate in the machinery spaces, provided that the open ends are so situated that issuing oil cannot come into contact with electrical equipment or heated surfaces.

3.2.7 The open ends of vent pipes to oil fuel and cargo oil tanks are to be situated where no danger will be incurred from issuing oil or vapour when the tank is being filled.

3.2.8 For details regarding height and closing devices for vent pipes see Pt.3, Ch.11.

3.2.9 The open ends of vent pipes to oil fuel, cargo oil and ballast tanks fitted with anodes for cathodic protection, are to be fitted with a wire gauze diaphragm of incorrodible material which can be readily removed for cleaning. The clear area through the wire gauze is to be at least equal to the area of the vent pipe.

3.2.10 In the case of all tanks which can be pumped up either by ship's pumps or by shore pumps through a filling main, the total cross-sectional area of the vent pipes to each tank, or of the overflow pipes where an overflow system is provided, is to be not less than 25 per cent greater than the effective area of the respective filling pipes.

3.3 Sounding arrangements

3.3.1 All tanks, cofferdams and pipe tunnels are to be provided with sounding pipes or other approved means for ascertaining the level of liquid in the tanks. Bilges of compartments which are not at all times readily accessible are to be provided with sounding pipes. The soundings are to be taken as near the suction pipes as practicable.

3.3.2 Where gauge glasses are used for indicating the level of liquid in tanks containing lubricating oil, oil fuel or other flammable liquid, the glasses are to be of heat resisting quality, adequately supported, protected from mechanical damage and fitted with self-closing valves at the lower ends and at the top ends if these are connected to the tanks below the maximum liquid level.

3.3.3 Except as permitted by 3.3.4 sounding pipes are to be led to positions above the bulkhead deck which are at all times accessible and in the case of oil fuel tanks, cargo oil tanks and lubricating oil tanks, the sounding pipes are to be led to safe positions on the open deck.

3.3.4 Short sounding pipes may be fitted to double bottom tanks and cofferdams in shaft tunnels and machinery spaces provided the pipes are readily accessible. Short sounding pipes to oil fuel tanks, cargo oil tanks and lubricating oil tanks are not to be placed in the vicinity of boilers, preheaters, heated surfaces, electric generators or motors with commutator or collector rings or electric appliances which are not totally enclosed. The short sounding pipes are to be arranged in such a way that overflow or oil spray will not reach any of machinery components mentioned above. The short sounding pipes are to be fitted with self-closing cocks having cylindrical plugs with weight loaded levers permanently attached and with pedals for opening or other approved arrangements. Short sounding pipes to tanks not intended for oil are to be fitted with screw caps attached by chain to the pipe or with shut off cocks.

3.3.5 In passenger ships, short sounding pipes are permissible only for sounding cofferdams and double bottom tanks situated in the machinery space and are in all cases to be fitted with self closing cocks as described in 3.3.4.

3.3.6 Striking plates of adequate thickness and size are to be fitted under open ended sounding pipes. Where slotted pipes having closed ends are employed, the closing plugs are to be of substantial construction.

3.3.7 The upper ends of all sounding pipes are to be provided with efficient closing devices. The sounding pipes are to be arranged to be as straight as practicable, and if curved, the curvature is to be large enough to permit easy passage of sounding rod/chain.

Section 4

Fuel Oil Systems

4.1 General

4.1.1 Oil fuel for machinery and boilers is normally to have a flash point not lower than 60°C (closed cup test). For emergency generator engines, the oil fuel is to have a flash point not lower than 43°C (closed cup test).

4.1.2 Fuels with flash point lower than 60°C may be used in ships intended for service restricted to geographical limits where it can be ensured that the temperature of the machinery and boiler spaces will always be 10°C below the flash point of the fuel. In such cases safety precautions and the arrangements for storage and pumping will be specially considered. However, the flash point of the fuel is not to be less than 43°C unless specially approved.

4.2 Oil fuel tanks

4.2.1 Oil fuel tanks are to be separated from fresh water and lubricating oil tanks by means of cofferdams.

4.2.2 Oil fuel tanks are not to be located directly above the highly heated surfaces.

4.3 Oil fuel piping

4.3.1 Oil fuel pressure pipes are to be led, where practicable, remote from heated surfaces and electrical appliances, but where this is impracticable the pipes are to have a minimum number of joints and are to be led in well lighted and readily visible positions.

4.3.2 Transfer, suction and other low pressure oil pipes and all pipes passing through oil storage tanks are to be made of cast iron or steel, having flanged joints suitable for a working pressure of not less than 0.69 [N/mm^2]. The flanges are to be machined and the jointing material is to be impervious to oil. Where the pipes are 25 [mm] bore or less, they may be seamless copper or copper alloy, except those which pass through storage tanks.

4.3.3 Pipes in connection with compartments storing fresh water are to be separate and distinct from any pipes which may be used for oil or oily water and are not to be led through tanks which contain oil, nor are oil pipes to be led through fresh water tanks.

4.3.4 Pipes conveying vegetable oils or similar cargo oils are not to be led through oil fuel tanks, nor are oil fuel pipes to be led through tanks containing such cargoes.

4.3.5 In passenger ships, provision is to be made for the transfer of oil fuel from any oil fuel storage or settling tank to any other oil fuel storage tank.

4.4 Arrangement of valves, cocks, pumps and fittings

4.4.1 The oil fuel and pumping piping arrangements are to be distinct from other pumping systems as far as practicable and the means provided for preventing dangerous interconnection in service are to be thoroughly effective.

4.4.2 All valves and cocks forming part of the oil fuel installation are to be capable of being controlled from readily accessible positions which, in the machinery spaces are to be above the working platform.

4.4.3 Every oil fuel suction pipe from a double bottom tank is to be fitted with a valve or a cock.

4.4.4 For oil fuel tanks which are situated above the double bottom tanks, the inlet and outlet, pipes which are connected to the tank at a point lower than the outlet of the overflow pipe or below the top of the tanks without an overflow pipe, are to be fitted with shut off valves located on the tank itself.

4.4.5 In the machinery spaces valves, mentioned in 4.4.4, are to be capable of being closed locally and from positions outside these spaces which will always be accessible in the event of fire occurring in these spaces. Instructions for closing the valves are to be indicated at the valves and at the remote control positions.

4.4.6 Settling tanks are to be provided with means for draining water from the bottom of the tanks. If the settling tanks are not provided, the oil fuel bunkers or daily service tanks are to be fitted with water drains.

Open drains for removing water from oil tanks are to be fitted with valves or cocks of self-closing type and suitable provision is to be made for collecting the oily discharge.

4.4.7 Where a power driven pump is necessary for transferring oil fuel, a stand by pump is to be provided and connected ready for use, or, alternatively, emergency connections may be made to another suitable power driven pump.

4.4.8 All pumps which are capable of developing a pressure exceeding the design pressure of the system are to be provided with relief valves. Each relief valve is to be in close circuit, i.e. arranged to discharge back to the suction side of the pump and to effectively limit the pump discharge pressure to the design pressure of the system.

4.4.9 Valves or cocks are to be interposed between the pumps on the suction and discharge pipes in order that any pump may be shut off for opening up and overhaul.

4.4.10 Drip trays are to be fitted under all oil fuel appliances which are required to be opened up frequently for cleaning or adjustment.

4.5 Filling arrangements

4.5.1 The bunkering of the ship is to be carried out through a permanently fitted pipeline, provided with the required fittings and ensuring fuel delivery to all storage tanks. The open end of the fitting pipe is to be led to the tank bottom.

In passenger ships fuel bunkering stations are to be isolated from other spaces and are to be efficiently drained and ventilated.

4.5.2 Provision is to be made against over-pressure in the filling pipes, and any relief valve fitted for this purpose is to be discharge in to an overflow tank or other safe position.

4.6 Oil fuel burning arrangements

4.6.1 Filters are to be fitted in the supply lines to the main and auxiliary machinery. For non-redundant units for essential services, it must be possible to clean the filters without stopping the unit or reducing the supply of filtered oil to the unit.

For auxiliary engines one single oil fuel filter for each engine may be accepted.

4.6.2 Where an oil fuel booster pump is fitted, which is essential to the operation of the main engine(s), a standby pump is to be provided. The standby pump is to be connected ready for immediate use but where two or more main engines are fitted, each with its own pump, a complete spare pump may be accepted provided that it readily accessible and can be easily installed.

4.6.3 Where pumps are provided for fuel valve cooling, the arrangements are to be as in 4.6.2.

4.7 Remote stop of oil fuel pumps and fans

4.7.1 Emergency stop of power supply to the following pumps and fans is to be arranged from a central place outside the engine and boiler room:

- oil fuel transfer pump;
- oil fuel booster pump;
- nozzle cooling pumps when oil fuel is used as coolant;
- oil fuel purifiers;
- pumps for oil-burning installations;
- fans for ventilation of engine rooms.

Section 5

Engine Cooling Water Systems

5.1 General

5.1.1 Centrifugal cooling water pumps are to be installed as low as possible in the ship.

5.2 Cooling water main supply

5.2.1 Provision is to be made for an adequate supply of cooling water to the main propelling machinery and essential auxiliary engines, also to lubricating oil and fresh water coolers, where these coolers are fitted. The cooling water pump(s) may be worked from the engines or be driven independently.

5.3 Cooling water standby supply

5.3.1 Provision is also to be made for a separate supply of cooling water from a suitable independent pump of adequate capacity.

5.3.2 The following arrangements are acceptable, depending on the purpose for which the cooling water is intended:

a) Where only one main engine, with power exceeding 370 [kW] (500 shp), is fitted, the standby pump is to be connected ready for immediate use;

b) Where more than one main engine is fitted, each with its own pump, a complete spare pump of each type may be accepted;

c) Where fresh water cooling is employed for main/auxiliary engines, a standby means of cooling need not be fitted if there are suitable emergency connections from a salt water system;

d) Where each auxiliary is fitted with a cooling water pump, standby means of cooling need not be provided for auxiliaries. Where, however a group of auxiliaries is supplied with cooling water from a common system, a standby cooling water pump is to be provided for this system. This pump is to be connected ready for immediate use and maybe a suitable general service pump.

5.3.3 When selecting a pump for standby purposes, consideration is to be given to the maximum pressure which it can develop if the overboard discharge valve is partly or fully closed and, when necessary, condenser doors, water boxes, etc. are to be protected by an approved device against inadvertent over pressure.

5.4 Relief valves on cooling water pumps

5.4.1 Where cooling water pumps can develop a pressure head greater than the design pressure of the system, they are to be provided with relief valves on the pump discharge to effectively limit the pump discharge pressure to the design pressure of the system.

5.5 Sea inlets for cooling water pumps

5.5.1 Sea-water cooling systems for main and auxiliary machinery are to be connected to at least two cooling water inlets, preferably on opposite sides of the ship.

5.5.2 Where sea water is used for the direct cooling of main engines and auxiliaries, the sea water suction pipes are to be provided with strainers which can be cleaned without interrupting the cooling water supply.

Section 6

Lubricating Oil Piping Systems

6.1 General

6.1.1 Lubricating oil systems are to be entirely separated from other systems. This requirement, however, does not apply to hydraulic governing and maneuvering systems for main and auxiliary engines.

6.1.2 Lubricating oil tanks are to be separated from other tanks containing water, fuel oil or cargo oil by means of cofferdams.

6.2 Pumps

6.2.1 Where lubricating oil for the main engine(s) is circulated under pressure, a standby lubricating oil pump is to be provided where one main engine is fitted and the output of the engine exceeds 370 [kW] (500 shp).

6.2.2 Satisfactory lubrication of the engines is to be ensured while starting and maneuvering.

6.2.3 Similar provisions to those of 6.2.1 and 6.2.2 are to be made where separate lubricating oil systems are employed for piston cooling, reduction gearing, oil operated couplings and controllable pitch propellers, unless approved alternative arrangements are provided. Where the oil glands for stern tubes are provided with oil circulating pump, and the continuous running of this pump is necessary during normal operation, then a standby pump for this purpose is to be provided.

6.2.4 Independently driven rotary type pumps are to be fitted with non-return valves on the discharge side of the pumps.

6.2.5 A relief valve in close circuit is to be fitted on the pump discharge if the pump is capable of developing a pressure exceeding the design pressure of the system, the relief valve is to effectively limit the pump discharge pressure to the design pressure of the system.

6.3 Control of pumps and alarms

6.3.1 The power supply, to all independently driven lubricating oil pumps is to be capable of being stopped from a position outside the space which will always be accessible in the event of fire occurring in the compartment in which they are situated, as well as from the compartment itself.

6.3.2 All main and auxiliary engines intended for essential services are to be provided with means of indicating the lubricating oil pressure supply to them. Where such engines and turbines are of more than 75 [kW] (100 shp), audible and visual alarms are to be fitted to given warning of an appreciable reduction in pressure of the lubricating oil supply. Further, these alarms are to be actuated from the outlet side of any restrictions, such as filters, coolers, etc.

6.4 Filters

6.4.1 In systems, where lubricating oil is circulated under pressure, provision is to be made for efficient filtration of the oil. For non-redundant units, for essential services, it must be possible to clean the filters without stopping the unit or reducing the supply of filtered oil to the units.

6.5 Valves and cocks on lubricating oil tanks

6.5.1 Outlet valves and cocks on lubricating oil service tanks, other than double bottom tanks, situated in machinery spaces are to be capable of being closed locally and from positions outside the space which will always be accessible in the event of fire occurring in these spaces. Remote controls need only be fitted to outlet valves and cocks which are open in normal service and are not required for other outlets such as those on storage tanks.

Section 7

Engine Exhaust Gas Piping Systems

7.1 General

7.1.1 Where the surface temperature of the exhaust pipes and silencer may exceed 220°C, they are to be water cooled or efficiently lagged.

7.1.2 Where lagging covering the exhaust piping including flanges, is oil-absorbing or may permit penetration of oil, the lagging is to be encased in sheet metal or equivalent. In locations where the Surveyor is satisfied that oil impingement could not occur, the lagging need not be encased.

7.1.3 Exhaust pipes which are led overboard near the waterline are to be protected against the possibility of water finding its way inboard. Where the exhaust is cooled by water spray, the exhaust pipes are to be self-draining overboard.

7.1.4 Exhaust pipes of two or more engines are not to be connected together, but are to be led separately to the atmosphere unless arranged to prevent the return of gases to an idle engine.

7.1.5 In two-stroke engines fitted with exhaust gas turbo-chargers which operate on the impulse systems, provision is to be made to prevent broken piston rings entering the turbine casing and causing damage to blades and nozzle rings.

Section 8

Pumping and Piping Systems for Vessels not Fitted with Propelling Machinery

8.1 Scope

8.1.1 Following requirements are applicable to vessels not fitted with propelling machinery.

8.2 Vessels without auxiliary power

8.2.1 Hand pumps are to be fitted in number and position, as may be required for the efficient drainage of the vessel.

8.2.2 In general, one hand pump is to be provided for each compartment. Alternatively, two pumps connected to a bilge main, having at least one branch to each compartment are to be provided through non-return valves.

8.2.3 The hand pumps are to be capable of being worked from the upper deck or from positions above the load waterline which are at all times readily accessible. The suction lift is not to exceed 7.3 [m] and is to be well within the capacity of the pump.

8.2.4 The pump capacity is to be based upon the diameter of the suction pipe required for the compartment and as determined in Sec.2.

8.3 Vessels with auxiliary power

8.3.1 In vessels in which auxiliary power is available on board, power pump suctions are to be provided for dealing with the drainage of tanks and of the bilges of the principal compartments.

8.3.2 The pumping arrangements are to be as required for self propelled vessels, so far as these requirements are applicable.

End of Chapter

Chapter 4

Prime Movers and Propulsion Shafting Systems

Contents

Section

Section 1

General

1.1 General

1.1.1 The requirements of this Chapter are applicable to all ships but may be modified for ships intended for special services.

1.1.2 Prime movers of electric generators of less than 50 [kW] capacity, supplying power for lighting loads only, when the ship is in harbour, need not be built under survey.

1.1.3 Attention is drawn to any relevant statutory requirements of the country in which the ship is to be registered.

1.1.4 Power transmission systems not specified in this Chapter will be specially considered.

1.2 Materials

1.2.1 Materials intended for the main parts of the prime movers and power transmission systems are to be manufactured and tested in accordance with the requirements of *Pt.2, Inspection and Testing of Materials, of Rules & Regulations for the Construction and Classification of Steel Ships.*

1.3 Primemovers and reduction gearing

1.3.1 Primemovers and reduction gearings are to be designed, manufactured and tested in accordance with the requirements of Rules and Regulations For the Construction & Classification of Steel Ships.

1.3.2 Engines below 100 [kW] including gear boxes used for propulsion and for essential auxiliary machinery may be accepted based on certificate from approved manufacturers. Such engines between 100 [kW] and 300 [kW] are to be type approved. Engines of 300 [kW] and over including gear boxes used for propulsion and for essential auxiliary machinery, are to be type approved and undergo unit certification. Unit certification may be exempted for those engines approved in accordance with the Alternative Certification Scheme of IRS (See Pt.1, Ch.1, Sec.4 of the '*Rules and Regulations for the Construction and Classification of Steel Ships'*

1.4 Turning Gear

1.4.1 Arrangements are to be provided to turn the primemover of main propulsion systems and auxiliary drives.

Section 2

Main Propulsion Shafting

2.1 Scope

2.1.1 The requirements of this Section relate, in particular, to formulae for determining the diameters of shafting for main propulsion installations, but requirements for couplings, coupling bolts, keys, keyways, sternbushes and associated components are also included. The diameter of shafting as calculated may require to be modified as a result of alignment considerations and vibration characteristics (See Sec.8) or the inclusion of stress raisers, other than those contained in this section.

2.2 Plans and particulars

2.2.1 The following plans, in triplicate, together with the necessary particulars of the machinery, including the maximum power and revolutions per minute, are to be submitted for approval before the work is commenced:

- Final gear shaft;
- Thrust shaft;
- Intermediate shafting;
- Tube shaft, where applicable;
- Tail shaft;
- Stern bush.

2.2.2 The specified minimum tensile strength of each shaft is to be stated.

2.2.3 A shafting arrangement plan indicating the relative position of the main engines, flywheel, flexible coupling, gearing, thrust block, line shafting and bearings, stern tube, 'A' brackets and propeller, as applicable, is to be submitted for information.

2.3 Materials for shafting

2.3.1 The materials are to comply with the relevant requirements of Ch.5, *Pt.2, Inspection and Testing of Materials, of Rules & Regulations for the Construction and Classification of Steel Ships.* The specified minimum tensile strength of forgings is to be selected within the following general limits :

a) Carbon and carbon-manganese steel - 400-600 [N/mm^2]

b) Alloy steels - Not exceeding 800 [N/mm^2]

2.3.2 Ultrasonic tests are required on shaft forgings where the diameter is 250 [mm] or greater.

2.4 Intermediate and thrust shafts

2.4.1 The diameter, d, of the shaft is to be not less than determined by the following formula :

$$d = 103.5\,k\,a\,\sqrt[3]{\frac{410\,P}{(U + 160)\,R}}\ \ [\text{mm}]$$

where,

a = 0.95 for turbine installations, electric propulsion installations and oil engine installations with slip type couplings;

= 1.0 for other oil engine installations;

k = 1.0 for shafts with integral coupling flanges complying with 2.7 or shrink fit couplings;

= 1.10 for shafts with keyways, where the fillet radii in the transverse section of the bottom of the keyway are not to be less than 0.0125 d; after a length of 0.2 d from the end of the keyway, the shaft diameter may be reduced to the diameter calculated with k = 1.0;

= 1.10 for shafts with transverse or radial holes, where the diameter of the hole is not greater than 0.3 d;

= 1.20 for shafts with longitudinal slots having a length of not more than 1.4 d and a width of not more than 0.2 d, where d is calculated with k=1.0;

U = Specified minimum tensile strength of the material [N/mm^2]

P = maximum shaft power [kW];

R = Revolutions per minute corresponding to maximum shaft power giving maximum torque.

2.4.2 For shafts with design features other than stated in 2.4.1, the value of k will be specially considered.

2.5 Tailshafts and tube shafts

2.5.1 The diameter, d_p, of the tailshaft immediately forward of the forward face of the propeller boss or, if applicable, the forward face of the tailshaft flange, is to be not less than determined by the following formula :

$$d_p = 103.5\,k\,a\,\sqrt[3]{\frac{410\,P}{(U+160)\,R}}\ \ [\text{mm}]$$

where,

k = 1.22 for a shaft carrying a keyless propeller, or where the propeller is attached to an integral flange, and where the shaft is fitted with continuous liner or is oil lubricated and provided with an approved type of oil sealing gland;

= 1.26 for a shaft carrying a keyed propeller, and where the shaft is fitted with a continuous liner or is oil lubricated and provided with an approved type of oil sealing gland;

= 1.25 for a shaft carrying a keyless propeller, or where the propeller is attached to an integral flange and is fitted with water lubricated bearings with non- continuous shaft liners;

= 1.29 for a shaft carrying a keyed propeller and is fitted with water lubricated bearings with non-continuous shaft liners;

U = Specified minimum tensile strength of the shaft [N/mm^2], but is not to be taken greater than 600 [N/mm^2];

P, a and R are defined in 2.4.1.

2.5.2 The diameter, d_p of the tailshaft determined in accordance with the formula in 2.5.1 is to extend over a length not less than that to the forward edge of the bearing immediately forward of the propeller or 2.5 d_p whichever is the greater.

2.5.3 The diameter of the portion of the tailshaft and tubeshaft forward of the length required by 2.5.2 to the forward end of the forward sterntube seal is to be determined in accordance with the formula in 2.5.1 except that:

k = 1.15, when k = 1.22 or 1.26 as required by 2.5.1

k = 1.18, when k = 1.25 or 1.29 as required by 2.5.1

The change of diameter from that required by 2.5.1 to that required by this clause should be gradual.

2.5.4 The taper of the shaft cone is normally not to be steeper than 1:12 on diameter in case of keyed shafts and 1:15 on diameter in case of keyless shafts.

2.5.5 Tailshafts which run in sterntubes and tube shafts may have the diameter forward of the forward stern tube seal gradually reduced to the diameter of the intermediate shaft. Abrupt changes in shaft section at the tailshaft/ tubeshaft to intermediate shaft couplings is to be avoided.

2.6 Hollow shafts

2.6.1 For hollow shafts where the bore exceeds 40 per cent of the outside diameter the minimum shaft diameter is not to be less than that given by the following equation :

$$d_o = d\,\sqrt[3]{\frac{1}{1-\left(\dfrac{d_i}{d_o}\right)^4}}\ \ [\text{mm}]$$

where,

d_o = outside diameter [mm],

d = Rule size diameter of shaft [mm], calculated in accordance with 2.4 or 2.5

d_i = diameter of central hole [mm].

2.6.2 Where the diameter of central hole does not exceed 0.4 times the outside diameter, no increase over Rule size need be provided.

2.7 Integral couplings

2.7.1 The thickness of coupling flanges is not to be less than the minimum required diameter of the coupling bolts calculated as in para 2.9, where U_B = U or 0.2 times the rule diameter of the shaft under consideration, whichever is greater.

2.7.2 The fillet radius at the base of the coupling flange is to be not less than 0.08 of the diameter of the shaft at the coupling. The fillets are to have a smooth finish and are not to be recessed in way of nuts and bolt heads.

2.7.3 Where the propeller is attached by means of a flange, the thickness of the flange is to be not less than 0.25 times the actual diameter of the adjacent part of the tailshaft. The fillet radius at the base of the coupling flange is to be not less than 0.125 times the diameter of the shaft at the coupling.

2.8 Demountable couplings

2.8.1 Couplings are to be made of steel or other approved ductile material. The strength of demountable couplings and keys is to be equivalent to that of the shaft. Couplings are to be accurately fitted to the shaft.

2.8.2 Hydraulic and other shrink fit couplings will be specially considered upon submittal of detailed pre-loading and stress calculations and fitting instructions. In general, the torsional holding capacity is to be at least 2.8 times the transmitted torque and pre-load stress is not to exceed 70 per cent of the yield strength.

2.8.3 Provision is to be made to resist astern pull.

2.9 Coupling bolts

2.9.1 The diameter of the coupling bolts of the fitted type at the joining faces of the coupling is to be not less than that given by the following formula:

$$d_b = \sqrt{\frac{0.427\, d^3 (U + 155)}{N\, D\, U_B}} \quad [\text{mm}]$$

where,

d_b = diameter of the fitted coupling bolts [mm];

d = required diameter [mm] for the shaft in accordance with 2.4 or 2.5 as appropriate calculated by taking the value of k as 1.0;

U = specified minimum tensile strength of the shaft material in [N/mm^2];

U_B = specified minimum tensile strength of the bolt material in [N/mm^2];

and also $U \leq U_B \leq 1.7U$;

N = Number of bolts in the coupling;

D = Pitch circle diameter of bolt holes [mm].

2.9.2 The diameter of the non-fitted bolts will be specially considered upon the submittal of detailed pre-loading and stress calculations and fitting instructions.

2.10 Tailshaft liners

2.10.1 The thickness, t, of bronze or gunmetal liners fitted on tail shafts, in way of bearings, is not to be less than given by following formula :

$$t = \frac{168 + d_p}{28} \quad [\text{mm}]$$

where,

t = thickness of liner [mm];

d_p = diameter of tail shaft under the liner [mm].

2.10.2 The thickness of the continuous liner between the bearings is not to be less than 0.75t.

2.10.3 Continuous liners are preferably to be cast in one length. If made of several lengths, the joining of the separate pieces is to be made by welding through the whole thickness of liner before shrinking. In general, the lead content of the gunmetal of each length forming a butt welded liner is not to exceed 0.5 per cent. The composition of the electrode or filler rods is to be substantially lead free.

2.10.4 The liners are to withstand a hydraulic pressure of 0.2 [N/mm^2] after rough machining.

2.10.5 The liners are to be carefully shrunk or forced upon the shaft by hydraulic pressure, and they are not to be secured by pins.

2.10.6 Effective means are to be provided for preventing water from reaching the shaft at the part between the after end of the liner and the propeller boss.

2.10.7 If the liner does not fit the shaft tightly between the bearing portions in the stern tube, the space between the shaft and the liner is to be filled with a plastic insoluble non- corrosive compound.

2.11 Keys and keyways

2.11.1 Round ended or sled-runner ended keys are to be used, and the key ways in the propeller boss and cone of the tail shaft are to be provided with a smooth fillet at the bottom of the keyways. The radius of the fillet is to be at least 0.0125 of the diameter of the tail shaft at the top of the cone. The sharp edges at the top of the keyways are to be removed.

2.11.2 Two screwed pins are to be provided for securing the key in the keyway, and the forward pin is to be placed at least one-third of the length of the key from the end. The depth of the tapped holes for the screwed pins is not to exceed the pin diameter and the edges of the holes are to be slightly beveled.

2.11.3 The distance between the top of the cone and the forward end of the keyway is to be not less than 0.2 of the diameter of the tailshaft at the top of the cone.

2.11.4 The effective sectional area of the key in shear, is to be not less than $\frac{d^3}{2.6 d_1}$ [mm²]

where,

d = diameter [mm], required for the intermediate shaft determined in accordance with 2.4, based on material having a specified minimum tensile strength of 400 [N/mm²];

d_1 = diameter of shaft at mid-length of the key [mm].

2.12 Stern tube and bearings

2.12.1 The length of the bearing in the sternbush next to and supporting the propeller is to be as follows :

a) For water lubricated bearings which are lined with lignum vitae, rubber composition or staves of approved plastic material; the length is to be not less than 4 times the rule diameter required for the tailshaft under the liner;

b) For bearings which are white-metal lined, oil lubricated and provided with an approved type of oil sealing gland; the length of the bearing is to be approximately twice the rule diameter required for the tailshaft and is to be such that the nominal bearing pressure will not exceed 0.8 [N/mm²]. The length of the bearing is to be not less than 1.5 times its rule diameter;

c) For bearings of cast iron, bronze which are oil lubricated and fitted with an approved oil sealing gland; the length of the bearing is, in general, to be not less than 4 times the rule diameter required for tailshaft;

d) For bearings which are grease lubricated; the length of bearing is to be not less than 4 times the rule diameter required for the tailshaft;

e) For water lubricated bearings lined with two or more circumferentially spaced sectors of an approved plastics material, in which it can be shown that the sectors operate on hydrodynamic principles, the length of the bearing is to be such that the nominal bearing pressure will not exceed 0.55 [N/mm²]. The length of the bearing is not to be less than twice actual diameter of shaft.

2.12.2 Forced water lubrication is to be provided for all bearings lined with rubber or plastics and for those bearings lined with lignum vitae where the shaft diameter is 380 [mm] or over. The supply water may come from a circulating pump or other pressure source. The water grooves in the bearings are to be of ample section and of a shape which will be little affected by weardown, particularly for bearings of the plastic type.

2.12.3 The shut off valve or cock controlling the supply of water is to be fitted direct to the after peak bulkhead, or to the sterntube where the water supply enters the sterntube forward of the bulkhead.

2.12.4 Where a tank supplying lubricating oil to the sterntube is fitted, it is to be located above the load water line and is to be provided with a low level alarm device in the engine room.

2.12.5 Where sternbush bearings are oil lubricated, provision is to be made for cooling the oil by maintaining water in the after peak tank above the level of the sterntube or by other approved means. Means of ascertaining the temperature of the oil in the sternbush are also to be provided.

2.12.6 The oil sealing glands used for sterntube bearings, which are oil lubricated, are to be of approved type.

Section 3

Propellers

3.1 Scope

3.1.1 The requirements of this Section cover the construction, materials and inspection of propellers.

3.2 Plans and particulars

3.2.1 A plan, in triplicate, of the propeller is to be submitted for approval, together with the following particulars:

a) Maximum shaft power, P, in [kW];

b) Revolutions per minute of the propeller at maximum power, R;

c) Propeller diameter, D [m];

d) Pitch at 25 per cent radius (for solid propellers only), $P_{0.25}$ [m];

e) Pitch at 35 per cent radius (for controllable pitch propellers only), $P_{0.35}$ [m];

f) Pitch at 70 per cent radius, $P_{0.7}$, [m];

g) Length of blade section of the expanded cylindrical section at 25 per cent radius (for solid propeller only), $L_{0.25}$, [mm];

h) Length of blade section of expanded cylindrical section art 35 per cent radius (for controllable pitch propellers only) $L_{0.35}$, in [mm];

i) Rake at blade tip measured at shaft axis (backward rake positive, forward rake negative), K, in [mm];

j) Number of blades, N;

k) Developed area ratio, a.

3.3 Materials

3.3.1 Castings for propellers and propeller blades are to comply with the requirement of *Ch.8, Pt.2, Inspection and Testing of Materials, of Rules & Regulations for the Construction and Classification of Steel Ships*. The specified minimum tensile strength is to be not less than stated in Table 3.4.1.

3.3.2 When it is proposed to use materials which are not included in Table 3.4.1, details of the chemical composition, mechanical properties and density are to be submitted for approval.

3.4 Design

3.4.1 Minimum blade thickness

3.4.1.1 Where the propeller blades are of conventional design, the thickness, t, of the propeller blades at 25 per cent radius for solid propellers, at 35 per cent for controllable pitch propellers, neglecting any increase due to fillets, is to be not less than :

a) For fixed propellers

$$t_{0.25} = 1003\sqrt{\frac{AP}{C_n\,C\,R\,N}} + \frac{0.024\,B\,K\,C_s}{C\,C_n}\ [\text{mm}]$$

b) For controllable pitch propellers

$$t_{0.25} = 805\sqrt{\frac{AP}{C_n\,C\,R\,N}} + \frac{0.015\,B\,K\,C_s}{C\,C_n}\ [\text{mm}]$$

where,

$t_{0.25}$ = minimum blade thickness required at 25 per cent radius;

$t_{0.35}$ = minimum blade thickness required at 35 per cent radius;

C_n = Section modulus coefficient at 25 per cent radius or 35 per cent radius as applicable;

$= \frac{I_o}{U_f\,L\,T^2}$ and is not to be taken greater than 0.10;

I_o = Moment of inertia of the expanded cylindrical section at 25 per cent radius or 35 per cent radius, as applicable, about a straight line passing through the center of gravity parallel to the pitch line or to the nose-tail line, in [mm^4];

U_f = maximum normal distance from the moment of inertia axis to points on the face boundary (tension side) of the Section at 25 per cent radius or 35 per cent radius, as applicable [mm];

L = Length of the blade Section of the expanded cylindrical Section at 25 per cent radius or 35 per cent radius, as applicable, [mm];

T = Maximum thickness of the expanded cylindrical Section as approved at 25 per cent or 35 per cent radius, as applicable [mm];

C_s = Section area coefficient at 25 per cent radius or 35 per cent radius as applicable;

$$= \frac{a_s}{L\,T}$$

a_s = area of the expanded cylindrical Section at 25 per cent radius or 35 per cent radius, as applicable [mm²];

f = material constant as per Table 3.4.1;

w = material constant as per Table 3.4.1;

a) For fixed-pitch propellers

$$A = 1.0 + \frac{6.0\,D}{p_{0.7}} + \frac{4.3\,P_{0.25}}{D}$$

$$B = \left(\frac{4300\,w\,a}{N}\right)\left(\frac{R}{100}\right)^2\left(\frac{D}{20}\right)^3$$

$$C = \left(1 + \frac{1.5\,P_{0.25}}{D}\right)\left(L_{0.25}\,f - B\right)$$

b) For controllable pitch propellers

$$A = 1.0 + \frac{6.0\,D}{p_{0.7}} + \frac{3.0\,P_{0.35}}{D}$$

$$B = \left(\frac{4900\,w\,a}{N}\right)\left(\frac{R}{100}\right)^2\left(\frac{D}{20}\right)^3$$

$$C = \left(1 + \frac{1.5\,P_{0.35}}{D}\right)\left(L_{0.35}\,f - B\right)$$

3.4.1.2 Propellers of unusual design or application will be subject to special consideration upon submittal of detailed stress calculations.

3.4.1.3 Fillets at the root of the blades are not to be considered in the determination of blade thickness.

Table 3.4.1 : Material constants

Materials	Specified min. UTS [N/mm²]	f	w
Manganese bronze Grade Cu 1	440	22.6	8.3
Ni-Manganese bronze Grade Cu 2	440	22.9	8.0
Ni-Aluminium bronze Grade Cu 3	590	25.7	7.5
Mn-Aluminium bronze Grade Cu 4	630	25.6	7.5
Cast iron	250	11.77	7.2
Carbon and low alloy steels	400	14.0	7.9
Note: The value of f may be increased by 10 percent for twin screw and outboard propellers of triple screw ships			

3.4.2 Keyless propellers

3.4.2.1 Where propellers are fitted without keys, detailed stress calculations and fitting instructions are to be submitted for approval.

3.4.3 Controllable pitch propellers

3.4.3.1 In the case of controllable - pitch propellers, means are to be provided to lock the blades in ahead position in case of the failure of the pitch operating mechanism.

3.4.3.2 A propeller pitch indicator is to be fitted at each station from which it is possible to control the pitch of the propeller.

3.5 Fitting of propellers

3.5.1 The propeller boss is to be a good fit on the tailshaft cone. The forward edge of the bore of the propeller boss is to be rounded to about 6 [mm] radius.

3.5.2 The exposed part of the tailshaft is to be protected from the action of water by filling all spaces between propeller hub, cap and shaft with a suitable filling material. The propeller assembly is to be sealed at the forward end with a well-fitted soft rubber packing ring. When the rubber ring is fitted in an external gland, the hub counterbore is to be filled with suitable material, and clearances between shaft liner and hub counterbore are to be kept to a minimum. When the rubber ring is fitted internally, ample clearance is to be provided between liner and hub and the ring is to be sufficiently sized to squeeze in to the clearance space when the propeller is driven up on the shaft; and, where necessary, a filler piece is to be fitted in the propeller - hub keyway to provide a flat unbroken seating for the ring. The recess formed at the small end of the taper by the over hanging propeller hub is to be packed with red lead putty or rust-preventing compound before the propeller nut is put on.

3.5.3 Effective means are to be provided to prevent the slackening of the propeller nut.

Section 4

Vibrations and Alignment

4.1 Scope

4.1.1 The requirements of this Section are applicable to main propulsion systems with power exceeding 200 [kW] and auxiliary machinery systems for essential services with powers exceeding 200 [kW].

4.1.2 Unless otherwise advised, it is the responsibility of the Shipbuilder as the main contractor to ensure, in co-operation with the Engine builders, that the information required by this Section is prepared and submitted.

4.2 Basic system requirements

4.2.1 The systems are to be free from excessive torsional, axial and lateral vibration, and are to be aligned in accordance with tolerances agreed with the respective manufacturers.

4.2.2 Where changes are subsequently made to a dynamic system which has been approved, revised calculations are to be submitted for consideration.

4.3 Resilient mountings

4.3.1 Where the machinery is installed on resilient mountings, linear vibration (steady state and transient) is not to exceed the limiting values agreed with the manufacturers of the machinery nor those of the resilient mountings.

4.3.2 Misalignment arising from such vibration is not to impose excessive loading on machinery components within the system.

4.4 Torsional vibration

4.4.1 Torsional vibration calculations, including an analysis of the vibratory torques and stresses for the dynamic systems formed by the oil engines, turbines, motors, generators, flexible couplings, gearing, shafting and propeller, where applicable, including all branches, are to be submitted for approval together with the associated plans.

4.4.2 Particulars of the division of power developed throughout the speed range for turbines, or from all intended combinations of operation in oil engine installations having more than one engine and/or with power take-off systems are to be submitted.

4.4.3 Any special speed requirements for prolonged periods in service are to be indicated, e.g., range of trawling revolutions per minute, range of operation revolutions per minute with a controllable pitch propeller, idling speed, etc.

4.4.4 The calculations and/or measurements carried out on oil engine installations containing transmission items sensitive to vibratory torque, e.g. gearing, flexible couplings, or generator rotors and their drives, are to take into account the effects of engine malfunction commonly experienced in service, such as cylinder(s) not firing.

4.4.5 Restricted speed ranges will be imposed in regions of speed where stresses are considered to be excessive for continuous running. Similar restrictions will be imposed, or other protective measures required to be taken, where vibratory torques are considered to be excessive for particular machinery items.

4.4.6 Where calculations indicate the possibility of excessive torsional vibration within the range of working speeds, torsional vibration measurements, using the appropriate recognized techniques, may be required to be taken from the machinery installation for the purpose of determining the need for restricted speed ranges.

4.5 Axial vibrations

4.5.1 For all main propulsion shafting systems, the Shipbuilders are to ensure that amplitudes due to axial vibrations are satisfactory throughout the speed range, so far as practicable. Where appropriate, amplitudes may be reduced by the use of suitable vibration dampers or phasing of propeller and engine, etc.

4.5.2 Unless previous experience of similar installation shows it to be unnecessary, calculations of the shafting system are to be carried out. These calculations are to include the effect of the thrust block seating and the surrounding hull structure taking part in the vibration. The result of these calculations or the evidence of previous experience is to be submitted for consideration.

4.5.3 Where calculations indicate the possibility of excessive axial vibration amplitudes within the range of working speeds, measurements using an appropriate recognized technique may be required to be taken from the shafting systems for the purpose of determining the need for restricted speed ranges.

4.6 Lateral vibrations

4.6.1 For all main propulsion shafting systems, the Shipbuilders are to ensure that amplitudes due to lateral vibrations are satisfactory throughout the speed range.

4.6.2 Unless previous experience of similar installations shows it to be unnecessary, calculations of lateral, or bending, vibration characteristics of the shafting system are to be carried out. These calculations, taking account of dynamic bearing stiffnesses, are to cover the frequencies giving rise to all critical speeds which may result in significant amplitudes within the speed range, and are to indicate relative deflections and bending moments throughout the shafting system.

4.6.3 The results of these calculations, or the evidence of previous experience, is to be submitted for consideration.

4.6.4 Where calculations indicate the possibility of excessive lateral vibration amplitudes within the range of working speeds, measurements using an appropriate recognized technique may be required to be taken from the shafting system for the purpose of determining the need for restricted speed ranges.

4.7 Shaft alignment

4.7.1 For main propulsion installations, the shafting is to be aligned to give acceptable bearing reactions, and bending moments at all conditions of ship loading and operation. The Shipbuilder is to position the bearings and construct the bearing seatings to minimize the effects of movements under all operating conditions.

4.7.2 For geared installations, where two or more pinions are driving the final reduction wheel, calculations are to be submitted to verify that shaft alignment is such that proper bearing reactions are maintained under all operating conditions.

4.7.3 Shaft alignment is to be verified by measurement.

End of Chapter

Chapter 5

Boilers and Pressure Vessels

Contents

Section

Section 1

General

1.1 Scope

1.1.1 The requirements of this Chapter are applicable to pressure vessels of seamless and fusion welded construction, and their mountings and fittings, for the following uses :

a) Fired boilers;

b) Exhaust gas heated boilers;

c) Economizers, superheaters, reheaters and steam receivers for, and associated with (a) and(b);

d) Steam heated steam generators;

e) Other pressure vessels, not included in (a) to (d).

1.1.2 Consideration will be given to arrangements or details of boilers, pressure vessels and equipment which can be shown to comply with other recognized standards, provided they are not less effective.

1.2 Design pressure

1.2.1 The design pressure is the maximum permissible working pressure and is to be not less than the highest set pressure of any safety valve.

1.2.2 The calculations made to determine the scantlings of the pressure parts are to be based on the design pressure, adjusted where necessary to take account of pressure variations corresponding to the most severe operational conditions.

1.2.3 It is desirable that there should be a margin between the normal pressure at which the boiler or pressure vessel operates and the lowest pressure at which any safety valve is set to lift, to prevent unnecessary lifting of the safety valve.

1.3 Metal temperature

1.3.1 The metal temperature, T, used to evaluate the allowable stress is to be taken as the actual metal temperature expected under operating conditions for the pressure part concerned, and is to be stated by the manufacturer when plans of the pressure parts are submitted for consideration.

1.3.2 For boilers, the design metal temperature is not to be taken less than the following values, unless justified by an exact calculation of the temperature drop and is in no case to be taken less than 250°C:

a) For steam heated steam generators, secondary drums of double evaporation boilers, steam receivers and pressure parts of fired pressure vessels not heated by hot gases and adequately protected by insulation, the metal temperature, T is to be taken as the maximum temperature of the internal fluid;

b) For pressure parts heated by hot gases, T is to be taken as not less than 25°C in excess of the maximum temperature of the internal fluid;

c) For combustion chambers of the type used in horizontal wet-back boilers, T is to be taken as not less than 50°C in excess of the maximum temperature of the internal fluid;

d) For furnaces, fire boxes, rear-tube plates of dry-back boilers and pressure parts subject to similar rates of heat transfer, T is to be taken as not less than 90°C in excess of the maximum temperature of the internal fluid;

e) For boiler, superheater, reheater and economizer tubes, the design temperature is to be taken as under :

   - For boiler tubes the design temperature is to be taken as not less than saturated steam temperature plus 25°C for tubes mainly subject to convection heat, or plus 50°C for tubes mainly subject to radiant heat;

   - For superheater and reheater tubes, the design temperature is to be taken as not less than steam temperature expected in the part being considered, plus 35°C for tubes mainly subject to convection heat. For tubes mainly subject to radiant heat the design temperature is to be taken as not less than the steam temperature expected in the part being considered, plus 50°C, but the actual metal temperature expected is to be stated when submitting plans;

   - The design temperature for economizer tubes is to be taken as not less than 35°C in excess of the maximum temperature of the internal fluid.

1.3.3 In general, any part of boiler drums or headers not protected by tubes, and exposed to radiation from the fire or to the impact of hot gases, is to be protected by a shield of good refractory material or by other approved means.

1.3.4 Drums and headers of thickness greater than 30 [mm] are not to be exposed to combustion gases having an anticipated temperature in excess of 650°C unless they are efficiently cooled by closely arranged tubes.

1.4 Plans and particulars

1.4.1 The following plans, in triplicate, for boiler and pressure vessels are to be submitted for approval, in so far as applicable:

a) General arrangement, including arrangement of valves and fittings;

b) Sectional assembly;

c) Seating arrangements;

d) Steam, water drum and header details;

e) Water wall details;

f) Steam and superheater tubing, including the tube support arrangements;

g) Economizer details;

h) Casing arrangement;

i) Reheat section;

j) Fuel oil burning arrangement;

k) Forced draft system;

l) Boiler mountings including steam stop valves, safety valves and their relieving capacities, feed water connections, blow-off arrangements, watergauges, test cocks, etc.

1.4.2 The plans are to include the following particulars, in so far as applicable :

a) Scantlings;

b) Materials;

c) Weld details;

d) Design pressures and temperatures;

e) Heating surface areas of boilers and superheaters;

f) Estimated pressure drop through superheater;

g) Estimated evaporation rate;

h) Proposed setting pressure of safety valves on steam drum and superheater;

i) Pressure vessel class;

j) Details of heat treatment and testing of welds;

k) Calculations of thicknesses, when required;

l) Test pressures.

1.5 Classification of pressure vessels

1.5.1 For Rule purposes, boilers and pressure vessels are graded as shown in Table 1.5.1.

1.5.2 Pressure vessels which are constructed in accordance with the requirements of Class 2 or Class 3 will, if manufactured in accordance with the requirements of a superior class, be approved with the scantlings appropriate to that class.

Table 1.5.1 : Grading of pressure vessels

	Boilers	Steam-heated steam generators	Other pressure vessels
Class 1	p > 3.5	$D_i > \left(\frac{15}{p} - 1\right)1000$	P > 50 or t > 38
Class 2	p ≤ 3.5	$D_i < \left(\frac{15}{p} - 1\right)1000$	P ≤ 50 or $D_i > \left(\frac{20}{p} - 1\right)1000$ and 16 < t ≤ 38 or material temperature > 150°C
Class 3			$D_i \leq \left(\frac{20}{p} - 1\right)1000$ and t ≤ 16 and material temperature ≤ 150°C

Notes:

P = design pressure, in bar D_i = internal diameter [mm]   t = shell thickness [mm]

1.5.3 In special circumstances relating to service conditions, materials, operating temperature, the carriage of dangerous gases and liquids, etc., it may be required that certain pressure vessels be manufactured in accordance with the requirements of a superior class.

1.6 Materials

1.6.1 Materials used in the construction of boilers and pressure vessels are to be manufactured in accordance with the requirements of *Pt.2, Inspection and Testing of Materials, of Rules & Regulations for the Construction and Classification of Steel Ships.*

1.6.2 The specified minimum tensile strength of carbon and carbon manganese steel plates, pipes, forgings and castings is to be within the following general limits :

a) For seamless and Class 1 and Class 2 fusion welded pressure vessels - 340 - 520 [N/mm^2];

b) For boiler furnaces, combustion chambers and flanged plates - 400 - 520 [N/mm^2].

1.6.3 The specified minimum tensile strength of low alloy steel plates, pipes, forgings and castings is to be within the general limits of 400 - 500 [N/mm^2], and pressure vessels made in these steels are to be either seamless or Class 1 fusion welded.

1.6.4 The specified minimum tensile strength of boiler and superheater tubes is to be within the following general limits :

a) Carbon and carbon-manganese steels - 320 - 460 [N/mm^2];

b) Low alloy steels - 400 - 500 [N/mm^2].

1.6.5 Where it is proposed to use materials other than those specified in *Pt.2, Inspection and Testing of Materials, of Rules & Regulations for the Construction and Classification of Steel Ships*, details of the chemical compositions, heat treatment and mechanical properties are to be submitted for approval. In such cases the values of the mechanical properties used for deriving the allowable stress are to be subject to agreement by IRS.

1.6.6 Where a fusion welded pressure vessel is to be made of alloy steel and approval of the scantlings is required on the basis of the high temperature properties of the material, particulars of the welding consumables to be used, including typical mechanical properties and chemical composition of the deposited weld metal, are to be submitted for approval.

1.7 Pressure parts of irregular shape

1.7.1 Where pressure parts are of such irregular shape that it is impracticable to design their scantlings by the application of formulae given in this Chapter, the suitability of their construction is to be determined by hydraulic proof test of a prototype or by an agreed alternative method.

1.8 Adverse working conditions

1.8.1 Where working conditions are adverse, special consideration may be required to be given to increasing the scantlings derived from the formulae, e.g. by increasing the corrosion or other allowance at present shown in the formulae, or by adopting a design pressure higher than defined in 1.2, to offset the possible reduction of life in service caused by the adverse conditions. In this connection, where necessary, account should also be taken of any excess of loading resulting from :

a) impact loads, including rapidly fluctuating pressures;

b) weight of the vessel and normal contents under operating and test conditions;

c) superimposed loads such as other pressure vessels, operating equipment, insulation, corrosion-resistant or erosion-resistant linings and piping;

d) reactions of supporting lugs, rings, saddles or other types of supports;

or

e) the effect of temperature gradients on maximum stress.

1.9 Design

1.9.1 The boilers and pressure vessels are to be designed in accordance with the requirements of *Ch.5, Pt.4, Main and Auxiliary Machinery, of Rules & Regulations for the Construction and Classification of Steel Ships.*

1.10 Manufacture

1.10.1 The manufacture of boilers and pressure vessels is to be carried out in accordance with the requirements of Ch.10, *Pt.4, Main and Auxiliary Machinery, of Rules & Regulations for the Construction and Classification of Steel Ships*.

End of Chapter

Chapter 6

Steering Gears

Contents

Section

Section 1

General

1.1 General

1.1.1 All ships are to be provided with reliable steering systems which would allow the vessel to be steered safely having regard to the use and principal dimensions of the ship. This requirement does not apply to ships intended to be pushed only. Proposals to fit a hand tiller only will receive special consideration.

1.1.2 For ships not fitted with rudders but equipped with steering propellers/nozzles or Voith-Schneider propellers, see 2.5. For ships fitted with rudders, a steering gear is to be provided.

1.1.3 The steering gear is to be secured to the seating by fitted bolts, and suitable chocking arrangements are to be provided. The seating is to be of substantial construction.

1.1.4 The steering gear is to be so designed that the rudder cannot change position when not intended to do so.

1.1.5 Steering gears may be manually operated (steering chains and rods or hand/hydraulic) or fully powered (electric or electric/hydraulic). However, when the rule diameter of the rudderstock exceeds 150 [mm] in way of tiller, a fully powered steering gear is to be provided.

1.1.6 Manually operated gears or power assisted gears are only acceptable when the operation does not require an effort exceeding 16 [kgf] under normal conditions.

1.1.7 If a fully powered steering gear is fitted an independent secondary means of steering is to be provided.

1.1.8 Requirements for chemical tankers, gas carriers and similar vessels will be specially considered by IRS.

Section 2

Design Criteria

2.1 General

2.1.1 The entire steering gear is to be designed, constructed and installed to allow for a permanent transverse list of up to 15 and for ambient temperatures commensurate with the area in which he ship is to operate.

2.1.2 The parts comprising the steering gear are to be so dimensioned that they can withstand all the maximum stresses to which they will be subjected in normal operating conditions. The steering gear is to be sufficiently strong so that in the event of rudder touching the bottom or bank, the maximum damage would be limited to deformation or fracturing of the rudder stock.

2.1.3 The steering gear is to be so designed that a rudder angle of not less than 35 on either side can be obtained.

2.1.4 Where the steering gear is manually operated, on an average one complete turn of the hand wheel is to correspond to at least 3 of rudder angle.

2.1.5 Where the steering gear is fully powered, it is to be capable of turning the rudder at an average rate of 4 per second through the entire rudder arc when the rudder is fully immersed and with the ship at full speed.

2.1.6 Where fully powered steering gear is provided with a second, manually operated gear, the latter is to permit the ship to proceed to a mooring at reduced speed.

2.2 Fully powered steering gear

2.2.1 Fully powered steering gears may be of the direct electric or electric/hydraulic type.

2.2.2 Powered steering gears are to be fitted with means to limit the torque exerted by the drive.

2.2.3 In case of failure of the main drive and the secondary drive not engaging automatically, it is to be possible to engage the secondary drive by hand at the steering position within 5 seconds, with the rudder in any position.

2.2.4 At the steering station, automatic indication is to be provided as to which drive is in operation.

2.2.5 If the independent secondary drive is manual the power drive is not to actuate the hand wheel. A device is to be fitted to prevent inadvertent turning of the hand wheel when the manual drive is engaged automatically.

2.2.6 Where the main steering gear is power hydraulically operated whilst the secondary steering is a manually operated hydraulic system, the piping of both systems is to be completely separate, and the main installation is to operate without using the steering wheel pump of the secondary installation.

2.2.7 Where both the main and secondary drive are power hydraulic, the respective pumps must be driven independently.

2.2.8 Where the secondary pump is driven by an engine which does not operate continuously whilst the ship is in motion, means are to be provided to operate the steering gear instantly whilst the emergency engine is gaining the required speed.

2.2.9 The two installations are to have separate pipes, valves, controls, etc. Where the independent functioning of the two installations is ensured, they may have common components.

2.3 Manual drive

2.3.1 Where the sole steering installation is a manually operated system, an independent secondary steering system is not required, provided that in the case of a hydraulic system, the dimensioning, construction and layout of the piping precludes deterioration through mechanical action or fire, and the construction of the steering wheel pump ensures faultless operation.

2.4 Rudder position

2.4.1 If the position of the rudder(s) is not clearly perceivable from the steering station, a reliable rudder angle indicator is to be provided at the steering station.

2.4.2 Any rudder angle indicator fitted, is to function for both the main and secondary steering gear.

2.5 Rudder propellers and Voith Schneider equipment

2.5.1 Where a steering propeller/nozzle or Voith Schneider propeller is fitted, two independent control systems are to be provided between the steering station and the propulsion installation.

2.5.2 Where two or more independent steering propulsion installations are fitted, a secondary independent control system is not required provided the ship remains sufficiently maneuverable in the event of one of the installations failing.

2.6 Tillers, quadrants and connecting rods

2.6.1 For the requirements regarding rudder, rudder stock, See Pt.3, Ch.12.

2.6.2 All components transmitting mechanical forces to the rudder stock are to have a strength of at least equivalent to the rudder stock in way of the tiller. The combined resultant stress, σ_e, caused by the transmission of rudder torque, Q_r, in tillers, vanes and other power transmitting components is not to exceed 138 [N/mm^2], i.e.

$$\sigma_e = \sqrt{\sigma^2 + 3\tau^2} \leq 138 \ \ [\mathrm{N/mm^2}]$$

where,

σ_e = The combined equivalent stress, [N/mm^2]

σ = The bending stress, [N/mm^2]

τ= The torsional shear stress, [N/mm^2]

Q_r = The rudder torque [N-m] calculated as per Pt.3, Ch.12, Sec.3.2;

2.6.3 The section modulus 'Z' [cm^3] and the sectional area 'A' [cm^2] of the tiller arms is not to be less than the following :

$$Z = 0.012\, Q_r \left(1 - \frac{x}{R}\right) [\mathrm{cm^3}]$$

$$A = 2.0 \frac{Q_r}{R} \times 10^{-4} \ \ [\mathrm{cm^2}]$$

where,

R = The distance [m] from the point of application of the effort on the tiller to the centre of rudder stock; and

x = The distance [m] from the section under consideration to the centre of the rudder stock.

2.6.4 The boss may be fitted on the rudder stock by shrinking with/without key or may be of the split type. The ratio between the mean of outer and inner diameters of the boss is to be not less than 1.75 and the height of the boss is not to be less than the inner diameter of the boss.

2.6.5 Co-efficient of friction for shrink fitting is not to be taken greater than 0.17 for dry fitting and 0.15 for oil injection fitting.

2.6.6 In case of split type boss, the total number of joining bolts is to be at least 4. The distance of the centre of the bolts from the centre of the rudder stock is generally to be 1.15du and the thickness of the coupling flange is to be at least 1.1 times the required bolt diameter. The thickness of shim to be fitted between two halves before machining is to be 0.0015du. The diameter of the coupling bolt, d_b is to be not less than :

$$d_b = 0.60 \frac{d_u}{\sqrt{n}} \ [\mathrm{mm}]$$

where,

d_u = The rudder stock diameter in way of the tiller calculated in accordance with Pt.3, Ch.12, Sec.3;

n = Total number of joining bolts.

2.6.7 The shear area of the key, As, is not to be less than :

$$A_s = \frac{0.18\, Q_r}{d_m} \ [\mathrm{cm^2}]$$

where,

d_m = diameter of the conical part of the rudderstock at midway of key, [mm] The keyway is to extend over the full depth of the tiller and have rounded edges. The abutting surface area of the key, A_b, (discounted rounded edges) between the key and the rudder stock or the key and the tiller boss is not to be less than:

$$A_b \geq 0.5\ A_s$$

2.6.8 Where higher tensile bolts are used on bolted tillers and quadrants, the yield and ultimate tensile stresses of the bolt material are to be stated on the plans submitted for approval, together with full details of the methods to be adopted to obtain the required setting-up stress. Where patent nuts or systems are used, the manufacturer's instructions for assembly should be adhered to.

2.6.9 In bow rudders having a vertical locking pin operated from the deck above, positive means are to be provided to ensure that the pin can be lowered only when the rudder is exactly central. In addition, an indicator is to be fitted at the deck to show when the rudder is exactly central.

2.6.10 Steel-wire rope, chain and other mechanical systems, when these are used for rudder stock diameters of 120 [mm] and less but excluding allowance for strengthening in ice, will be specially considered. In general the breaking strength of rods/chains etc. is not to be less than:

$$\text{Breaking strength} \geq 6\ \frac{Q_r}{R}\ [\text{ N }]$$

Where R is defined in 2.6.3.

2.7 Locking or brake gear and springs

2.7.1 An efficient locking or brake arrangement is to be fitted to all gears to keep the rudder steady when necessary. In the case of hydraulic steering gears which are fitted with isolating valves on the body of the gear and duplicate power units, an additional mechanical brake need not be fitted.

2.7.2 In bow rudders having a vertical locking pin operated from the deck above, positive means are to be provided to ensure that the pin can be lowered only when the rudder is exactly central. In addition, an indicator is to be fitted at the deck to show when the rudder is exactly central.

2.7.3 The steering gear, unless hydraulically powered, is to be protected by means of springs or buffers from damage by impact on the rudder.

2.8 Rudder stops

2.8.1 Suitable stopping arrangements are to be provided for the rudder. Cut-outs on the steering engine are to be arranged to operate at a smaller angle of helm than those for the rudder.

End of Chapter

Chapter 7

Control Engineering Systems

Contents

Section

Section 1

General Requirements

1.1 General

1.1.1 This Chapter applies to all ships and is in addition to other relevant Chapters of the Rules.

1.1.2 Attention should also be given to any relevant requirements of National, International or Local Authorities which would apply to the ships in service.

1.1.3 This Chapter states requirements for systems of automatic or remote control which may be used for controlling the machinery contained in 1.2.2. The design and installation of other control equipment is to be such that there is no risk of danger due to failure.

1.1.4 The details of control systems will vary with the type of machinery being controlled and special consideration will be given to each case.

1.2 Plans

1.2.1 Where control systems are applied to essential machinery or equipment as listed in 1.2.2, plans are to be submitted in triplicate. They are to include or to be accompanied by:

– Details of operating medium, i.e. pneumatic, hydraulic or electric, including standby sources of power.

– Description and/or block diagram showing method of operation.

– Line diagrams of control circuits.

– Lists of points monitored.

– List of alarm points.

– List of control points.

– Test facilities provided.

– Test schedules.

1.2.2 **Control systems**. Plans are required for the following:

– Ballast systems.

– Bilge systems.

– Cargo pumping systems for tankers.

– Controllable pitch propellers.

– Electrical generating plant.

– Fire detection systems.

– Main propelling machinery including essential auxiliaries.

– Steam raising plant.

– Transverse thrust units.

– Steering gear plant.

– Inert gas generators.

1.2.3 **Alarm systems**. Details of the overall alarm system linking engine room, wheelhouse and, where applicable, accommodation spaces are to be submitted.

1.2.4 **Control Station**. Location and details of control station are to be submitted, e.g. control panels.

1.2.5 **Standard system.** Where it is intended to employ a system which has been previously approved, plans may not be required to be submitted.

1.2.6 **Computer based systems**. In addition to documentation specified at 1.2.2 following plans/ documents are to be submitted as applicable:

- System requirement specification
- System block diagram showing details of hardware
- Software quality plans when requested
- Factory acceptance test procedures.

1.3 Alarm and control equipment

1.3.1 Major units of equipment associated with control, alarm and safety systems as defined in 1.2 are to be surveyed at the manufacturers' works and the inspection and testing is to be to the Surveyor's satisfaction.

1.3.2 Equipment used in control, alarm and safety systems should whenever practicable, be selected from the List of Type Approved Control and Electrical Equipment published by IRS. A copy of IRS Test Requirements for the Type Approval of Control and Electrical Equipment will be furnished on application.

1.3.3 Assessment of performance parameters, such as accuracy, repeatability and the like, are to be in accordance with an acceptable National or International Standard.

1.4 Alterations or additions

1.4.1 When an alteration or addition to the approved system(s) is proposed, plans are to be submitted for approval. The alterations or additions are to be carried out under survey, and the inspection, testing and installation is to be to the Surveyor's satisfaction.

1.4.2 Any changes in software are to be submitted for consideration. Where considered necessary, validation tests may be required to be carried out to verify the software performance. Software version changes are to be identified and submitted to surveyor on request.

Section 2

Essential Features for Control and Alarm Systems

2.1 General

2.1.1 Where it is proposed to install control and alarm systems to the equipment defined in 1.2.2 the applicable features contained in 2.2 to 2.5 are to be incorporated in the system design.

2.2 Control station(s) for machinery

2.2.1 A system of alarm displays and controls are to be provided which readily ensure identification of faults in the machinery and satisfactory supervision of related equipment.

2.3 Alarm system

2.3.1 Where an alarm system, which will provide warning of faults in the machinery and control systems is installed, the requirements of 2.3.1 to 2.3.10 are to be satisfied.

2.3.2 Machinery and control system faults are to be indicated at the relevant control station to advise duty personnel of a fault condition.

2.3.3 Individual alarm channels may be displayed as group alarms at the main control station (if fitted) or alternatively at subsidiary control stations.

2.3.4 All alarms are to be both audible and visual. If arrangements are made to silence audible alarms they are not to extinguish visual alarms.

2.3.5 If an alarm has been acknowledged and a second fault occurs before the first was rectified then audible and visual alarms are again to operate.

2.3.6 Failure of the power supply to the alarm system is to be indicated.

2.3.7 The alarm system should be designed with self-monitoring properties. As far as practical, any fault in the alarm system should cause it to fail to the alarm condition.

2.3.8 The alarm system is to be designed as far as practical to function independently of control systems, such that a failure or malfunction in these systems will not prevent the alarm from operating.

2.3.9 Disconnection or manual overriding of any part of the alarm system should be clearly indicated.

2.3.10 The alarm system is to be capable of being tested.

2.3.11 The alarm system is to be designed with self-monitoring capabilities.

2.3.12 In wheelhouse illumination of all indications and controls are to be provided with dimming facility.

2.4 Control systems

2.4.1 Control systems for machinery operations are to be stable throughout their operating range.

2.4.2 Failure of the power supply to a control system for propulsion machinery and associated systems is to operate an audible and visual alarm.

2.4.3 When remote or automatic controls are provided, sufficient instrumentation is to be fitted at the relevant control stations to ensure effective control and indicate that the system is functioning correctly.

2.4.4 Where valves are operated by remote or automatic control, the system of control should include the following safety features:

(a) Failure of actuator power should not permit a closed valve to open inadvertently.

(b) Positive indication is to be provided at the remote control station for the service to show the actual valve position or alternatively that the valve is fully open or closed. Valve position indicating systems are to be of an approved type.

(c) Equipment located in places which may be flooded should be capable of operating when submerged.

(d) A secondary means of operating the valves, which may be local manual control is to be provided.

2.5 Computer based systems

2.5.1 The requirements specified in this sub-section are to be complied with for equipment, which are intended to be used for essential services and safety critical equipment, which incorporate computer based systems.

2.5.2 Computer based systems are to be provided with self-monitoring facilities

2.5.3 Systems is to revert to a defined safe state on initial startup or restart in the event of failure.

2.5.4 In the event of failure of any programmable electronic equipment the system is to fail to a defined safe state or maintain safe operation, as applicable.

2.5.5 Where software is used for control of essential equipment, the software is to be certified towards software quality assurance.

Note: The certification of software for computer based control systems is to be carried out in accordance with IRS '*Guidelines on Certification of Software for Computer based Systems*'.

2.5.6 Alternate means of back-up fully independent and hard wired are to be provided. Alternatively, if they are dependent on software then the software is to be certified by IRS towards software quality assurance.

2.5.7 Failure of power supply is to initiate an alarm.

2.5.8 Emergency stop systems are to be hard wired and where they are implemented through computer based system, then the software is to be certified by IRS.

2.5.9 Essential equipment in integrated system are to be able to operate independently.

2.5.10 Failure of one part of integrated system is not to affect the functionality of other parts of the integrated system.

2.6 Fire detection alarms systems

2.6.1 Where an automatic fire detection system is to be fitted in a machinery space the requirements of 2.6.2 to 2.6.9 are to be satisfied.

2.6.2 A fire detector indicator panel is to be located in such a position that a fire in the machinery spaces will not render it inoperative.

2.6.3 The audible fire alarm is to have a characteristic tone which distinguishes it from any other alarm system. The audible fire alarm is to be audible on all parts of the bridge and in the accommodation areas.

2.6.4 The alarm system should, so far as practicable, be designed with self-monitoring properties.

2.6.5 Failure of power supply to the alarm system is to be indicated.

2.6.6 Detector heads of an approved type are to be located in the machinery spaces so that all potential fire outbreak points are guarded.

2.6.7 The fire detection system is to be capable of being tested.

2.6.8 It is to be demonstrated to the Surveyor's satisfaction that detector heads are so located that air currents will not render the system ineffective.

2.6.9 A drawing showing the location of the fire detector heads and the fire indicator panel, is to be submitted.

Section 3

Control and Supervision of Machinery

3.1 General

3.1.1 When machinery, as defined in 1.2.2, is fitted with automatic or remote controls so that under normal operating conditions it does not require any manual intervention by the operators then it is to be provided with the arrangements specified in 3.2 to 3.7. Alternative arrangements which provide equivalent safeguards will be considered.

3.2 Oil engines for propulsion purposes

3.2.1 The following systems are to be provided with alarms:

System	Alarm
Lubricating oil pressure for the engine including gearing	Low
Lubricating oil pressure for the engine including gearing	Failure, see 3.2.2
Cooling system(s) temperature	High
Cooling system(s) temperature	Excessively high, see 3.2.3

3.2.2 In the case of the lubricating oil system, in addition to the alarm indication as required by 3.2.1, at complete loss of lubricating oil the engine is to be stopped automatically or alternatively a second and separate alarm is to be provided giving audible and visible warning in the wheelhouse and in the engine room. The circuit and sensor employed for this automatic stop or alarm are to be additional to the alarm circuit and sensor required by 3.2.1.

3.2.3 In the case of cooling system(s), in addition to the alarm indication as required by 3.2.1, a shutdown system for excessively high temperatures may be fitted, which is to be independent of the alarm system.

3.2.4 Prolonged running in a restricted speed range is to be prevented automatically; alternatively, indication of restricted speed ranges is to be provided at each control station.

3.3 Boilers

3.3.1 A system of water level detection is to be fitted which will operate alarms and shut off automatically the oil supply to the burners when the water level falls to a predetermined low level.

3.3.2 The oil fuel is to be shut off automatically from the burners, and alarms are to operate on flame failure and failure of combustion air supply detected by either low pressure at the fan outlet or stopping of the fan motor.

3.3.3 Where the burner flame(s) is/are extinguished and reignited automatically in response to steam demand then after total flame failure re-ignition shall not take place until the furnace has been purged of explosive gases.

3.4 Auxiliary engines

3.4.1 The following systems for auxiliary engines of more than 37 kW (50 shp) are to be provided with alarms:

System	Alarm
Lubricating oil pressure	Low *
Cooling system temperature	High *
* These alarms may be combined with an automatic shutdown system, if fitted	

3.5 Remote control for propulsion machinery

3.5.1 The following systems are to be provided with alarms:

System	Alarm
Operating medium for hydraulic or pneumatic coupling in propulsion system	Low pressure
Operating medium for hydraulic or pneumatic remote control system for main engine	Low pressure
Electrical supply to remote control system for main engine	Loss of supply

3.6 Controllable pitch propellers and transverse thrust units

3.6.1 Preferred alarms and safeguards are indicated in 3.6.2 to 3.6.4.

3.6.2 In the case of main propulsion systems, means are to be provided to prevent the engines and shafting being subjected to excessive torque due to changes in propeller pitch, alternatively an engine overload indicator may be fitted at each station for which it is possible to control the pitch of the propeller.

3.6.3 Where transverse thrust units are remotely controlled, means are to be provided at the remote control station to stop the propulsion
unit.

3.6.4 The following systems are to be provided with alarms:

System	Alarm
Hydraulic system pressure	Low
Power supply to the control system between the remote control station and hydraulic actuator	Loss of supply

3.7 Steering gear

3.7.1 For power operated steering gear, safeguards and alarms are to be provided as indicated in 3.7.2 and 3.7.5.

3.7.2 Provision should be made at the bridge to ensure that the steering gear may be rapidly and effectively transferred to an alternative power and control system, which may be manual.

3.7.3 Where the alternative steering gear system is also power operated this system should be independent of the main power system.

3.7.4 The control system for the alternative steering gear system required by 3.7.2 is to be independent of the main steering gear control system.

3.7.5 The following systems are to be provided with alarms:

System	Alarm
Steering gear power system(s)	Failure
Steering gear control system(s)	Failure
Steering gear hydraulic oil tank level	Low

3.8 Main propulsion shafting

3.8.1 Where a tank supplying lubricating oil to the sternbush is fitted, it is to be located above the load waterline and is to be provided with a low level alarm.

End of Chapter

Chapter 8

Electrical Installations - Equipment and Systems

Contents

Section 1

General Requirements

1.1 General

1.1.1 The requirements of this Chapter apply to self-propelled and non self-propelled ships for service on inland waterways unless otherwise stated. Attention should also be given to any relevant applicable requirements of National or Local Authorities.

1.1.2 In passenger ships, services essential for safety are to be maintained under emergency conditions and the safety of ship and personnel from electrical hazards is to be assured.

1.1.3 Electrical installations are to be constructed and installed in accordance with the relevant sections of this Chapter and are to be inspected and tested by the Surveyors. Compliance with the requirements of an acceptable National or International Standard may be accepted as meeting the requirements of this Chapter, subject to inspection and testing by the Surveyors.

1.1.4 IRS will be prepared to give consideration to special cases or to arrangements which are equivalent to the Rules. Consideration will also be given to the electrical arrangements of small ships and ships to be assigned class notation for a specified limited service.

1.1.5 In addition to the requirements of this Chapter, vessels using batteries as the main and/ or additional source of power for propulsion are also to be in accordance with IRS '*Guidelines on Battery Powered Vessels*'. Requirements for approval of Lithium-ion battery systems to be used in battery powered vessels or hybrid vessels are specified in IRS Classification Note "*Approval of Lithium-ion Battery Systems*".

1.2 Plans

1.2.1 The plans and particulars in 1.2.2 to 1.2.4 are to be submitted in triplicate for approval.

1.2.2 **Electrical Equipment**: The arrangement plan and circuit diagram of the switchboard(s). Diagrams of the wiring system including cable sizes, type of insulation, normal working current in the circuits and the capacity, type and make of protective devices. Calculations of short circuit currents at main busbars and the secondary side of transformers are to be submitted.

1.2.3 **Oil tankers, and similar vessels**: A general arrangement of the ship showing hazardous zones or spaces and the location of electrical equipment in such zones or spaces. A schedule of safe type electrical equipment located in hazardous zones or spaces giving details of the type of equipment fitted, the Certifying Authority, the certificate number and copies of the certificate.

1.2.4 **Centralised, remote or automatic controls:** See Ch.7.

1.3 Additions or alterations

1.3.1 Additions or alterations, (temporary or permanent) to the approved load of an existing installation are not to be made until it has been ascertained that the current carrying capacity and the condition of the existing accessories, conductors and switchgear are adequate for the proposed modification.

1.3.2 Plans for the proposed modifications are to be submitted for approval and the alterations or additions are to be carried out under the inspection, and to the satisfaction of the Surveyors.

1.4 Application

1.4.1 Except where a specific statement is made to the contrary, all requirements of this Chapter are applicable to both alternating current and direct current installations.

1.4.2 Direct current equipment is to operate satisfactorily under voltage fluctuations of plus 6 per cent and minus 10 per cent.

1.4.3 Alternating current equipment is to operate satisfactorily under voltage fluctuations of plus 6 per cent and minus 10 per cent at rated frequency, and under frequency fluctuations of $\pm$ 5 per cent at rated voltage.

1.4.4 Contactors and similar electromagnetic equipment are not to drop out at or above 85 per cent rated voltage.

1.4.5 For D.C. installations supplied by batteries, consideration is to be given to the supply voltage variations between the battery's full charged and minimum charged voltages. For installations with float charging, the maximum charging voltage is also to be considered.

1.5 Ambient reference conditions

1.5.1 The rating of electrical equipment is to be suitable for the temperature conditions associated with the geographical limits of the intended service. See also Ch.1.

1.6 Location and construction

1.6.1 Electrical equipment is to be placed in accessible and adequately lighted spaces clear of flammable material and heat sources. The spaces should be well ventilated, and the equipment should not be exposed to risk of mechanical injury or damage from water, excessive moisture, steam, oil or any other dangerous fluid. Where necessarily exposed to such hazards, the equipment is to be suitably constructed or enclosed.

1.6.2 Live parts are to be efficiently shielded from any accidental contact.

1.6.3 All electrical apparatus and equipment is to be constructed and installed so as to avoid injury or electrical shock when handled or touched in the course of normal operation.

1.6.4 All nuts and bolts/screws used to connect or secure current- carrying parts and working parts are to be effectively locked, to prevent them from working loose during operation.

1.7 Earthing

1.7.1 All non-current-carrying exposed metal parts of electrical machines or equipment are to be effectively earthed.

1.7.2 All accessible non-current-carrying metal parts of portable electrical apparatus rated in excess of 55 volts are to be earthed through a suitable conductor unless equivalent safety provisions are made such as by double insulation or by an isolating transformer.

1.7.3 In general earthing connections are to be equal to the cross section of the current-carrying conductor up to 16 [mm^2]. Above this figure they are to be equal to at least half the cross section of the current carrying conductor with a minimum of 16 [mm^2]. Earthing connections which are not made of copper are to have a conductance not less than that specified for a copper earthing connection. These are to be securely installed and protected where necessary against mechanical damage and electrolytic corrosion. These are to be made in an accessible location and secured at both ends by corrosion resistant screws or clamps with cross section corresponding to the earth conductor. Such screws or clamps are not to be used for other purposes. Suitable washers and conductor terminals are to be used so that a reliable contact is ensured.

1.7.4 The metallic sheaths of cables other than the measuring circuits are to be earthed at their two ends.

1.8 Creepage and clearance

1.8.1 Distance between live parts and between live parts and earthed metal, whether across surfaces or in air, are to be adequate for the working voltages considering the nature of the insulating material and the transient over voltages developed by switch and fault conditions.

1.9 Electrical equipment for use in explosive gas atmospheres

1.9.1 Where the Rules require electrical equipment to be of a "safe type", such equipment is to be certified for the gases/vapours involved. The equipment should conform to IEC publication 79, "Electrical Apparatus for Explosive Gas Atmospheres", or an equivalent national standard.

1.9.2 Copies of type test certificate by a competent independent Testing Authority are to be made available.

1.9.3 When "safe type" equipment is permitted in hazardous zones or spaces all switches and protective devices are to interrupt all lines or phases and, where practicable, are to be located in a non-hazardous zone or space unless specifically permitted otherwise. Appropriate labels of non-flammable material are to be permanently affixed to such equipment, switches and protective devices for identification purposes.

Section 2

System Design

2.1 Design

2.1.1 Supply and distribution systems

2.1.1.1 The following systems of generation and distribution are acceptable for parallel systems at constant voltage (refer Table 2.1.1 for details):-

a) d.c. two-wire insulated,

b) a.c. single-phase two-wire insulated,

c) a.c. three-phase, three-wire insulated,

d) a.c. three-phase, four-wire with neutral earthed but without hull return.

System voltages for both alternating current and direct current are not to exceed:

- 500 V for generation, power, cooking and heating equipment permanently connected to fixed wiring.

- 250 V for lighting, heaters in cabins and public rooms, and other applications not mentioned above.

2.1.1.2 Systems of generation and distribution, having voltages other than those specified above, will, upon application, be given special consideration.

Table 2.1.1 : Systems of generation and distribution

Description	Tankers intended for the carriage in bulk of oil, liquefied gases and other hazardous liquids having a flashpoint not exceeding 60°C (closed cup test)	Other vessels
d.c. two wire insulated system (See Note 1)	Acceptable	Acceptable
a.c., single-phase, two wire insulated system (See Note 1)	Acceptable	Acceptable
a.c., three-phase, three wire insulated system (See Note 2)	Acceptable	Acceptable
a.c. or d.c. earthed systems	Normally not acceptable (See Note 3)	Acceptable
a.c. three-phase, four wire system with neutral earthed but without hull return	Not acceptable	Acceptable upto 1000V
Hull return system of distribution (a.c. or d.c.)	Normally not acceptable (See Notes 4 and 5)	Normally not acceptable (See Notes 4 and 5)

Note 1 : None of the poles/phases is earthed (see also para 2.1.2).

Note 2 : Neutral is not earthed.

Note 3 : This may be acceptable for -

a) Power supplied control circuits and instrumentation circuits, where technical or safety reasons require connection to earth, provided the current in the hull is limited to not more than 5 amps in both normal and fault conditions.

b) Earthed intrinsically safe circuits.

c) Limited and locally earthed systems, provided that any possible resulting current does not flow directly through any of the dangerous spaces.

Note 4 : This may be acceptable for -

a) Impressed current cathodic protection systems.

b) Limited and locally earthed systems, such as starting and ignition systems of internal combustion engines, provided that any possible resulting current does not flow directly through any of the dangerous spaces.

c) Insulation level monitoring devices, provided the circulation current does not exceed 30 mA under the most unfavourable conditions.

Note 5 : All final sub-circuits, i.e. all circuits fitted after the last protective device are to be of two insulated wires the hull return being achieved by connecting to the hull, one of the busbars of the distribution board from which wires originate.

2.1.2 Earth indication

2.1.2.1 Every insulated distribution system is to be provided with lamps or other devices to indicate the state of electrical insulation from earth and to give an alarm in case of abnormally low insulated values. Where lamp indicators are used, the lamps are to be of the metal filament type and their power is not to exceed 30 watts.

2.1.3 Number and rating of generating sets

2.1.3.1 The number and rating of service generating sets are to be adequate to ensure the operation of services essential for the propulsion and safety of the ship. The power source can be in the form of:

a) two diesel alternator sets
b) one diesel generator and battery. The battery is to be capable of supplying all essential services for a period of at least 30 minutes. Means are to be provided to charge the batteries even when main engine is stationary.

Note: Generator driven by main propulsion unit is accepted as main source of power provided that a battery source is arranged in 2.1.3.1 (b) as back up source. The generator voltage is to regulated.

2.1.3.2 On oil tankers and similar vessels, where electrical power is required for essential equipment, the generating plant and converting plant is to be of such capacity that this essential equipment can be operated satisfactorily even with one generating set or converting set out of action.

2.1.4 Essential services

2.1.4.1 Where essential services are duplicated, they are to be served by individual circuits separated throughout their length as widely as is practicable and without the use of common feeders, protective devices or control circuits.

2.1.5 Diversity factor

2.1.5.1 Circuits supplying two or more final sub-circuits are to be rated in accordance with the total connected load subject, where justified, to the application of a diversity factor. Where spare ways (feeders) are provided on a section or distribution board, an allowance for future increase of load is to be added to the total connected load before application of any diversity factor.

2.1.5.2 The diversity factor may be applied when calculating cable size and when calculating the rating of switchgear and fusegear.

2.1.5.3 The diversity factors are not applicable to supply cables to distribution switchboards for lighting and heating.

2.1.6 Lighting circuits

2.1.6.1 Lighting circuits are to be supplied by final sub-circuits, which are separate from those for heating and power. This provision need not be applied to cabin fans and small wardrobe heaters.

2.1.6.2 A final sub-circuit of rating exceeding 15 amperes is not to supply more than one point.

2.1.6.3 A final sub-circuit of rating 15 amperes or less is not to supply more than the following number of lighting points:-

10	for 24 - 55 V circuits
14	for 110 - 127 V circuits
18	for 220 - 250 V circuits

This provision is not applicable to final sub-circuits for cornice lighting, panel lighting and electric signs where lampholders are closely grouped. In such cases, the number of points is unrestricted provided the maximum operating current in the sub-circuit does not exceed 10 amperes.

2.1.6.4 Lighting of unattended spaces, such as cargo spaces is to be controlled by multi-pole linked switches located outside such spaces. Provision is to be made for the complete isolation of these circuits and locking in the "OFF" position of the means of control.

2.1.6.5 Emergency lighting where required to be provided for passenger vessels, is to be fitted in accordance with Part 5, Chapter 3.

2.1.6.6 Where more than one light is installed in a space, the lighting is to be supplied from at least two final sub-circuits in such a way that failure of one of the circuits does not leave the space in darkness.

2.1.6.7 In general, main and emergency lighting are to be provided at the following locations, where required by the Rules/ statutory authorities, as applicable:

(a) at all stowage and designated preparation positions for life-saving appliances;

(b) at all muster stations and, where applicable, embarkation stations and over sides;

(c) escape route alleyways, stairways and exits;

(d) accommodation areas, cabins and personnel lift cars;

(e) in other areas intended for use by persons with reduced mobility;

(f) in the machinery spaces and main generating stations, including their control positions and their exits;

(g) in the wheelhouse;

(h) at all stowage positions for fireman's outfits.

2.1.7 Motor circuits

2.1.7.1 A separate final sub-circuit is to be provided for every motor required for essential services and for every motor of 1 [kW] or more.

2.1.8 Motor control

2.1.8.1 Every electric motor is to be provided with an efficient means of starting and stopping so placed as to be easily accessible to the person controlling the motor.

2.1.8.2 Every motor required for essential services and every motor of 0.5 [kW] or more is to be provided with the control apparatus as mentioned in 2.1.8.4 to 2.1.8.8.

2.1.8.3 When motor control gear is being selected, the maximum current of the motor is to be taken as its rated full load current.

2.1.8.4 Efficient means of isolation are to be provided so that all voltage may be cut off from the motor and any associated apparatus including any automatic circuit breaker.

2.1.8.5 Where the primary means of isolation (viz. that provided at the switchboard, section board or distribution fuse board) is remote from a motor, one of the following provisions is to be made :-

a) An additional means of isolation fitted adjacent to the motor; or

b) Provision made for locking the primary means of isolation in the OFF position; or

c) Provision made so that the fuses in each line can be readily removed and retained by authorized personnel.

2.1.8.6 Means to prevent the undesired restarting after a stoppage due to low volts or complete loss of volts are to be provided. This does not apply to motors where a dangerous condition might result from the failure to restart automatically e.g. steering gear motor. It is, however, to be ensured that the total starting current of motors having automatic re-start will not cause excessive voltage drop or overcurrent on the installation.

2.1.8.7 Means for automatic disconnection of the supply in the event of excess current due to mechanical overloading of the motor are to be provided. (This does not apply to steering gear motors).

2.1.8.8 Where fuses are installed to protect polyphaser motor circuits, means are to be provided to protect the motor against unacceptable overload in the case of single phasing.

2.1.9 Remote stops for ventilation fans and pumps

2.1.9.1 Ventilating fans for machinery and cargo spaces are to be provided with means for stopping them from easily accessible control stations located outside such spaces.

2.1.9.2 Motors driving forced and induced draught fans, independently driven pumps delivering oil to main propulsion machinery for bearing lubrication and piston cooling, oil fuel transfer pumps, oil fuel unit pumps and other similar fuel pumps, fuel and lubricating oil purifiers and their attached pumps are to be fitted with remote controls situated outside the space concerned so that the electrical supply thereto can be disconnected in the event of fire arising in the space in which they are located.

2.1.9.3 In passenger ships all power ventilation systems, except cargo and machinery spaces ventilation, which is to be in accordance with 2.1.9.1, are to be fitted with master controls so that all fans may be stopped from either of two separate positions which are to be situated as far apart as practicable.

2.1.10 Steering gear

2.1.10.1 Where electrical control of the steering system is fitted, an independent alternative control system is to be installed. This may be a duplicate electrical control system or control by other means.

2.1.10.2 Provision is to be made on the bridge to transfer the steering control instantaneously to the alternative means of control.

2.1.10.3 Indicators for running indication of steering gear motors are to be installed on the bridge.

2.1.10.4 Audible and visual alarms are to operate at the steering positions for failure of steering gear power system and failure of steering gear control system.

2.1.11 Fire detection, alarm and extinguishing systems on passenger ships

2.1.11.1 Where electrically driven emergency fire pumps are installed in accordance with Ch.9 the supply to such pumps is not to pass through the main machinery space.

2.1.11.2 Any fire alarm system is to operate both audible and visual signals at the fire detection control station(s).

2.1.12 Navigation lights

2.1.12.1 Each navigation light is to be controlled and protected in each insulated pole by a switch and fuse or circuit breaker mounted in the distribution board.

2.1.12.2 Automatic indication of failure is to be provided unless the lights are visible from the bridge.

2.1.12.3 Any statutory requirements of the country of registration are to be complied with and may be accepted as an alternative to the above.

2.1.13 Size of batteries and charging facilities

2.1.13.1 Where batteries are used for starting main engines, they are to be of adequate capacity to meet the requirements of Ch.4.

2.1.13.2 Adequate charging facilities are to be provided, and where batteries are charged from line voltage by means of a series resistor, protection against reversal of current is to be provided when the charging voltage is 20 per cent of line voltage or higher. Means are also to be provided to isolate the batteries from the low voltage system when being charged from a higher voltage system.

2.1.14 Heating and cooking equipment

2.1.14.1 Every heating or cooking appliance is to be controlled as a complete unit by a multi-pole linked switch mounted in the vicinity of the appliance.

2.1.14.2 In the case of small heaters, for individual cabins or similar small dry accommodation spaces where the floor coverings, bulkheads and ceiling linings are of insulating materials, a single pole switch is acceptable.

2.1.14.3 Heating arrangements of the exposed element type are not to be used in any location.

2.1.15 Temporary external supply/shore connection

2.1.15.1 Where arrangements are provided for the supply of electric power from a source on shore or elsewhere, a connection box is to be installed in an easily accessible location in a manner suitable for the convenient reception of flexible cables from the external source. This box should contain a circuit-breaker or isolating switch and fuses and terminals of ample size and suitable shape to facilitate a satisfactory connection. The mechanical stress of the portable cable is to be conveyed directly to the metallic framework and not to electrical connectors. Suitable cables, permanently fixed, are to be provided, connecting the circuit breaker/isolating switch in the connection box to a linked switch and/or circuit breaker at the main switchboard.

2.1.15.2 For alternating current systems an earthed terminal is to be provided for the reception of three-phase external supplies with earthed neutrals.

2.1.15.3 The external connection is to be provided with an indicator at the main switchboard in order to show when the cable is energized.

2.1.15.4 Means are to be provided for checking the polarity (for direct current) or the phase sequence (for three-phase alternating current) of the incoming supply. This device should be connected between the incoming connectors and the interrupting device in the connection box.

2.1.15.5 A notice is to be provided at the connection box giving complete information on the system of supply and the normal voltage (and frequency for alternating current) of the ship's installed system. Full details of the procedure for effecting the connection are to be given on this notice.

2.1.15.6 Alternate arrangements for providing a temporary external supply will be specially considered.

2.2 Protection

2.2.1 General

2.2.1.1 Installations are to be protected against accidental over- currents including short circuits. The choice, location and characteristics of the protective device are to provide complete and co-ordinated protection to ensure:-

a) Elimination of the fault to reduce damage to the system and hazard of fire.

b) Continuity of service so as to maintain, through the discriminative action of the protective devices, the supply to circuits not directly affected by the fault.

2.2.2 Protection against overload

2.2.2.1 Protection against overloads may be provided by circuit-breakers, automatic switches or fuses. The tripping characteristics of these devices are to be appropriate to the system. Fuses rated above 320 amperes are not to be used for protection against overload, but may be used for short- circuit protection.

2.2.3 Protection against short-circuit

2.2.3.1 Protection against short-circuit currents is to be provided by circuit-breakers or fuses.

2.2.3.2 The breaking capacity of every protective device is to be not less than the maximum value of the short-circuit current which can flow at the point of installation at the instant of contact separation.

2.2.3.3 The making capacity of every circuit-breaker or switch intended to be capable of being closed, if necessary, on short circuit, is to be not less than the maximum value of the short-circuit current at the point of installation. On alternating current this maximum value corresponds to the peak value allowing for maximum asymmetry.

2.2.3.4 Every protective device or contactor not intended for short circuit interruption is to be adequate for the maximum short-circuit current which can occur at the point of installation having regard to the time required for the short circuit to be removed.

2.2.3.5 In the absence of precise data of rotating machines the following short-circuit currents at the machine terminals are to be assumed. The short circuit current is to be the sum of short circuit currents of generators and that of motors;

a) Direct current systems
Ten times full load current for generators normally connected (including spare),
Six times full load current for motors simultaneously in service;

b) Alternating current systems.
Ten times full load current for generators normally connected (including spare) - symmetrical RMS,
Three times full load current for motors simultaneously in service.

2.2.4 Combined circuit-breakers and fuses

2.2.4.1 The use of a circuit-breaker of breaking capacity less than the prospective short-circuit current at the point of installation is permitted, provided that it is preceded on the generator side by fuses, or by a circuit-breaker having at least the necessary breaking capacity. The generator breakers are not to be used for this purpose.

2.2.4.2 Fused circuit-breakers with fuses connected to the load side may be used where operation of the circuit-breaker and fuses is co-ordinated.

2.2.4.3 The characteristics of the arrangement are to be such that:-

a) When the short-circuit current is broken, the circuit-breaker on the load side is not to be damaged and is to be capable of further service,

b) When the circuit-breaker is closed on the short-circuit current, the remainder of the installation is not to be damaged. However, it is admissible that the circuit-breaker on the load side may require servicing after the fault has been cleared.

2.2.5 Protection of circuits

2.2.5.1 Short circuit protection is to be provided in each live pole of a direct current system and in each phase of an alternating current system.

2.2.5.2 Protection against overloads is to be provided as follows:-

a) Two-wire direct current or single-phase alternating current system - at least one line or phase,

b) Insulated three-phase alternating current system - at least two phases,

c) Earthed three-phase alternating current system - all three phases.

2.2.5.3 No fuse, non-linked switch or non-linked circuit-breaker is to be inserted in an earthed conductor. Any switch or circuit-breaker fitted is to operate simultaneously in the earthed conductor and the insulated conductors.

2.2.5.4 These requirements do not preclude the provision (for test purposes) of an isolating link to be used only when the other conductors are isolated.

2.2.6 Protection of generators

2.2.6.1 In addition to over-current protection, the provisions of 2.2.6.2 to 2.2.6.7 are to be adhered to as a minimum.

2.2.6.2 For generators not arranged to run in parallel a multi-pole circuit-breaker arranged to open simultaneously all insulated poles or in the case of generators rated at less than 50 [kW] a multi-pole linked switch with a fuse in each insulated pole on the generator side is to be provided. The fuse rating in such cases is to be maximum 125 per cent of the generator rated current.

2.2.6.3 For generators arranged to run in parallel a circuit-breaker arranged to open simultaneously all insulated poles is to be provided. This circuit-breaker is to be provided with:-

a) For direct current generators, instantaneous reverse-current protection operating at not more than 15 per cent rated current,

b) For alternating current generators -

   i) A reverse-power protection, with time delay selected and set within the limits of 2 per cent to 15 per cent of full load to a value fixed in accordance with characteristics of primemovers.

   ii) A device for protection against the effects of parallel connection in opposite phase.

2.2.6.4 The reverse-current protection is to be adequate to deal with the reverse-current conditions emanating from the network, e.g. from winches. The reverse-power protection specified for alternating current generators may be replaced by other devices ensuring adequate protection of the prime movers.

2.2.6.5 Generator circuit-breakers are normally to be provided with under voltage release.

2.2.7 Protection of feeder circuits

2.2.7.1 Isolation and protection of each main distribution circuit is to be ensured by a multi-pole circuit-breaker or multi-pole switch and fuses. The provisions of 2.2.2, 2.2.3 and 2.2.5 are to be complied with. The protective devices are to allow excess current to pass during the normal accelerating period of motors. Where multi-pole switch and fuses are used, the fuses are generally to be installed between the busbars and the switch.

2.2.7.2 Circuits which supply motors fitted with overload protection may be provided with short-circuit protection only.

2.2.7.3 Motors of rating exceeding 0.5 [kW] are to be protected individually against overload and short- circuit. The short-circuit protection can be provided by the same protective device for the motor and its supply cable. The overload protection may be replaced by an overload alarm, if desired by the Owner.

2.2.8 Protection of power transformers

2.2.8.1 The primary circuits of power transformers are to be protected against short-circuit by circuit-breakers or fuses. The rating of fuses or the setting for overcurrent releases of circuit breakers is not to exceed 125 per cent of rated primary current.

2.2.8.2 When transformers are arranged to operate in parallel, means are to be provided for isolation of the secondary circuits. Switches and circuit-breakers are to be capable of withstanding surge currents.

2.2.9 Protection of lighting circuits

2.2.9.1 Lighting circuits are to be provided with overload and short- circuit protection.

2.2.10 Protection of meters, pilot lamps, capacitors and control circuits

2.2.10.1 Protection is to be provided for voltmeters, voltage coils of measuring instruments, earth indicating devices and pilot lamps, together with their connecting leads by means of protective devices fitted to each insulated pole or phase.

2.2.10.2 A pilot lamp installed as an integral part of another item of equipment need not be individually protected, provided it is fitted in the same enclosure. Where a fault in a pilot lamp would jeopardise the supply to essential equipment such lamps are to be individually protected.

2.2.11 Protection of batteries

2.2.11.1 Accumulator batteries other than engine starting batteries are to be protected against short circuit by devices, in each insulated pole, placed at a position adjacent to the battery compartment.

2.2.12 Protection of communication circuits

2.2.12.1 Communication circuits other than those supplied from primary batteries are to be protected against overload and short-circuit.

2.3 Renewable sources of electrical power

2.3.1 General requirements for solar power systems

2.3.1.1 Solar power may be used as an additional source for charging battery systems. Suitable changeover arrangements are to be provided to ensure charging of the batteries when the output from photovoltaic (PV) panels is not sufficient to charge the batteries.

2.3.1.2 The components of solar power systems are to be suitably sized for charging the connected batteries.

2.3.1.3 The PV panels and associated power system components are to be suitable for marine use.

2.3.1.4 Following are to be considered while designing and sizing the solar power system:

- environmental conditions
- geographical conditions
- solar radiation
- rated voltage and current
- photovoltaic module maintenance requirements
- storage battery capacity

2.3.1.5 Adequate space and access is to be provided for operation, inspection and maintenance. Cables are to be secured by cable ties, hangers or similar fittings and terminated appropriately.

2.3.1.6 All live parts of the solar power system are to be insulated and protected by barrier/ enclosure, where required by the Rules.

2.3.1.7 Manufacturer's instructions regarding maintenance and replacement of PV modules are to be available onboard.

2.3.1.8 Tests and trials are to be carried out to verify satisfactory operation of solar power systems.

2.3.1.9 PV modules are to comply with recognised standards such as:

(a) IEC 61215-1:2021 *Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1: Test requirements*

(b) IEC 61215-2:2021 *Terrestrial photovoltaic (PV) modules - Design qualification and type approval - Part 1: Test procedures*

(c) IEC 61701:2020 - *Photovoltaic (PV) modules - Salt mist corrosion testing*

(d) IEC 61730-1:2016 – *Photovoltaic (PV) module safety qualification, Requirements for construction*

(e) IEC 62716:2016 – *Photovoltaic (PV) modules - Ammonia corrosion testing*
(for modules installed on-board ammonia carriers)

Section 3

Cables

3.1 General

3.1.1 Cables are to be in accordance with an acceptable National or International Standard, due regard being given to the ambient conditions stated in 1.5.

3.2 Insulating materials

3.2.1 Permitted insulating materials with maximum rated conductor temperatures are given in Table 3.2.1.

3.2.2 The rated operating temperature of the insulating material is to be at least 10°C higher than the maximum ambient temperature liable to be produced in the space where the cable is installed.

3.2.3 Where a rubber or rubber like material with maximum conductor temperature greater than 60°C is used, it is to be readily identifiable.

Table 3.2.1 : Insulating materials

Insulating materials	Max. rated conductor temp.°C
Elastomeric Compounds	
Natural or synthetic rubber (general purpose)	60
Rubber	
Butyl rubber	80
Ethylene propylene rubber	85
Silicone rubber	95
Thermoplastic Compounds	
Polyvinyl chloride (general purpose)	60
Polyvinyl chloride (heat resisting quality)	75
Other Materials	
Minerals	95

Notes:

1. Silicone rubber and mineral insulation may be used for higher temperatures (upto 150°C for silicone rubber and upto 250°C for mineral insulation) when installed where they are not liable to be touched by personnel. Proposals for such installations will be specially considered.

2. The temperature of the conductor is the combination of ambient temperature and temperature rise due to load.

3. Other insulating materials will be considered.

3.3 Sheaths and protective coverings

3.3.1 Cables are to be protected by one or more of the following, and the material of the sheath or protective covering is to be compatible with the material of the insulation:-

a) Sheath
   Lead-alloy
   Copper
   Non-metallic

b) Protective covering
   Steel-wire armour
   Steel-tape armour
   Metal-braid armour (basket weave)
   Fibrous braid

3.3.2 Unsheathed cables, e.g. rubber insulated taped and braided or equivalent, may be used only if installed in conduit.

3.3.3 Non-metallic sheath : Polychloroprene compound, polyvinyl chloride compound and chlorosulphonated polyethylene may be used for impervious sheaths. Other compounds will be given due consideration.

3.3.4 Fibrous braid : Textile braid is to be of cotton, hemp, asbestos, glass or other equivalent fiber, and is to be of strength suitable for the size of the cable. It is to be effectively impregnated with a compound which is resistant to moisture and which is flame retarding.

3.3.5 Cables fitted in the following locations:-

- Decks exposed to weather;

– Bathrooms;

– Cargo holds;

– Machinery spaces;

or any other location where water condensation or harmful vapour (e.g. oil vapour) may be present are to have an impervious sheath. In permanently wet situations, metallic sheaths are to be used for cables with hygroscopic insulation.

3.3.6 All cables are to be of flame-retardant type or fire-resisting type, except that non flame-retardant cables may be accepted for final circuits only where cables are installed in metallic conduits having internal diameter not exceeding 25 [mm] and provided the conduits are electrically and mechanically continuous.

3.4 Voltage rating

3.4.1 The rated voltage of any cable is to be not lower than the nominal voltage of the circuit for which it is used.

3.4.2 The voltage drop from the main switchboard bus bars to any point in the installation when the cables are carrying maximum current under normal conditions of service is not to exceed 6 per cent of the nominal voltage.

3.5 Current rating

3.5.1 The highest continuous load carried by a cable is not to exceed its current rating. The diversity factor of the individual loads and the duration of the maximum demand may be allowed for in estimating the maximum continuous load and is to be shown on the plans submitted for approval.

3.5.2 In assessing the current rating of lighting circuits, every lampholder is to be assessed at the maximum load likely to be connected to it, with a minimum of 60 W, unless the fitting is so connected as to take only a lamp rated at less than 60 W.

3.5.3 Cables supplying winches, cranes, windlasses and capstans are to be suitably rated for their duty. Unless the duty is such as to require a longer time rating, cables for winch or crane motors may be half hour rated on the basis of the half hour [kW] rating of the motors. Cables for windlass and capstan motors are to be not less than one hour rated on the basis of the one hour [kW] rating of the motor. In all cases the rating is to be subject to the voltage drop being within the specified limits.

3.5.4 The current ratings given in Tables 3.5.1 to 3.5.5 are based on the maximum operating conductor temperatures, given in Table 3.2.1. Alternatively current rating in accordance with an acceptable National or International Standard may be applied. See 3.1.1.

Table 3.5.1 : General purpose rubber and PVC insulation current rating (Based on ambient temp. 45°C)

Nominal cross-section	Single core		2 core		3 or 4 core	
[mm^2]	amperes		amperes		amperes	
1	8		7		6	
1.5	12		10		8	
2.5	17		14		12	
4	22		19		15	
6	29		25		20	
10	40		34		28	
16	54		46		38	
25	71		60		50	
35	87		74		61	
50	105		89		74	
70	135		115		95	
95	165		140		116	
120	190		162		133	
150	220		187		154	
185	250		213		175	
240	290		247		203	
300	335		285		235	
	d.c.	a.c.	d.c.	a.c.	d.c.	a.c.
400	390	380	332	323	273	266
500	450	430	383	365	315	301
630	520	470	442	400	364	329

3.6 Correction factors for current rating

3.6.1 **Bunching of cables** : Where more than six cables belonging to the same circuit are bunched together a correction factor of 0.85 is to be applied.

Table 3.5.2 : Heat resisting PVC insulation current rating (Based on ambient temp. 45°C)

Nominal cross-section	Single core	2 core	3 or 4 core
[mm^2]	amperes	amperes	amperes
1	13	11	9
1.5	17	14	12
2.5	24	20	17
4	32	27	22
6	41	35	29
10	57	48	40
16	76	65	53
25	100	85	70
35	125	106	88
50	150	128	105
70	190	162	133
95	230	196	161
120	270	230	189
150	310	264	215
185	350	298	245
240	415	353	291
300	475	404	333
	d.c. a.c.	d.c. a.c.	d.c. a.c.
400	570 560	485 475	400 390
500	650 620	550 530	455 435
630	740 670	630 570	520 470

Table 3.5.3 : Butyl insulation current rating (Based on ambient temp. 45°C)

Nominal cross-section	Single core	2 core	3 or 4 core
[mm^2]	amperes	amperes	amperes
1	15	13	11
1.5	19	16	13
2.5	26	22	18
4	35	30	25
6	45	38	32
10	63	54	44
16	84	71	59
25	110	94	77
35	140	119	98
50	165	140	116
70	215	183	151
95	260	221	182
120	300	255	210
150	340	289	238
185	390	332	273
240	460	391	322
300	530	450	371
	d.c. a.c.	d.c. a.c.	d.c. a.c.
400	610 590	519 502	427 413
500	690 640	587 544	483 448
630	790 690	672 587	553 483

Table 3.5.4 : Ethylene propylene rubber, cross-linked polyethylene insulation current rating (Based on ambient temp. 45°C)

Nominal cross-section	Single core		2 core		3 or 4 core	
[mm²]	amperes		Amperes		amperes	
1	16		14		11	
1.5	20		17		14	
2.5	28		24		20	
4	38		32		27	
6	48		41		34	
10	67		57		47	
16	90		77		63	
25	120		102		84	
35	145		123		102	
50	180		153		126	
70	225		191		158	
95	275		234		193	
120	320		272		224	
150	365		310		256	
185	415		353		291	
240	490		417		343	
300	560		476		392	
	d.c.	a.c.	d.c.	a.c.	d.c.	a.c.
400	650	630	553	536	445	441
500	740	680	629	578	518	476
630	840	740	714	629	588	516

Table 3.5.5 : Silicon rubber, mineral insulation current rating (Based on ambient temp. 45°C)

Nominal cross-section	Single core	2 core	3 or 4 core
[mm²]	amperes	Amperes	amperes
1	20	17	14
1.5	24	20	17
2.5	32	27	22
4	42	36	29
6	55	47	39
10	75	64	53
16	100	85	70
25	135	115	95
35	165	140	116
50	200	175	140
70	255	217	179
95	310	264	217
120	360	306	252
150	410	349	287
185	470	400	329
240	570	485	400
300	660	560	460

Table 3.6.1 : Correction factors for temperature

Insulation	Correction factor for ambient temperature in °C						
	25	30	35	40	45	50	55
Rubber or PVC (general purpose)	1.53	1.41	1.29	1.15	1.00	0.82	0.58
PVC (heat-resisting quality)	1.29	1.22	1.15	1.08	1.00	0.91	0.82
Butyl rubber	1.25	1.2	1.13	1.07	1.pp	0.93	0.85
Ethylene propylene rubber, cross-linked polyethylene	1.22	1.17	1.12	1.06	1.00	0.94	0.87
Mineral, silicone rubber	-	-	-	1.05	1.00	0.95	0.89

Notes:

1 For cables in refrigerated chambers and holds and for vessels restricted to service in non-tropical waters, correction factors for 35°C may be acceptable.

2 Correction factors for intermediate values of the ambient temperature can be ascertained by interpolation.

Table 3.6.2 : Correction factors for intermittent rating

Correction factor	Half-hour rating		One-hour rating	
	With metallic sheath [mm^2]	Without metallic sheath [mm^2]	With metallic sheath [mm^2]	Without metallic sheath [mm^2]
1.00	Upto 20	Upto 75	Upto 67	Upto 230
1.10	21 - 40	76 - 125	68 - 170	231 - 400
1.15	41 - 65	126 - 180	171 - 290	401 - 600
1.20	66 - 95	181 - 250	291 - 430	-
1.25	96 - 120	251 - 320	431 - 600	-
1.30	131 - 170	321 - 400	-	-
1.35	171 - 220	401 - 500	-	-
1.40	221 - 270	-	-	-

3.6.2 **Ambient temperature** : The current ratings in Table 3.5.1 to 3.5.5 are based on an ambient temperature of 45°C. For other values of ambient temperature the correction factors shown in Table 3.6.1, are to be applied.

3.6.3 **Intermittent service** : Where the load is intermittent, the correction factors in Table 3.6.2 may be applied for half hour and one hour ratings. In no case is a shorter rating than one half hour rating to be used, whatever the degree of intermittency.

3.7 Testing

3.7.1 Tests in accordance with an acceptable National or International Standard are to be made at the manufacturer's works prior to dispatch.

3.8 Connections between entrained ships

3.8.1 Cables are to be suitable for use in the connections between entrained ships i.e., are to be flexible, robust and of commensurate cross-section area.

3.8.2 The connection is to include provisions for the continuity of out-of-balance or earth-fault current return. The connecting device is to include provisions to ensure that this circuit is closed before, and opened after, the live circuits.

3.8.3 Terminal plugs and sockets, if used, are to be so arranged that any exposed pins cannot be energized.

3.8.4 Where hull-return systems are used, hull polarity is to be compatible.

3.9 Installation of cables

3.9.1 Cable runs are to be, as far as practicable, straight and accessible and as high as possible above bilges.

3.9.2 Cables having insulating materials with different maximum-rated conductor temperatures are not to be bunched together, or, where this is not practicable, the cables are to be operated so that no cable reaches temperature higher than that permitted for the lowest temperature-rated cable in the group.

3.9.3 Cables having a protective covering which may damage the covering of other cables are not to be bunched with those other cables.

3.9.4 The minimum internal radius of bends of installed cables is to be generally in accordance with following :

4d	for cables without braiding, armouring or other metal sheath and with an overall diameter not exceeding 25 [mm]
6d	for all other cables
(d = overall diameter of cable)	

3.9.5 Cables, are to be effectively supported and secured in a manner that prevents damage to their coverings.

3.9.6 Supports and accessories are to be robust and are to be of corrosion-resistant material or suitably corrosion inhibited before erection.

3.9.7 The distance between supports, for horizontal as well as vertical runs of cables, is to be chosen according to the type/size of cable, but generally in accordance with Table 3.9.1.

3.10 Mechanical protection of cables

3.10.1 Cables exposed to risk of mechanical damage are to be protected by metal channels or casing or enclosed in steel conduit unless the protective covering (e.g. armour or sheath) is adequate to withstand the possible damage.

Table 3.9.1 : Distance between supports

External diameter of cable		Non-armoured cables	Armoured cables
Exceeding	Not exceeding		
[mm]	[mm]	[mm]	[mm]
-	8	200	250
8	13	250	300
13	20	300	350
20	30	350	400

3.10.2 Cables, in spaces where there is exceptional risk of mechanical damage (e.g. on weather decks, in cargo hold areas and inside the cargo holds) and also below the floor in engine room, are to be suitably protected, even if armoured, unless the steel structure affords adequate protection.

3.10.3 Metal casings for mechanical protection of cables are to be efficiently protected against corrosion.

3.11 Earthing of metal coverings

3.11.1 Metal coverings of cables are to be effectively earthed at both ends of the cable, except in final sub-circuits, where earthing at the supply end only will be considered adequate. This does not necessarily apply to instrumentation cables where single point earthing may be desirable for technical reasons.

3.11.2 The electrical continuity of all metal coverings of cables throughout the length of the cable, particularly at joints and tappings, is to be ensured.

3.11.3 The lead sheath of lead-sheathed cables is not to be used as the sole means of earthing the non-current carrying parts of items of equipment.

3.12 Penetration of bulkheads and decks by cables

3.12.1 Penetration of watertight bulkheads or decks is to be carried out with either individual watertight glands or with packed watertight boxes carrying several cables. In either case, the watertight integrity and strength of the bulkheads and decks are to be maintained. Where cables with polyvinyl chloride insulation are being installed, particular care is to be taken to avoid damage to the sheathing during the fitting of watertight bulkhead glands.

3.12.2 Where cables pass through non-watertight bulkheads or structural steel, the holes are to be bushed, in order to protect the cables, with lead or other approved material which will prevent damage to the cables by abrasion. If the steel is 6 [mm] thick, adequately rounded edges may be accepted as the equivalent of bushing.

3.12.3 Cables passing through decks are to be protected by deck tubes or ducts.

3.12.4 Materials used for glands and bushings are to be such that there is no risk of corrosion.

3.12.5 Where rectangular holes are cut in bulkheads or structural steel the corners are to be adequately rounded.

3.13 Installation of cables in pipes and conduits

3.13.1 Installation of cables in pipes and conduits is to be carried out in such a manner that there is no damage to the cable covering.

3.13.2 Metal conduit systems are to be earthed and are to be mechanically and electrically continuous across joints. Individual short lengths of conduit need not be earthed.

3.13.3 The internal radius of bend of pipes and conduit is to be not less than that laid down for cables, provided that for pipes exceeding 64 [mm] diameter the internal radius of bend is not less than twice the diameter of the pipe.

3.13.4 The drawing-in factor (ratio of the sum of the cross-sectional areas of the cables, based on their external diameter, to the internal cross-section area of the pipe) is not to exceed 0.4.

3.13.5 Expansion joints are to be provided where necessary.

3.13.6 Cable pipes and conduits are to be adequately and effectively protected against corrosion. Where necessary, openings are to be provided at the highest and lowest points to permit air circulation and to prevent accumulation of water.

3.13.7 Where cables are laid in trunks, the trunks are to be so constructed as not to afford passage for fire from one deck or compartment to another.

3.13.8 Non-metallic ducting or conduit is to be of flame-retardant material. PVC conduit is not to be used in refrigerated spaces or on open decks, unless specially approved.

3.14 Cables for alternating current

3.14.1 Generally, multi-core cables are to be used in A.C. installations. Where it is necessary to use single-core cables for alternating current circuits rated in excess of 20 amperes the requirements of 3.14.2 to 3.14.8 are to be complied with.

3.14.2 Cables are to be either non-armoured or armoured with non- magnetic material.

3.14.3 If installed in pipe or conduit, cables belonging to the same circuit are to be installed in the same conduit, unless the conduit or pipe is of non-magnetic material.

3.14.4 Cable clips are to include cables of all phases of a circuit unless the clips are of non-magnetic material.

3.14.5 When installing two, three or four single-core cables forming respectively single-phase circuits, three-phase circuits or three-phase and neutral circuits, the cables are to be in contact with one another, as far as possible. In any case, the distance between the external covering of two adjacent cables is not to be greater than one diameter.

3.14.6 In the case of circuits using two or more parallel connected cables per phase, all cables are to have the same length and cross sectional area.

3.14.7 Where single core cables of rating exceeding 50 amperes are used, magnetic material is not to be placed between single-core cables of a group. If these cables pass through steel plates, all cables of the same circuit are to pass through the plate or gland so constructed that there is no magnetic material between the cables, and suitable clearance is provided between the cable core and magnetic material. This clearance, wherever practicable, is not to be less than 75 [mm] when the current exceeds 300 amperes. For currents between 50 amperes and 300 amperes the clearance may be proportionately reduced.

3.14.8 If single-core cables of current rating greater than 250 amperes are run along a steel bulkhead, wherever practicable the cables should be spaced away from the steel.

3.15 Cable ends

3.15.1 The ends of all conductors of cross-sectional area greater than 4 [mm^2] are to be fitted with soldering sockets, compression type sockets or mechanical clamps. Corrosive fluxes are not to be used.

3.15.2 Cables having hygroscopic insulation (e.g. mineral insulated) are to have their ends sealed against ingress of moisture.

3.15.3 Cables with a supplementary insulating belt beneath the protective sheath are to have additional insulation at those points where the insulation of each core makes or may make contact with earthed metal.

3.16 Joints and branch circuits in cable systems

3.16.1 Cable runs are normally not to include joints. However, if a joint is necessary it is to be carried so that all conductors are adequately secured, insulated and protected from atmospheric action. Terminals and busbars are to be of dimensions adequate for the cable rating.

Section 4

Switchboards

4.1 General

4.1.1 Switchboards, section boards and distribution boards are to be constructed of, or enclosed with non-flammable, non-hydroscopic material and are to be so installed that live parts are sufficiently guarded and adequate space is provided for maintenance. Also they are to be protected where necessary in way of pipes etc.

4.1.2 All measuring instruments and all apparatus controlling circuits are to be clearly and indelibly labeled for identification purposes. An indelible label is to be permanently secured adjacent to every fuse and every circuit breaker and marked with particulars of the full load current of the generator, motor or cable which the fuse or circuit breaker protects. Where inverse time limit and/or reverse current devices are provided in connection with a circuit breaker, the appropriate settings of these devices are to be stated on the label. Name plates are to be of flame retardant material.

4.2 Instruments

4.2.1 Sufficient instrumentation is to be provided for measuring voltage, current, frequency and, for alternating current generators above 50 [kW].

4.2.2 Where alternating current generators are required to operate in parallel, synchronising arrangements are to be fitted.

4.3 Instrument transformers

4.3.1 The secondary windings of instrument transformers are to be earthed.

4.4 Switchgear

4.4.1 Circuit breakers and switches are to be of the air break type and are to be constructed in accordance with an acceptable National or International Standard.

4.4.2 Report of tests to establish the capacity of circuit-breakers are to be submitted for consideration when required.

4.4.3 Overcurrent releases are to be calibrated in amperes and settings marked on the circuit-breaker.

4.5 Fuses

4.5.1 Fuses are to comply with an acceptable National or International Standard.

4.5.2 Fuse links and fuse bases are to be marked with particulars of rated current and rated voltage. Each fuse position is to be permanently and indelibly labeled with the current carrying capacity of the circuit protected by it and with the appropriate approved size of fuse or replaceable element.

4.6 Testing

4.6.1 Before installation, switchboards complete or in sections with all components are to pass the following tests at the manufacturer's works and a certificate furnished. A high voltage test is to be carried out in all switching and control apparatus for systems greater than 60V with a test voltage of 1000V plus twice the rated voltage with a minimum of 2000V at any frequency between 25 and 100 Hz for one minute applied between (a) all current-carrying parts connected together and earth and (b) between current carrying parts of opposite polarity or phases.

4.6.2 For systems of 60V or less the test shall be at 500V for one minute.

4.6.3 Instruments and ancillary apparatus may be disconnected during the high voltage test.

4.6.4 Immediately after the high voltage test, the insulation resistance between (a) all current-carrying parts connected together and earth and (b) between current carrying parts of opposite polarity or phase, shall not be less than 1 Megohm when tested with a direct current voltage of at least 500V.

4.6.5 Functional tests. The correct functions of the installation components in line with the connections intended to be made have to be checked as far as possible.

Section 5

Control Gear

5.1 General

5.1.1 Control gear is to comply with an acceptable National or International Standard, amended where necessary for ambient temperature.

5.1.2 Control gear, including isolating and reversing switches, is to be so arranged that shunt field circuits are not disconnected without adequate discharging path being provided.

5.2 Testing

5.2.1 Control gear and resistors are to be tested by the manufacturers with a high voltage applied between the earthed frame and all live parts and a certificate furnished by them to this effect. For operating voltages above 55 V, the test voltage is to be 1000 V plus twice the rated voltage with a minimum of 2000 V. The voltage is to be alternating at any frequency between 25 and 100 Hz and is to be maintained for one minute without failure.

5.2.2 Control gear and resistors operating at 55 V or below are to be tested to 500 V for one minute.

5.2.3 Immediately after the high voltage test, the insulation resistance between (a) all current-carrying parts connected together and earth, and (b) between current-carrying parts of opposite polarity or phase, is not to be less than 1 megaohm when tested with a direct current voltage of at least 500 V.

5.2.4 Instruments and ancillary apparatus may be disconnected during the high voltage test.

5.2.5 **Functional Test** : The correct functions of the installation components in line with the connections intended to be made, have to be checked as far as possible.

Section 6

Rotating Machines Construction and Testing

6.1 General

6.1.1 Rotating machines are to be constructed in accordance with an acceptable National or International Standard, due regard being given to the ambient conditions stated in 1.5.

6.2 Rating

6.2.1 Ship's service generators including their exciters, and continuously rated motors are to be suitable for continuous duty at their full rated output at maximum cooling air or water temperature for an unlimited period, without the limits of temperature rise in 6.3 being exceeded. Other generators and motors are to be rated in accordance with the duty which they are to perform, and when tested under rated load conditions the temperature rise is not to exceed the values in 6.3. Alternatively limits of temperature rise in accordance with an acceptable National or International Standard may be applied.

6.3 Temperature rise

6.3.1 The limits of temperature rise specified in Table 6.3.1 are based on a cooling air temperature of 45°C and a cooling water temperature of 30°C.

6.3.2 If the temperature of the cooling medium is known to exceed the value given in 6.3.1, the permissible temperature rise is to be reduced by an amount equal to the excess temperature of the cooling medium.

6.3.3 If the temperature of the cooling medium is known to be permanently less than the value given in 6.3.1, the permissible temperature rise may be increased by an amount equal to the difference between the declared temperature and that given in 6.3.1 upto a maximum of 15°C.

Table 6.3.1 : Limits of temperature rise in °C

Item	Part of machines	Method of measurement of temperature	Temperature rise in air-cooled machines °C Insulation Class		
			A	E	B
1 (a)	a.c. windings	R	50	65	70
		T	40	55	60
(b)	Field windings of a.c. and d.c. machines having d.c. excitation other than those in Items 2 and 3	R	50	65	70
		T	40	55	60
(c)	Windings of armatures having commutators	R	50	65	70
		T	40	55	60
2	Field windings of turbine-type machines having d.c. excitation	R	-	-	80
3 (a)	Low-resistance field windings of more than one layer and compensating windings	T,R	50	65	70
(b)	Single-layer windings with exposed bare surfaces	T,R	55	70	80
4	Permanently short-circuited insulated windings	T	50	65	70
5	Permanently short-circuited windings uninsulated	T	The temperature rise of these parts shall in no case reach such a value that there is a risk of injury to any insulating or other material on adjacent parts		
6	Iron core and other parts not in contact with windings	-	The temperature rise of these parts shall in no case reach such a value that there is a risk of injury to any insulating or other material on adjacent parts		
7	Iron core and other parts in contact with windings	T	50	65	70
8	Commutators and slip-rings open or enclosed	T	50	60	70

Notes:

1 T = Thermometer method
R = Resistance method

2 When Class F or Class H insulation is employed, the permitted temperature rises are respectively 20°C and 40°C higher than the values given for Class B insulation.

3 Classes of insulation are to be in accordance with IEC Publication 85 (1957) - "Recommendations for the Classification of Material for the Insulation of Electrical Machinery and Apparatus in relation to their Thermal Stability in Service".

6.4 Direct current service generators

6.4.1 Shunt wound direct current generators are to be provided with automatic voltage regulators.

6.4.2 Direct current generators used for charging batteries without series-regulating resistors are to be either:-

a) Shunt wound, or

b) Compound wound with switches arranged so that the series winding can be switched out of service.

6.4.3 If terminal voltage is required to be manually adjusted to ensure satisfactory operation of generators, then, facilities are to be provided at the switchboard or at an appropriate and convenient control position to enable such adjustments to be made.

6.4.4 For each direct current generator, whilst being driven by its prime mover, at any temperature within the working range, the means provided is to be capable of adjusting the voltage at any load between no load and full load to within:-

a) 1.0 per cent of rated voltage for generators of rating less than 100 [kW],

b) 0.5 per cent of rated voltage for generators of rating exceeding 100 [kW].

6.4.5 The inherent regulation of service generators is to be such that the following conditions are fulfilled:-

a) For shunt or stabilised shunt wound generators when the voltage has been set at full load, the steady voltage at no load is not to exceed 115 per cent of the full load value, and the voltage obtained at any intermediate value of load is not to exceed the no-load value.

b) For compound wound generators with the generator at full load operating temperature, and starting at 20 per cent load with voltage within 1 per cent of rated voltage, then at full load the voltage is to be within 2.5 per cent of rated voltage. The average of the ascending and descending load/voltage curves between 20 per cent load and full load is not to vary more than 4 per cent from rated voltage.

6.4.6 Generators are to be capable of delivering continuously the full load current and normal rated voltage at the terminals when running at full load engine speed at all ambient temperatures up to the specified maximum.

6.4.7 Generators required to run in parallel are to be stable from no load up to the total combined load of the group, and load sharing is to be satisfactory.

6.4.8 The series winding of each two-wire generator is to be connected to the negative terminal.

6.4.9 Equalizer connections are to have a cross-sectional area appropriate to the system but in no case less than 50 per cent of that of the negative connection from the generator to the switchboard.

6.5 Alternating current service generators

6.5.1 Each alternating current service generator, unless of the self regulating type, is to be provided with automatic means of voltage regulation.

6.5.2 The voltage regulation of any alternating current generator with its regulating equipment is to be such that at all loads from zero to full load the voltage at rated power factor is maintained under steady conditions within 2.5 per cent of rated voltage.

6.5.3 Alternating current generators required to run in parallel are to be stable from 20 per cent full load [kW] up to the total combined full load [kW] of the group, and load sharing is to be such that the load on any generator does not normally differ from its proportionate share of the total load by more than 15 per cent of the rated output [kW] of the largest machine or 25 per cent of the rated output [kW] of the individual machine, whichever is less.

6.5.4 When generators are operated in parallel, the KVA loads of the individual generating sets are not to differ from their proportionate share of the total KVA load by more than 5 per cent of the rated KVA output of the largest machine when operating at 0.8 power factor.

6.6 Inspection and testing

6.6.1 On machines for essential services tests are to be carried out in accordance with the relevant standard and a certificate furnished by the manufacturers.

6.6.2 Generators and motors of 100 [kW] or over intended for essential services are to be inspected by the Surveyors during manufacture and testing.

Section 7

Transformers - Construction and Testing

7.1 General

7.1.1 Transformers are to be in accordance with an acceptable National or International Standard, due regard being given to the ambient conditions stated in 1.5.

7.1.2 Transformers are to be of the dry, natural air cooled type. Proposals for the use of liquid cooled transformers will be subject to special consideration.

7.2 Installation

7.2.1 Transformers are to be placed in easily accessible well ventilated spaces free from any gaseous or acid fumes. They are to be clear of non-protected ignitable materials, and so arranged as to be protected against shocks and any damage resulting from water, oil, liquid fuel, steam etc.

7.3 Construction

7.3.1 Transformers are to be double wound except those for motor starting.

7.3.2 Each transformer is to be provided with a nameplate of corrosion-resistant metal giving information on make, type, serial number, insulation class and any other technical data necessary for the application of the transformer.

7.4 Regulation

7.4.1 The inherent regulation at 0.8 power factor is not to exceed 5 per cent.

7.4.2 Regulation of the complete system is to comply with 3.4.2.

7.5 Short circuit

7.5.1 All transformers are to be constructed to withstand, without damage, the thermal and mechanical effects of a short-circuit at the terminals of any winding for 2 seconds with rated primary voltage and frequency without damage.

7.6 Tests

7.6.1 Transformers for essential services are to be tested by the manufacturer in accordance with the relevant standard and test certificates supplied.

Section 8

Miscellaneous Equipment

8.1 Accumulator batteries

8.1.1 Construction

8.1.1.1 The cells of all batteries are to be so constructed and secured as to prevent spilling of the electrolyte due to the motion of the ship and to prevent emission of acid or alkaline spray.

8.1.1.2 All batteries are to be provided with durable labels of flame retardant material, giving information on the application for which the battery is intended, voltage and capacity.

8.1.2 Location

8.1.2.1 Alkaline batteries and lead acid batteries of the vented type are not to be installed in the same compartment.

8.1.2.2 Large batteries are to be installed in a space assigned to them only. A box on deck would meet this requirement if adequately ventilated and provided with means to prevent ingress of water.

8.1.2.3 Engine starting batteries are to be located as close as practicable to the engine(s) served. If such batteries cannot be accommodated in the battery compartment, they are to be installed so that adequate ventilation is ensured.

8.1.3 Installation

8.1.3.1 Batteries should be so arranged that each cell or crate of cells is accessible from the top and at least one side.

8.1.3.2 Cells or crates are to be carried on non-absorbent insulating supports. Similar insulators are to be fitted to prevent any movement of cells arising from the motion of the vessel. Adequate space for circulation of air is to be ensured.

8.1.3.3 Where acid is used as the electrolyte a tray of acid resisting material is to be provided below the cells unless the deck below is similarly protected.

8.1.3.4 The interiors of all compartments including the shelves, are to be painted with corrosion resistant paint.

8.1.3.5 A permanent notice is to be fitted to all compartments prohibiting naked lights and smoking in the compartment.

8.1.3.6 Switches, fuses and other electrical equipment liable to cause an arc are not to be fitted in battery compartments.

8.1.4 Ventilation

8.1.4.1 Battery compartments, lockers and boxes are to be adequately ventilated by an independent ventilating system to avoid accumulation of flammable gases. Particular attention should be given to the fact that these gases are lighter than air and tend to accumulate at the top of the spaces.

8.1.4.2 Natural ventilation may be employed if ducts can be run directly from the top of the compartment to the open air with no part of the duct more than 45 degrees from the vertical. If natural ventilation is impracticable, mechanical ventilation is to be installed. Interior surfaces of ducts and fans are to be painted with corrosion-resistant paint. Fan motors are not to be located in the air stream.

8.1.4.3 Necessary precautions are to be taken to prevent sparking due to possible contact by the ventilation fan blades with fixed parts.

8.1.4.4 All openings through the battery compartment bulkheads or decks, other than ventilation openings, are to be effectively sealed to reduce the possibility of escape of gas from the battery compartment into the ship.

8.2 Luminaries

8.2.1 General

8.2.1.1 Lighting fittings installed in engine rooms or similar spaces where they are exposed to the risk of mechanical damage are to be provided with suitable grilled mechanical guards to protect their lamps and glass globes against such damage.

8.2.1.2 Precautions are to be taken so that a lamp for one voltage cannot be inserted in a lampholder for another voltage.

8.2.1.3 Incandescent lamps are to be in accordance with the following :-

B22	upto 250 V and 200 W
E27	upto 250 V and 200 W
E40	upto 210 V and 3000 W

8.2.1.4 Lampholders are to be constructed of flame-retarding and non- hygroscopic material. All metal parts are to be of robust construction. Goliath lampholders (E40) are to be provided with means for locking the lamp in the holder. The temperature of cable connections is not to exceed the maximum conductor temperature permitted for the cable as given in Table 3.2.1.

8.2.1.5 The ratings of tubular fluorescent lamps are not to exceed 250 V and 80 W.

8.3 Accessories - Construction and testing

8.3.1 Enclosures

8.3.1.1 Enclosures are to be of metal or of flame-retardant insulating materials.

8.3.2 Inspection and draw boxes

8.3.2.1 If metal conduit systems are used, inspection and draw boxes are to be of metal and are to be in rigid electrical and mechanical connection with the conduits.

8.3.3 Socket outlets and plugs

8.3.3.1 Socket outlets and plugs are to be so constructed that they cannot be readily short-circuited whether the plug is in or out, and so that a pin of the plug cannot be made to earth either pole of the socket outlet.

8.3.3.2 All socket outlets of current rating 16 amperes or more are to be provided with a switch.

8.3.3.3 Where it is necessary to earth the non-current-carrying parts of portable or transportable equipment, an effective means of earthing is to be provided at the socket outlet.

8.3.3.4 In all wet situations socket outlets and plugs are to be effectively shielded against rain and spray and are to be provided with means for maintaining this quality after removal of the plug.

8.4 Heating and cooking equipment

8.4.1 General

8.4.1.1 Heaters are to be so constructed, installed and protected that clothing, bedding and other inflammable material cannot come in contact with them in such a manner as to cause risk of fire. There is to be no excessive heating of adjacent bulkheads or decks.

8.5 Lightning conductors

8.5.1 Lightning conductors are to be fitted to each mast of all wood, composite and steel ships having wooden masts or topmasts. They need not be fitted to steel ships having steel masts, unless the mast is partly or completely insulated from the ship's hull.

8.5.2 Lightning conductors are to be run as straight as possible, and sharp bends in the conductors are to be avoided. All clamps used are to be of brass or copper, preferably of the serrated contact type, and efficiently locked. Soldered connections are not acceptable.

8.5.3 The resistance of the lightning conductors, measured between the mast head and the position on the earth plate or hull to which the lightning conductor is earthed, is not to exceed 0.02 ohms.

8.5.4 The lightning conductors are to be composed of continuous copper tape and/or rope, having a section not less than 100 [mm^2] and are to be riveted with copper rivets or fastened with copper clamps to an appropriate copper spike of not less than 13 [mm] in diameter and projecting at last 150 [mm] above the top of the mast. The lower end of the lightning conductor is to be securely clamped to a copper plate having an area of at least 0.2 [m^2], fixed to the ship's hull well below the light load waterline in such a manner that it is immersed under all conditions of heel. In steel ships fitted with wooden masts, the lower end of the lightning conductor is to be securely clamped to the nearest metal forming part of the hull.

Section 9

Trials

9.1 General

9.1.1 Before a new installation, or any alteration or addition to an existing installation, is put into service the tests and trials specified in this Section are to be carried out. These tests and trials are intended to demonstrate the general condition of the installation at the time of completion. They are in addition to any acceptance tests which may have been carried out at the manufacturer's works.

9.2 Insulation resistance measurement

9.2.1 Insulation resistance is to be measured using a self-contained instrument such as a direct reading ohm-meter of the generator type applying a voltage of at least 500 V. Where a circuit incorporates capacitors of more than 2μF total capacitance, a constant-voltage type instrument is to be used to ensure accurate test readings.

9.2.2 Power and light circuits : The insulation resistance between all insulated poles and earth and, where practicable, between poles, is to be at least 1 megaohm. The installation may be subdivided and appliances may be disconnected if initial tests produce results less than this figure.

9.2.3 Low voltage circuits : Circuits operating at less than 55 V are to have an insulation resistance of at least 0.33 megaohm.

9.2.4 Switchboards, Section boards and distribution boards : The insulation resistance is to be at least 1 megaohm when measured between each busbar and earth and between busbars. This test may be made with all circuit-breakers and switches open, all fuse links for pilot lamps, earth fault-indicating lamps, voltmeters, etc., removed and voltage coils temporarily disconnected, where otherwise damage may result.

9.2.5 Generators and motors : The insulation resistance of generators and motors, in normal working condition and with all parts in place, is to be measured and recorded. The test should be carried out with the machine hot, if possible. The insulation resistance of generator and motor cables, field windings and control gear is to be at least 1 megaohm.

9.3 Earth continuity

9.3.1 Tests are to be made to verify that all earth continuity conductors are effective and that the bonding and earthing of metallic conduit and/or sheathing of cables is effective.

9.4 Performance

9.4.1 It is to be established that the provisions of the Rules have been complied with respect to the criteria mentioned in this sub-section.

9.4.2 Temperatures of joints, connections, circuit-breakers and fuses.

9.4.3 The operation of engine governors, synchronising devices, overspeed trips, reverse-current, reverse-power, over-current and under-voltage trips and other safety devices.

9.4.4 Satisfactory commutation, excitation and performance of each generator throughout a run at full rated load.

9.4.5 Voltage regulation of every generator when full rated load is suddenly thrown off.

9.4.6 For alternating current and direct current generators, satisfactory parallel operation and [kW] load sharing of all generators capable of being operated in parallel at all loads up to normal working load. For alternating current generators satisfactory parallel operation and KVA load sharing of all generators capable of being operated in parallel at all loads up to normal working load.

9.4.7 All essential motors and other important equipment are to be operated under service conditions, though not necessarily at full load or simultaneously, for a sufficient length of time to demonstrate that they are satisfactory.

9.5 Voltage drop

9.5.1 Voltage drop is to be measured, where necessary, to verify that this is not excessive.

End of Chapter

Chapter 9

Fire Protection, Detection and Extinction

Contents

Section

Section 1

General

1.1 Scope

1.1.1 The requirements of this Chapter are applicable to all ship types.

1.1.2 Special attention is drawn to National and International Statutory Requirements of countries where the ship is registered or operating and which are outside the scope of classification as defined in these Rules.

1.1.3 Consideration will be given to the acceptance of the statutory requirements of National Authorities as an alternative to the requirements of this Chapter.

1.1.4 Consideration will be given to special cases where the arrangements are equivalent to those required by these Rules.

1.1.5 Consideration will be given to the acceptance of the approval of a National Authority in respect of fire insulating materials, fire fighting appliances and items of equipment as an alternative to the relevant requirements of this Chapter.

1.2 Applicable requirements depending on vessel type

1.2.1 Unless expressly provided otherwise requirements not referring to a specific ship type apply to all ships

1.2.2 Additional requirements for fire safety on tankers are given in the relevant Sections of Part 5, Chapter 2.

1.2.3 Additional requirements for fire safety on passenger ships are given in Part 5, Chapter 3.

1.3 Plans and information

1.3.1 The plans and information detailed in 1.3.2, where applicable, are to be submitted for approval together with all relevant details like Rule dimensions of the ship L, B and D and the number of passengers.

1.3.2 Following plans are to be submitted for approval

a) Means of escape and, where required, the relevant dimensioning.

b) Fire Alarm system

c) Arrangement of Fire pumps and fire main including pumps head and capacity, hydrant and hose locations

d) Arrangement of fixed fire-extinguishing systems

e) Arrangement of sprinkler systems including the capacity and head of the pumps

f) Fire control plan

g) Electrical diagram of power control and position indication circuits for fire doors.

1.4 Definitions

1.4.1 **Accommodation space** is a living space of a crew accommodation or a passenger room.

1.4.2 **Crew Accommodation** is a space intended for the use of persons normally living on board, including galleys, store rooms, toilets and washing facilities, laundry facilities, passageways, but not the wheelhouse.

1.4.3 **Passenger Spaces** are spaces on board intended for passengers and enclosed areas such as offices, shops, hairdressing salons, drying rooms, laundries, saunas, toilets, washrooms, passageways, connecting passages and stairs not encapsulated by walls.

1.4.4 **Store Room of high risk** is a space for the storage of flammable liquids or a room with an area of over 4 [m^2] for storing supplies.

1.4.5 **Passageway** is an area intended for the normal movement of persons and goods.

1.4.6 **Main engine room** is a space where the propulsion engines are installed.

1.4.7 **Engine room** is a space where combustion engines are installed.

1.4.8 **Boiler room** is a space housing a fuel-operated installation designed to produce steam or heat a thermal fluid

1.4.9 **Cargo spaces** are all spaces used for cargo (including cargo oil tanks) and trunks to such spaces.

1.4.10 **Non-combustible material** is a material which neither burns nor gives off flammable vapours in sufficient quantity for self-ignition when heated to approximately 750°C according to an established test procedure. Any other material is a combustible material.

1.4.11 **Steel or other equivalent material.** Where the **words steel or other equivalent material** occur, 'equivalent material' means any non- combustible material which, by itself or due to insulation provided, has structural and integrity properties equivalent to steel at the end of the applicable fire exposure to the standard fire test (e.g. aluminium alloy with appropriate insulation).

1.4.12 **A Standard Fire Test** is one in which specimens of the relevant bulkheads or decks are exposed in a test furnace to temperatures corresponding approximately to the standard time temperature curve. The test method is to be in accordance with the Fire Test Procedures Code of IMO.

1.4.13 **Machinery spaces** are all spaces containing propulsion machinery, boilers, oil fuel units, internal combustion engines, generators and major electrical machinery, oil filling stations, refrigerating, stabilizing, ventilation and air conditioning machinery, and similar spaces, and trunks to such spaces.

1.4.14 **Oil fuel unit** is the equipment used for the preparation of oil fuel for delivery to an oil fired boiler, or equipment used for the preparation for delivery of heated oil to an internal combustion engine, and includes any oil pressure pumps, filters and heaters dealing with oil at a pressure of more than 0.18 [N/mm^2] gauge.

1.4.15 **Service spaces** are those spaces used for galleys, pantries containing cooking appliances, lockers, mail and specie rooms, store rooms, workshops other than those forming part of machinery spaces, and similar spaces and trunks to such spaces.

1.5 Ship types

1.5.1 **Passenger ship** is a ship which carries more than twelve passengers, a passenger being every person other than :

- the master and members of the crew or other persons employed or engaged in any capacity on board a ship on the business of the ship; and
- a child under one year of age.

1.5.2 **Cargo ship** is any ship which is not a passenger ship or a fishing vessel.

1.5.3 **Fishing vessel** is a vessel used for catching living resources of the sea.

Section 2

Fire Protection

2.1 General

2.1.1 Boundaries of main engine rooms, engine rooms, boiler rooms, galleys and stores, containing highly combustible materials such as paints and oils, are to be constructed of steel or other equivalent material, where adjacent to accommodation spaces and emergency generator rooms.

2.1.2 Fuel oil and lubricating oil tanks are not to have common vertical boundaries with accommodation spaces.

2.1.3 Deck coverings within accommodation spaces on the decks, forming the crown of machinery and cargo spaces, are to be of a type which will not readily ignite.

2.1.4 Pipes conveying oil or combustible liquids are to be of an approved material having regard to the fire risk. Materials readily rendered ineffective by heat are not to be used for overboard scuppers, sanitary discharges and other outlets where the failure of the material in the event of fire would give rise to danger of flooding. The approval of plastic piping in any location will be subject to the consideration of strength and fire hazards involved with special reference to penetrations through bulkheads, decks or other significant compartment boundaries. Attention is to be paid to the provisions of the IMO FTP code, as applicable.

2.2 Paints and similar coatings

2.2.1 Paints, varnishes and similar preparations having a nitro-cellulose or other highly flammable base are not to be used in accommodation and machinery spaces.

2.3 Ventilation

2.3.1 Power ventilation of machinery spaces is to be capable of being stopped from an easily accessible position outside the machinery spaces.

2.4 Means of escape

2.4.1 Engine rooms and boiler rooms are to be provided with two means of escape as widely separated as possible. One of the means of escape may be an emergency exit. If a skylight is permitted as an escape, it is to be possible to open it from the inside.

2.4.2 The escape trunk is to have clear dimensions of at least 0.6 × 0.6 [m].

2.4.3 In case of engine rooms and boiler rooms of less than 35 [m^2], one means of escape may be accepted.

2.4.4 At least two widely separated means of escape from each restricted space or group of spaces are to be provided at all levels of accommodation.

2.4.5 Stairways are to be constructed of steel or equivalent material. They may be lined with suitable material.

2.4.6 Stairways and ladderways, in and from all passenger and crew spaces and spaces in which crew are normally employed, are to be arranged to provide ready means of escape to suitable open deck areas.

2.5 Non-propelled vessels

2.5.1 For ships with no crew and passengers, no fire protection, detection or fire extinguishing arrangements are required.

2.5.2 Ships having accommodation and being manned are to comply with the requirements of this Section and Sec.4 in so far as applicable.

Section 3

Fire Detection

3.1 General

3.1.1 Following rooms are to be monitored by means of a fire alarm system.

a) Engine rooms
b) Boiler rooms
c) Stairways, corridors and escape routes in crew accommodation spaces using smoke detectors for ships of 24[m] length and over.

The alarm is to be noticeable in the wheelhouse, the accommodation spaces and the room to be protected.

3.1.2 Consideration may be given to waiver of requirements for fire alarm system in continuously manned engine rooms and boiler rooms.

3.2 Fire Alarm System

3.2.1 Components of Fire Alarm System

3.2.1.1 Fire alarm systems consist of :

a) fire detection system,

b) fire indicator system,

c) control panel

as well as the external power supply.

3.2.1.2 The fire detection system may be divided into one or more sections.

3.2.1.3 The fire indicator system may have one or more indicator devices.

3.2.1.4 The control panel is the central control unit of the fire alarm system. It also includes parts of the fire indicator system (i.e. an indicator device).

3.2.1.5 A fire detection section may have more than one manual call points or fire detectors.

3.2.1.6 Fire detectors may be

a) heat detectors,

b) smoke detectors,

c) ion detectors,

d) flame detectors,

e) combination detectors (fire detectors combining two or more of the detectors listed in (a) to (d)).

3.2.1.7 Fire detectors which respond to other factors indicating the onset of a fire may be approved provided that they are no less sensitive than the detectors referred to under (a) to (g).

3.2.1.8 Fire detectors may be installed with or without individual identification

3.2.2 Construction Requirements of Fire Alarm System

3.2.2.1 General

3.2.2.1.1 Fire alarm systems are to be operational at all times.

3.2.2.1.2 Rooms and areas monitored by the fire alarm system are to be equipped with fire detectors required in accordance with 3.2.3.2 and are to be automatic. One manually operated call point is to be installed at each exit of the compartment fitted with fire detectors. In Cargo Ships, manual call points are to be readily accessible in the corridors and escape routes in crew accommodation spaces of each deck such that no part is more than 20 [m] from a manual call point.

3.2.2.1.3 The system and its components are to be able to withstand voltage fluctuations and surges, changes in ambient temperature, vibrations, humidity, shocks, impacts and corrosion such as commonly occur on ships.

3.2.2.2 Energy Supply

3.2.2.2.1 Energy sources and electric circuits necessary for the operation of the fire alarm system are to be self-monitoring. Any fault occurring is to activate a visual and acoustic failure signal on the control panel which can be distinguished from a fire alarm signal.

3.2.2.2.2 The fire alarm system is to have at least two power sources, one of which is to be an emergency power system (i.e. emergency power source and emergency switchboard). There are to be two separate power-feeds solely for this purpose. These are to lead to an automatic switch in or near the control panel of the fire alarm system.

3.2.2.3 Fire Detection System

3.2.2.3.1 Manual call points and fire detectors are to be grouped in fire detection sections.

3.2.2.3.2 Fire detection systems are not to be used for any other purpose. Only closing of the doors in accordance with Pt.5, Ch.3, 5.3.2.12 and similar functions may be triggered at the control panels of fire alarm system and indicated on the control panels and indicator device.

3.2.2.3.3 Fire detection systems are to be designed in such a way that the first indicated fire alarm does not prevent fire alarms set off by other manual call points or fire detectors.

3.2.2.4 Fire Detection Sections

3.2.2.4.1 Where the fire detectors cannot remotely identify individually the manual call points or fire detectors, a fire detection section is not to comprise more than one deck. This does not apply to a fire detection section which comprises an encapsulated stairwell. In order to avoid delays in detecting the origin of the fire, the number of enclosed spaces included in each fire detection section are to be limited. There are not to be more than fifty enclosed spaces in one fire detection section. Where the fire alarm system can remotely identify individually the manual call points or fire detectors, the fire detection sections may comprise several decks and any number of enclosed spaces.

3.2.2.4.2 Engine rooms and boiler rooms are to constitute separate fire detection sections.

3.2.2.5 Fire Detectors

3.2.2.5.1 Only heat, smoke or ion detectors are to be used as fire detectors. Other types may only be used as additional detectors.

3.2.2.5.2 Fire detectors are to be type-approved.

3.2.2.5.3 All fire detectors are to be designed in such a way that they can be tested to ensure that they are working properly and brought back into service without having to replace any components.

3.2.2.5.4 Smoke detectors are to be set so that they respond to a reduction in visibility per metre caused by smoke of more than 2 % to 12.5 %. Smoke detectors fitted in galleys, engine rooms and boiler rooms are to respond within sensitivity limits meeting the requirements of the inspection body, whereby under-sensitivity or over-sensitivity of the smoke detectors are to be avoided.

3.2.2.5.5 Heat detectors are to be set so that with temperature increase rates of less than 1 [°C/min] they respond at temperatures of between 54 [°C] and 78 [°C]. With higher rates of temperature increase, the heat detector is to respond within temperature limits where under- or over-sensitivity of the heat detector is avoided.

3.2.2.5.6 The permissible operating temperature of heat detectors may be increased to 30 [°C] above the maximum temperature in the upper part of engine and boiler rooms.

3.2.2.5.7 The sensitivity of flame detectors is to be sufficient to detect flames against an illuminated background. Flame detectors are also to be equipped with a system for identifying false alarms.

3.2.2.6 Control Panel

3.2.2.6.1 Activation of a manual call point or fire detector is to set off a visual and acoustic fire alarm signal at the control panel and the indicator devices.

3.2.2.6.2 The control panel and the indicator devices are to be at a location, which is permanently manned by crew. One indicator is to be at the steering position.

3.2.2.6.3 The indicator devices are to indicate at least the fire detection section in which a manual call point or fire detector has been activated.

3.2.2.6.4 On or near each indicator device there is to be clear information on the areas monitored and the location of the fire detection sections.

3.2.3 Installation Requirements of Fire Alarm System

3.2.3.1 Manual call points or fire detectors are to be installed in such a manner as to ensure the best possible operation of the system. Locations in the vicinity of deck girders and ventilation shafts or other locations where air currents could adversely affect system operation and locations where impacts or mechanical damage are likely are to be avoided.

3.2.3.2 In general, fire detectors located on the ceiling are to be at least 0.5 [m] away from bulkheads. The maximum distance between fire detectors and bulkheads is to conform to the Table3.2.3.2: IRS may require or approve other distances on the basis of tests which prove the characteristics of the fire detectors.

3.2.3.3 The routing of electric cables for the fire alarm system through engine rooms and boiler rooms or other high fire risk areas is not permitted unless this is necessary for fire detection through manual call points or fire detectors or fire alarm device in those areas or connection to the corresponding power supply.

Table 3.2.3.2: Fire detector Location

Type of Fire detector	Maximum floor surface area per fire detector	Maximum distance between fire detectors	Maximum distance of fire detectors from bulkheads
Heat	37 [m^2]	9 [m]	4.5 [m]
Smoke	74 [m^2]	11 [m]	5.5 [m]

3.2.4 Acceptance Test

3.2.4.1 Fire alarm systems must be checked:

a) before being put into service for the first time,

b) before being put back into service after any major modification or repair,

c) regularly, at each annual survey.

In the case of engine rooms and boiler rooms these checks are to be made under various machine operation conditions and under changing ventilation conditions. Inspections as referred to in (c) above may also be carried out.

Section 4

Fire Extinction

4.1 Water supply system

4.1.1 General

4.1.1.1 Requirements of water supply system for passenger ships are provided in Pt.5, Ch.3

4.1.2 Fire pumps

4.1.2.1 Ships are to be equipped with a power-driven pump suitable for use as a fire pump. The pump is to have a drive independent of the main propulsion units. On ships with a gross volume (L X B X D) of up to 800 [m^3] or with a propulsive power of up to 375 [kW], a bilge pump or cooling water pump coupled to the main engine may also be used provided that the propeller shafting can be disengaged.

4.1.2.2 Sanitary, ballast, bilge or general service pumps may be accepted as fire pumps.

4.1.2.3 The fire pump suction is to be so arranged that the pump will operate efficiently at the lightest draught likely to be encountered in service.

4.1.2.4 The capacity of power fire pumps is to be not less than 10 [m^3/h].

4.1.2.5 Relief valves are to be provided in conjunction with all fire pumps if the pumps are capable of developing a pressure exceeding the design pressure of the water service pipes, hydrants and hoses. These valves are to be so placed and adjusted as to prevent excessive pressure in any part of the fire main system.

4.1.2.6 In ships having a value LxBxD of 1500 [m^3] and over, not less than two power driven pumps are to be provided, one of which may be main engine driven where the engine can be declutched.

4.1.3 Fire main

4.1.3.1 In ships of 24 [m] length and over, a fire main is to be provided so that at least one jet of water can reach any part of the ship.

4.1.3.2 Deck-washing lines may be incorporated in the fire extinguishing system.

4.1.3.3 Materials readily rendered ineffective by heat are not to be used for fire mains. Where steel pipes are used they are to be galvanized internally and externally. Cast iron pipes are not to be used. The pipes and hydrants are to be so placed that the fire hoses may be easily coupled to them. The arrangement of pipes and hydrants shall be such as to avoid the possibility of freezing. Suitable drainage provisions are to be provided for fire main piping. Isolation valves are to be installed for all open deck fire main branches used for purposes other than fire fighting.

4.1.4 Hydrants

4.1.4.1 The number and position of the hydrants are to be such that at least one jet of water from a single length of hose may reach any part of the ship normally accessible to the passengers and crew while the ship is being navigated.

4.1.4.2 The positions of hydrants and valves or cocks are to be such that they are always readily accessible.

4.1.4.3 All water pipes for fire extinguishing are to be provided with drain valves for use in frosty weather. The valves are to be located where they will not be damaged by cargo.

4.1.5 Fire hoses and nozzles

4.1.5.1 Fire hoses are to be of approved material. The hoses are to be sufficient in length to project a jet of water to any of the spaces in which they may be required to be used. Their length, in general, is not to exceed 18 [m]. Each hose is to be provided with a nozzle and the necessary couplings. Fire hoses, together with any necessary fittings and tools, are to be kept ready for use in conspicuous positions near the water service hydrants or connections.

4.1.5.2 In general, not less than two fire hoses with dual purposes nozzles (jet/spray) of not less than 12 [mm] bore are to be provided.

4.1.5.3 The jet throw at the nozzle is to be about 12 [m].

4.2 Permanently installed firefighting systems for protecting accommodation spaces, wheelhouses and passenger spaces

4.2.1 General

4.2.1.1 Where fitted, permanently installed fire fighting systems for protecting accommodation spaces, wheelhouses and passenger spaces, following requirements are to be complied with.

4.2.1.2 The systems are to be made of steel or equivalent non-combustible materials.

4.2.1.3 The systems are to be able to spray water at a rate of at least 5 [l/m^2 per minute] over the area of the largest room to be protected subject to 4.2.1.4 (b).

4.2.1.4 For large areas to be protected, either of the following approaches may be followed depending upon the fire risk:

(a) the areas to be protected are considered without sprinkler installation for determining the appropriate fire integrity standards to be applied to boundaries (Refer Table 5.3.2.1(a) in Part 5, Chapter 3);

(b) the sprinkler pump capacity is determined on the basis of a minimum water rate of 5 [l/m^2 per minute], considering the area of the largest space, limited to 280 [m^2].

4.2.1.5 Systems spraying smaller quantities of water are to have a type-approval pursuant to IMO Resolution A.800 (19) or another recognized Standard.

4.2.1.6 The systems are to be checked :

a) before being put into service for the first time;

b) before being put back into service after they have been triggered;

c) before being put back into service after any major modification or repair; and

d) regularly, at each annual survey.

4.2.2 Automatic Pressurized Water Sprinklers

4.2.2.1 The automatic pressurised water sprinkler systems is to be ready for service at all times when there are persons on board. No additional action by crew members is to be required to trigger operation.

4.2.2.2 The system is to be permanently maintained at the necessary pressure. The pipes are to be filled with water up to the spray nozzles at all times. The system is to have a continuously working water supply. It is not to be possible for impurities harmful to operation to enter the system. Appropriate display instruments and test systems (e.g. pressure gauges, pressure-tank water level indicators, pump test piping) are to be installed for monitoring and checking the system. The pressurised water sprinkler systems located in the cold storage and freezer rooms should not be permanently filled with water. These rooms can be protected with dry sprinklers.

4.2.2.3 The pump for the water supply to the spray nozzles is to be activated automatically by a pressure drop in the system. The pump is to be dimensioned so that it can continuously provide a sufficient water supply at the necessary pressure if all the spray nozzles necessary for covering the area of the largest room to be protected are activated simultaneously (Also refer Cl. 4.2.1.3 and 4.2.1.4). The pump is to supply the automatic pressurised water sprinkler system exclusively. In the event of pump failure, it is to be possible to provide the spray nozzles with a sufficient water supply from another on-board pump.

4.2.2.4 The system is to be divided into sections, each with no more than 50 spray nozzles. A larger number of spray nozzles may be authorised by IRS with appropriate corroboration, in particular a hydraulic calculation.

4.2.2.5 The number and the layout of spray nozzles are to ensure effective distribution of water in the rooms to be protected.

4.2.2.6 Spray nozzles are to be triggered at a temperature between 68 [°C] and 79 [°C], in the galley areas at a maximum of 93 [°C] and in the saunas at a maximum of 141 [°C].

4.2.2.7 The installation of components of automatic pressurised water sprinklers within the rooms to be protected is to be limited to the necessary minimum. No such system components are to be installed in main engine rooms.

4.2.2.8 Visual and acoustic indicators are to be provided in one or more suitable locations, at least one of which must be permanently manned, displaying activation of automatic pressurised water sprinklers for each section.

4.2.2.9 The energy supply of the installation of automatic pressurised water sprinklers is to be provided by two independent energy sources that are not to be installed in the same location. Each energy source is to be capable of supplying the entire system unassisted.

4.3 Fire extinguishing arrangements in machinery spaces

4.3.1 General

4.3.1.1 Main engine rooms (regardless of engine power), other engine rooms where total power output is not less than 375 [kW], boiler rooms and space containing oil fuel units are to be provided with:

a) An approved foam type fire extinguisher of at least 45 [litre] capacity or carbon dioxide extinguisher of 15 [kg] capacity or dry powder extinguisher of 15 [kg] capacity to be directed on to any part of the fuel and lubricating oil pressure systems, gearing and other fire hazards.

b) At least two portable foam extinguishers or equivalent.

4.3.1.2 Where the size of the space precludes access under normal operating conditions, provision is to be made to inject the extinguishing medium into the space from an external location whilst maintaining the fire integrity of the space boundaries.

4.3.1.3 Machinery spaces with electrical installations are to be provided with one or more extinguishers suitable for extinguishing electrical fire as deemed necessary. One or more of the fire extinguishers required by this section may be of the type required by this paragraph.

4.3.1.4 In ships constructed of composite material, engines rooms where total power output is 375 [kW] and above are to be provided with any one of the fixed fire-extinguishing systems as per 4.3.2, instead of compliance with 4.3.1.1 a) and 4.3.1.2,

4.3.2 Fixed fire extinguishing system

4.3.2.1 General

4.3.2.1.1 Where fitted, fixed fire extinguishing systems are to meet the following requirements.

4.3.2.2 Extinguishing Agents

4.3.2.2.1 The following extinguishing agents may be used in permanently installed fire-fighting systems:

a) CO_2 (carbon dioxide);

b) HFC 227 ea (heptafluoropropane);

c) IG-541 (52 % nitrogen, 40 % argon, 8 % carbon dioxide);

d) FK-5-1-12 (Dodecafluoro-2-methylpentane-3-on);

e) Water.

f) K_2CO_3 (potassium carbonate)

4.3.2.3 Ventilation

a) Combustion air for the propulsion engines is not to be extracted from rooms that are to be protected by permanently installed fire-fighting systems. This is not applicable where there are two mutually independent and hermetically separated main engine rooms or if next to the main engine room there is a separate engine room with a bow thruster, ensuring that the ship can continue to make steerageway under its own power in the event of fire in the main engine room.

b) Any forced ventilation present in the room to be protected is to switch off automatically if the fire-fighting system is triggered.

c) There are to be devices available with which all apertures which can allow air to enter or gas to escape from the room to be protected can be quickly closed. It is to be clearly recognisable whether they are open or closed.

d) The volume of starting air receivers, converted to free air volume, is to be added to the gross volume of the machinery space when calculating the necessary quantity of the fire extinguishing medium. Alternatively, a discharge pipe from the safety valves may be fitted and led directly to the open air.

e) Over- or under-pressure resulting from the inflow of extinguishing agent is not to destroy the components of the surrounding partitions of the room to be protected. It is to be possible for the pressure to equalise without danger.

f) Protected rooms are to have a facility for extracting the extinguishing agent and the combustion gases. Such facilities are to be capable of being operated from positions outside the protected rooms and which must not be made inaccessible by a fire within such spaces. If there are permanently installed extractors, it is not to be possible for these to be switched on while the fire is being extinguished.

4.3.2.4 Fire Alarm System

a) The room to be protected is to be monitored by means of a fire alarm system (See 3.2). The fire alarm is to be noticeable in the wheelhouse, the accommodation spaces and the room to be protected.

4.3.2.5 Piping System

a) The extinguishing agent is to be conveyed to the room, which is to be protected and distributed there by means of a fixed piping system. Inside the room to be protected the piping and associated fittings are to be made of steel. Tank connecting pipes and expansion joints are to be exempt from this provided the materials used have equivalent properties in case of fire. Pipes are to be both internally and externally protected against corrosion.

b) Outlet nozzles are to be dimensioned and fitted such that the extinguishing agent is evenly distributed. In particular the extinguishing agent is also to be effective beneath the floor plates.

4.3.2.6 Triggering Device

a) Fire-fighting systems with automatic triggering is not permissible.

b) It is to be possible to trigger the fire-fighting system from a suitable place outside the room to be protected.

c) Triggering devices are to be installed such that they can be activated also in the event of a fire, and that the required quantity of extinguishing agent can still be provided in the space to be protected in the event of a fire or of damage caused by a fire or an explosion. Non-mechanical triggering devices are to be powered from two different mutually independent power sources. These power sources are to be located outside the room to be protected. Control lines in the room to be protected are to be designed so as to remain functional for at least 30 [minutes] in the event of fire. This requirement is to be fulfilled in the case of electric wiring if it complies with the International Standard IEC 6033121: 1999. If triggering devices are installed in such a way that they are out of sight, the panel covering them is to be identified by the 'fire-fighting installation' symbol, having a side length of at least 10 cm, and the following text in red lettering on a white background:

   FIRE-FIGHTING INSTALLATION

d) If the fire-fighting system is intended for the protection of several rooms, the triggering devices for each room have to be separate and clearly identified.

e) The instructions are to be posted alongside all triggering devices and are to be clearly visible and indelible. They are to contain, in particular, instructions regarding:

   i. triggering of the fire-fighting system;

   ii. the need for checking to ensure that all persons have left the room to be protected;

   iii. action to be taken by the crew when the firefighting system is triggered and when accessing the protected room after triggering or flooding, in particular with regard to the possible presence of dangerous substances;

   iv. action to be taken by the crew in the case of failure of the fire-fighting system.

f) The operating instructions are to mention that before the fire-fighting system is triggered, combustion engines drawing air from the room to be protected are to be shut down.

4.3.2.7 Warning System

a) Permanently installed fire-fighting systems are to be provided with acoustic and optical warning systems.

b) The warning system is to be set off automatically as soon as the fire-fighting system is first triggered. The warning signal is to sound for an appropriate time before the extinguishing agent is released and it is not to be possible to switch it off.

c) Warning signals are to be clearly visible in the rooms to be protected and outside the accesses to them and clearly audible even under operating conditions producing the loudest inherent noise. They are to be clearly distinct from all other acoustic and optical signals in the room to be protected.

d) The acoustic warning signals are to be clearly audible in the adjacent rooms even when connecting doors are closed and under operating conditions producing the loudest inherent noise.

e) If the warning system is not self-monitoring as regards short-circuits, wire breaks and voltage drops, it is to be possible to check that it is working properly.

f) A sign with the following text in red letters on a white ground is to be clearly posted at the entrance to any space the extinguishing agent may reach:
   WARNING, FIRE-FIGHTING INSTALLATION !
   LEAVE THE ROOM AS SOON AS THE
   WARNING SIGNAL SOUNDS (description of the signal)

4.3.2.8 Pressure tanks, fittings and pressure pipes

a) Pressure tanks, fittings and pressure pipes are to comply with the requirements of national/local authorities or, if there are no such requirements, to those of Ch.8, Pt.6, *Fire Safety Requirements, of Rules and Regulations for the Construction and Classification of Steel Ships*.

b) Pressure tanks are to be installed in accordance with the manufacturer's instructions.

c) Pressure tanks, fittings and pressure pipes are not to be installed in accommodation spaces.

d) The temperature in cabinets and installation spaces containing pressure tanks is not to exceed 50 [°C].

e) Cabinets or installation spaces on deck are to be firmly fixed in place and have air vents which are to be arranged in such a way that in the event of a leak in the pressure tank no gas can escape into the interior of the ship. Direct connections to other rooms are not permitted.

4.3.2.9 Quantity of extinguishing agent

a) If the quantity of extinguishing agent is intended for protecting more than one room, the total amount of extinguishing agent available does not need to be greater than the quantity necessary for the largest room to be protected.

4.3.2.10 Fire extinguishing system using CO_2

4.3.2.10.1 Fire-fighting systems using CO_2 as the extinguishing agent are to comply with the following provisions in addition to the 4.3.2.2 to 4.3.2.9:

a) CO_2 containers are to be housed outside the room to be protected in a space or cabinet hermetically separated from other rooms. The doors to these installation spaces and cabinets are to open outwards, be lockable and bear on the outside a symbol for 'General danger warning', at least 5 [cm] in height, together with the marking 'CO_2' in the same colour and with the same height.

b) Installation spaces below decks for CO_2 containers are to be accessible only from the open air. These spaces are to have their own adequate artificial ventilation system with extraction ducts, completely separate from other ventilation systems on board.

c) The CO_2 containers are not to be filled to more than 0.75 [kg/l]. The specific volume of unpressurised CO2 gas is to be taken as 0.56 [m^3/kg].

d) The volume of CO_2 for the room to be protected shall be at least 40 % of its gross volume. It shall be possible to supply this volume within 120 [seconds], and to check whether supply has been completed.

e) Opening the container valves and operating the flood valve are to be by separate control operations.

f) The appropriate time mentioned under 4.3.2.7 b) is to be at least 20 [seconds]. There is to be a reliable device to ensure the delay before delivery of the CO_2 gas.

4.3.2.11 Fire extinguishing system using HFC-227 ea (heptafluropropane)

4.3.2.11.1 Fire-fighting systems using HFC-227 ea (heptafluropropane) as the extinguishing agent is to comply with the following provisions in addition to the 4.3.2.2 to 4.3.2.9:

a) If there are several rooms to be protected, each with a different gross volume, each room is to be provided with its own fire-fighting system.

b) Each container of HFC-227ea that is installed in the room to be protected is to be equipped with a pressure relief valve. This is to harmlessly release the contents of the container into the room to be protected if the container is exposed to the effects of fire and the fire-fighting system has not been triggered.

c) Each container is to be fitted with a device for checking the gas pressure.

d) The containers are not to be filled to more than 1.15 [kg/l]. The specific volume of the unpressurised HFC-227ea is to be taken as 0.1374 [m^3/kg].

e) The volume of HFC-227ea for the room to be protected is to be at least 8 % of the room's gross volume. This volume is to be supplied within 10 seconds.

f) The HFC-227ea containers are to be provided with a pressure monitor which triggers an acoustic and optical alarm signal in the wheelhouse in the event of an unauthorised loss of propellant.

g) After flooding, the concentration in the room to be protected is not to exceed 10.5 %.

h) The fire-fighting system is not to contain any parts made of aluminium.

4.3.2.12 Fire extinguishing system using IG-541

4.3.2.12.1 Fire-fighting systems using IG-541 as the extinguishing agent is to comply with the following provisions in addition to the 4.3.2.2 to 4.3.2.9:

a) If there are several rooms to be protected, each with a different gross volume, each room is to be provided with its own fire-fighting system.

b) Each container of IG-541 that is installed in the room to be protected is to be equipped with a pressure relief valve. This is to harmlessly release the contents of the container into the room to be protected if the container is exposed to the effects of fire and the fire-fighting system has not been triggered.

c) Each container is to be fitted with a device for checking the contents.

d) the filling pressure of the container is not to exceed 200 [bar] at + 15 [°C].

e) the volume of IG-541 for the room to be protected is to be at least 44 % and no more than 50 % of the room's gross volume. This volume is to be supplied within 120 [seconds].

4.3.2.13 Fire extinguishing system using FK-5-1-12

4.3.2.13.1 Fire-fighting systems using FK-5-1-12 as the extinguishing agent is to comply with the following provisions in addition to the 4.3.2.2 to 4.3.2.9:

a) If there are several rooms to be protected, each with a different gross volume, each room is to be provided with its own firefighting system.

b) Each container of FK-5-1-12 installed in the room to be protected is to be equipped with an overpressure relief valve. The pressure relief valve is to harmlessly release the contents of the container into the room to be protected if the container is exposed to the effects of fire and the fire-fighting system has not been triggered.

c) Each container is to be fitted with a device for checking the gas pressure.

d) The containers are not to be filled to more than 1.00 [kg/l]. The specific volume of the unpressurised FK-5-1-12 is to be taken as 0.0719 [m^3/kg].

e) The volume of FK-5-1-12 for the room to be protected is to be at least 4 % of the room’s gross volume. This volume is to be supplied within 10 [seconds].

f) The FK-5-1-12 containers are to be provided with a pressure monitor which triggers an acoustic and optical alarm signal in the wheelhouse in the event of an unauthorised loss of propellant.

g) After flooding, the concentration in the room to be protected is not to exceed 10 %.

4.3.2.14 Fire extinguishing system using water as the extinguishing agent

4.3.2.14.1 Fire-fighting systems using water as the extinguishing agent may only release this agent into the room to be protected in the form of a water mist. The droplet size must be between 5 and 300 [microns].

4.3.2.14.2 Fire-fighting systems using water mist as the extinguishing agent is to comply with the following provisions in addition to the 4.3.2.2 to 4.3.2.9:

a) The fire-fighting system is to have a type-approval pursuant to MSC/Circ. 1165 or another recognized Standard.

b) The fire-fighting system must be sized according to the largest of the rooms to be protected and must be able to spray water continuously into the room for a minimum of 30 [minutes].

c) The pumps, their switching mechanisms and the valves that are required in order for the system to operate should be installed in a room outside the rooms to be protected. The room in which they are installed should be separated from adjacent by at least type A30 partition walls.

d) The fire-fighting system must be completely full of water at all times at least as far as the trip valves and be under the required initial operating pressure. The water supply pumps must be automatically initiated when the system is triggered. The system must feature a continuously operating water supply. Measures must be taken to ensure impurities do not affect system operation.

e) The capacity and design of the system's pipe network must be based on a hydraulic calculation.

f) The number and arrangement of nozzles must ensure sufficient distribution of water in the rooms to be protected. The spray nozzles must be located so as to ensure that the water mist is distributed throughout the room to be protected, especially in those areas where there is a higher risk of fire, including behind the fittings and beneath the floor.

g) The fire-fighting system's electrical components in the room to be protected must at a minimum comply with protection class IP54. The system is to feature two independent energy sources with automatic switching. One of the power sources must be located outside the room to be protected. Each power source should on its own be capable of ensuring the operation of the system.

h) The fire-fighting system must feature redundant pumps.

i) The fire-fighting system must be equipped with a monitoring device which triggers an alarm signal in the wheelhouse in the following cases:

- drop in water tank level (if fitted),
- power supply failure,
- loss of pressure in the low pressure system pipework,
- loss of pressure in the high pressure circuit,
- when the system is activated.

4.3.2.15 Fire extinguishing system using K_2CO_3(Potassium Carbonate)

4.3.2.15.1 Fire-fighting systems using K_2CO_3 as the extinguishing agent is to comply with the following provisions:

a) The fire-fighting system is to have a type approval pursuant to MSC/Circ. 1270 or another recognized Standard.

b) Each room is to be provided with its own firefighting system.

c) The extinguishing agent is to be stored in specially provided unpressurised tanks in the room to be protected. These tanks are to be fitted in such a way that the extinguishing agent is dispensed evenly in the room. In particular the extinguishing agent is also to work underneath the deck plates.

d) Each tank is to be separately connected with the triggering device.

e) The quantity of extinguishing agent relative to the room to be protected is at least 120 [g/m^3] of the net volume of this room. This net volume is calculated according to MSC/Circ. 1270. It is to be possible to supply the extinguishing agent within 120 [seconds].

4.4 Portable fire extinguishers

4.4.1 All fire extinguishers are to be of an approved type.

4.4.2 The extinguishing medium employed is to be suitable for extinguishing fires in the compartments in which they are intended to be used.

4.4.3 Fire extinguishers, containing an extinguishing medium which, either in itself or when in use, gives off gases harmful to persons, are not to be used.

4.4.4 Extinguishers are to be stowed in readily accessible positions.

4.4.5 There is to be at least one portable fire extinguisher in accordance with a recognized standard at each of the following places::

- in the wheelhouse;
- near each entrance to accommodation spaces;
- near the entrance to service spaces containing heating/cooking equipment or any other equipment having similar fire risk when not directly accessible from the accommodation;
- near each entrance to machinery spaces;
- in a suitable position below deck in machinery space such that no position in the space is more than 10 [m] walking distance away from an extinguisher.

4.4.6 For the portable fire extinguishers required by 4.4.5, only powder type extinguishers with a content of at least 6 [kg] or other portable extinguishers with the same extinguishing capacity may be used. They are to be suitable for Class A, B and C fires. On ships with no liquefied gas installations, spray foam fire extinguishers using aqueous film-forming foam (AFFF-AR) frost proof to -20 [°C] are permissible even if they are unsuitable for Class C fires. These fire extinguishers are to have a minimum capacity of 9 litres.

4.4.7 On ships with electrical installations having an operating voltage greater than 50 [V], the extinguishing agent shall also be suitable for fighting fire in electrical equipment.

4.4.8 In addition powder, water or foam fire extinguishers may be used which are suitable at least for the class of fire most likely to occur in the room for which they are intended.

4.4.9 As extinguishing agent, fire-extinguishers may contain neither CO_2 nor agents capable of emitting toxic gases in use. Portable fire extinguishers with CO_2 as the extinguishing agent may be used only for extinguishing fires in galleys and electrical installations.

End of Chapter

Chapter 10

Spare Gear

Contents

Section

Section 1

General

1.1 General

1.1.1 Adequate spare parts for the propelling and essential auxiliary machinery together with necessary tools for maintenance and repair are to be readily available for use.

1.1.2 Spare parts are to be supplied and their location is to be the responsibility of the Owner but must take in to account the design and arrangements of the machinery and the intended service and operation of the ship. Account should also be taken of the recommendations of the machinery manufacturer and any applicable statutory requirements of the country of registration of the ship.

1.2 Table of spare parts

1.2.1 For guidance purposes spare parts for main and auxiliary machinery installations are shown in the following Tables:-

- Table 1.2.1 - Spare parts for main internal combustion engines;
- Table 1.2.2 - Spare parts for auxiliary boilers;
- Table 1.2.3 - Spare parts for auxiliary air compressors.

Table 1.2.1 : Main internal combustion engines

Sr. No.	Item	Spare Part	Qty.
1	Main thrust block	Pads for one face of thrust block	1 set
		Complete white metal thrust shoe of solid ring type	1
		Inner and outer race with rollers, where roller thrust bearings are fitted	1
2	Cylinder valves	Exhaust valves, complete with casings, seats, springs and other fittings for one cylinder	1 set
		Air inlet valves, complete with casings, seats springs and other fittings for one cylinder	1 set
		Starting air valve, complete with casing, seat, springs and other fittings	1
		Relief valve, complete	1
		Fuel valves of each size and type fitted complete with all fittings, for one engine	1/4 set
3		Special gaskets and packing of each size and type fitted for cylinder cover and cylinder liner for one cylinder	1 set

Table 1.2.2 : Auxiliary boilers			
Sr. No.	**Item**	**Spare Part**	**Qty.**
1	Tube stoppers or plugs	Tube stoppers or plugs, of each size used, for boiler superheater and economiser tubes	10
2	Fire bars	Fire bars for one boiler, where coal fired	Half set
3	Oil fuel burners	Oil fuel burners complete, for one boiler	1 set

Table 1.2.3 : Auxiliary air compressor			
Sr. No.	**Item**	**Spare Part**	**Qty.**
1	Piston rings	Rings of each size fitted for one piston	1 set
2	Valves	Suction and delivery valves, complete, of each size fitted	Half set

End of Chapter

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Part 5

Special Ship Types

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Chapter 1

Dry Bulk Cargo Carriers

Contents

Section

Section 1

General

1.1 Application

1.1.1 The requirements of this chapter apply to single deck vessels designed primarily for carriage of dry bulk cargoes and are supplementary to those given for the assignment of main characters of class. It is implied that the cargo loading would largely be homogeneous, without any hold being empty in fully loaded condition.

1.1.2 In general, bulk carriers, built in compliance with the above mentioned requirements, as applicable, will be eligible to be assigned one of the following class notations:

BULK CARRIER
BULK CARRIERS, "Strengthened for heavy Cargoes".

The notation "BULK CARRIER" implies that any hold may be filled up to the top of hatch coaming with bulk cargo of density at least upto 0.8 [t/m^3].

The notation "BULK CARRIER", "Strengthened for heavy cargoes" implies that the vessel is designed for heavier bulk cargo loadings and any hold may be filled up to the top of hatch coaming with bulk cargo of density at least upto 1.0 [t/m^3].

1.1.3 Ore carriers built in compliance with the above mentioned requirements, as applicable, will be eligible to be assigned class notation "**ORE CARRIER**".

1.2 Documentation

1.2.1 The following additional documents are to be submitted for approval, as applicable:

a) Design values of maximum mass of bulk cargo to be carried in the vessel and total volume of holds upto top of the hatch coaming.

b) Maximum density of heavy bulk cargo envisaged and the corresponding angle of repose.

c) Details of all envisaged loading conditions clearly stating special features if any e.g. loading in heaps. Calculations of still water bending moments in all these loading conditions and also for transient conditions during loading / unloading, if more onerous, are to be submitted.

1.3 Design loads in cargo holds

1.3.1 Definitions

M = maximum mass [tonnes], to be carried in the vessel

V = Total volume of the holds upto the top of hatch coaming [m^3]

ρ_f = value of maximum density of bulk cargo to be carried in the holds assuming the cargo is filed homogeneously upto the top of hatch coaming i.e. (M/V) [t/m^3].

ρ_f is not to be taken less than the following:

= 0.8 [t/m^3] for vessels with class notation "Bulk carrier".

= 1.0 [t/m^3] for vessels with class notation, "Bulk carrier" "Strengthened for heavy cargoes" and for "Ore carriers".

H = height [m], from the load point to the top of hatch coaming.

ρ_h = Maximum density of heavy bulk cargo envisaged [t/m^3].

h_c = height [m], from the load point to the actual cargo surface determined by considering the corresponding hold geometry, cargo volume at density ρ_h angle of repose and the loading pattern e.g. loading in heaps.

δ = angle of repose of bulk cargo in degrees, not to be taken greater than:

δ = 20° for light bulk cargo (e.g. grain, coal)

= 25° for bulk cement cargo

= 35° for heavy bulk cargo (e.g. iron ore).

1.3.2 The scantlings of inner bottom and sloping or vertical bulkhead plating and stiffeners are to be based on the cargo pressure or the flooding pressure given below, whichever is greater.

Cargo pressure, p = 12.5 C.q [kN/m^2]

Flooding pressure, p = 10h [kN/m^2]

where,

C = 1.0 for inner bottom

= $\tan^2 (45 - \delta/2)$ for vertical bulkheads

= $\sin^2\alpha \cdot \tan^2(45° - \delta/2) + \cos^2\alpha$ for sloping bulkheads

α = angle of sloping bulkhead with the horizontal plane, [degrees]

q = ρ_f . H [t/m^2], or

= ρ_f . h_c [t/m^2]; whichever is greater.

h = vertical distance from load point to the deck at side [m].

Section 2

Bulk Carriers

2.1 Hull arrangement

2.1.1 Bulk carriers are to be constructed with two longitudinal bulkheads bounding the cargo space or with single side skin construction in association with hopperside tanks at the bottom and topside tanks fitted below the deck. Between the longitudinal bulkheads or hopperside tanks, double bottom construction is generally to be adopted. However, for vessels upto 65 [m] in length single bottom construction with floors at each frame may be accepted.

2.1.2 For vessels of L ≥ 65 [m] longitudinal framing system is to be adopted within the cargo region on deck and in the double bottom, wing spaces or hopperside and topside tanks.

2.1.3 The number and disposition of transverse bulkheads are to be as per Pt.3, Ch.9. Additional bulkheads may have to be fitted from side to side or in wing spaces to provide sufficient transverse strength.

2.2 Longitudinal strength

2.2.1 The longitudinal strength is to be in accordance with the requirements given in Pt.3 Ch.4, considering the maximum of still water bending moments calculated as per 1.2.1.

2.3 Bottom structure

2.3.1 The scantlings and arrangements are, in general, to be as per Pt.3, Ch.6, except as given below.

2.3.2 In double bottom spaces, the spacing of plate floors and girders is generally not to exceed 2.5 [m] and 3 [m], respectively.

2.3.3 The scantlings of inner bottom and hopper side plating and stiffeners based on Pt.3, Ch.6 and design pressures given in 1.3.2 are minimum requirements. It should be noted that for vessels where cargoes are to be regularly discharged by grabs, the scantlings would require to be increased suitably to reduce the risk of local damage and erosion and are to be as per Pt.3, Ch.6, 4.2.3..

2.3.4 In addition to the requirements of Pt.3, Ch.6, the section modulus of single bottom floors in cargo holds is also to be not less than the following:

$Z = 0.006 \, s \, le^2 \, (\rho_f \, . \, H - 0.3T)$ [cm^3]

- Where the cargo is always to be leveled

$Z = 0.006 \, s \, l_e^2 \, (1.25\rho_f \, . \, H - 0.3T)$ [cm^3]

- Where the cargo is loaded in heaps.

where,

s = spacing of floors [mm]

l_e = span of floors, measured between longitudinal bulkheads [m].

The strength of floors is to be maintained in way of and outboard of the connection with longitudinal bulkheads.

2.4 Side structure – single skin

2.4.1 The scantlings and arrangement of side shell plating and stiffening is to be, in general, as per Pt.3, Ch.7. The thickness of hold frame web and its lower bracket is not to be less than 8 [mm] and 10 [mm] respectively.

2.5 Side structure – double skin

The following apply to vessels where double skin structure is provided.

2.5.1 Scantlings of the longitudinal bulkhead plating and stiffening is to be as per Pt.3, Ch.9 based on the actual spacing of stiffeners and design pressure given in 1.3.2.

2.5.2 The longitudinal bulkheads are generally to have the same framing system as the side shell.

2.5.3 Where longitudinal framing is adopted, transverses supporting longitudinal are to be arranged in line with double bottom floors.

2.5.4 Where transverse framing is adopted, the section modulus of the stiffeners of side shell and longitudinal bulkhead may be reduced by 20% provided a strut is fitted at mid span of the stiffeners. The strut is to have the same cross sectional area as the greater of the members interconnected.

2.5.5 The inner bottom plating is to be extended into the wing tank structure in the form of a gusset plate, arranged to ensure a smooth structural transition in way of transverse primary members. The gusset plate is to be of sufficient width to provide effective scarfing of the inner bottom into the wing tank structure.

2.5.6 All watertight and non-watertight bulkheads in wing tanks are to be suitably reinforced in way of double bottom scarfing arrangements. Openings in wing tank bulkheads are to be kept clear of these areas.

2.5.7 Ends of longitudinal bulkheads are to be well scarfed into the fore and aft structure.

2.5.8 It is recommended that the space between the side shell and longitudinal bulkhead be adequately subdivided such that the vessel remains afloat even when one of the compartments is flooded.

2.6 Deck structure

2.6.1 The scantlings and arrangements of the deck structure are generally to be as per Pt.3, Ch.8.

2.6.2 The thickness of the deck plating is to be maintained over the length of hatch opening and in any case over 0.5L region amidships.

2.7 Continuous longitudinal hatch coamings

2.7.1 In addition to the requirements of Pt.3, Ch.4, Sec.3 and Ch.11, Sec.2; the following requirements are to be complied with.

2.7.2 Coamings are to be stiffened at the upper edge by a horizontal stiffener of substantial size. Additional longitudinal stiffeners are to be fitted on the coaming above deck to provide sufficient strength against buckling.

2.7.3 Substantial coaming stays are to be fitted generally not more than 2.0 [m] apart. Special attention is to be paid to their attachment to deck and stiffening below.

2.8 Bulkheads

2.8.1 The scantlings of bulkheads are to be as per Pt.3, Ch.9, taking into account the dry bulk cargo loading given in 1.3.2.

2.8.2 Where bulkheads are of corrugated construction, the angle of corrugation (i.e. of webs with the plane of bulkheads) is not to be less than 55°.

Section 3

Ore Carriers

3.1 Hull arrangement

3.1.1 Ore carriers are to be provided two longitudinal bulkheads and a double bottom in way of the cargo holds. It is assumed that only spaces between the longitudinal bulkheads are used as cargo holds.

3.1.2 The bottom and deck outside the hatch openings are to be longitudinally framed. The side shell and longitudinal bulkheads also, in general, are to be longitudinally framed.

3.1.3 In wing tanks, primary bottom structure is to be so arranged as to maintain structural continuity of the hold double bottom structure in the transverse direction.

3.1.4 Other additional requirements given in Sec.2.2 to 2.8 for bulk carriers, also apply to ore carriers.

End of Chapter

Chapter 2

Tankers

Contents

Section 1

General

1.1 Application

1.1.1 This chapter applies to vessels intended for carriage of liquid cargo in tanks.

1.1.2 The requirements in this chapter are supplementary to the applicable requirements of Part 1, 2, 3 and 4 of these rules.

1.2 Class Notation

1.2.1 Vessels complying with the requirements of this chapter are eligible for the assignment of the notation **TANKER.**

1.2.2 Tanker Vessels carrying dangerous goods will be given additional notations as indicated in the individual sections of this chapter.

Section 2

Hull Scantlings

2.1 General

2.1.1 Hull scantlings are to be determined as specified in Part 3 using appropriate design loads, unless otherwise specified in this chapter.

2.2 Thermal Stress

2.2.1 Where heated liquids are intended to be carried in tanks, a calculation of thermal stresses is required, if carriage temperature of liquid exceeds 90 degree Celsius.

Section 3

Structural Arrangement

3.1 General

3.1.1 The bottom shell, inner bottom and deck are generally to be longitudinally framed in the cargo tank region. Vessels provided with transverse framing will be specially considered.

3.1.2 Inner hull and longitudinal bulkheads are to extend beyond the cargo tank region as far forward and aft as practicable and are to be effectively scarfed into the adjoining structure.

3.1.3 Primary members are to be so arranged as to ensure effective continuity of strength throughout the tank structure. Abrupt changes in depth of sections are to be avoided. Vertical webs on structure are to be arranged in line with the double bottom floors, deck transverses and vertical transverses at the longitudinal bulkheads to ensure continuity of transverse structure. Longitudinal deck girders are to be supported at transverse bulkheads by vertical webs or equivalent. The depth and scantlings of the continuous girders are to be increased in way to provide effective support. Where members abutt on both sides of bulkhead or other deeper members, the alignment of webs and faceplates are to be ensured.

3.2 Bottom Structure

3.2.1 Longitudinal girders are to be provided at

a) centerline (or duct keel)

b) under longitudinal bulkhead (or sloping plates of bulkhead stool in case of vertically corrugated longitudinal bulkheads)

c) under sloping plate of hopper side tank where fitted.

3.2.2 Plate floors are to be arranged in way of transverse bulkheads and sloping plates of bulkhead stools.

3.2.3 Transverse continuity of inner bottom is to be maintained outboard of inner hull.

3.2.4 Spacing of girders is to be in accordance with Part 3, Ch 6, Sec 6.3.

3.3 Side Structure

3.3.1 Brackets are to be provided at the ends of the crossties to connect to the transverses or girders. Transverses and vertical webs are to be fitted with tripping brackets at the junctions with cross ties. Where the width of the face plate of the cross ties exceeds 150 [mm] on any one side of the web, additional tripping brackets are to be provided to support the face plate.

3.3.2 End connections of cross-ties are to ensure adequate area of connection and may require additional bracket thickness. Full penetration welding may be required particularly in way of toes of the end brackets.

3.4 Deck Structure

3.4.1 A trunk deck, if fitted is to extend over the full length of the cargo tanks and is to be effectively scarfed into the main hull structure. The trunk deck and the sides are to be longitudinally framed and the transverse primary members are to be aligned with the outboard deck transverses.

3.4.2 Where external stiffening is carried in way of the trunk deck, appropriate tripping brackets are to be fitted in way of the underdeck supporting structure. The arrangement and details of the external girders will be specially considered.

3.5 Tank Bulkheads

3.5.1 The arrangement and stiffening of transverse oil tight bulkheads are to efficiently support the lateral liquid pressure as well as the loads transmitted by end connection of inner hull, longitudinal bulkheads, shell and deck longitudinal. Where transverse bulkheads are vertically corrugated, horizontal stringers or equivalent is to be fitted to provide adequate resistance to transverse compressive forces.

3.5.2 The top and bottom strakes of longitudinal corrugated bulkheads are to be plane over width of 0.1D from the deck and bottom. The thickness of this plating is not to be less than 75% of the adjoining deck and inner bottom plating. Stools provided for corrugated bulkheads will be specially considered.

3.5.3 Particular attention is to be paid to the through thickness properties at the connection to the deck and inner bottom.

3.5.4 Where longitudinal bulkheads are corrugated horizontally, the corrugations are to be aligned, and stiffening arrangements on plane members are to be arranged to provide adequate support in way of flanges of abutting corrugations. Where both the longitudinal and transverse bulkheads are horizontally corrugated, the ends are to be connected to ensure continuity.

3.5.5 Where horizontal girders (or vertical webs) on the transverse bulkheads do not form part of a ring structure, they are to be arranged with substantial end brackets forming a buttress extending to the adjacent vertical web (or transverse). The shear and combined stresses in the buttress arrangement is to be specially examined.

3.6 Vessels with independent tanks

3.6.1 The side frames may be inside or outside the tank. When tank longitudinal sides are framed vertically, stiffeners are to form continuous frames with the top and bottom stiffeners, whether the frames are connected or not by brackets.

3.6.2 The vertical or horizontal stiffeners of transverse sides are to be welded on to the perpendicular tank sides, either directly or by means of brackets extending up to the first of previous side.

3.6.3 Bottom structure is to be adequately stiffened, to ensure proper contact between tank plates and vessel bottom.

3.6.4 Fastening of Independent tanks

3.6.4.1 The tank seatings are to be constructed in such a manner so as to make it impossible for the tanks to move in relation to the vessel structure. Suitable partial girders are to be provided below this seatings.

3.6.4.2 The tanks are to be supported by the floors or bottom longitudinals.

3.6.4.3 When stringer is chocked against tanks in way of some web frames or side shell transverses, chocking may consist in a bolted assembly. Arrangements are to be provided to avoid an accidental shifting during navigation in case of applying wedges in hard wood or synthetic material capable of transmitting the chocking stress.

3.6.4.4 Anti-flotation arrangements are to be provided for independent tanks. The anti-flotation arrangements are to be suitable to withstand an upward force caused by an empty tank in a hold space flooded to the damage draught of the vessel, without plastic deformation likely to endanger the hull structure.

3.6.4.5 Strength check of the seatings and stays is to be done. Stress concentrations in the tank walls are to be avoided and care is to be taken to ensure that the tank seatings do not impede the contraction of the tank when cooled down to transport temperature.

3.6.4.6 When refrigerated cargo is carried, material used for fastening is to be suitable for the corresponding lower temperature

3.7 Construction Details

3.7.1 The members are to have adequate end fixity, lateral support and web stiffening, and the structure is to be arranged to minimize hard spots or other sources of stress concentration. Openings are to have well rounded corners and smooth edges and are to be located having regard to the stress distribution and buckling strength of the plate panel.

3.7.2 To maintain continuity of strength, substantial horizontal and vertical brackets are to be fitted to transverses or stringers at the ends of the cross ties. Horizontal brackets are to be aligned with the cross tie face plates, and vertical end brackets are to be aligned with the cross tie web.

3.7.3 In a ring system where the end bracket is integral with the webs of the members, and the face plate is carried continuously along the edges of the members and the bracket, the full area of the largest face plate is to be maintained upto the mid-point of the bracket and then gradually tapered to the smaller face plates. Butts in face plates are to be kept well clear of the toes of brackets.

3.7.4 The thickness of separate end brackets is generally to be not less than that of the thicker of the primary member webs being connected, but may be required to be locally increased at the toes. The bracket is to extend to adjacent tripping brackets, stiffeners or other support points. Bracket toes are to be well radiused. Where the bracket is attached to a corrugated bulkhead, the plating at the bracket toe is to be suitably reinforced.

3.7.5 Tripping brackets are generally to be fitted close to the toes of end brackets, in way of cross ties and generally at every fourth stiffener elsewhere. Arrangements should also be made to prevent tripping at the intersection with other primary members.

3.7.6 In way of cross ties and their end connections lightening holes are not to be cut in side and longitudinal bulkhead stringers. Lightening holes are also to be avoided on vertical webs on longitudinal bulkheads and in wing ballast tanks.

3.7.7 Holes cut in primary longitudinal members within 0.1D of deck and bottom are, in general to be reinforced. Where holes are cut in primary longitudinal members in areas of high stress and where primary members are of higher tensile steel, they are to be elliptical, or equivalent, to minimise stress concentration.

3.7.8 Longitudinals within the range of cargo tanks are not permitted to have closely spaced scallops except in way of ballast pipe suctions. Reinforcement in these areas will be specially considered. Small air and drain holes, cut-outs at erection butts and similar widely spaced openings are, in general not to be less than 200 [mm] clear of the toes of end brackets, intersections with primary supporting members and other areas of high stress. All openings are to be well rounded with smooth edges.

3.7.9 Where holes are cut for heating coils, the lower edge of the hole is to be not less than 100 [mm] from the inner bottom. Where large notches are cut in the transverses for the passage of longitudinal framing, adjacent to openings for heating coils, the notches for longitudinals are to be collared.

Section 4

General Requirements for Tankers Carrying Dangerous Goods

4.1 General

4.1.1 Application

4.1.1.1 The requirements in this section apply to tankers intended for carriage of dangerous goods in bulk.

4.1.1.2 Attention is also drawn to National and International technical and operational requirements of countries where the vessel is registered or operating, which are outside Classification.

4.1.1.3 The requirements of Classification of Inland Waterways tankers intended for the carriage of dangerous liquids in bulk are based on the United Nation's ADN regulations. The ADN are the regulations for the transport of dangerous goods. The abbreviation ADN stands for:

In French:

***A**ccord europeen relatif au transport international des marchandises **D**angereuses par voies de **N**avigation interieures.*

In English:

The European Agreement concerning the International Carriage of Dangerous Goods by River.

4.1.1.4 Electronic copies of the ADN can be downloaded from the site of the United Nations Economic Commission for Europe at:

https://www.unece.org/trans/danger/publi/adn/adn_e.html

4.1.2 ADN, The European Agreement concerning the International Carriage of Dangerous Goods by River.

The European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) was done at Geneva on 26 May 2000 on the occasion of a Diplomatic Conference held under the joint auspices of the United Nations Economic Commission for Europe (UNECE) and the Central Commission for the Navigation of the Rhine (CCNR).

4.2 Class Notations

4.2.1 Tanker Type Notations

4.2.1.1 Vessels complying with the applicable requirements of section 4, 5 ,6 and 7, are eligible for the assignment of the following notations.

a) tankers complying with the requirements of Section 5, 5.4 and other relevant rule requirements will be eligible to be classed as:

TYPE N

b) tankers complying with the requirements of Section5, 5.5 and other relevant rule requirements will be eligible to be classed as:

TYPE C

c) tankers complying with the requirements of Section 6 and other relevant rule requirements will be eligible to be classed as:

TYPE G

4.2.2 Cargo Tank Design Notations

4.2.2.1 Following additional notations will be assigned in accordance with the chosen cargo tank design:

a) When pressure tank is used, following additional notation will be assigned

TANK DESIGN 1

b) When closed tank is used, following additional notation will be assigned

TANK DESIGN 2

c) When open tank with flame arresters is used, following additional notation will be assigned

TANK DESIGN 3

d) When open tank is used, following additional notation will be assigned

TANK DESIGN 4

4.2.3 Cargo Tank Type Notations

4.2.3.1 Following additional notations will be assigned in accordance with the chosen cargo tank type:

a) When independent tank is used, following additional notation will be assigned

TANK TYPE 1

b) When integral tank is used, following additional notation will be assigned

TANK TYPE 2

c) When walls of cargo tank used are distinct from outer hull of vessel, following additional notation will be assigned

TANK TYPE 3

4.2.4 Based on allowed tanker type and cargo tank configuration for the cargoes mentioned in list of cargoes, an appropriate combination of *Tanker Type Notation, Cargo Tank Design Notation* and *Cargo Tank Type Notation* is to be assigned.

4.3 Classification of Dangerous Goods

4.3.1 Classification of dangerous goods are defined according to the UN Model Regulations.

4.3.2 The following dangerous goods of the classes listed below may be carried in tankers complying with the rules for carriage of the intended cargo:

Class 2	Gases
Class 3	Flammable Liquids
Class 6.1	Toxic Substances
Class 8	Corrosive Substances
Class 9	Miscellaneous dangerous substances and articles

4.3.3 Products listed in the product list (see Part 3 Table C of ADN Regulations) are permitted to be carried in tankers complying with the requirements of this chapter.

4.4 Types of Tankers

4.4.1 Based on type of cargo carried by the tanker, a distinction can be made between three different tanker types:

a) **Type G**: means a tank vessel intended for carriage of liquefied gases. Carriage may be under pressure or under refrigeration.

b) **Type C**: means a tank vessel intended for the carriage of liquids.

The vessel is to be of the flush-deck/double-hull type with double-hull spaces, double bottoms, but without trunk. The cargo tanks may be formed by the vessel's inner hull or may be installed in the hold spaces as independent tanks.

c) **Type N**: means a tank vessel intended for the carriage of liquids.

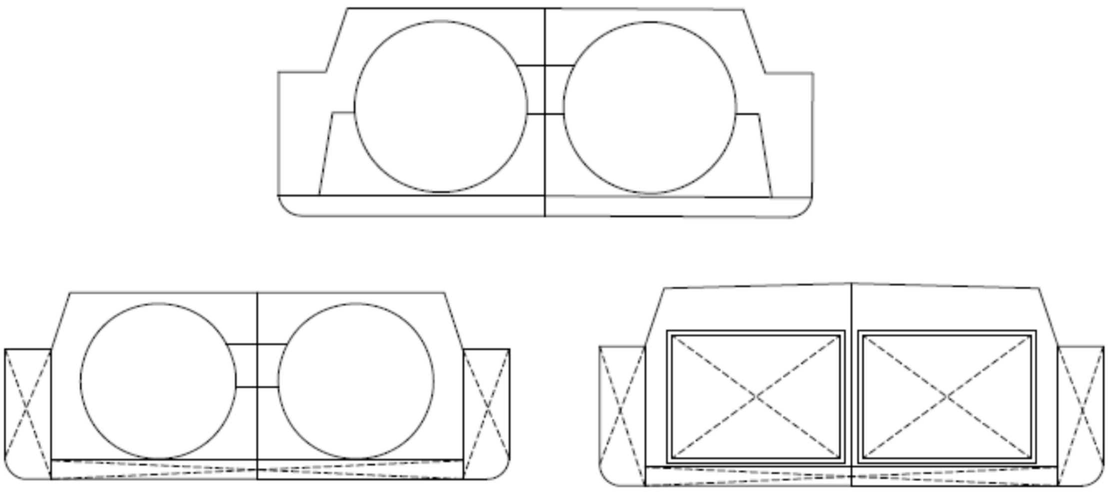


Fig.1 : Examples of possible hull configurations for Tankers of the Type G

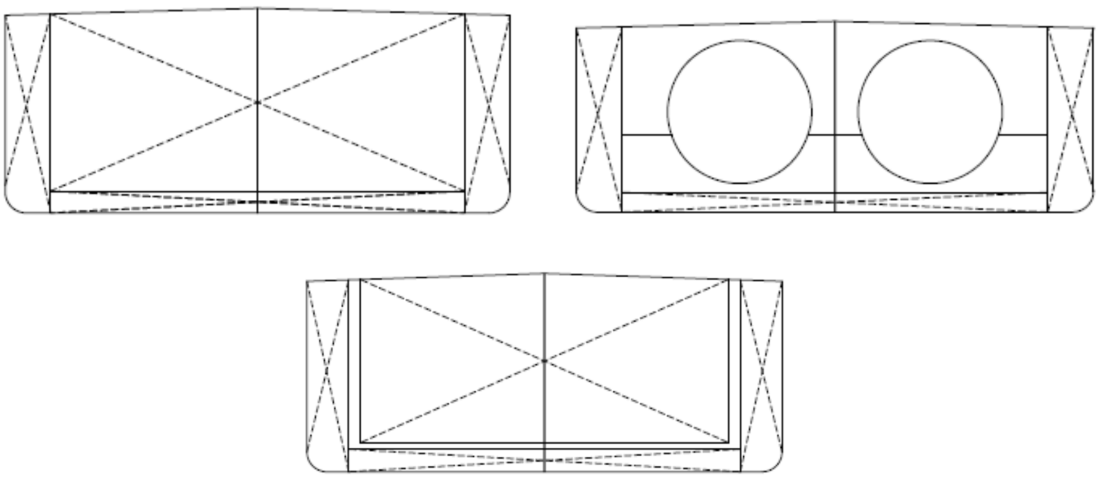


Fig.2 : Examples of possible hull configurations for Tankers of the Type C

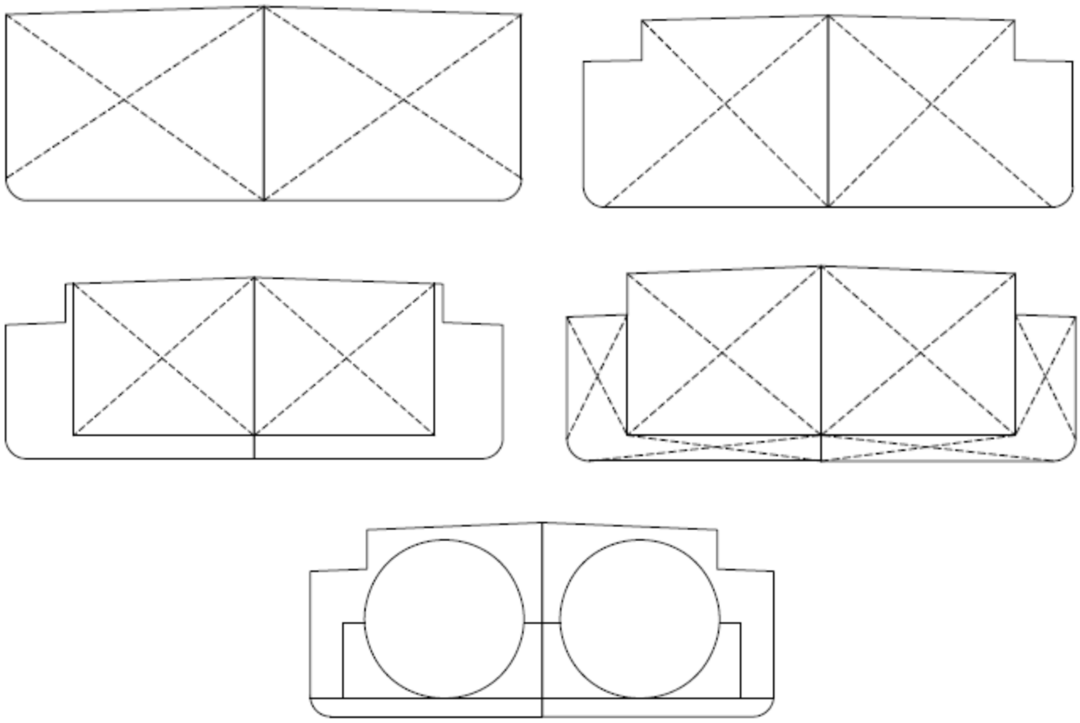


Fig.3 : Examples of possible hull configurations for Tankers of the Type N

4.4.2 Cargo Tank Design

a) Pressure cargo tank (see 4.8.11.1)

b) Closed cargo tank (see 4.8.11.2)

c) Open cargo tank with flame arrester (see 4.8.11.3)

d) Open cargo tank (see 4.8.11.4)

4.4.3 Cargo Tank Type

a) Independent cargo tank (see 4.8.12.1)

b) Integral cargo tank (see 4.8.12.2)

c) Cargo tank with walls distinct from the outer hull (see 4.8.12.3)

Table 1: Variations of Cargo Tank Configurations

Type N Tankers				
		Cargo Tank Type		
		Independent TANK TYPE 1	**Integral TANK TYPE 2**	**Walls Distinct from outer hull TANK TYPE 3**
Cargo Tank Design	**Pressure Tank TANK DESIGN 1**	X	N.A	N.A
	Closed Tank TANK DESIGN 2	X	X	X
	Open Tank with flame arresters TANK DESIGN 3	X	X	X
	Open Cargo Tank TANK DESIGN 4	X	X	X
Type C Tankers				
		Independent TANK TYPE 1	**Integral TANK TYPE 2**	**Walls Distinct from outer hull TANK TYPE 3**
Cargo Tank Design	**Pressure Tank TANK DESIGN 1**	X	N.A	N.A
	Closed Tank TANK DESIGN 2	X	X	N.A
	Open Tank with flame arresters TANK DESIGN 3	N.A	N.A	N.A
	Open Cargo Tank TANK DESIGN 4	N.A	N.A	N.A
Type G Tankers				
		Independent TANK TYPE 1	**Integral TANK TYPE 2**	**Walls Distinct from outer hull TANK TYPE 3**
Cargo Tank Design	**Pressure Tank TANK DESIGN 1**	X	N.A	N.A
	Closed Tank TANK DESIGN 2	X	N.A	N.A
	Open Tank with flame arresters TANK DESIGN 3	N.A	N.A	N.A
	Open Cargo Tank TANK DESIGN 4	N.A	N.A	N.A

4.5 Designation of dangerous liquids to vessel types

4.5.1 Permitted Vessels

4.5.1.1 Dangerous substances may be carried in tankers of Type N, C and G in accordance with the requirements of Sec 6, or 7. The type of vessel to be used is specified in Column (6) of Table C of Chapter 3.2 of ADN and in 4.5.2.1 to 4.5.2.7. Cargo tank design and cargo tank type to be used are mentioned in column (7) and (8) of Table C of Chapter 3.2 of ADN respectively.

Dangerous Goods Class	Vessel Type
2	Gases; compressed, liquefied or dissolved under pressure are to be carried in Type G tankers.
3	Flammable liquids are generally to be carried in Type N tankers unless, depending on their properties and classification, a higher vessel type is required. Liquids for which a certain vessel type is requested may also be carried in a higher vessel type.
6.1	Poisonous (toxic) liquids are to be carried in Chemical tankers of Type C. These liquids may also be carried in Type C or G tankers respectively.
8	Corrosive liquids are generally to be carried in Tankers of Type N, having, (depending on the properties of the liquids), open integral cargo tanks or open cargo tanks independent from the vessel's structure. For some liquids, depending on their properties and classification, a higher vessel type may be required. Corrosive liquids for which a certain vessel type is requested may also be carried in a higher vessel type.
9	Liquids having a potential hazard during transport not described in the above categories are to be carried in Tankers of Type N, having, (depending on the properties of the liquids), open integral cargo tanks or open cargo tanks independent from the vessel's structure. These liquids may also be carried in tankers of Type N Closed, Type C and Type G respectively.

4.5.2 Carriage in Cargo Tanks

4.5.2.1 Substances, which according to column (6) of Table C of Chapter 3.2 of ADN, have to be carried in a tank vessel of type N, open, may also be carried in a tank vessel of

- type N, open, with flame arresters;
- type N, closed;
- types C or G provided that all conditions of carriage prescribed for tank vessels of type N, open, as well as all other conditions of carriage required for these substances in Table C of Chapter 3.2 of ADN are met.

4.5.2.2 Substances which, according to column (6) of Table C of Chapter 3.2 of ADN have to be carried in a tank vessel of type N, open, with flame-arresters, may also be carried in tank vessels of

- type N, closed, and types C or G provided that all conditions of carriage prescribed for tank vessels of type N, open, with flame arresters, as well as all other conditions of carriage required for these substances in Table C of Chapter 3.2 of ADN are met.

4.5.2.3 Substances which, according to column (6) of Table C of Chapter 3.2 of ADN have to be carried in a tank vessel of type N, closed, may also be carried in tank vessels of

- type C or G provided that all conditions of carriage prescribed for tank vessels of type N, closed, as well as all other conditions of carriage required for these substances in Table C of Chapter 3.2 of ADN are met.

4.5.2.4 Substances which, according to column (6) of Table C of Chapter 3.2 of ADN have to be carried in tank vessels of type C may also be carried in tank vessels of

- type G provided that all conditions of carriage prescribed for tank vessels of type C as well as all other conditions of carriage required for these substances in

Table C of Chapter 3.2 of ADN are met.

4.5.2.5 Oily and greasy wastes resulting from the operation of the vessel may only be carried in fire-resistant receptacles, fitted with a lid, or in cargo tanks.

4.5.2.6 A substance which according to column (8) of Table C of Chapter 3.2 of ADN must be carried in cargo tank type 2 (integral cargo tank), may also be carried in a :

- cargo tank type 1 (independent cargo tank) or
- cargo tank type 3 (cargo tank with walls distinct from the outer hull) of the vessel type prescribed in Table C or a vessel type prescribed in 4.5.2.1 to 4.5.2.4, provided that all other conditions of carriage required for this substance by Table C of Chapter 3.2 of ADN are met.

4.5.2.7 A substance which according to column (8) of Table C of Chapter 3.2 of ADN must be carried in cargo tank type 3 (cargo tank with walls distinct from the outer hull), may also be carried in a :

- cargo tank type 1 (independent cargo tank) of the vessel type prescribed in Table C of Chapter 3.2 of ADN or a vessel type prescribed in 4.5.2.1 to 4.5.2.4 or in a type C vessel with cargo tank type 2 (integral cargo tank), provided that at least the conditions of carriage concerning the prescribed N type are met and all other conditions of carriage required for this substance by Table C of Chapter 3.2 of ADN or 4.5.2.1 to 4.5.2.4 are met.

4.5.2.8 All requirements for the particular substance as contained in Table C of Part 3 of the ADN are to be complied with. An approved list of defined cargoes is to be carried on board.

4.6 Stability

4.6.1 The intact or damage stability of tankers of Type G, C or N is to be in accordance with requirements given in the individual sections.

4.6.2 A stability booklet is to be provided containing the following details:

- General description of the vessel:
  – General arrangement and capacity plans indicating the assigned use of compartments and spaces (cargo tanks, stores, accommodation, etc.);
  – A sketch indicating the position of the draught marks referring to the vessel's perpendiculars;
  – A scheme for ballast/bilge pumping and overflow prevention systems;
  – Hydrostatic curves or tables corresponding to the design trim, and, if significant trim angles are foreseen during the normal operation of the vessel, curves or tables corresponding to such range of trim are to be introduced;
  – Cross curves or tables of stability calculated on a free trimming basis, for the ranges of displacement and trim anticipated in normal operating conditions, with an indication of the volumes which have been considered buoyant;
  – Tank sounding tables or curves showing capacities, centres of gravity, and free surface data for all cargo tanks, ballast tanks and compartments, drinking water and sewage water tanks and tanks containing products for the operation of the vessel;
  – Lightship data (weight and centre of gravity) resulting from an inclining test or deadweight measurement in combination with a detailed mass balance or other acceptable measures. Where the above-mentioned information is derived from a sister vessel, the reference to this sister vessel is to be clearly indicated, and a copy of the approved inclining test report relevant to this sister vessel is to be included;
  – A copy of the approved test report is to be included in the stability booklet;

- Operating loading conditions with all relevant details, such as:
- Lightship data, tank fillings, stores, crew and other relevant items on board (mass and centre of gravity for each item, free surface moments for liquid loads);
- Draughts amidships and at perpendiculars;
- Metacentric height corrected for free surfaces effect;
- Righting lever values and curve;
- Longitudinal bending moments and shear forces at read–out points;
- Information about openings (location, type of tightness, means of closure); and
- Information for the master;

4.7 Approved List of cargoes

4.7.1 IRS will give approved list of all the dangerous goods accepted for carriage in tankers. To the extent required for safe carriage the list can contain reservation for certain goods regarding

- the criteria for strength and stability of the vessel; and
- the compatibility of the accepted dangerous goods with all the construction materials of the vessel, including installations and equipment, which come into contact with the cargo.

4.7.2 A list of cargoes, for the carriage of which the vessel has been approved, will be attached to the Classification Certificate.

4.7.3 Only those cargoes which are included in the approved list of cargoes may be carried.

4.7.4 An approved list of cargoes will be issued by IRS and will be based on Table C of Part 3, Chapter 3.2 of the ADN. Parameters will include the tanker type, cargo tank design and cargo tank type as well as the characteristics of all relevant equipment fitted in the cargo zone. All relevant requirements of Table C will be used as a basis for the list, including any relevant additional requirements contained in column 20.

4.8 Definitions

4.8.1 **Accommodation** means spaces intended for the use of persons normally living on board, including galleys, food stores, lavatories, washrooms, bathrooms, laundries, halls, alleyways, etc., but excluding the wheelhouse.

4.8.2 **ADN** means European agreement concerning the *International Carriage of Dangerous Goods by Inland Waterways*.

4.8.3 **Bilge water** means oily water from the engine room bilges, the peak, the cofferdams and the double-hull spaces;

4.8.4 **Boil-off** means the vapour produced above the surface of a boiling cargo due to evaporation. It is caused by heat ingress or a drop in pressure;

4.8.5 **Bulkhead** means a metal wall, generally vertical, inside the vessel and which is bounded by the bottom, the side plating, a deck, the hatchway covers or by another bulkhead;

4.8.6 **Bulkhead (watertight)** means in a tank vessel: a bulkhead constructed to withstand a water pressure of 1[m] above the deck;

4.8.7 **Cargo area** means the whole of the following spaces(Refer to *Fig.4: Cargo Area*)

4.8.7.1 **Cargo area (additional part above deck) (when anti-explosion protection is required, comparable to Zone 1)** means the spaces not included in the main part of the cargo area above deck comprising 1 [m] radius spherical segments centred over the ventilation openings of the cofferdams and the service spaces located in the cargo area part below the deck and 2 [m] spherical segments centred over the ventilation openings of the cargo tanks and the opening of the pump-rooms.

4.8.7.2 **Cargo area (main part above deck) (when anti-explosion protection is required – comparable to Zone 1)** means the space which is bounded:

- At the sides, by the shell plating extending upwards from the deck sides

- Fore and aft, by planes inclined at 45˚ towards the cargo area, starting at the boundary of the cargo area part below deck
- Vertically, 3 [m] above the deck

4.8.7.3 **Cargo area (part below deck)** means the space between two vertical planes perpendicular to the centre-line plane of the vessel, which comprises cargo tanks, hold spaces, cofferdams, double-hull spaces and double bottom; these planes normally coincide with the outer cofferdam bulkheads or hold end bulkheads. Their intersection line with the deck is refers to as the boundary of the cargo area part below deck.

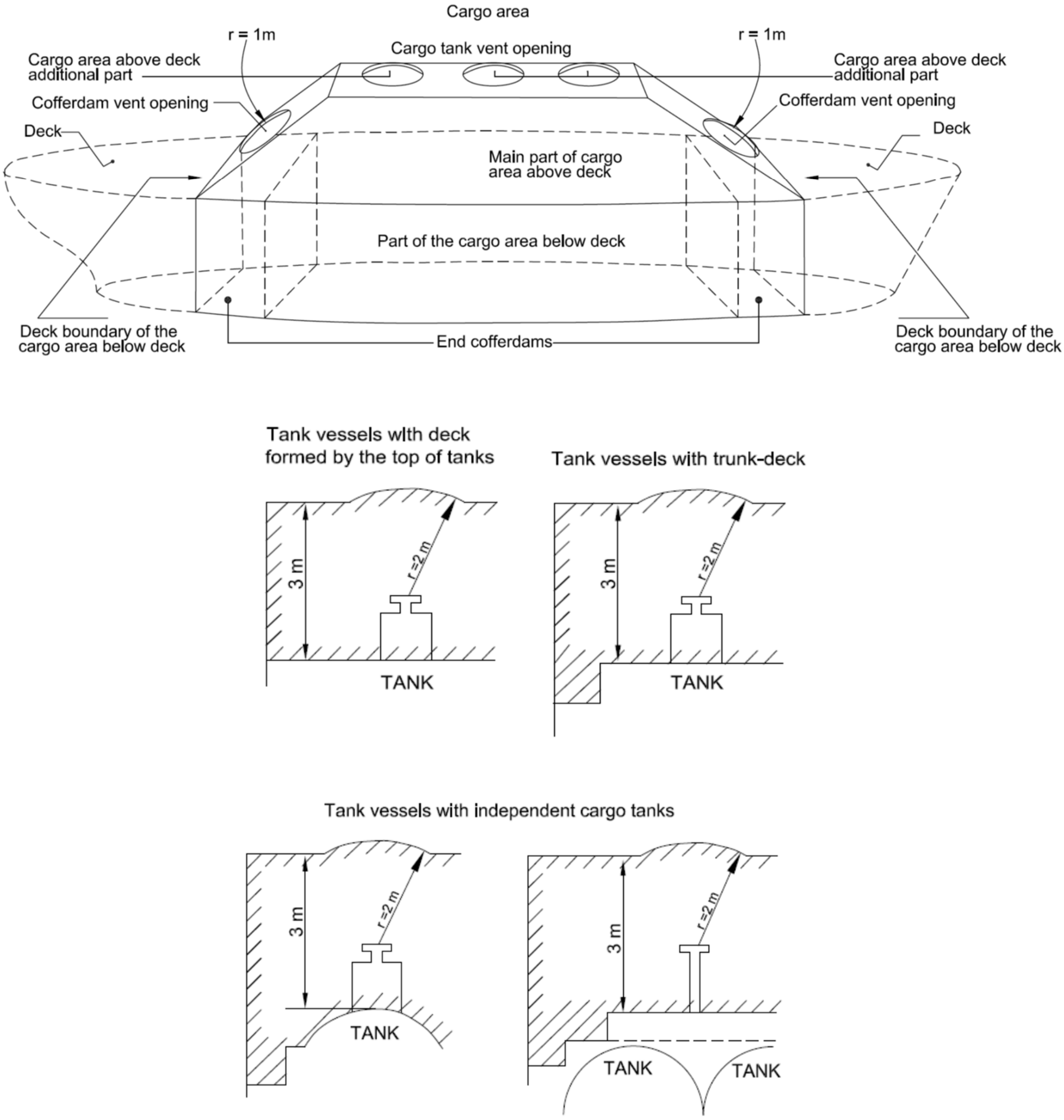


Fig.4: Cargo Area

4.8.8 **Cargo pump room (when anti-explosion protection is required, comparable to Zone 1)** means a service space where the cargo pumps and stripping pumps are installed together with their operational equipment.

4.8.9 **Cargo residues** means liquid cargo which cannot be pumped out of the cargo tanks or piping by means of the stripping system.

4.8.10 **Cargo tank (when anti-explosion protection is required, comparable to zone 0)** means a tank which is permanently attached to the vessel and intended for the carriage of dangerous goods.

4.8.11 Cargo Tank Design

4.8.11.1 **Pressure cargo tank** means a cargo tank independent of the vessel's hull, built according to dedicated recognized standards for a working pressure ≥ 400 [kPa]

4.8.11.2 **Closed cargo tank** means a cargo tank connected to the outside atmosphere through a device preventing unacceptable overpressure or under pressure

4.8.11.3 **Open cargo tank with flame arrester** means a cargo tank connected to the outside atmosphere through a device fitted with a flame arrester.

4.8.11.4 **Open cargo tank** means a cargo tank in open connection with the outside atmosphere.

4.8.12 Cargo tank type

4.8.12.1 **Independent cargo tank** means a cargo tank which is permanently built in, but which is independent of the vessel's structure.

4.8.12.2 **Integral cargo tank** means a cargo tank which is constituted by the vessel's structure itself and bounded by the outer hull or by walls separate from the outer hull.

4.8.12.3 **Cargo tank with wall distinct from the outer hull** means an integral cargo tank of which the bottom and side walls do not form the outer hull of the vessel or an independent cargo tank.

4.8.13 **Classification of zones** (*see* IEC publication 79-10, EU directive 1999/92/CE):

- Zone 0: areas in which dangerous explosive atmospheres of gases, vapours or sprays exist permanently or during long periods;
- Zone 1: areas in which dangerous explosive atmospheres of gases, vapours or sprays are likely to occur occasionally;
- Zone 2: areas in which dangerous explosive atmospheres of gases, vapours or sprays are likely to occur rarely and, if so, for short periods only.

4.8.14 **Certified safe type electrical apparatus** means an electrical apparatus which has been tested and approved by the competent authority regarding its safety of operation in an explosive atmosphere, e.g.

- intrinsically safe apparatus;
- flameproof enclosure apparatus;
- apparatus protected by pressurization;
- powder filling apparatus;
- apparatus protected by encapsulation;
- increased safety apparatus.

4.8.15 **Cofferdam** (when anti-explosion protection is required, comparable to zone 1) means an athwartship compartment which is bounded by watertight bulkheads and which can be inspected. The cofferdam is to extend over the whole area of the end bulkheads of the cargo tanks. The bulkhead not facing the cargo area is to extend from one side of the vessel to the other and from the bottom to the deck in one frame plane.

4.8.16 **Deflagration** means an explosion which propagates at subsonic speed (see EN 13237:2011);

4.8.17 **Design pressure** means the pressure on the basis of which the cargo tank or the residual cargo tank has been designed and built.

4.8.18 **Detonation** means an explosion which propagates at supersonic speed and is characterized by a shock-wave (see EN 13237:2011);

4.8.19 **Explosion** means a sudden reaction of oxidation or decomposition with an increase in temperature or in pressure or both simultaneously (see EN 13237:2011);

4.8.20 **Flame arrester** means a device mounted in the vent of part of an installation or in the interconnecting piping of a system of installations, the purpose of which is to permit flow but prevent the propagation of a flame front. This device is to be tested according to the European standard EN ISO 16852:2010;

4.8.21 **Flame arrester plate stack** means the part of the flame arrester the main purpose of which is to prevent the passage of a flame front;

4.8.22 **Flame arrester housing** means the part of a flame arrester the main purpose of which is to form a suitable casing for the flame arrester plate stack and ensure a mechanical connection with other systems;

4.8.23 **Flash-point** means the lowest temperature of a liquid at which its vapours form a flammable mixture with air.

4.8.24 **Gas** (for the purposes of Class 2) means a substance which:

a) at 50 [° C] has a vapour pressure greater than 300 [kPa] (3 bar); or
b) is completely gaseous at 20 [° C] under standard pressure of 101.3 [kPa];

Otherwise, **Gases** means gases or vapours;

4.8.25 **Gas detection system** means a fixed system capable of detecting in time significant concentrations of flammable gases given off by the cargoes at concentrations below the lower explosion limit and capable of activating the alarms;

4.8.26 **High-velocity vent valve** means a pressure relief valve designed to have nominal flow velocities which exceed the flame velocity of the flammable mixture, thus preventing flame transmission. This type of installation is to be tested in accordance with standard EN ISO 16852:2010;

4.8.27 **Identification number** means the number for identifying a substance to which no UN number has been assigned or which cannot be classified under a collective entry with a UN number. These numbers have four figures beginning with 9.

4.8.28 **Liquid** means a substance which at 50 [° C] has a vapour pressure of not more than 300 [kPa] (3 bar) which is not completely gaseous at 20 [° C] and 101.3 [kPa], and which:

a) has a melting point or initial melting point of 20 [° C] or less at a pressure of 101.3 [kPa], or
b) is liquid according to the ASTM D 4359-90 test method or
c) is not pasty according to the criteria applicable to the test for determining fluidity (penetrometer test)

4.8.29 **Loading instrument:** A loading instrument consists of a computer (hardware) and a programme (software) and offers the possibility of ensuring that in every ballast or loading case:

- the permissible values concerning longitudinal strength as well as the maximum permissible draught are not exceeded; and
- the stability of the vessel complies with the requirements applicable to the vessel. For this purpose, intact stability and damage stability are to be calculated.

4.8.30 **Maximum working pressure** means the maximum pressure occurring in a cargo tank or a residual cargo tank during operation. This pressure equals the opening pressure of high velocity vent valves.

4.8.31 **Naked light** means a source of light using a flame which is not enclosed in a flameproof enclosure.

4.8.32 **Opening pressure** means the pressure referred to in a list of substances at which the high velocity vent valves open.

4.8.33 **Packing group** means a group to which, for packing purposes, certain substances may be assigned in accordance with their degree of danger. The packing groups have the following meanings which are explained in a more detailed manner in Part 2 of the ADN:

- Packing group I: Substances presenting high danger;
- Packing group II: Substances presenting medium danger; and
- Packing group III: Substances presenting a lower danger.

4.8.34 **Pressure relief device** means a spring-loaded device which is activated automatically by pressure the purpose of which is to protect the cargo tank against unacceptable excess internal pressure;

4.8.35 **Pressure receptacle** means a collective term that includes cylinders, tubes, pressure drums, closed cryogenic receptacles, metal hydride storage systems, bundles of cylinders and salvage pressure receptacles;

4.8.36 **Pressures.** For tanks, all kinds of pressures (e.g. working pressure, opening pressure of the high velocity vent valves, test pressure) are to be expressed as gauge pressures in kPa (bar); the vapour pressure of substances, however, is to be expressed as an absolute pressure in kPa (bar).

4.8.37 **Receptacle** means a containment vessel for receiving and holding substances or articles, including any means of closing. This definition does not apply to shells (see also Cryogenic receptacle, Inner receptacle, Rigid inner receptacle and Gas cartridge);

4.8.38 **Receptacle for residual products** means a tank, intermediate bulk container or tank-container or portable tank intended to collect residual cargo, washing water, cargo residues or slops which are suitable for pumping;

4.8.39 **Receptacle for slops** means a steel drum intended to collect slops which are unsuitable for pumping;

4.8.40 **Safety valve** means a spring-loaded device which is activated automatically by pressure the purpose of which is to protect the cargo tank against unacceptable excess internal pressure or negative internal pressure (see also, High velocity vent valve, Pressure-relief device and Vacuum valve);

4.8.41 **Service space** means a space which is accessible during the operation of the vessel and which is neither part of the accommodation nor of the cargo tanks, with the exception of the forepeak and after peak, provided no machinery has been installed in these latter spaces;

4.8.42 **Slops** means a mixture of cargo residues and washing water, rust or sludge which is either suitable or not suitable for pumping;

4.8.43 **Tanker.** A vessel which has been specially designed and constructed for the carriage of liquids or gases in bulk.

4.8.44 **Test pressure** means the pressure at which a cargo tank, a residual cargo tank, a cofferdam or the loading and unloading pipes is to be tested prior to being brought into service for the first time and subsequently regularly within prescribed times.

4.8.45 **UN number** means the four-figure identification number of the substance or article as indicated in the United Nations Model Regulations

4.8.46 **Water film** means a deluge of water for protection against brittle fracture;

4.8.47 **Water spray system** means an on-board installation that, by means of a uniform distribution of water, is capable of protecting all the vertical external surfaces of the vessel's hull fore and aft, all vertical surfaces of superstructures and deckhouses and deck surfaces above the superstructures, engine rooms and spaces in which combustible materials may be stored. The capacity of the water spray system for the area to be protected should be at least 10 [l/m^2 per minute]. The water spray system is to be designed for full-year use. The spray system should be operable from the wheelhouse and the safe area;

Section 5

Vessels Carrying Dangerous Cargoes in Liquid State (Type N & C Vessels)

5.1 Application

5.1.1 This section applies to propelled and non-propelled tankers of Types C, N Closed, N Open with flame arrestors and N Open, in general, intended for the carriage of dangerous liquid oil and chemical cargoes of Classes 3, 6.1, 8 and 9 in bulk.

5.2 Documents to be submitted

5.2.1 Following plans and documents are to be submitted in addition to the documentation required in the other Parts of the Rules for the parts of the vessel not affected by the cargo, as applicable.

5.2.1.1 Documents for Approval

a) Ventilation duct arrangement in gas-dangerous spaces and adjacent zones

b) Details of hull structure in way of cargo tanks, including support arrangement for tanks, saddles, anti-floating and anti-lifting devices, deck sealing arrangements, independent cargo tanks, etc.

c) Intact and damage stability calculations

d) Scantlings, material and arrangement of the cargo containment system.

e) Details of cargo handling system, including arrangements and details of piping and fittings

f) Details of cargo pumps

g) Details of temperature and pressure control systems

h) Bilge and ballast system in cargo area

i) Gas freeing system in cargo tanks including inert gas system

j) Ventilation system in cargo area

k) Details of electrical equipment installed in cargo area, including the list of certified safe equipment and apparatus and electrical bonding of cargo tanks and piping

l) Schematic electrical wiring diagram

m) Pressure drop calculation note

n) Gas detection system

o) Cargo tank instrumentation

p) Details of fire-extinguishing appliances and systems in cargo area

q) Arrangement drawing of the various fire bulkheads and decks with standard fire test reports for the various arrangements, surface coverings, paints and similar

r) Gas return system

5.2.1.2 Documents for Information

a) Design characteristics of products to be carried, including maximum vapour pressure, maximum liquid cargo temperature and other important design conditions

b) General arrangement plan, showing location of cargo tanks and fuel oil, ballast and other tanks, void spaces

c) Loading and unloading operation description, including cargo tank filling limits, where applicable

5.3 Materials of Construction

5.3.1 Materials and grades of steel are to comply with the requirements of Part 2 Inspection and Testing of Materials and as required by the individual vessel type. The independent cargo tanks may also be constructed of other materials, provided these have at least equivalent properties and resistance against the effects of temperature and fire.

5.3.2 Every part of the vessel including any installation and equipment which may come into contact with the cargo is to consist of materials which can neither be dangerously affected by the cargo nor cause decomposition of the cargo or react with it so as to form harmful or hazardous products. In case this aspect has not been examined during classification and inspection of the vessel a relevant reservation is to be entered in the list of cargoes.

5.3.3 Venting piping is to be protected against corrosion.

5.3.4 The use of wood, aluminium alloys or plastic materials within the cargo area is prohibited except where explicitly permitted as below or in the certificate of approval

- The use of wood, aluminium alloys or plastic materials within the cargo area is only permitted for:
    - gangways and external ladders;
    - movable items of equipment (aluminium gauging rods are, however permitted, provided that they are fitted with brass feet or protected in another way to avoid sparking);
    - chocking of cargo tanks which are independent of the vessel’s hull and chocking of installations and equipment;

- masts and similar round timber;
- engine parts;
- parts of the electrical installation;
- loading and unloading appliances;
- lids of boxes which are placed on the deck.

• The use of wood or plastic materials within the cargo area is only permitted for:

- supports and stops of any kind.

• The use of plastic materials or rubber within the cargo area is only permitted for:

- coating of cargo tanks and of piping for loading and unloading;
- all kinds of gaskets (e.g. for dome or hatch covers);
- electric cables;
- hose assemblies for loading and unloading;
- insulation of cargo tanks and of piping for loading and unloading;
- photo-optical copies of the certificate of approval.

• All permanently fitted materials in the accommodation or wheelhouse, with the exception of furniture, are not to readily ignite. They are not to evolve fumes or toxic gases in dangerous quantities, if involved in a fire.

5.3.5 The paint used in the cargo area is not to be liable to produce sparks in case of impact.

5.3.6 To avoid corrosive attack of the cargo tank structure by chemical cargoes, it is strongly recommended the structure be protected by suitable lining or coating.

5.3.7 The suitability of the lining or coating and its compatibility with the intended cargoes is the responsibility of the Builder and Owner. IRS will require the confirmation of the manufacturer that the lining or coating used to protect the cargo tank structure is compatible with the cargoes mentioned in list of cargoes.

5.4 Requirements for Type N Tankers

5.4.1 General

5.4.1.1 Application

5.4.1.1.1 Requirements of this subsection are applicable to Type N tankers.

5.4.2 Arrangement

5.4.2.1 Protection against the penetration of gases - Type N closed and Type N open with flame arrester

5.4.2.1.1 The vessel is to be designed so as to prevent gases from penetrating into the accommodation and the service spaces.

5.4.2.1.2 Outside the cargo area, the lower edges of door-openings in the sidewalls of superstructures and the coamings of access hatches to under-deck spaces are to have a height of not less than 0.50 [m] above the deck. This requirement need not be complied with if the wall of the superstructures facing the cargo area extends from one side of the vessel to the other and has doors the sills of which have a height of not less than 0.50 [m]. The height of this wall is not to be less than 2.00 [m]. In this case, the lower edges of door-openings in the sidewalls of superstructures and of coamings of access hatches behind this wall are to have a height of not less than 0.10 [m]. The sills of engine room doors and the coamings of its access hatches are to, however, always have a height of not less than 0.50 [m].

5.4.2.1.3 In the cargo area, the lower edges of door-openings in the sidewalls of superstructures are to have a height of not less than 0.50 [m] above the deck and the sills of hatches and ventilation openings of premises located under the deck are to have a height of not less than 0.50 [m] above the deck. This requirement does not apply to access openings to double-hull and double bottom spaces.

5.4.2.1.4 The bulwarks, foot-rails, etc. are to be provided with sufficiently large openings which are located directly above the deck.

5.4.2.2 Ventilation

5.4.2.2.1 General

5.4.2.2.1.1 Each hold space is to have two openings. The dimensions and location of these openings are to be such as to permit effective ventilation of any part of the hold space. If there are no such openings, it is to be possible to fill the hold spaces with inert gas or dry air.

5.4.2.2.1.2 Double-hull spaces and double bottoms within the cargo area which are not arranged for being filled with ballast water, hold spaces and cofferdams, are to be provided with ventilation systems.

5.4.2.2.1.3 Any service spaces located in the cargo area below deck are to be provided with a system of forced ventilation with sufficient power for ensuring at least 20 changes of air per hour based on the volume of the space. The ventilation exhaust ducts are to be located up to 50 [mm] above the bottom of the service space. The fresh air inlets are to be located in the upper part; they are not to be less than 2.0 [m] above the deck, not less than 2.0 [m] from the openings of the cargo tanks and not less than 6.0 [m] from the outlets of safety valves. The extension pipes which may be necessary may be of the hinged type. On board open type N vessels other suitable installations without ventilator fans are sufficient.

5.4.2.2.1.4 Ventilation of accommodation and service spaces is to be possible.

5.4.2.2.2 Additional requirements for Type N closed and Type N open with flame arrester

5.4.2.2.2.1 Ventilators used in the cargo area are to be designed so that no sparks may be emitted on contact of the impeller blades with the housing and no static electricity may be generated.

5.4.2.2.2.2 Notice boards are to be fitted at the ventilation inlets indicating the conditions when they are to be closed. All ventilation inlets of accommodation and service spaces leading outside are to be fitted with fire flaps. Such ventilation inlets are to be located not less than 2 [m] from the cargo area. Ventilation inlets of service spaces in the cargo area below deck may be located within such area.

5.4.2.2.2.3 The flame-arresters prescribed in 5.4.2.6.4.1, 5.4.3.2.3, 5.4.3.2.4.2, 5.4.3.2.4.3, 5.4.8.4, 5.4.8.5, 5.4.8.6 and 5.4.8.7 are to be type approved for this purpose by the IRS.

5.4.2.3 Engine rooms

5.4.2.3.1 Internal combustion engines for the vessel's propulsion as well as internal combustion engines for auxiliary machinery are to be located outside the cargo area. Entrances and other openings of engine rooms are to be at a distance of not less than 2.0 [m] from the cargo area. The engine rooms are to be accessible from the deck; the entrances are not to face the cargo area.

5.4.2.3.2 The hinges are to face the cargo area when the doors are not located in a recess whose depth is at least equal to the door width.

5.4.2.4 Accommodation and Service Spaces

5.4.2.4.1 Accommodation spaces and the wheelhouse are to be located outside the cargo area forward of the fore vertical plane or abaft the aft vertical plane bounding the part of cargo area below deck. Windows of the wheelhouse which are located not less than 1.0 [m] above the bottom of the wheelhouse may tilt forward.

5.4.2.4.2 Entrances to spaces and openings of superstructures are not to face the cargo area. Doors opening outward and not located in a recess the depth of which is at least equal to the width of the doors are to have their hinges facing the cargo area.

5.4.2.4.3 Entrances from the deck and openings of spaces facing the weather are to be capable of being closed. The following instruction is to be displayed at the entrance of such spaces:

"DO NOT OPEN DURING LOADING, UNLOADING OR GAS-FREEING WITHOUT PERMISSION.

CLOSE IMMEDIATELY."

5.4.2.4.4 Entrances and windows of superstructures and accommodation spaces which can be opened as well as other openings of these spaces are to be located not less than 2.0 [m] from the cargo area. Wheelhouse doors and windows are not to be located within 2.0 [m] from the cargo area, except when there is no direct connection between the wheelhouse and the accommodation.

5.4.2.4.5 Penetrations

5.4.2.4.5.1 Driving shafts of the bilge or ballast pumps may penetrate through the bulkhead between the service space and the engine room, provided the arrangement of the service space is in compliance with 5.4.3.1.13 and 5.4.3.1.14.

5.4.2.4.5.2 The penetration of the shaft through the bulkhead is to be gastight and is to be approved by IRS.

5.4.2.4.5.3 The necessary operating instructions are to be displayed.

5.4.2.4.5.4 Penetrations through the bulkhead between the engine room and the service space in the cargo area, and the bulkhead between the engine room and the hold spaces may be provided for electrical cables, hydraulic and piping for measuring, control and alarm systems, provided that the penetrations are approved by IRS. The penetrations are to be gastight. Penetrations through a bulkhead with an “A-60” fire protection insulation according to SOLAS 74 Ch II-2, Reg.3, are to have an equivalent fire protection.

5.4.2.4.5.5 Pipes may penetrate the bulkhead between the engine room and the service space in the cargo area provided that these are pipes between the mechanical equipment in the engine room and the service space which do not have any openings within the service space and which are provided with shut-off devices at the bulkhead in the engine room.

5.4.2.4.5.6 Notwithstanding 5.4.3.1.11, pipes from the engine room may pass through the service space in the cargo area or a cofferdam or a hold space or a double hull space to the outside provided that within the service space or cofferdam or hold space or double-hull space they are of the thick-walled type and have no flanges or openings.

5.4.2.4.6 Additional requirements for Type N closed and Type N open with flame arrester

5.4.2.4.6.1 Where a driving shaft of auxiliary machinery penetrates through a wall located above the deck the penetration is to be gastight.

5.4.2.4.6.2 A service space located within the cargo area below deck is not to be used as a cargo pump room for the loading and unloading system, except where:

- the cargo pump-room is separated from the engine room or from service spaces outside the cargo area by a cofferdam or a bulkhead with an “A-60” fire protection insulation according to SOLAS 74, Ch II-2 Reg 3, or by a service space or a hold space
- the “A-60” bulkhead required above does not include penetrations referred to in 5.4.2.4.5.1
- ventilation exhaust outlets are located not less than 6.0 [m] from entrances and openings of the accommodation and service spaces outside the cargo area
- the access hatches and ventilation inlets can be closed from the outside
- all pipes for loading and unloading as well as those of stripping systems are provided with shut-off devices at the pump suction side in the cargo pump-room immediately at the bulkhead. The necessary operation of the control devices in the pump room, starting of pumps and necessary control of the liquid flow rate is to be effected from the deck

- the bilge of the cargo pump-room is equipped with a gauging device for measuring the filling level which activates a visual and audible alarm in the wheelhouse when liquid is accumulating in the cargo pump-room bilge
- the cargo pump room is provided with a permanent gas detection system which automatically indicates the presence of explosive gases or lack of oxygen by means of direct-measuring sensors and which actuates a visual and audible alarm when the gas concentration has reached 20% of the lower explosive limit. The sensors of this system are to be placed at suitable positions at the bottom and directly below the deck. Measurement is to be continuous. The audible and visual alarms are installed in the wheelhouse and in the cargo pump room and, when the alarm is actuated, the loading and unloading system is shut down. Failure of the gas detection system is to be immediately signalled in the wheelhouse and on deck by means of audible and visual alarms
- the ventilation system prescribed in 5.4.2.2.1.3 has a capacity of not less than 30 changes of air per hour based on the total volume of the service space.

5.4.2.4.6.3 The following instruction is to be displayed at the entrance of the cargo pump room:

" BEFORE ENTERING THE CARGO PUMP-ROOM CHECK WHETHER IT IS FREE FROM GASES AND CONTAINS SUFFICIENT OXYGEN.

DO NOT OPEN DOORS AND ENTRANCE OPENINGS WITHOUT PERMISSION.

LEAVE IMMEDIATELY IN EVENT OF ALARM."

5.4.2.5 Inerting Facility

5.4.2.5.1 In cases in which inerting or blanketing of the cargo is prescribed, the vessel is to be equipped with an inerting system.

5.4.2.5.2 This system is to be capable of maintaining a permanent minimum pressure of 7 [kPa] (0.07 bar) in the spaces to be inerted. In addition, the inerting system is not to increase the pressure in the cargo tank to a pressure greater than that at which the pressure valve is regulated. The set pressure of the vacuum-relief valve is to be 3.5 [kPa] (0.035 bar).

5.4.2.5.3 A sufficient quantity of inert gas for loading or unloading is to be carried or produced on board if it is not possible to obtain it on shore. In addition, a sufficient quantity of inert gas to offset normal losses occurring during carriage is to be on board.

5.4.2.5.4 The premises to be inerted are to be equipped with connections for introducing the inert gas and monitoring systems so as to ensure the correct atmosphere on a permanent basis.

5.4.2.5.5 When the pressure or the concentration of inert gas in the gaseous phase falls below a given value, this monitoring system is to activate an audible and visible alarm in the wheelhouse. When the wheelhouse is unoccupied, the alarm is also to be audible in a location occupied by a crew member.

5.4.2.6 Cofferdam Arrangements

5.4.2.6.1 Cofferdams or cofferdam compartments remaining once a service space has been arranged in accordance with 5.4.3.1.13 and 5.4.3.1.14 are to be accessible through an access hatch.

5.4.2.6.2 Cofferdams are to be capable of being filled with water and emptied by means of a pump. Filling is to be effected within 30 minutes. These requirements are not applicable when the bulkhead between the engine room and the cofferdam comprises fire-protection insulation "A- 60" in accordance with SOLAS 74 Ch II-2, Reg 3. The cofferdams are not to be fitted with inlet valves.

5.4.2.6.3 No fixed pipe is to permit connection between a cofferdam and other piping of the vessel outside the cargo area.

5.4.2.6.4 Additional requirements for Type N closed and Type N open with flame arrester

5.4.2.6.4.1 When the list of substances on the vessel contains substances for which protection against explosion is required in column (17) of Table C of Chapter 3.2 of ADN, the ventilation openings of cofferdams are to be fitted with a flame-arrester withstanding a deflagration

5.4.2.7 Engines

5.4.2.7.1 Only internal combustion engines running on fuel with a flashpoint of more than 55 [°C] are allowed. This provision does not apply to internal combustion engines which are part of propulsion and auxiliary systems. These systems are to meet the requirements of IRS Classification Note "*Natural Gas Fuelled Vessels for Coastal and Inland Waters*".

5.4.2.7.2 Ventilation inlets of the engine room and, when the engines do not take in air directly from the engine room, the air intakes of the engines are to be located not less than 2 [m] from the cargo area.

5.4.2.7.3 Sparking is not to be possible within the cargo area.

5.4.2.7.4 The surface temperature of the outer parts of engines used during loading or unloading operations, as well as that of their air inlets and exhaust ducts are not to exceed the allowable temperature according to the temperature class of the substances carried. This provision does not apply to engines installed in service spaces provided the provisions of 5.4.9.3.7 are fully complied with.

5.4.2.7.5 The ventilation in the closed engine room is to be designed so that, at an ambient temperature of 20 [°C], the average temperature in the engine room does not exceed 40 [°C].

5.4.2.8 Oil fuel tanks

5.4.2.8.1 When the vessel is provided with hold spaces, the double bottoms within these spaces may be arranged as oil fuel tanks, provided their depth is not less than 0.6 [m]. Oil fuel pipes and openings of such tanks are not permitted in the hold space.

5.4.2.8.2 The open ends of the air pipes of oil fuel tanks are to extend to 0.5 [m] above the open deck. Their open ends and the open ends of overflow pipes leading on the deck are to be provided with a protective device consisting of a gauze diaphragm or a perforated plate.

5.4.2.9 Exhaust pipes

5.4.2.9.1 Exhausts are to be evacuated from the vessel into the open air either upwards through an exhaust pipe or through the shell plating. The exhaust outlet is to be located not less than 2 [m] from the cargo area. The exhaust pipes of engines are to be arranged so that the exhausts are led away from the vessel. The exhaust pipes are not to be located within the cargo area.

5.4.2.9.2 Exhaust pipes are to be provided with a device preventing the escape of sparks, e.g. spark arresters.

5.4.2.10 Bilge pumping and ballasting arrangements

5.4.2.10.1 Bilge and ballast pumps for spaces within the cargo area are to be installed within such area.

This provision does not apply to:

- double hull spaces and double bottoms which do not have a common boundary wall with the cargo tanks;
- cofferdams, double hull spaces, hold spaces and double bottoms where ballasting is carried out using the piping of the fire fighting system in the cargo area and bilge pumping is performed using eductors.

5.4.2.10.2 Where the double bottom is used as oil fuel tank, it is not to be connected to the bilge piping system.

5.4.2.10.3 Where the ballast pump is installed in the cargo area, the standpipe and its outboard connection for suction of ballast water is to be located within the cargo area but outside the cargo tanks.

5.4.2.10.4 A cargo pump-room below deck is to be capable of being drained in an emergency by an installation located in the cargo area and independent from any other installation. This installation is to be provided outside the cargo pump room.

5.4.3 Cargo Containment

5.4.3.1 Cargo Tanks

5.4.3.1.1 The maximum permissible capacity of a cargo tank is to be determined in accordance with the following table

Table 2 : Tank Sizes	
Loa x *Boa* x *D*, in m^3	Maximum permissible capacity of a cargo tank (m^3)
≤ 600	*Loa* x *Boa* x *D* x 0.3
600 – 3750	180 + (*Loa* x *Boa* x *D* – 600) x 0.0635
> 3750	380

where:

L_{OA} X B_{OA} X D : Product of the tank vessel main dimensions, in [m^3]

L_{OA} : overall length of the hull, in [m]

B_{OA} : extreme breadth in [m]

D : Shortest vertical distance between the top of the keel and the lowest point of the deck at the side of the vessel; (moulded depth) within the cargo area in [m].

In the case of trunk deck vessels, D' is to be substituted for D.

D' is to be determined by the following formula:

$$\boldsymbol{D' = D + \left(h_t \times \frac{b_t}{B} \times \frac{l_t}{L}\right)}$$

Where,

h_t: Height, in [m], of trunk (distance between trunk deck and main deck on trunk side measured at $L_{OA}/2$)

b_t : Trunk breadth, in [m]

l_t : Trunk length, in [m]

5.4.3.1.2 Alternative constructions in compliance with Chapter 9, 9.3.4 of ADN are acceptable..

5.4.3.1.3 The relative density of the substance to be carried is to be taken into consideration in the design of the cargo tanks. The maximum relative density will be indicated in the class certificate.

5.4.3.1.4 When the vessel is provided with pressure tanks, these tanks are to be designed for working pressure of 400 [kPa]

5.4.3.1.5 The cargo tank is to comply with the following:

- for vessels with a length not more than 50 [m], the length of a cargo tank is not to exceed 10 [m]
- for vessels with a length of more than 50 [m], the length of a cargo tank is not to exceed 0.2 L, where L is the vessel rule length.

This provision does not apply to vessels with independent built-in cylindrical tanks having a length to diameter ratio ≤ 7

5.4.3.1.6 The cargo tanks independent of the vessel's hull are to be fixed so that they cannot float.

5.4.3.1.7 The capacity of a suction well is to be limited to not more than 0.10 [m^3].

5.4.3.1.8 The cargo tanks are to be separated by cofferdams of at least 0.60 [m] in width from the accommodation, engine room and service spaces outside the cargo area below deck or, if there are no such accommodation, engine room and service spaces, from the vessel's ends. Where the cargo tanks are installed in a hold space, a space of not less than 0.50 [m] is to be provided between such tanks and the end bulkheads of the hold space. In this case an insulated end bulkhead meeting the definition for Class "A-60" according to SOLAS 74 Ch II-2, Reg 3, is deemed equivalent to a cofferdam. For pressure cargo tanks, the 0.50 [m] distance may be reduced to 0.20 [m].

5.4.3.1.9 Hold spaces, cofferdams and cargo tanks are to be capable of being inspected.

5.4.3.1.10 All spaces in the cargo area are to be capable of being ventilated. Means for checking their gas-free condition are to be provided.

5.4.3.1.11 The bulkheads bounding the cargo tanks, cofferdams and hold spaces are to be watertight. The cargo tanks and the bulkheads bounding the cargo area are to have no openings or penetrations below deck. The bulkhead between the engine room and the cofferdam or service space in the cargo area or between the engine room and a hold space may be fitted with penetrations provided that they conform to the provisions of 5.4.2.4.5 and 5.4.2.4.6.1(if applicable). The bulkhead between the cargo tank and the cargo pump room below deck may be fitted with penetrations provided that they conform to the provisions of 5.4.2.4.6.2. The bulkheads between the cargo tanks may be fitted with penetrations provided that the loading and unloading pipes are fitted with shut-off devices in the cargo tank from which they come. These pipes are to be fitted at least 0.60 [m] above the bottom. The shut-off devices are to be operable from the deck.

5.4.3.1.12 Double hull spaces and double bottoms in the cargo area are to be arranged for being filled with ballast water only. Double bottoms may, however, be used as fuel oil tanks, provided they comply with 5.4.2.8.

5.4.3.1.13 A cofferdam, the centre part of a cofferdam or another space below deck in the cargo area may be arranged as a service space, provided the bulkheads bounding the service space extend vertically to the bottom. This service space is only to be accessible from the deck.

5.4.3.1.14 The service space is to be watertight with the exception of its access hatches and ventilation inlets.

5.4.3.1.15 Where independent cargo tanks are used, or for double-hull construction where the cargo tanks are integrated in the vessel's structure, the space between the wall of the vessel and wall of the cargo tanks is to be not less than 0.6 [m]. The space between the bottom of the vessel and the bottom of the cargo tanks is not to be less than 0.5 [m]. The space may be reduced to 0.4 [m] under the pump sumps. The vertical space between the suction well of a cargo tank and the bottom structures is to be not less than 0.1 [m]. When a hull is constructed in the cargo area as a double hull with independent cargo tanks located in hold spaces, the above values are applicable to the double hull. If in this case the minimum values for the inspections of independent tanks referred to in 5.4.3.1.17 are not feasible, it must be possible to remove the cargo tanks easily for inspection.

5.4.3.1.16 Where service spaces are located in the cargo area under deck, they are to be arranged so as to be easily accessible and to permit persons wearing protective clothing and breathing apparatus to safely operate the service equipment contained therein. They are to be designed so as to allow injured or unconscious personnel to be removed from such spaces without difficulty, if necessary by means of fixed equipment.

5.4.3.1.17 Cofferdams, double-hull spaces, double bottoms, cargo tanks, hold spaces and other accessible spaces within the cargo area are to be arranged so that they may be completely inspected and cleaned. The dimensions of openings except for those of double hull spaces and double bottoms which do not have a wall adjoining the cargo tanks are to be sufficient to allow a person wearing breathing apparatus to enter or leave the space without difficulties. These openings are to have a minimum cross-sectional area of 0.36 [m^2] and a minimum side length of 0.50 [m]. They are to be designed so as to allow an injured or unconscious person to be removed from the bottom of such a space without difficulties, if necessary by means of fixed equipment. In these spaces the distance between the reinforcements is not to be less than 0.50 [m]. In double bottoms this distance may be reduced to 0.45 [m]. Cargo tanks may have circular openings with a diameter of not less than 0.68 [m].

5.4.3.2 Cargo tank opening

5.4.3.2.1 Cargo tank openings are to be located on deck in the cargo area.

5.4.3.2.2 Cargo tank openings with a cross-section of more than 0.1 [m^2] and openings of safety devices for preventing overpressures are to be located not less than 0.5 [m] above deck.

5.4.3.2.3 Each cargo tank or group of cargo tanks connected to a common venting piping is to be fitted with safety devices for preventing unacceptable overpressures or vacuums. These safety devices are to be as follows

5.4.3.2.3.1 For Type N Open vessels

- Safety devices designed to prevent any accumulation of water and its penetration into the cargo tanks;

5.4.3.2.3.2 For Type N Open with flame arrestors

- Safety equipment fitted with flame arrestors capable of withstanding steady burning and designed to prevent any accumulations of water and its penetration into the cargo tanks.

5.4.3.2.3.3 For Type N closed

- Safety devices for preventing unacceptable overpressure or vacuum. Where anti-explosion protection is required in column (17) of Table C of Chapter 3.2 of ADN, the vacuum is to be fitted with a flame arrestors capable of withstanding a deflagration and the pressure relief valve with a high-velocity vent valve acting as a flame arrester capable of withstanding steady burning. Gases are to be discharged upwards. The opening pressure of the high-velocity vent valves and the opening pressure of the vacuum valve is to be permanently marked on the valves.;
- A connection for the safe return ashore of gases expelled during loading;
- A device for depressurization of the tanks. When the list of substances on the vessel contains substances for which protection against explosion is required in column (17) of Table C of Chapter 3.2 of ADN, this device is to include at least a fire-resistant flame arrester and a stop valve which clearly indicates whether it is open or shut.

5.4.3.2.4 Additional requirements for Type N closed

5.4.3.2.4.1 Cargo tanks openings are to be fitted with gastight closures capable of withstanding the test pressure in accordance with 5.4.10.1.3 .

5.4.3.2.4.2 The outlets of high-velocity vent valves are to be located not less than 2 [m] above the deck and at a distance of not less than 6 [m] from the accommodation and from the service spaces outside the cargo area. This height may be reduced when within a radius of 1 [m] round the outlet of the high-velocity vent valve, there is no equipment, no work is being carried out and signs indicate the area. The setting of the high-velocity vent valves is to be such that during the transport operation they do not blow off until the maximum permissible working pressure of the cargo tanks is reached.

5.4.3.2.4.3 One of the following are to be complied with:

A. Insofar as anti-explosion protection is prescribed in column (17) of Table C of Chapter 3.2 of ADN, venting piping connecting two or more cargo tanks are to be fitted, at the connection to each cargo tank, with a flame arrester with a fixed or spring-loaded plate stack, capable of withstanding detonation. This equipment may consist of:

   a) A flame arrester fitted with a fixed plate stack, where each cargo tank is fitted with a vacuum valve capable of withstanding a deflagration and a high-velocity vent valve of withstanding steady burning;

   b) A flame arrester fitted with a spring-loaded plate stack, where each cargo tank is fitted with a vacuum valve capable of withstanding a deflagration;

   c) A flame arrester with a fixed or spring-loaded plate stack

   d) A flame arrester with a fixed plate stack, where the pressure measurement device is fitted with an alarm system in accordance with 5.4.5.9.2 to 5.4.5.9.5;

   e) A flame arrester with a spring-loaded plate stack, where the pressure measurement device is fitted with an alarm system in accordance with 5.4.5.9.2 to 5.4.5.9.5.

   Only substance which do not mix and which do not react dangerously with each other may be carried simultaneously in cargo tanks connected to a common venting piping. Or,

B. Insofar as anti-explosion protection is prescribed in column (17) of Table C of Chapter 3.2 of ADN, venting piping connecting two or more cargo tanks are to be fitted, at the connection to each cargo tank, with a pressure/vacuum valve incorporating a flame arrester capable of withstanding a detonation/deflagration so that any gas releases is removed by the venting piping. Only substances which do not mix and which do not react dangerously with each other may be carried simultaneously in cargo tanks connected to a common venting piping; Or,

C. Insofar as anti-explosion protection is prescribed in column (17) of Table C of Chapter 3.2 of ADN, venting piping connecting two or more cargo tanks are to be fitted, at the connection to each cargo tank, fitted with a vacuum valve incorporating a flame arrester capable of withstanding a deflagration and a high-velocity vent valve incorporating a flame arrester capable of withstanding steady burning. Several different substances may be carried simultaneously. Or,

D. Insofar as anti-explosion protection is prescribed in column (17) of Table C of Chapter 3.2 of ADN, venting piping connecting two or more cargo tanks are to be fitted, at the connection to each cargo tank, with a shut-off device capable of withstanding a detonation, where each cargo tank is fitted with a vacuum valve capable of withstanding a deflagration and a high-velocity vent valve capable of withstanding steady burning. Only substances which do not mix and which do not react dangerously with each other may be carried simultaneously in cargo tanks connected to a common venting piping.

5.4.3.2.5 Additional requirements for Type N closed and Type N open with flame arrester

5.4.3.2.5.1 Closures which are normally used during loading or unloading operations are not to cause sparling when operated.

5.4.4 Stability

5.4.4.1 General

5.4.4.1.1 Proof of sufficient stability is to be submitted.

5.4.4.1.2 The basic value for the stability calculation, the vessel's lightweight and location of centre of gravity, is to be determined wither by means of an inclining experiment or by detailed mass and moment calculation. In latter case the light weight of the vessel is to be checked by means of a light weight test with a tolerance limit of ±5% between the mass determined by calculation and the displacement determined by the draught readings.

5.4.4.1.3 Proof of sufficient intact stability is to be submitted for all stages of loading and unloading and for the final loading condition for all the relative densities of the substances transported contained in the list of cargoes. For every loading operation, taking account of the actual fillings and floating position of cargo tanks, ballast tanks and compartment, drinking water and sewage tanks and tanks containing products for the operation of the vessel, the vessel is to comply with the intact and damage stability requirements. Intermediate stages during operations are also to be taken into consideration. The proof of sufficient stability is to be shown for every operating, loading and ballast condition in the stability booklet, to be approved. If it is unpractical to pre-calculate the operating, loading and ballast conditions, an approved loading instrument is to be installed and used which contains the contents of the stability booklet.

5.4.4.1.4 Floatability after damage is to be proved for the most unfavorable loading condition. For this purpose, calculated proof of sufficient stability is to be established for critical intermediate stages of flooding and for the final stage of flooding.

5.4.4.2 Intact Stability

5.4.4.2.1 For vessels with independent cargo tanks and for double-hull constructions with cargo tanks integrated in the frames of the vessel, the requirements for intact stability resulting from the damage stability calculation is to be fully complied with.

5.4.4.2.2 For vessels with cargo tanks of more than 0.7B in width, proof is to be submitted that the following stability requirements have been complied with:

a) In the positive area of the righting lever curve up to immersion of the first non-watertight opening, righting lever(GZ) is not to be less than 0.1 [m]

b) The surface of the positive area of the righting lever curve up to immersion of the first non-watertight opening and in any event up to an angle of heel ≤27˚ is not to be less than 0.024 [m rad]

c) The metacentric height (GM) should not be less than 0.1 [m]

This condition are to be meet bearing in mind the influence of all free surface in tanks for all stages of loading and unloading.

5.4.4.3 Damage Stability

5.4.4.3.1 For vessels with independent cargo tanks and for double hull constructions with cargo tanks integrated in the frames of the vessel, the following assumptions are to be taken into consideration for the damaged condition.

a) extent of side damage:

Longitudinal extent :	At least 0.10 L_{OA}, but not less than 5 [m]
Transverse extent:	0.59 [m] inboard from the vessel's side at right angles to the centerline at the level corresponding to the maximum draught , or when applicable, the distance allowed by 5.4.3.1.2, reduced by 0.01[m]
Vertical extent :	From the base line upwards without limit

b) extent of bottom damage:

Longitudinal extent:	At least 0.10 L_{OA}, but not less than 5 [m]
Transverse extent:	3 [m]
Vertical extent:	From the base 0.49[m] upwards, the sump excepted

c) Any bulkhead within the damaged area is to be assumed damaged, which means that the location of bulkheads is to be chosen to ensure that the vessel remains afloat after the flooding of two or more adjacent compartments in the longitudinal direction.

The following provisions are applicable:

- For bottom damage, adjacent athwartship compartments are also to be assumed flooded
- the lower edge of any non-watertight opening (e.g. windows, doors and access hatchways), at the final stage of flooding, is to be not less than 0.10 [m] above the damage waterline.
- In general, permeability is to be assumed to be 95%. Where an average permeability of less than 95% is calculated for any compartment, this calculated value obtained may be used. However, minimum values of permeability, μ, given in
- are to be used. For the main engine room, only the one-compartment standard need be taken into account, i.e. the end bulkheads of the engine room are to be assumed as not damaged.

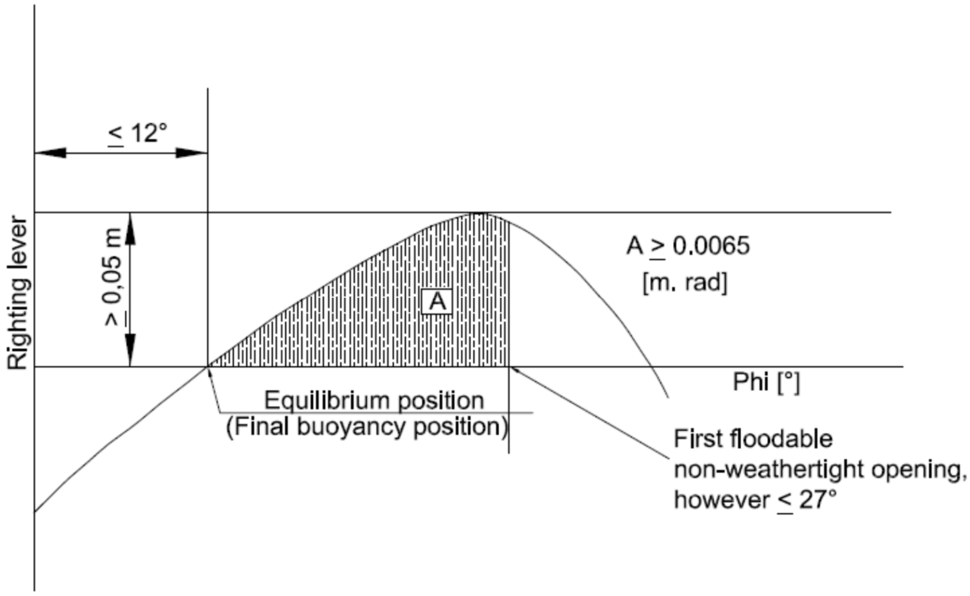
Table 3: Permeability	
Engine Room	85%
Accommodation	95%
Double Bottom, Oil Fuel Tanks, Ballast Tanks, etc. depending on whether, according to their function, they have to be assumed as full or empty for vessel floating at the maximum permissible draft	0% or 95%

5.4.4.3.2 For the intermediate stage of flooding the following criteria have to be fulfilled:

- GZ≥0.03[m]
- Range of positive GZ: 5˚

5.4.4.3.3 At the stage of equilibrium (in the final stage of flooding), the angle of heel is not to exceed 12°. Non-watertight openings are not to be flooded before reaching the stage of equilibrium. If such openings are immersed before the stage of equilibrium, the corresponding spaces are to be considered flooded for the purpose of stability calculation.

5.4.4.3.4 The positive range of the righting lever curve beyond the stage of equilibrium is to have a righting lever of ≥ 0.05 [m] in association with an area under the curve of ≥ 0.0065 [m.rad]. The minimum values of stability are to be satisfied up to immersion of the first non-weathertight openings and in any event up to an angle of heel ≤ 27°. If nonwatertight openings are immersed before that stage, the corresponding spaces are to be considered flooded for the purpose of stability calculation.



5.4.4.3.5 If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances are to be marked accordingly.

5.4.4.3.6 Where cross- or down-flooding openings are provided for reduction of unsymmetrical flooding, the time of equalization is not to exceed 15 min, provided during the intermediate stages of flooding sufficient stability has been proved.

5.4.5 Safety and Control Installations

5.4.5.1 Cargo tanks are to be provided with the following equipment:

a) a mark inside the tank indicating the liquid level of 97%

b) a level gauge

c) a level alarm device which is activated at the latest when a degree of filling of 90% is reached

d) a high level sensor for actuating the facility against overflowing when a degree of filling of 97.5% is reached

e) for Type N closed, an instrument for measuring the pressure of the vapour phase inside the cargo tank

f) an instrument for measuring the temperature of the cargo if in column (9) of Table C of Chapter 3.2 of ADN a heating installation is required or if in column (20) a possibility of heating the cargo is required or if a maximum temperature is indicated.

g) a connection for a closed-type or partly closed-type sampling device, and/or at least one sampling opening as required in column (13) of Table C of Chapter 3.2 of ADN.

5.4.5.2 When the degree of filling in percent is determined, an error of not more than 0.5% is permitted. It is to be calculated on the basis of the total cargo tank capacity including the expansion trunk.

5.4.5.3 The level gauge is to allow readings from the control position of the shut-off devices of the particular cargo tank. The permissible maximum filling level of 95% and 97%, as given in list of substances is to be marked on each level gauge. Permanent reading of the overpressure and vacuum is to be possible from a location from which loading or unloading operations may be interrupted. The permissible maximum overpressure and vacuum is to be marked on each level gauge. Readings are to be possible in all weather conditions.

5.4.5.4 The level alarm device is to give a visual and audible warning on board when actuated. The level alarm device is to be independent of the level gauge.

5.4.5.5 The visual and audible signals given by the level alarm device are to be clearly distinguishable from those of the high level sensor. The visual alarm is to be visible at each control position on deck of the cargo tank stop valves. It is to be possible to easily check the functioning of the sensors and electric circuits or these are to be “intrinsically safe apparatus”.

5.4.5.6 When the control elements of the shut-off devices of the cargo tanks are located in a control room, it is to be possible to stop the loading pumps and read the level gauges in the control room, and the visual and audible warning given by the level alarm device, the high level sensor referred to in 5.4.5.1 d) and the instruments for measuring the pressure and temperature of the cargo is to be noticeable in the control room and on deck.

5.4.5.7 When refrigerated substances are carried the opening pressure of the safety system is to be determined by the design of the cargo tanks. In the event of the transport of substances that must be carried in a refrigerated state the opening pressure of the safety system is not to be less than 25 [kPa] greater than the maximum pressure calculated according to 5.4.6.2.

5.4.5.8 High Level Sensor

5.4.5.8.1 The high level sensor referred in 5.4.5.1 d) above is to give a visual and audible alarm on board and at the same time actuate an electrical contact which in the form of a binary signal interrupts the electric current loop provided and fed by the shore facility against overflowing during loading operations. The signal is to be transmitted to the shore facility via a watertight two-pin lug of a connecter device in accordance with IEC 60309 for direct current of 40 to 50 volts, identification color white, position of the nose 10 h. The plug is to be permanently fitted to the vessel close to the shore connections of the loading and unloading piping.

5.4.5.8.2 The high level sensor is also to be capable of switching off the vessel’s own discharging pump.

5.4.5.8.3 The high level sensor is to be independent of the level alarm device, but it may be connected to the level gauge.

5.4.5.8.4 During discharging by means of the on-board pump, it is to be possible for the shore facility to switch it off. For this purpose, an independent intrinsically safe power line, fed by the vessel, is to be switched off by the shore facility by means of an electrical contact. It is to be possible for the binary signal of the shore facility to be transmitted via a watertight two-pole socket or a connecter device in accordance with IEC 60309 for direct current of 40 to 50 volts, identification color white, position of the nose 10 h. This socket is to be permanently fitted to the vessel close to the shore connections of the unloading piping.

5.4.5.9 Cargo tank pressure and temperature monitoring

5.4.5.9.1 Following requirements are applicable to Type N closed

5.4.5.9.2 When the pressure or temperature exceeds a set value, instruments for measuring the vacuum or overpressure of the gaseous phase in the cargo tank or the temperature of the cargo is to activate a visual and audible alarm in the wheelhouse. When the wheelhouse is unoccupied the alarm also is also to be audible in a location occupied by a crew member.

5.4.5.9.3 When the pressure exceeds the set value during loading and unloading, the instrument for measuring the pressure by means of the plug referred to in 5.4.5.8, is to initiate simultaneously an electrical contact which is to put into effect measures to interrupt the loading and unloading operation. If the vessel's own discharge pump is used, it is to be switched off automatically.

5.4.5.9.4 The instrument for measuring the overpressure or vacuum is to activate the alarm at latest when an overpressure equal to 1.15 times the opening pressure of the pressure relief device, or a vacuum pressure equal to the construction vacuum pressure but not exceeding 5 [kPa]. The maximum allowable temperature is indicated in column (20) of Table C of ADN Chapter 3.2 of ADN. The sensors for these alarms may be connected to the alarm device of the sensor.

5.4.5.9.5 When it is prescribed in column (20) of Table C of ADN Chapter 3.2 of ADN, the instrument for measuring the overpressure of the gaseous phase is to activate a visible and audible alarm in the wheelhouse when the overpressure exceeds 40 [kPa] during the voyage. When the wheelhouse is unoccupied, the alarm is also to be audible in a location occupied by a crew member. It is to be possible to read the gauges in direct proximity to the control for the water spray system.

5.4.6 Cargo pressure and temperature Control

5.4.6.1 Requirements for maintenance of cargo pressure and temperature

5.4.6.1.1 Unless the entire cargo system is designed to resist the full effective vapour pressure of the cargo at the upper limits of the ambient design temperatures, the pressure of the tanks is to be kept below the permissible maximum set pressure of the safety valves, by one or more of the following means:

a) A system for the regulation of cargo tank pressure using mechanical refrigeration.

b) A system ensuring safety in the event of the heating or increase in pressure of the cargo. The insulation or the design pressure of the cargo tank, or the combination of these two elements, is to be such as to leave an adequate margin for the operating period and the temperatures expected; in each case the system is to be deemed acceptable by IRS and is to ensure safety for a minimum time of three times the operation period;

5.4.6.1.2 The systems prescribed above are to be constructed, installed and tested to the satisfaction of IRS. The materials used in their construction is to be compatible with the cargoes to be carried. For normal service, the upper ambient design temperature limits are to be:

Air: +45˚ C

Water : +32˚ C

5.4.6.1.3 The cargo storage system is to be capable of resisting the full vapour pressure of the cargo at upper limits of the ambient design temperatures, whatever the system adopted to deal with the boil-off gas. This requirement is indicated by remark 37 in column (20) of Table C of Chapter 3.2 of ADN.

5.4.6.2 Refrigeration system

5.4.6.2.1 The refrigeration system referred to in 5.4.6.1.1 a) is to be composed of one or more units capable of keeping the pressure and temperature of the cargo at the upper limits of the ambient design temperatures at the prescribed level. Unless another means of regulating cargo pressure and temperature deemed satisfactory by IRS is provided, provision is to be made for one or more stand-by units with an output at least equal to that of the largest prescribed unit. A stand-by unit is to include a compressor, its engine, its control system and all necessary accessories to enable it to operate independently of the units normally used. Provision is to be made for a stand-by heat-exchanger unless the system's normal heat-exchanger has a surplus capacity equal to at least 25% of the largest prescribed capacity. It is not necessary to make provision for separate piping. Cargo tanks, piping and accessories are to be insulated so that, in the event of a failure of all cargo refrigeration systems, the entire cargo remains for at least 52 hours in a condition not causing the safety valves to open.

5.4.6.2.2 The security devices and the connecting lines from the refrigeration system are to be connected to the cargo tanks above the liquid phase of the cargo when the tanks are filled to their maximum permissible degree of filling. They are to remain within the gaseous phase, even if the vessel has a list up to 12 degrees.

5.4.6.2.3 When several refrigerated cargoes with a potentially dangerous chemical reaction are carried simultaneously, particular care is to be given to the refrigeration systems so as to prevent any mixing of the cargoes. For the carriage of such cargoes, separate refrigeration systems, each including the full stand-by unit referred to in 5.4.6.2.1, is to be provided for each cargo. When, however, refrigeration is ensured by an indirect or combined system and no leak in the heat exchangers can under any foreseeable circumstances lead to the mixing of cargoes, no provision need be made for separate refrigeration units for the different cargoes.

5.4.6.2.4 When several refrigerated cargoes are not soluble in each other under conditions of carriage such that their vapour pressures are added together in the event of mixing, particular care is to be given to the refrigeration systems to prevent any mixing of the cargoes.

5.4.6.2.5 When the refrigeration systems require water for cooling, a sufficient quantity is to be supplied by a pump or pumps used exclusively for the purpose. This pump or pumps are to have at least two suction pipes, leading from two water intakes, one to port, the other to starboard. Provision is to be made for a stand-by pump with a satisfactory flow; this may be a pump used for other purposes provided that its use for supplying water for cooling does not impair any other essential service.

5.4.6.2.6 The refrigeration system may take one of the following forms:

a) Direct system: the cargo vapours are compressed, condensed and returned to the cargo tanks. This system is not to be used for certain cargoes specified in Table C of Chapter 3.2 of ADN. This requirement is indicated by remark 35 in column (20) of Table C of Chapter 3.2 of ADN;

b) Indirect system: the cargo or the cargo vapours are cooled or condensed by means of a coolant without being compressed;

c) Combined system: the cargo vapours are compressed and condensed in a cargo/coolant heat-exchanger and returned to the cargo tanks. This system is not to be used for certain cargoes specified in Table C of Chapter 3.2 of ADN. This requirement is indicated by remark 36 in column (20) of Table C of Chapter 3.2 of ADN.

5.4.6.2.7 All primary and secondary coolant fluids are to be compatible with each other and with the cargo with which they may come into contact. Heat exchange may take place either at a distance from the cargo tank, or by using cooling coils attached to the inside or the outside of the cargo tank.

5.4.6.2.8 When the refrigeration system is installed in a separate service space, this service space is to meet the requirements of 5.4.2.4.6.2.

5.4.6.2.9 For all cargo systems, the heat transmission coefficient as used for the determination of the holding time is to be determined by calculation. Upon completion of the vessel, the correctness of the calculation is to be checked by means of a heat balance test. The calculation and test is to be performed under supervision by IRS. The heat transmission coefficient is to be documented and kept on board. The heat transmission coefficient is to be verified at every renewal of the certificate of approval.

5.4.6.3 Cargo heating system

5.4.6.3.1 Boilers which are used for heating the cargo are to be fuelled with a liquid fuel having a flashpoint of more than 55 °C. They are to be placed either in the engine room or in another separate space below deck and outside the cargo area, which is accessible from the deck or from the engine room.

5.4.6.3.2 The cargo heating system is to be designed so that the cargo cannot penetrate into the boiler in the case of a leak in the heating coils. A cargo heating system with artificial draught is to be ignited electrically.

5.4.6.3.3 The ventilation system of the engine room is to be designed taking into account the air required for the boiler.

5.4.6.3.4 Where the cargo heating system is used during loading, unloading or gas-freeing, the service space which contains this system is to fully comply with the requirements of 5.4.9.3.7.1. This requirement does not apply to the inlets of the ventilation system. These inlets are to be located at a minimum distance of 2 [m] from the cargo area and 6 [m] from the openings of cargo tanks or residual cargo tanks, loading pumps situated on deck, openings of high velocity vent valves, pressure relief devices and shore connections of loading and unloading piping and must be located not less than 2 m above the deck. The requirements of 5.4.9.3.7.1 are not applicable to the unloading of substances having a flashpoint of 60 °C or more when the temperature of the product is at least 15 K lower at the flashpoint.

5.4.6.4 Water spray system

5.4.6.4.1 When water-spraying is required in column (9) of Table C of Chapter 3.2 of ADN, a water-spray system is to be installed in the cargo area on deck for the purpose of cooling the tops of cargo tanks by spraying water over the whole surface so as to avoid safely the activation of the high-velocity vent valve at 10 [kPa] or as regulated.

5.4.6.4.2 The spray nozzles are to be so installed that the entire cargo deck area is covered and the gases released are precipitated safely. The system is to be capable of being put into operation from the wheelhouse and from the deck. Its capacity is to be such that when all the spray nozzles are in operation, the outflow is not less than 50 litres per square metre of deck area and per hour.

5.4.7 Pumps and piping

5.4.7.1 Cargo pumps are to be capable of being shut down from the cargo area and from a position outside cargo area.

5.4.7.2 Piping for loading and unloading is to be independent of any other piping of the vessel.

5.4.7.3 The piping for loading and unloading is to be arranged so that, after loading or unloading operations, the liquid remaining in these pipes may be safely removed and may flow either into the vessel's cargo tanks or the tanks ashore;

5.4.7.4 Piping for loading and unloading is to be clearly distinguishable from other piping.

5.4.7.5 Each shore connection of the venting piping and shore connections of the piping for loading and unloading, through which the loading or unloading operation is carried out, is to be fitted with a shut-off device. However, each shore connection is to be fitted with a blind flange when it is not in operation.

5.4.7.6 Piping for loading and unloading and venting piping, is not to have flexible connections fitted with sliding seals.

5.4.7.7 The stop valves or other shut-off devices of the piping for loading and unloading are to indicate whether they are open or shut.

5.4.7.8 The piping for loading and unloading is to have, at the test pressure, the required elasticity, leakproofness and resistance to pressure.

5.4.7.9 The piping for loading and unloading is to be fitted with pressure gauges at the outlet of the pumps. The permissible maximum overpressure or vacuum is to be indicated on each measuring device. Readings are to be possible in all weather conditions.

5.4.7.10 When piping for loading and unloading are used for supplying the cargo tanks with washing or ballast water, the suctions of these pipes are to be located within the cargo area but outside the cargo tanks. Pumps for tank washing systems with associated connections may be located outside the cargo area, provided the discharge side of the system is arranged in such a way that the suction is not possible through that part. A spring-loaded non-return valve is to be provided to prevent any gases from being expelled from the cargo area through the tank washing system.

5.4.7.11 A non-return valve is to be fitted at the junction between the water suction pipe and the cargo loading pipe.

5.4.7.12 The permissible loading and unloading flows are to be calculated. Calculations concern the permissible maximum loading and unloading flow for each cargo tank or each group of cargo tanks, taking into account the design of the ventilation system. These calculations are to take into consideration the fact that in the event of an unforeseen cut-off of the vapour return piping of the shore facility, the safety devices of the cargo tanks will prevent pressure in the cargo tanks from exceeding the following values:

- over-pressure: 115% of the opening pressure of the high-velocity vent valve;
- vacuum pressure: not more than the construction vacuum pressure but not exceeding 5 [kPa] (0.05 bar).

The main factors to be considered are the following:

a) Dimensions of the ventilation system of the cargo tanks

b) Gas formation during loading: multiply the largest loading flow by a factor of not less than 1.25

c) Density of the vapour mixture of the cargo based on 50% volume vapour of 50% volume air;

d) Loss of pressure through ventilation pipes, valves and fittings. Account will be taken of a 30% clogging of the mesh of the flame-arrester;

e) Clocking pressure of the safety valves

The permissible maximum loading and unloading flows for each cargo tank or for each group of cargo tanks is to be given in an on-board instruction.

5.4.7.13 Compressed air generated outside the cargo area or wheelhouse can be used in the cargo area subject to the installation of a spring-loaded non-return valve to ensure that no gases can escape from the cargo area through the compressed air system into accommodation or service spaces outside the cargo area.

5.4.7.14 If the vessel is carrying several dangerous substances liable to react dangerously with each other, a separate pump with its own piping for loading and unloading is to be installed for each substance. The piping is not to pass through a cargo tank containing dangerous substances with which the substance in question is liable to react.

5.4.7.15 Additional requirements for Type N open vessel carrying substances having corrosive properties, Type Closed and Type N open with flame arrester

5.4.7.15.1 Pumps and accessory loading and unloading piping is to be located in the cargo area

5.4.7.15.2 Cargo pumps situated on deck are to be located not less than 6 [m] from entrances to or openings of, the accommodation and service spaces outside the cargo area.

5.4.7.15.3 No cargo piping is to be located below deck, except those inside the cargo tanks and inside the cargo pump-room;

5.4.7.15.4 The shore connections are to be located not less than 6 [m] from the entrances to, or openings of, the accommodation and services spaces outside the cargo area.

5.4.7.15.5 The distance referred to in 5.4.7.15.2 and 5.4.7.15.4 may be reduced to 3[m] if a transverse bulkhead complying with 5.4.2.2.2 is situated at the end of the cargo area. The openings are to be provided with doors. The following notice is to be displayed on the doors:

"DO NOT OPEN DURING LOADING AND UNLOADING WITHOUT PERMISSION.

CLOSE IMMEDIATELY."

5.4.7.15.6 Every compartment of the piping for loading and unloading is to be electrically connected to the hull.

5.4.7.16 Additional requirements for Type Closed and Type N open with flame arrester

5.4.7.16.1 The piping for loading is to extent down to the bottom of the cargo tanks.

5.4.8 Receptacles for residual products and receptacles for slops

5.4.8.1 If vessels are provided with a tank for residual products, it is to comply with the provisions of 5.4.8.3 , 5.4.8.4 to 5.4.8.7. Receptacles for residual products and receptacles for slops are to be located only in the cargo area. During the filling of the receptacles for residual products, means for collecting any leakage are to be placed under the filling connections.

5.4.8.2 Receptacles for slops are to be fire resistant and are to be capable of being closed with lids. The receptacles for slops are to be marked and be easy to handle.

5.4.8.3 The maximum capacity of a tank for residual products is 30 [m^3].

5.4.8.4 The tank for residual products is to be equipped with:

5.4.8.4.1 in the case of open system:

- A device for ensuring pressure equilibrium;
- An ullage opening
- Connections, with slop valves, for pipes and hose assemblies;

5.4.8.4.2 in the case of a protected system:

- A device for ensuring pressure equilibrium, fitted with a flame-arrester capable of withstanding steady burning;
- An ullage opening;
- Connections, with stop valves, for pipes and hose assemblies;

5.4.8.4.3 in case of a closed system:

- A vacuum valve and high-velocity vent valve.
  The high velocity vent valve is to be so regulated as not to open during carriage. This condition is met when the opening pressure of the valve meets the conditions set out in column (10) of Table C of Chapter 3.2 of ADN; When anti-explosion protection is required in column (17) of Table C of Chapter 3.2 of ADN, the vacuum-relief valve is to be capable of withstanding deflagrations and the high velocity vent valve is to withstand steady burning;

5.4.8.4.4 a device for measuring the degree of filling;

5.4.8.4.5 connections, with stop valves, for pipes and hose assemblies

5.4.8.5 Receptacles for residual products are to be equipped with:

- a connection enabling gases released during filling to be evacuated safely;
- a possibility of indicating the degree of filling;
- connections with shut-off devices, for pipes and hose assemblies.

5.4.8.6 Receptacles for residual products are to be connected to the venting piping of cargo tanks only for the time necessary to fill them. During the filling of the receptacle, released gases are to be safely evacuated.

5.4.8.7 Receptacles for residual products and receptacles for slops placed on the deck are to be located at a minimum distance from the hull equal to one quarter of the vessel's breadth.

5.4.9 Requirements for Electrical Installations

5.4.9.1 Documents concerning electrical installations

5.4.9.1.1 In addition to the other required documentations, the following documents are to be on board:

a) a drawing indicating the boundaries of the cargo area and the location of the electrical equipment installed in this area;

b) a list of the electrical equipment referred to in (a) above including the following particulars: machine or appliance, location, type of protection, type of protection against explosion, testing body and approval number;

c) a list of or general plan indicating the electrical equipment outside the cargo area which may be operated during loading, unloading or gas-freeing. All other electrical equipment is to be marked in red. See 5.4.9.3.7.1 and 5.4.9.3.8.

5.4.9.2 Electrical installations

5.4.9.2.1 Only distribution systems without return connection to the hull are permitted.

This provision does not apply to:

- active cathodic corrosion protection;
- certain limited sections of the installations situated outside the cargo area (e.g. connections of starters of diesel engines);
- the device for checking the insulation level referred to in 5.4.9.2.2 below.

5.4.9.2.2 Every insulated distribution network is to be fitted with an automatic device with a visual and audible alarm for checking the insulation level.

5.4.9.2.3 For the selection of electrical equipment to be used in zones presenting an explosion risk, the explosion groups and temperature classes assigned to the substances carried in accordance with columns (15) and (16) of Table C of Chapter 3.2 of ADN is to be taken into consideration.

5.4.9.3 Type and location of electrical equipment

5.4.9.3.1 Only the following equipment may be installed in cargo tanks, residual cargo tanks, and piping for loading and unloading (comparable to zone 0):

- measuring, regulation and alarm devices of the EEx (ia) type of protection.

5.4.9.3.2 Only the following equipment may be installed in the cofferdams, double-hull spaces, double bottoms and hold spaces (comparable to zone 1):

- measuring, regulation and alarm devices of the certified safe type;
- lighting appliances of the “flame-proof enclosure” or “apparatus protected by pressurization” type of protection;
- hermetically sealed echo sounding devices the cables of which are led through thick-walled steel tubes with gastight connections up to the main deck;
- cables for the active cathodic protection of the shell plating in protective steel tubes such as those provided for echo sounding devices.

The following equipment may be installed only in double-hull spaces and double bottoms if used for ballasting:

- Permanently fixed submerged pumps with temperature monitoring, of the certified safe type.

5.4.9.3.3 Only the following equipment may be installed in the service spaces in the cargo area below deck (comparable to zone 1):

- measuring, regulation and alarm devices of the certified safe type;
- lighting appliances of the “flame-proof enclosure” or “apparatus protected by pressurization” type of protection;
- motors driving essential equipment such as ballast pumps with temperature monitoring; they are to be of the certified safe type.

5.4.9.3.4 The control and protective equipment of the electrical equipment referred to in paragraphs 5.4.9.3.1,5.4.9.3.2 and 5.4.9.3.3 above is to be located outside the cargo area if they are not intrinsically safe.

5.4.9.3.5 The electrical equipment in the cargo area on deck (comparable to zone 1) are to be of the certified safe type.

5.4.9.3.6 Accumulators are to be located outside the cargo area.

5.4.9.3.7 Electrical equipment used during loading, unloading and gas-freeing during berthing and which are located outside the cargo area are to (comparable to zone 2) be at least of the “limited explosion risk” type.

5.4.9.3.7.1 This provision does not apply to:

a) lighting installations in the accommodation, except for switches near entrances to accommodation;

b) radiotelephone installations in the accommodation or the wheelhouse;

c) mobile and fixed telephone installations in the accommodation or the wheelhouse;

d) electrical installations in the accommodation, the wheelhouse or the service spaces outside the cargo areas if:

A. These spaces are fitted with a ventilation system ensuring an overpressure of 0.1 [kPa] (0.001 bar) and none of the windows is capable of being opened; the air intakes of the ventilation system are to be located as far away as possible, however, not less than 6 [m] from the cargo area and not less than 2 [m] above the deck;

B. The spaces are fitted with a gas detection system with sensors:

i. at the suction inlets of the ventilation system;

ii. directly at the top edge of the sill of the entrance doors of the accommodation and service spaces;

C. The gas concentration measurement is continuous;

D. When the gas concentration reaches 20% of the lower explosive limit, the ventilators are switched off. In such a case and when the overpressure is not maintained or in the event of failure of the gas detection system, the electrical installations which do not comply with 5.4.9.3.7 above, are to be switched off. These operations are to be performed immediately and automatically and activate the emergency lighting in the accommodation, the wheelhouse and the service spaces, which is to comply at least with the "limited explosion risk" type. The switching-off is to be indicated in the accommodation and wheelhouse by visual and audible signals;

E. The ventilation system, the gas detection system and the alarm of the switch-off device fully comply with the requirements of 5.4.9.3.7 above;

F. The automatic switch-off device is set so that no automatic switching-off may occur while the vessel is under way.

e) Inland AIS (automatic identification systems) stations in the accommodation and in the wheelhouse if no part of an aerial for electronic apparatus is situated above the cargo area and if no part of a VHF antenna for AIS stations is situated within 2 [m] from the cargo area.

5.4.9.3.8 The electrical equipment which does not meet the requirements set out in 5.4.9.3.7.1 above together with its switches are to be marked in red. The disconnection of such equipment is to be operated from a centralised location on board.

5.4.9.3.9 An electric generator which is permanently driven by an engine and which does not meet the requirements of 5.4.9.3.7.1 above, is to be fitted with a switch capable of shutting down the excitation of the generator. A notice board with the operating instructions is to be displayed near the switch.

5.4.9.3.10 Sockets for the connection of signal lights and gangway lighting are to be permanently fitted to the vessel close to the signal mast or the gangway. Connecting and disconnecting is not to be possible except when the sockets are not live.

5.4.9.3.11 The failure of the power supply for the safety and control equipment is to be immediately indicated by visual and audible signals at the locations where the alarms are usually actuated.

5.4.9.4 Earthing

5.4.9.4.1 The metal parts of electrical appliances in the cargo area which are not live as well as protective metal tubes or metal sheaths of cables in normal service are to be earthed, unless they are so arranged that they are automatically earthed by bonding to the metal structure of the vessel.

5.4.9.4.2 The provisions of 5.4.9.4.1 above apply also to equipment having service voltages of less than 50 [V].

5.4.9.4.3 Independent cargo tanks are to be earthed.

5.4.9.4.4 Receptacles for residual products are to be capable of being earthed.

5.4.9.5 Electrical cables

5.4.9.5.1 All cables in the cargo area are to have a metallic sheath.

5.4.9.5.2 Cables and sockets in the cargo area are to be protected against mechanical damage.

5.4.9.5.3 Movable cables are prohibited in the cargo area, except for intrinsically safe electric circuits or for the supply of signal lights, gangway lighting

5.4.9.5.4 Cables of intrinsically safe circuits are only to be used for such circuits and are to be separated from other cables not intended for being used in such circuits (e.g. they are not to be installed together in the same string of cables and they are not to be fixed by the same cable clamps).

5.4.9.5.5 For movable cables intended for signal lights, gangway lighting, only sheathed cables of type H 07 RN-F in accordance with IEC publication-60 245-4 (1994) or cables of at least equivalent design having conductors with a cross-section of not less than 1.5 [mm^2] is to be used. These cables are to be as short as possible and installed so that damage is not likely to occur.

5.4.9.5.6 The cables required for the electrical equipment referred to in

5.5.9.3.2 and 5.5.9.3.3 are accepted in cofferdams, double-hull spaces, double bottoms, hold spaces and service spaces below deck. When the vessel is only authorized to carry substances for which no antiexplosion protection is required in column (17) of Table C in Chapter 3.2 of ADN, cable penetration is permitted in the hold spaces.

5.4.10 Inspection and Testing

5.4.10.1 Pressure tests

5.4.10.1.1 The cargo tanks, residual cargo tanks, cofferdams, piping of loading and unloading, with the exception of discharge hoses are subjected to initial tests before being put into service and thereafter at prescribed intervals.

5.4.10.1.2 Where a heating system is provided inside the cargo tanks, the heating coils are to be subjected to initial tests before being put into service and thereafter at prescribed intervals

5.4.10.1.3 The test pressure for the cargo tanks and residual cargo tanks is not to be less than 1.3 times the design pressure. The test pressure for the cofferdams and open cargo tanks is to be not less than 10 [kPa] gauge pressure.

5.4.10.1.4 The test pressure for piping for loading and unloading is to be not less than 1000 [kPa] gauge pressure.

5.4.10.1.5 The maximum intervals for the periodic teats is to be 11 years.

5.5 Requirements for Type C Tankers

5.5.1 General

5.5.1.1 Application

5.5.1.1.1 Requirements of this subsection are applicable to Type C tankers.

5.5.2 Arrangement

5.5.2.1 Protection against the penetration of gases

5.5.2.1.1 The vessel is to be designed so as to prevent gases from penetrating into the accommodation and the service spaces.

5.5.2.1.2 Outside the cargo area, the lower edges of door-openings in the sidewalls of superstructures and the coamings of access hatches to under-deck spaces are to have a height of not less than 0.50 [m] above the deck. This requirement need not be complied with if the wall of the superstructures facing the cargo area extends from one side of the vessel to the other and has doors the sills of which have a height of not less than 0.50 [m]. The height of this wall is not to be less than 2.00 [m]. In this case, the lower edges of door-openings in the sidewalls of superstructures and of coamings of access hatches behind this wall are to have a height of not less than 0.10 [m]. The sills of engine room doors and the coamings of its access hatches are to, however, always have a height of not less than 0.50 [m].

5.5.2.1.3 In the cargo area, the lower edges of door-openings in the sidewalls of superstructures are to have a height of not less than 0.50 [m] above the deck and the sills of hatches and ventilation openings of premises located under the deck are to have a height of not less than 0.50 [m] above the deck. This requirement does not apply to access openings to double-hull and double bottom spaces.

5.5.2.1.4 The bulwarks, foot-rails, etc. are to be provided with sufficiently large openings which are located directly above the deck.

5.5.2.2 Ventilation

5.5.2.2.1 Each hold space is to have two openings, the dimensions and location of which are to be such as to permit effective ventilation of any part of the hold space. If there are no such openings, it is to be possible to fill the hold spaces with inert gas or dry air.

5.5.2.2.2 Double-hull spaces and double bottoms within the cargo area which are not arranged for being filled with ballast water, hold spaces and cofferdams are to be provided with ventilation systems.

5.5.2.2.3 Any service spaces located in the cargo area below deck are to be provided with a system of forced ventilation with sufficient power for ensuring at least 20 changes of air per hour based on the volume of the space. The ventilation exhaust ducts are to extend down to 50 [mm] above the bottom of the service space. The air is to be supplied through a duct at the top of the service space. The air inlets are to be located not less than 2 [m] above the deck, at a distance of not less than 2 [m] from tank openings and 6 [m] from the outlets of safety valves. The extension pipes, which may be necessary, may be of the hinged type.

5.5.2.2.4 Ventilation of accommodation and service spaces is to be possible.

5.5.2.2.5 Ventilators used in the cargo area are to be designed so that no sparks may be emitted on contact of the impeller blades with the housing and no static electricity may be generated.

5.5.2.2.6 Notice boards are to be fitted at the ventilation inlets indicating the conditions when they are to be closed. Any ventilation inlets of accommodation and service spaces leading outside are to be fitted with fire flaps. Such ventilation inlets are to be located not less than 2 [m] from the cargo area. Ventilation inlets of service spaces in the cargo area may be located within such area.

5.5.2.2.7 The flame-arresters prescribed in 5.5.2.6.4, 5.5.3.2.5, 5.5.3.2.6, 5.5.3.2.7, 5.5.8.4, 5.5.8.5, 5.5.8.6 and 5.5.8.7 are to be of a type approved for this purpose by IRS.

5.5.2.3 Engine rooms

5.5.2.3.1 Internal combustion engines for the vessel's propulsion as well as internal combustion engines for auxiliary machinery is to be located outside the cargo area. Entrances and other openings of engine rooms are to be at a distance of not less than 2 [m] from the cargo area. The engine rooms are to be accessible from the deck; the entrances are not to face the cargo area.

5.5.2.3.2 Where the doors are not located in a recess whose depth is at least equal to the door width, the hinges are to face the cargo area.

5.5.2.4 Accommodation and service spaces

5.5.2.4.1 Accommodation spaces and the wheelhouse are to be located outside the cargo area forward of the fore vertical plane or abaft the aft vertical plane bounding the part of the cargo area below deck. Windows of the wheelhouse which are located not less than 1 [m] above the bottom of the wheelhouse may tilt forward.

5.5.2.4.2 Entrances to spaces and openings of superstructures are not to face the cargo area. Doors opening outward and not located in a recess the depth of which is at least equal to the width of the doors are to have their hinges face the cargo area.

5.5.2.4.3 Entrances from the deck and openings of spaces facing the weather are to be capable of being closed. The following instruction is to be displayed at the entrance of such spaces:

DO NOT OPEN DURING LOADING, UNLOADING AND DEGASSING

WITHOUT PERMISSION.

CLOSE IMMEDIATELY.

5.5.2.4.4 Entrances and windows of superstructures and accommodation spaces which can be opened as well as other openings of these spaces are to be located not less than 2 [m] from the cargo area. No wheelhouse doors and windows are to be located within 2 [m] from the cargo area, except where there is no direct connection between the wheelhouse and the accommodation.

5.5.2.4.5 Penetrations

5.5.2.4.5.1 Driving shafts of the bilge or ballast pumps in the cargo area may penetrate through the bulkhead between the service space and the engine room, provided the arrangement of the service space is in compliance with 5.5.3.1.16, 5.5.3.1.17, 5.5.3.1.18 and 5.5.3.1.19.

5.5.2.4.5.2 The penetration of the shaft through the bulkhead is to be gastight and is to be approved by IRS.

5.5.2.4.5.3 The necessary operating instructions are to be displayed.

5.5.2.4.5.4 Penetrations through the bulkhead between the engine room and the service space in the cargo area and the bulkhead between the engine room and the hold spaces may be provided for electrical cables, hydraulic and piping for measuring, control and alarm systems, provided that the penetration are approved by IRS. The penetrations are to be gastight. Penetrations through a bulkhead with an "A-60" fire protection insulation according to SOLAS 74, Chapter II-2, Regulation 3, are to have an equivalent fire protection.

5.5.2.4.5.5 Pipes may penetrate the bulkhead between the engine room and the service space in the cargo area provided that these are pipes between the mechanical equipment in the engine room and the service space which do not have any openings within the service space and which are provided with shut-off devices at the bulkhead in the engine room.

5.5.2.4.5.6 Notwithstanding 5.5.3.1.14, pipes from the engine room may pass through the service space in the cargo area or a cofferdam or a hold space or a double-hull space to the outside provided that within the service space or cofferdam or hold space or doublehull space they are of the thick-walled type and have no flanges or openings.

5.5.2.4.5.7 Where a driving shaft of auxiliary machinery penetrates through a wall located above the deck the penetration is to be gastight.

5.5.2.4.6 A service space located within the cargo area below deck is not to be used as a cargo pump room for the loading and unloading system, except where:

- the pump room is separated from the engine room or from service spaces outside the cargo area by a cofferdam or a bulkhead with an “A-60” fire protection insulation according to SOLAS 74, Chapter II-2, Regulation 3, or by a service space or a hold space;
- the “A-60” bulkhead required above does not include penetrations referred to in 6.5.7.5.1;
- ventilation exhaust outlets are located not less than 6 [m] from entrances and openings of the accommodation and service spaces outside the cargo area;
- the access hatches and ventilation inlets can be closed from the outside;
- all piping for loading and unloading as well as those of stripping systems are provided with shut-off devices at the pump suction side in the cargo pump-room immediately at the bulkhead. The necessary operation of the control devices in the pump-room, starting of pumps and necessary control of the liquid flow rate is to be effected from the deck;
- the bilge of the cargo pump-room is equipped with a gauging device for measuring the filling level which activates a visual and audible alarm in the wheelhouse when liquid is accumulating in the cargo pump-room bilge;
- the cargo pump-room is provided with a permanent gas–detection system which automatically indicates the presence of explosive gases or lack of oxygen by means of direct-measuring sensors and which actuates a visual and audible alarm when the gas concentration has reached 20% of the lower explosive limit. The sensors of this system are to be placed at suitable positions at the bottom and directly below the deck. Measurement is to be continuous. The audible and visual alarms are installed in the wheelhouse and in the cargo pumproom and, when the alarm is actuated, the loading and unloading system is shut down. Failure of the gas detection system is to be immediately signalled in the wheelhouse and on deck by means of audible and visual alarms;
- the ventilation system prescribed in 5.5.2.2.3 has a capacity of not less than 30 changes of air per hour based on the total volume of the service space.

5.5.2.4.7 The following instruction is to be displayed at the entrance of the cargo pump-room:

BEFORE ENTERING THE CARGO PUMP-ROOM CHECK WHETHER

IT IS FREE FROM GASES AND CONTAINS SUFFICIENT OXYGEN.

DO NOT OPEN DOORS AND ENTRANCE OPENINGS WITHOUT

PERMISSION.

LEAVE IMMEDIATELY IN THE EVENT OF ALARM.

5.5.2.5 Inerting facility

5.5.2.5.1 In cases in which inerting or blanketing of the cargo is prescribed, the vessel is to be equipped with an inerting system.

5.5.2.5.2 This system is to be capable of maintaining a permanent minimum pressure of 7 [kPa] (0.07 bar) in the spaces to be inerted. In addition, the inerting system is not to increase the pressure in the cargo tank to a pressure greater than that at which the pressure valve is regulated. The set pressure of the vacuum-relief valve is to be 3.5 [kPa] (0.035 bar).

5.5.2.5.3 A sufficient quantity of inert gas for loading or unloading is to be carried or produced on board if it is not possible to obtain it on shore. In addition, a sufficient quantity of inert gas to offset normal losses occurring during carriage is to be on board.

5.5.2.5.4 The premises to be inerted are to be equipped with connections for introducing the inert gas and monitoring systems so as to ensure the correct atmosphere on a permanent basis.

5.5.2.5.5 When the pressure or the concentration of inert gas in the gaseous phase falls below a given value, this monitoring system is to activate an audible and visible alarm in the wheelhouse. When the wheelhouse is unoccupied, the alarm is to also be perceptible in a location occupied by a crew member.

5.5.2.6 Cofferdam Arrangements

5.5.2.6.1 Cofferdams or cofferdam compartments remaining once a service space has been arranged in accordance with 5.5.3.1.16, 5.5.3.1.17, 5.5.3.1.18 and 5.5.3.1.19 are to be accessible through an access hatch.

5.5.2.6.2 Cofferdams are to be capable of being filled with water and emptied by means of a pump. Filling is to be effected within 30 minutes. These requirements are not applicable when the bulkhead between the engine room and the cofferdam comprises fire-protection insulation “A-60” in accordance with SOLAS 74, Chapter II-2, Regulation 3, or has been fitted out as a service space. The cofferdams are not to be fitted with inlet valves.

5.5.2.6.3 No fixed pipe is to permit connection between a cofferdam and other piping of the vessel outside the cargo area.

5.5.2.6.4 When the list of substances on the vessel contains substances for which protection against explosion is required in column (17) of Table C of Chapter 3.2 of ADN, the ventilation openings of cofferdams are to be fitted with a flame-arrester withstanding a deflagration.

5.5.2.7 Engines

5.5.2.7.1 Only internal combustion engines running on fuel with a flashpoint of more than 55º C are allowed. This provision does not apply to internal combustion engines which are part of propulsion and auxiliary systems. These systems are to meet the requirements of IRS Classification Note “*Natural Gas Fuelled Vessels for Coastal and Inland Waters*”.

5.5.2.7.2 Ventilation inlets of the engine room, and when the engines do not take in air directly from the engine room, air intakes of the engines are to be located not less than 2 [m] from the cargo area.

5.5.2.7.3 Sparking is not to be possible within the cargo area.

5.5.2.7.4 The surface temperature of the outer parts of engines used during loading or unloading operations, as well as that of their air inlets and exhaust ducts is not to exceed the allowable temperature according to the temperature class of the substances carried. This provision does not apply to engines installed in service spaces provided the provisions of 5.5.9.3.7 are fully complied with.

5.5.2.7.5 The ventilation in the closed engine room is to be designed so that, at an ambient temperature of 20 °C, the average temperature in the engine room does not exceed 40º C.

5.5.2.8 Oil fuel tanks

5.5.2.8.1 Where the vessel is provided with hold spaces, the double bottoms within these spaces may be arranged as oil fuel tanks, provided their depth is not less than 0.6 [m]. Oil fuel pipes and openings of such tanks are not permitted in the hold space.

5.5.2.8.2 The open ends of the air pipes of all oil fuel tanks are to extend to not less than 0.5 [m] above the open deck. Their open ends and the open ends of overflow pipes leading to the deck are to be fitted with a protective device consisting of a gauze diaphragm or a perforated plate.

5.5.2.9 Exhaust pipes

5.5.2.9.1 Exhausts are to be evacuated from the vessel into the open air either upwards through an exhaust pipe or through the shell plating. The exhaust outlet is to be located not less than 2 [m] from the cargo area. The exhaust pipes of engines are to be arranged so that the exhausts are led away from the vessel. The exhaust pipes are not to be located within the cargo area.

5.5.2.9.2 Exhaust pipes are to be provided with a device preventing the escape of sparks, e.g. spark arresters.

5.5.2.10 Bilge pumping and ballasting arrangements

5.5.2.10.1 Bilge and ballast pumps for spaces within the cargo area are to be installed within such area.

This provision does not apply to:

- double-hull spaces and double bottoms which do not have a common boundary wall with the cargo tanks;
- cofferdams, double-hull spaces, hold spaces and double bottoms where ballasting is carried out using the piping of the fire-fighting system in the cargo area and bilge pumping is performed using eductors.

5.5.2.10.2 Where the double bottom is used as a liquid oil fuel tank, it is not to be connected to the bilge piping system.

5.5.2.10.3 Where the ballast pump is installed in the cargo area, the standpipe and its outboard connection for suction of ballast water is to be located within the cargo area but outside the cargo tanks.

5.5.2.10.4 A cargo pump-room below deck is to be capable of being drained in an emergency by an installation located in the cargo area and independent from any other installation. This installation is to be provided outside the cargo pump-room.

5.5.3 Cargo Containment

5.5.3.1 Hold spaces and cargo tanks

5.5.3.1.1 The maximum permissible capacity of a cargo tank is to be determined in accordance with the following table:

Table 4: Tank Sizes

Loa x Boa x D, in m^3	Maximum permissible capacity of a cargo tank (m^3)
≤ 600	Loa x Boa x D x 0.3
600 – 3750	180 + (Loa x Boa x D – 600) x 0.0635
> 3750	380

where:

L_{OA} X B_{OA} X D : Product of the tank vessel main dimensions, in [m^3]

L_{OA} : overall length of the hull, in [m]

B_{OA} : extreme breadth in [m]

D : Shortest vertical distance between the top of the keel and the lowest point of the deck at the side of the vessel; (moulded depth) within the cargo area in [m].

5.5.3.1.2 Alternative constructions in compliance with Chapter 9, 9.3.4 of ADN are acceptable

5.5.3.1.3 The relative density of the substances to be carried is to be taken into consideration in the design of the cargo tanks. The maximum relative density is to be indicated in the certificate of approval;

5.5.3.1.4 When the vessel is provided with pressure cargo tanks, these tanks are to be designed for a working pressure of 400 [kPa] (4 bar);

5.5.3.1.5 The cargo tank is to comply with the following:

- For vessels with a length of not more than 50 [m], the length of a cargo tank is not to exceed 10 [m];
- For vessels with a length of more than 50 [m], the length of a cargo tank is not to exceed 0.20 L;

  This provision does not apply to vessels with independent built–in cylindrical tanks having a length to diameter ratio ≤ 7.

5.5.3.1.6 In the cargo area (except cofferdams) the vessel is to be designed as a flush–deck double-hull vessel, with double-hull spaces and double bottoms, but without a trunk; Cargo tanks independent of the vessel's hull and refrigerated cargo tanks may only be installed in a hold space which is bounded by double-hull spaces and double bottoms in accordance with 5.5.3.1.20 below. The cargo tanks are not to extend beyond the deck. Refrigerated cargo tank fastenings are to meet the requirements 3.6.4.

5.5.3.1.7 The cargo tanks independent of the vessel's hull are to be fixed so that they cannot float;

5.5.3.1.8 The capacity of a suction well is to be limited to not more than 0.10 [m^3].

5.5.3.1.9 Side–struts linking or supporting the load-bearing components of the sides of the vessel with the load-bearing components of the longitudinal walls of cargo tanks and side–struts linking the load-bearing components of the vessel's bottom with the tank-bottom are prohibited;

5.5.3.1.10 A local recess in the cargo deck, contained on all sides, with a depth greater than 0.1 [m], designed to house the loading and unloading pump, is permitted if it fulfils the following conditions:

- The recess is not to be greater than 1 [m] in depth;

- The recess is to be located not less than 6 [m] from entrances and openings to accommodation and service spaces outside the cargo area;
- The recess is to be located at a minimum distance from the side plating equal to one quarter of the vessel's breadth;
- All pipes linking the recess to the cargo tanks are to be fitted with shut-off devices fitted directly on the bulkhead;
- All the controls required for the equipment located in the recess are to be activated from the deck;
- If the recess is deeper than 0.5 [m], it is to be provided with a permanent gas detection system which automatically indicates the presence of explosive gases by means of direct-measuring sensors and actuates a visual and audible alarm when the gas concentration has reached 20% of the lower explosion limit. The sensors of this system are to be placed at suitable positions at the bottom of the recess. Measurement is to be continuous;
- Visual and audible alarms are to be installed in the wheelhouse and on deck and, when the alarm is actuated, the vessel loading and unloading system is to be shut down. Failure of the gas detection system is to be immediately signalled in the wheelhouse and on deck by means of visual and audible alarms;
- It is to be possible to drain the recess using a system installed on deck in the cargo area and independent of any other system;
- The recess is to be provided with a level alarm device which activates the draining system and triggers a visual and audible alarm in the wheelhouse when liquid accumulates at the bottom;
- When the recess is located above the cofferdam, the engine room bulkhead is to have an 'A-60' fire protection insulation according to SOLAS 74, Chapter II-2, Regulation 3;
- When the cargo area is fitted with a water-spray system, electrical equipment located in the recess is to be protected against infiltration of water;
- Pipes connecting the recess to the hull are not to pass through the cargo tanks.

5.5.3.1.11 The cargo tanks are to be separated by cofferdams of at least 0.60 [m] in width from the accommodation, engine rooms and service spaces outside the cargo area below deck or, if there are no such accommodation, engine rooms and service spaces, from the vessel's ends. Where the cargo tanks are installed in a hold space, a space of not less than 0.50 [m] is to be provided between such tanks and the end bulkheads of the hold space. In this case an end bulkhead meeting at least the definition for Class "A-60" according to SOLAS 74, Chapter II-2, Regulation 3, is to be deemed equivalent to a cofferdam. For pressure cargo tanks, the 0.50 [m] distance may be reduced to 0.20 [m];

5.5.3.1.12 Hold spaces, cofferdams and cargo tanks are to be capable of being inspected;

5.5.3.1.13 All spaces in the cargo area are to be capable of being ventilated. Means for checking their gas-free condition is to be provided.

5.5.3.1.14 The bulkheads bounding the cargo tanks, cofferdams and hold spaces are to be watertight. The cargo tanks and the bulkheads bounding the cargo area are to have no openings or penetrations below deck. The bulkhead between the engine room and the cofferdam or service space in the cargo area or between the engine room and a hold space may be fitted with penetrations provided that they conform to the provisions of 5.5.2.4.5. The bulkhead between the cargo tank and the cargo pump-room below deck may be fitted with penetrations provided that they conform to the provisions of 5.5.2.4.6. The bulkheads between the cargo tanks may be fitted with penetrations provided that the loading or unloading piping are fitted with shut-off devices in the cargo tank from which they come. These shut-off devices are to be operable from the deck.

5.5.3.1.15 Double-hull spaces and double bottoms in the cargo area are to be arranged for being filled with ballast water only. Double bottoms may, however, be used as oil fuel tanks, provided they comply with the provisions of 5.5.2.8.

5.5.3.1.16 A cofferdam, the centre part of a cofferdam or another space below deck in the cargo area may be arranged as a service space, provided the bulkheads bounding the service space extend vertically to the bottom. This service space is only to be accessible from the deck;

5.5.3.1.17 The service space is to be watertight with the exception of its access hatches and ventilation inlets;

5.5.3.1.18 No piping for loading and unloading is to be fitted within the service space referred to under 5.5.3.1.16 above;

5.5.3.1.19 Piping for loading and unloading may be fitted in the cargo pump-rooms below deck only when they conform to the provisions of 5.5.2.4.6.

5.5.3.1.20 For double-hull construction with the cargo tanks integrated in the vessel's structure, the distance between the side wall of the vessel and the longitudinal bulkhead of the cargo tanks is to be not less than 1 [m]. The distance may be reduced to 0.80 [m], provided that, the following reinforcements have been made:

a) 25% increase in the thickness of the deck stringer plate;

b) 15% increase in the side plating thickness;

c) Arrangement of a longitudinal framing system at the vessel's side, where depth of the longitudinals are to be not less than 0.15 [m] and the longitudinals are to have a face plate with the cross-sectional area of at least 7.0 [cm^2];

d) The stringer or longitudinal framing systems are to be supported by web frames, and like bottom girders fitted with lightening holes, at a maximum spacing of 1.80 [m]. These distances may be increased if the longitudinals are strengthened accordingly.

When a vessel is built according to the transverse framing system, a longitudinal stringer system is to be arranged instead of (c) above. The distance between the longitudinal stringers is not to exceed 0.80 [m] and their depth is to be not less than 0.15 [m], provided they are completely welded to the frames. The cross-sectional area of the facebar or faceplate is to be not less than 7.0 [cm^2] as in (c) above. Where cut-outs are arranged in the stringer at the connection with the frames, the web depth of the stringer is to be increased with the depth of cut-outs.

The mean depth of the double bottoms is to be not less than 0.70 [m]. It is to be, however, never be less than 0.60 [m]. The depth below the suction wells may be reduced to 0.50 [m].

Alternative constructions in accordance with Chapter 9, 9.3.4 of ADN are acceptable.

5.5.3.1.21 When a vessel is built with cargo tanks located in a hold space or refrigerated cargo tanks, the distance between the double walls of the hold space is to be not less than 0.80 [m] and the depth of the double bottom is to be not less than 0.60 [m].

5.5.3.1.22 Where service spaces are located in the cargo area under deck, they are to be arranged so as to be easily accessible and to permit persons wearing protective clothing and breathing apparatus to safely operate the service equipment contained therein. They are to be designed so as to allow injured or unconscious personnel to be removed from such spaces without difficulties, if necessary by means of fixed equipment.

5.5.3.1.23 Cofferdams, double-hull spaces, double bottoms, cargo tanks, hold spaces and other accessible spaces within the cargo area are to be arranged so that they may be completely inspected and cleaned in an appropriate manner. The dimensions of openings except for those of double-hull spaces and double bottoms which do not have a wall adjoining the cargo tanks are to be sufficient to allow a person wearing breathing apparatus to enter or leave the space without difficulties. These openings are to have a minimum cross-sectional area of 0.36 [m^2] and a minimum side length of 0.50 [m]. They are to be designed so as to allow an injured or unconscious person to be removed from the bottom of such a space without difficulties, if necessary by means of fixed equipment. In these spaces the distance between the reinforcements are not to be less than 0.50 [m]. In double bottoms this distance may be reduced to 0.45 [m]. Cargo tanks may have circular openings with a diameter of not less than 0.68 [m].

5.5.3.2 Cargo tank openings

5.5.3.2.1 Cargo tank openings are to be located on deck in the cargo area.

5.5.3.2.2 Cargo tank openings with a cross-section of more than 0.10 [m^2] and openings of safety devices for preventing overpressures are to be located not less than 0.50 [m] above deck.

5.5.3.2.3 Cargo tank openings are to be fitted with gastight closures capable of withstanding the test pressure in accordance with 5.5.10.1.2.

5.5.3.2.4 Closures which are normally used during loading or unloading operations are not to cause sparking when operated.

5.5.3.2.5 Each cargo tank or group of cargo tanks connected to a common venting piping are to be fitted with:

- safety devices for preventing unacceptable overpressures or vacuums. When anti-explosion protection is required in column (17) of Table C of Chapter 3.2 of ADN, the vacuum valve is to be fitted with a flame arrester capable of withstanding a deflagration and the pressure–relief valve with a high-velocity vent valve capable of withstanding steady burning. The gases are to be discharged upwards. The opening pressure of the high velocity vent valve and the opening pressure of the vacuum valve is to be indelibly indicated on the valves;
- a connection for the safe return ashore of gases expelled during loading;
- a device for the safe depressurization of the tanks. When the list of substances on the vessel contains substances for which protection against explosion is required in column (17) of Table C of Chapter 3.2 of ADN, this device is to include at least a flame arrester capable of withstanding steady burning and a stop valve which clearly indicates whether it is open or shut.

5.5.3.2.6 The outlets of high-velocity vent valves are to be located not less than 2 [m] above the deck and at a distance of not less than 6 [m] from the accommodation and from the service spaces outside the cargo area. This height may be reduced when within a radius of 1 [m] round the outlet of the high-velocity vent valve, there is no equipment, no work is being carried out and signs indicate the area. The setting of the high-velocity vent valves is to be such that during the transport operation they do not blow off until the maximum permissible working pressure of the cargo tanks is reached.

5.5.3.2.7 One of the following is to be complied with:

5.5.3.2.7.1 Insofar as anti-explosion protection is prescribed in column (17) of Table C of Chapter 3.2 of ADN, venting piping connecting two or more cargo tanks is to be fitted, at the connection to each cargo tank, with a flame arrester with a fixed or spring-loaded plate stack, capable of withstanding a detonation. This equipment may consist of:

- a flame arrester fitted with a fixed plate stack, where each cargo tank is fitted with a vacuum valve capable of withstanding a deflagration and a high-velocity vent valve capable of withstanding steady burning;
- a flame arrester fitted with a spring-loaded plate stack, where each cargo tank is

fitted with a vacuum valve capable of withstanding a deflagration;

- a flame arrester with a fixed or spring-loaded plate stack;
- a flame arrester with a fixed plate stack, where the pressure–measuring device is fitted with an alarm system in accordance with 5.5.5.8.1, 5.5.5.8.2 and 5.5.5.8.3;

When a fire-fighting installation is permanently mounted on deck in the cargo area and can be brought into service from the deck and from the wheelhouse, flame arresters need not be required for individual cargo tanks. Only substances which do not mix and which do not react dangerously with each other may be carried simultaneously in cargo tanks connected to a common venting piping; or,

5.5.3.2.7.2 Insofar as anti-explosion protection is prescribed in column (17) of Table C of Chapter 3.2 of ADN, venting piping connecting two or more cargo tanks are to be fitted, at the connection to each cargo tank, with a pressure/vacuum relief valve incorporating a flame arrester capable of withstanding a detonation/deflagration. Only substances which do not mix and which do not react dangerously with each other may be carried simultaneously in cargo tanks connected to a common venting piping; or,

5.5.3.2.7.3 Insofar as anti-explosion protection is prescribed in column (17) of Table C of Chapter 3.2 of ADN, an independent venting piping for each cargo tank, fitted with a vacuum valve incorporating a flame arrester capable of withstanding a deflagration and a high velocity vent valve incorporating a flame arrester capable of withstanding steady burning. Several different substances may be carried simultaneously;or,

5.5.3.2.7.4 Insofar as anti-explosion protection is prescribed in column (17) of Table C of Chapter 3.2 of ADN, venting piping connecting two or more cargo tanks are to be fitted, at the connection to each cargo tank, with a shut-off device capable of withstanding a detonation, where each cargo tank is fitted with a vacuum valve capable of withstanding a deflagration and a high-velocity vent valve capable of withstanding steady burning.

Only substances which do not mix and which do not react dangerously with each other may be carried simultaneously in cargo tanks connected to a common venting piping.

5.5.4 Stability

5.5.4.1 General

5.5.4.1.1 Proof of sufficient stability is to be submitted including for stability in damaged condition.

5.5.4.1.2 The basic values for the stability calculation, the vessel's lightweight and location of the centre of gravity, are to be determined either by means of an inclining experiment or by detailed mass and moment calculation. In the latter case the lightweight of the vessel is to be checked by means of a lightweight test with a tolerance limit of ± 5% between the mass determined by calculation and the displacement determined by the draught readings.

5.5.4.1.3 Proof of sufficient intact stability is to be submitted for all stages of loading and unloading and for the final loading condition for all the relative densities of the substances transported contained in the list of cargoes. For every loading operation, taking account of the actual fillings and floating position of cargo tanks, ballast tanks and compartments, drinking water and sewage tanks and tanks containing products for the operation of the vessel, the vessel is to comply with the intact and damage stability requirements. Intermediate stages during operations are also to be taken into consideration. The proof of sufficient stability is to be shown for every operating, loading and ballast condition in the stability booklet, to be approved. If it is unpractical to pre-calculate the operating, loading and ballast conditions, an approved loading instrument is to be installed and used which contains the contents of the stability booklet.

5.5.4.1.4 Floatability after damage is to be proved for the most unfavourable loading condition. For this purpose, calculated proof of sufficient stability is to be established for critical intermediate stages of flooding and for the final stage of flooding.

5.5.4.2 Intact stability

5.5.4.2.1 The requirements for intact stability resulting from the damage stability calculation are to be fully complied with.

5.5.4.2.2 For vessels with cargo tanks of more than 0.70 B in width, proof is to be submitted that the following stability requirements have been complied with:

a) In the positive area of the righting lever curve up to immersion of the first non-watertight opening there is to be a righting lever (GZ) of not less than 0.10 [m];

b) The surface of the positive area of the righting lever curve up to immersion of the first non-watertight opening and in any event up to an angle of heel < 27°is not to be less than 0.024 [m.rad];

c) The metacentric height (GM) is to be not less than 0.10 [m].

These conditions are to be met bearing in mind the influence of all free surfaces in tanks for all stages of loading and unloading.

5.5.4.2.3 The most stringent requirement of 5.5.4.2.1 and 5.5.4.2.2 is applicable to the vessel.

5.5.4.3 Damage stability

5.5.4.3.1 The following assumptions are to be taken into consideration for the damaged condition:

a) extent of side damage:

Longitudinal extent:	At least 0.10 LOA, but not less than 5 [m]
Transverse extent :	0.79 [m] inboard from the vessel's side at right angles to the centerline at the level corresponding to the maximum draught , or when applicable, the distance allowed by sec Chapter 9, 9.3.4 of ADN, reduced by 0.01[m]
Vertical extent :	From the base line upwards without limit

b) extent of bottom damage:

Longitudinal extent:	At least 0.10 L_{OA}, but not less than 5 [m]
Transverse extent :	3 [m]
Vertical extent :	From the base 0.59[m] upwards, the sump excepted

c) Any bulkhead within the damaged area is to be assumed damaged, which means that the location of bulkheads is to be chosen to ensure that the vessel remains afloat after the flooding of two or more adjacent compartments in the longitudinal direction.

The following provisions are applicable:

- For bottom damage, adjacent athwartship compartments are also to be assumed flooded
- the lower edge of any non-watertight opening (e.g. windows, doors and access hatchways), at the final stage of flooding, is to be not less than 0.10 [m] above the damage waterline.
- In general, permeability is to be assumed to be 95%. Where an average permeability of less than 95% is calculated for any compartment, this calculated value obtained may be used. However, minimum values of permeability, μ, given in **Table 5** are to be used. For the main engine room, only the one-compartment standard need be taken into account, i.e. the end bulkheads of the engine room are to be assumed as not damaged.

Table 5: Permeability	
Engine Room	85%
Accommodation	95%
Double Bottom, Oil Fuel Tanks, Ballast Tanks, etc. depending on whether, according to their function, they have to be assumed as full or empty for vessel floating at the maximum permissible draft	0% or 95%

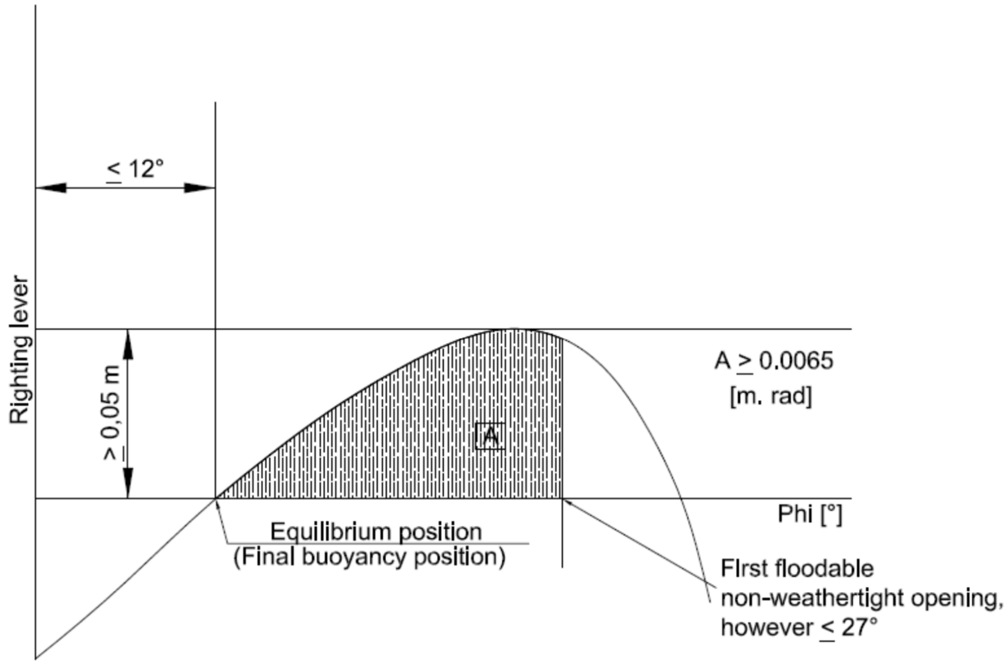
5.5.4.3.2 For the intermediate stage of flooding the following criteria have to be fulfilled:

GZ≥0.03[m]

Range of positive GZ: 5˚

5.5.4.3.3 At the stage of equilibrium (in the final stage of flooding), the angle of heel is not to exceed 12°. Non-watertight openings are not to be flooded before reaching the stage of equilibrium. If such openings are immersed before the stage of equilibrium, the corresponding spaces are to be considered flooded for the purpose of stability calculation.

5.5.4.3.4 The positive range of the righting lever curve beyond the stage of equilibrium is to have a righting lever of ≥ 0.05 [m] in association with an area under the curve of ≥ 0.0065 [m.rad]. The minimum values of stability are to be satisfied up to immersion of the first non-weathertight openings and in any event up to an angle of heel ≤ 27°. If nonwatertight openings are immersed before that stage, the corresponding spaces are to be considered flooded for the purpose of stability calculation.



5.5.4.3.5 If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances are to be marked accordingly.

5.5.4.3.6 Where cross- or down-flooding openings are provided for reduction of unsymmetrical flooding, the time of equalization is not to exceed 15 min, provided during the intermediate stages of flooding sufficient stability has been proved.

5.5.5 Safety and control installations

5.5.5.1 Cargo tanks are to be provided with the following equipment:

a) a mark inside the tank indicating the liquid level of 95%;

b) a level gauge;

c) a level alarm device which is activated at the latest when a degree of filling of 90% is reached;

d) a high level sensor for actuating the facility against overflowing at the latest when a degree of filling of 97.5% is reached;

e) an instrument for measuring the pressure of the vapour phase inside the cargo tank;

f) an instrument for measuring the temperature of the cargo, if in column (9) of Table C of Chapter 3.2 of ADN a heating installation is required, or if a maximum temperature is indicated in column (20) of that list;

g) a connection for a closed-type or partly closed-type sampling device, and/or at least one sampling opening as required in column (13) of Table C of Chapter 3.2 of ADN.

5.5.5.2 When the degree of filling in per cent is determined, an error of not more than 0.5% is permitted. It is to be calculated on the basis of the total cargo tank capacity including the expansion trunk.

5.5.5.3 The level gauge is to allow readings from the control position of the shut-off devices of the particular cargo tank. The permissible maximum filling levels of 95% and 97%, as given in the list of substances, are to be marked on each level gauge. Permanent reading of the overpressure and vacuum is to be possible from a location from which loading or unloading operations may be interrupted. The permissible maximum overpressure and vacuum are to be marked on each level gauge. Readings are to be possible in all weather conditions.

5.5.5.4 The level alarm device is to give a visual and audible warning on board when actuated. The level alarm device is to be independent of the level gauge.

5.5.5.5 High Level Sensors

5.5.5.5.1 The high level sensor referred to in 5.5.5.1d) above is to give a visual and audible alarm on board and at the same time actuate an electrical contact which in the form of a binary signal interrupts the electric current loop provided and fed by the shore facility, thus initiating measures at the shore facility against overflowing during loading operations. The signal is to be transmitted to the shore facility via a watertight two–pin plug of a connector device in accordance with standard EN 60309 for direct current of 40 to 50 volts, identification colour white, position of the nose 10 h. The plug is to be permanently fitted to the vessel close to the shore connections of the loading and unloading piping.

5.5.5.5.2 The high level sensor is also to be capable of switching off the vessel's own discharging pump.

5.5.5.5.3 The high level sensor is to be independent of the level alarm device, but it may be connected to the level gauge.

5.5.5.5.4 During discharging by means of the on-board pump, it is to be possible for the shore facility to switch it off. For this purpose, an independent intrinsically safe power line, fed by the vessel, is to be switched off by the shore facility by means of an electrical contact. It is to be possible for the binary signal of the shore facility to be transmitted via a watertight two–pole socket or a connector device in accordance with standard EN 60309, for direct current of 40 to 50 volts, identification colour white, position of the nose 10 h. This socket is to be permanently fitted to the vessel close to the shore connections of the unloading piping.

5.5.5.6 Vessels which may be delivering products required for operation of vessels are to be equipped with a transhipment facility compatible with European standard EN 12827:1999 and a rapid closing device enabling refuelling to be interrupted. It is to be possible to actuate this rapid closing device by means of an electrical signal from the overflow prevention system. The electrical circuits actuating the rapid closing device are to be secured according to the quiescent current principle or other appropriate error detection measures. The state of operation of electrical circuits which cannot be controlled using the quiescent current principle are to be capable of being easily checked. It is to be possible to actuate the rapid closing device independently of the electrical signal. The rapid closing device is to actuate a visual and audible alarm on board.

5.5.5.7 The visual and audible signals given by the level alarm device are to be clearly distinguishable from those of the high level sensor. The visual alarm is to be visible at each control position on deck of the cargo tank stop valves. It is to be possible to easily check the functioning of the sensors and electric circuits or these are to be “intrinsically safe apparatus”.

5.5.5.8 Cargo tank pressure and temperature monitoring

5.5.5.8.1 When the pressure or temperature exceeds a set value, instruments for measuring the vacuum or overpressure of the gaseous phase in the cargo tank or the temperature of the cargo, is to activate a visual and audible alarm in the wheelhouse. When the wheelhouse is unoccupied the alarm is also to be perceptible in a location occupied by a crew member.

5.5.5.8.2 When the pressure exceeds the set value during loading and unloading, the instrument for measuring the pressure is to, by means of the plug referred to in 5.5.5.5 and 5.5.5.6 above, initiate immediately an electrical contact which is to put into effect measures to interrupt the loading or unloading operation. If the vessel's own discharge pump is used, it is to be switched off automatically. The instrument for measuring the overpressure or vacuum is to activate the alarm at latest when an overpressure is reached equal to 1.15 times the opening pressure of the pressure relief device, or a vacuum pressure equal to the construction vacuum pressure but not exceeding 5 [kPa] (0.05 bar). The maximum allowable temperature is indicated in column (20) of Table C of Chapter 3.2 of ADN. The sensors for the alarms mentioned in this paragraph may be connected to the alarm device of the sensor.

5.5.5.8.3 When it is prescribed in column (20) of Table C of Chapter 3.2 of ADN, the instrument for measuring the overpressure of the gaseous phase is to activate a visible and audible alarm in the wheelhouse when the overpressure exceeds 40 [kPa] (0.4 bar) during the voyage. When the wheelhouse is unoccupied, the alarm is also to be perceptible in a location occupied by a crew member.

5.5.5.9 Where the control elements of the shut-off devices of the cargo tanks are located in a control room, it is to be possible to stop the loading pumps and read the level gauges in the control room, and the visual and audible warning given by the level alarm device, the high level sensor referred to in 5.5.5.1d) and the instruments for measuring the pressure and temperature of the cargo are to be noticeable in the control room and on deck. Satisfactory monitoring of the cargo area is to be ensured from the control room.

5.5.5.10 The vessel is to be so equipped that loading or unloading operations can be interrupted by means of switches, i.e. the quick-action stop valve located on the flexible vessel–to–shore connecting line must be capable of being closed. The switch is to be placed at two points on the vessel (fore and aft). This provision applies only when prescribed in column (20) of Table C of Chapter 3.2 of ADN. The interruption system is to be designed according to the quiescent current principle.

5.5.5.11 When refrigerated substances are carried the opening pressure of the safety system is to be determined by the design of the cargo tanks. In the event of the transport of substances that must be carried in a refrigerated state the opening pressure of the safety system is to be not less than 25 [kPa] (0.25 bar) greater than the maximum pressure calculated according to 5.5.6.2.

5.5.6 Cargo Pressure and Temperature Control

5.5.6.1 Requirements for maintenance of cargo pressure and temperature

5.5.6.1.1 Unless the entire cargo system is designed to resist the full effective vapour pressure of the cargo at the upper limits of the ambient design temperatures, the pressure of the tanks is to be kept below the permissible maximum set pressure of the safety valves, by one or more of the following means:

a) a system for the regulation of cargo tank pressure using mechanical refrigeration;

b) a system ensuring safety in the event of the heating or increase in pressure of the cargo. The insulation or the design pressure of the cargo tank, or the combination of these two elements, is to be such as to leave an adequate margin for the operating period and the temperatures expected; in each case the system is to be deemed acceptable by IRS and is to ensure safety for a minimum time of three times the operation period;

5.5.6.1.2 The systems prescribed in 5.5.6.1.1 are to be constructed, installed and tested to the satisfaction of IRS. The materials used in their construction are to be compatible with the cargoes to be carried. For normal service, the upper ambient design temperature limits are to be:

Air: +45° C;

Water: +32° C.

5.5.6.1.3 The cargo storage system is to be capable of resisting the full vapour pressure of the cargo at the upper limits of the ambient design temperatures, whatever the system adopted to deal with the boil-off gas. This requirement is indicated by remark 37 in column (20) of Table C of Chapter 3.2 of ADN.

5.5.6.2 Refrigeration system

5.5.6.2.1 The refrigeration system referred to in 5.5.6.1.1a) is to be composed of one or more units capable of keeping the pressure and temperature of the cargo at the upper limits of the ambient design temperatures at the prescribed level. Unless another means of regulating cargo pressure and temperature deemed satisfactory by IRS is provided, provision is to be made for one or more stand-by units with an output at least equal to that of the largest prescribed unit. A stand-by unit is to include a compressor, its engine, its control system and all necessary accessories to enable it to operate independently of the units normally used.

Provision is to be made for a stand-by heat-exchanger unless the system's normal heat-exchanger has a surplus capacity equal to at least 25% of the largest prescribed capacity. It is not necessary to make provision for separate piping. Cargo tanks, piping and accessories are to be insulated so that, in the event of a failure of all cargo refrigeration systems, the entire cargo remains for at least 52 hours in a condition not causing the safety valves to open.

5.5.6.2.2 The security devices and the connecting lines from the refrigeration system are to be connected to the cargo tanks above the liquid phase of the cargo when the tanks are filled to their maximum permissible degree of filling. They are to remain within the gaseous phase, even if the vessel has a list up to 12 degrees.

5.5.6.2.3 When several refrigerated cargoes with a potentially dangerous chemical reaction are carried simultaneously, particular care is to be given to the refrigeration systems to prevent any mixing of the cargoes. For the carriage of such cargoes, separate refrigeration systems, each including the full stand-by unit referred to in 5.5.6.2.1, is to be provided for each cargo. When, however, refrigeration is ensured by an indirect or combined system and no leak in the heat exchangers can under any foreseeable circumstances lead to the mixing of cargoes, no provision need be made for separate refrigeration units for the different cargoes.

5.5.6.2.4 When several refrigerated cargoes are not soluble in each other under conditions of carriage such that their vapour pressures are added together in the event of mixing, particular care is to be given to the refrigeration systems to prevent any mixing of the cargoes.

5.5.6.2.5 When the refrigeration systems require water for cooling, a sufficient quantity is to be supplied by a pump or pumps used exclusively for the purpose. This pump or pumps are to have at least two suction pipes, leading from two water intakes, one to port, the other to starboard. Provision is to be made for a stand-by pump with a satisfactory flow; this may be a pump used for other purposes provided that its use for supplying water for cooling does not impair any other essential service.

5.5.6.2.6 The refrigeration system may take one of the following forms:

a) Direct system: the cargo vapours are compressed, condensed and returned to the cargo tanks. This system is not to be used for certain cargoes specified in Table C of Chapter 3.2 of ADN. This requirement is indicated by remark 35 in column (20) of Table C of Chapter 3.2 of ADN;

b) Indirect system: the cargo or the cargo vapours are cooled or condensed by means of a coolant without being compressed;

c) Combined system: the cargo vapours are compressed and condensed in a cargo/coolant heat-exchanger and returned to the cargo tanks. This system is not to be used for certain cargoes specified in Table C of Chapter 3.2 of ADN. This requirement is indicated by remark 36 in column (20) of Table C of Chapter 3.2 of ADN.

5.5.6.2.7 All primary and secondary coolant fluids are to be compatible with each other and with the cargo with which they may come into contact. Heat exchange may take place either at a distance from the cargo tank, or by using cooling coils attached to the inside or the outside of the cargo tank.

5.5.6.2.8 When the refrigeration system is installed in a separate service space, this service space is to meet the requirements of 5.5.2.4.6.

5.5.6.2.9 For all cargo systems, the heat transmission coefficient as used for the determination of the holding time is to be determined by calculation. Upon completion of the vessel, the correctness of the calculation is to be checked by means of a heat balance test. The calculation and test is to be performed under supervision by IRS. The heat transmission coefficient is to be documented and kept on board. The heat transmission coefficient is to be verified at every renewal of the certificate of approval.

5.5.6.3 Cargo heating system

5.5.6.3.1 Boilers, which are used for heating the cargo, are to be fueled with a liquid fuel having a flashpoint of more than 55 °C. They are to be placed either in the engine room or in another separate space below deck and outside the cargo area, which is accessible from the deck or from the engine room.

5.5.6.3.2 The cargo heating system is to be designed so that the cargo cannot penetrate into the boiler in the case of a leak in the heating coils. A cargo heating system with artificial draught is to be ignited electrically.

5.5.6.3.3 The ventilation system of the engine room is to be designed taking into account the air required for the boiler.

5.5.6.3.4 Where the cargo heating system is used during loading, unloading or gas-freeing, the service space which contains this system is to fully comply with the requirements of 5.5.9.3.7. This requirement does not apply to the inlets of the ventilation system. These inlets are to be located at a minimum distance of 2 [m] from the cargo area and 6 [m] from the openings of cargo tanks or residual cargo tanks, loading pumps situated on deck, openings of high velocity vent valves, pressure relief devices and shore connections of loading and unloading piping and must be located not less than 2 [m] above the deck. The requirements of 5.5.9.3.7.are not applicable to the unloading of substances having a flash point of 60 [°C] or more when the temperature of the product is at least 15 K lower at the flash point.

5.5.6.4 Water-spray system

5.5.6.4.1 When water-spraying is required in column (9) of Table C of Chapter 3.2 of ADN, a water-spray system is to be installed in the cargo area on deck to enable gas emissions from loading to be precipitated and to cool the tops of cargo tanks by spraying water over the whole surface so as to avoid safely the activation of the high-velocity vent valve at 50 [kPa] (0.5 bar). The gas precipitation system is to be fitted with a connection device for supply from a shore installation.

5.5.6.4.2 The spray nozzles are to be so installed that the entire cargo deck area is covered and the gases released are precipitated safely. The system is to be capable of being put into operation from the wheelhouse and from the deck. Its capacity is to be such that when all the spray nozzles are in operation, the outflow is not less than 50 litres per square metre of deck area and per hour.

5.5.7 Pumps and piping

5.5.7.1 Pumps, compressors and accessory loading and unloading piping are to be placed in the cargo area. Cargo pumps are to be capable of being shut down from the cargo area and, in addition, from a position outside the cargo area. Cargo pumps situated on deck are to be located not less than 6 [m] from entrances to, or openings of, the accommodation and service spaces outside the cargo area.

5.5.7.2 Piping for loading and unloading is to be independent of any other piping of the vessel. No cargo piping is to be located below deck, except those inside the cargo tanks and inside the cargo pump-room.

5.5.7.3 The piping for loading and unloading is to be arranged so that, after loading or unloading operations, the liquid remaining in these pipes may be safely removed and may flow either into the vessel’s tanks or the tanks ashore.

5.5.7.4 Piping for loading and unloading is to be clearly distinguishable from other piping, e.g. by means of colour marking.

5.5.7.5 The piping for loading and unloading located on deck, with the exception of the shore connections, is to be located not less than a quarter of the vessel's breadth from the outer shell.

5.5.7.6 The shore connections are to be located not less than 6 [m] from the entrances to, or openings of, the accommodation and service spaces outside the cargo area.

5.5.7.7 Each shore connection of the venting piping and shore connections of the piping for loading and unloading, through which the loading or unloading operation is carried out, is to be fitted with a shut-off device. However, each shore connection is to be fitted with a blind flange when it is not in operation.

5.5.7.8 The flanges and stuffing boxes are to be provided with a spray protection device.

5.5.7.9 Piping for loading and unloading, and venting piping, are not to have flexible connections fitted with sliding seals.

5.5.7.10 The distance referred to in 5.5.7.1 and 5.5.7.6 may be reduced to 3 [m] if a transverse bulkhead complying with 5.5.2.1.2 is situated at the end of the cargo area. The openings are to be provided with doors. The following notice is to be displayed on the doors:

DO NOT OPEN DURING LOADING AND UNLOADING WITHOUT

PERMISSION.

CLOSE IMMEDIATELY.

5.5.7.11 Every component of the piping for loading and unloading are to be electrically connected to the hull.

5.5.7.12 The piping for loading is to extend down to the bottom of the cargo tanks.

5.5.7.13 The stop valves or other shut-off devices of the piping for loading and unloading are to indicate whether they are open or shut.

5.5.7.14 The piping for loading and unloading is to have, at the test pressure, the required elasticity, leakproofness and resistance to pressure.

5.5.7.15 The piping for loading and unloading is to be fitted with pressure gauges at the outlet of the pumps. The permissible maximum overpressure or vacuum value is to be indicated on each measuring device. Readings are to be possible in all weather conditions.

5.5.7.16 When piping for loading and unloading are used for supplying the cargo tanks with washing or ballast water, the suctions of these pipes are to be located within the cargo area but outside the cargo tanks. Pumps for tank washing systems with associated connections may be located outside the cargo area, provided the discharge side of the system is arranged in such a way that the suction is not possible through that part. A spring-loaded non-return valve is to be provided to prevent any gases from being expelled from the cargo area through the tank washing system.

5.5.7.17 A non-return valve is to be fitted at the junction between the water suction pipe and the cargo loading pipe.

5.5.7.18 The permissible loading and unloading flows are to be calculated. Calculations concern the permissible maximum loading and unloading flow for each cargo tank or each group of cargo tanks, taking into account the design of the ventilation system. These calculations are to take into consideration the fact that in the event of an unforeseen cut–off of the vapour return piping of the shore facility, the safety devices of the cargo tanks will prevent pressure in the cargo tanks from exceeding the following values:

- over–pressure: 115% of the opening pressure of the high-velocity vent valve;
- vacuum pressure: not more than the construction vacuum pressure but not exceeding 5 [kPa] (0.05 bar).

The main factors to be considered are the following:

a) Dimensions of the ventilation system of the cargo tanks;

b) Gas formation during loading: multiply the largest loading flow by a factor of not less than 1.25;

c) Density of the vapour mixture of the cargo based on 50% volume vapour and 50% volume air;

d) Loss of pressure through ventilation pipes, valves and fittings. Account will be taken of a 30% clogging of the mesh of the flame-arrester;

e) Chocking pressure of the safety valves.

The permissible maximum loading and unloading flows for each cargo tank or for each group of cargo tanks are to be given in an on-board instruction.

5.5.7.19 Compressed air generated outside the cargo area or wheelhouse can be used in the cargo area subject to the installation of a spring-loaded non-return valve to ensure that no gases can escape from the cargo area through the compressed air system into accommodation or service spaces outside the cargo area.

5.5.7.20 If the vessel is carrying several dangerous substances liable to react dangerously with each other, a separate pump with its own piping for loading and unloading is to be installed for each substance. The piping is not to pass through a cargo tank containing dangerous substances with which the substance in question is liable to react.

5.5.8 Tanks and receptacles for residual products and receptacles for slops

5.5.8.1 If vessels are provided with a tank for residual products, it is to comply with the provisions of 5.5.8.3, 5.5.8.4, 5.5.8.5, 5.5.8.6 and 5.5.8.7.Receptacles for residual products and receptacles for slops are to be located only in the cargo area. During the filling of the receptacles for residual products, means for collecting any leakage is to be placed under the filling connections.

5.5.8.2 Receptacles for slops are to be fire resistant and are to be capable of being closed with lids. The receptacles for slops are to be marked and be easy to handle.

5.5.8.3 The maximum capacity of a tank for residual products is 30 [m^3].

5.5.8.4 The tank for residual products is to be equipped with:

- pressure-relief and vacuum relief valves.

  The high velocity vent valve is to be so regulated as not to open during carriage. This condition is met when the opening pressure of the valve meets the conditions set out in column (10) of Table C of Chapter 3.2 of ADN; When anti-explosion protection is required in column (17) of Table C of Chapter 3.2 of ADN, the vacuum-relief valve is to be capable of withstanding deflagrations and the highvelocity vent valve is to withstand steady burning;

- a level indicator;

- connections with shut-off devices, for pipes and hose assemblies.

5.5.8.5 Receptacles for residual products are to be equipped with:

- a connection enabling gases released during filling to be evacuated safely;
- a possibility of indicating the degree of filling;
- connections with shut-off devices, for pipes and hose assemblies.

5.5.8.6 Receptacles for residual products are to be connected to the venting piping of cargo tanks only for the time necessary to fill them. During the filling of the receptacle, released gases are to be safely evacuated.

5.5.8.7 Receptacles for residual products and receptacles for slops placed on the deck are to be located at a minimum distance from the hull equal to one quarter of the vessel's breadth.

5.5.9 Requirements for Electrical Installations

5.5.9.1 Documents concerning electrical installations

5.5.9.1.1 In addition to the other required documentations, the following documents are to be on board:

a) a drawing indicating the boundaries of the cargo area and the location of the electrical equipment installed in this area;

b) a list of the electrical equipment referred to in (a) above including the following particulars: machine or appliance, location, type of protection, type of protection against explosion, testing body and approval number;

c) a list of or general plan indicating the electrical equipment outside the cargo area which may be operated during loading, unloading or gas-freeing. All other electrical equipment is to be marked in red. See 5.5.9.3.7 and 5.5.9.3.8.

5.5.9.2 Electrical installations

5.5.9.2.1 Only distribution systems without return connection to the hull are permitted.

This provision does not apply to:

- active cathodic corrosion protection;

- certain limited sections of the installations situated outside the cargo area (e.g. connections of starters of diesel engines);
- the device for checking the insulation level referred to in 5.5.9.2.2 below.

5.5.9.2.2 Every insulated distribution network is to be fitted with an automatic device with a visual and audible alarm for checking the insulation level.

5.5.9.2.3 For the selection of electrical equipment to be used in zones presenting an explosion risk, the explosion groups and temperature classes assigned to the substances carried in accordance with columns (15) and (16) of Table C of Chapter 3.2 of ADN is to be taken into consideration.

5.5.9.3 Type and location of electrical equipment

5.5.9.3.1 Only the following equipment may be installed in cargo tanks, residual cargo tanks, and piping for loading and unloading (comparable to zone 0):

- measuring, regulation and alarm devices of the EEx (ia) type of protection.

5.5.9.3.2 Only the following equipment may be installed in the cofferdams, double-hull spaces, double bottoms and hold spaces (comparable to zone 1):

- measuring, regulation and alarm devices of the certified safe type;
- lighting appliances of the “flame-proof enclosure” or “apparatus protected by pressurization” type of protection;
- hermetically sealed echo sounding devices the cables of which are led through thick-walled steel tubes with gastight connections up to the main deck;
- cables for the active cathodic protection of the shell plating in protective steel tubes such as those provided for echo sounding devices.

The following equipment may be installed only in double-hull spaces and double bottoms if used for ballasting:

- Permanently fixed submerged pumps with temperature monitoring, of the certified safe type.

5.5.9.3.3 Only the following equipment may be installed in the service spaces in the cargo area below deck (comparable to zone 1):

- measuring, regulation and alarm devices of the certified safe type;
- lighting appliances of the “flame-proof enclosure” or “apparatus protected by pressurization” type of protection;
- motors driving essential equipment such as ballast pumps with temperature monitoring; they are to be of the certified safe type.

5.5.9.3.4 The control and protective equipment of the electrical equipment referred to in paragraphs 5.5.9.3.1, 5.5.9.3.2 and 5.5.9.3.3 above is to be located outside the cargo area if they are not intrinsically safe.

5.5.9.3.5 The electrical equipment in the cargo area on deck (comparable to zone 1) is to be of the certified safe type.

5.5.9.3.6 Accumulators are to be located outside the cargo area.

5.5.9.3.7 Electrical equipment used during loading, unloading and gas-freeing during berthing and which are located outside the cargo area are to (comparable to zone 2) be at least of the “limited explosion risk” type.

5.5.9.3.7.1 This provision does not apply to:

a) lighting installations in the accommodation, except for switches near entrances to accommodation;

b) radiotelephone installations in the accommodation or the wheelhouse;

c) mobile and fixed telephone installations in the accommodation or the wheelhouse;

d) electrical installations in the accommodation, the wheelhouse or the service spaces outside the cargo areas if:

A. These spaces are fitted with a ventilation system ensuring an overpressure of 0.1 [kPa] (0.001 bar) and none of the windows is capable of being opened; the air intakes of the ventilation system are to be located as far away as possible, however, not less than 6 [m] from the cargo area and not less than 2 [m] above the deck;

B. The spaces are fitted with a gas detection system with sensors:

i. at the suction inlets of the ventilation system;

ii. directly at the top edge of the sill of the entrance doors of the accommodation and service spaces;

C. The gas concentration measurement is continuous;

D. When the gas concentration reaches 20% of the lower explosive limit, the ventilators are switched off. In such a case and when the overpressure is not maintained or in the event of failure of the gas detection system, the electrical installations which do not comply with 5.5.9.3.7 above, are to be switched off. These operations are to be performed immediately and automatically and activate the emergency lighting in the accommodation, the wheelhouse and the service spaces, which is to comply at least with the "limited explosion risk" type. The switching-off is to be indicated in the accommodation and wheelhouse by visual and audible signals;

E. The ventilation system, the gas detection system and the alarm of the switch-off device fully comply with the requirements of 5.5.9.3.7 above;

F. The automatic switch-off device is set so that no automatic switching-off may occur while the vessel is under way.

e) Inland AIS (automatic identification systems) stations in the accommodation and in the wheelhouse if no part of an aerial for electronic apparatus is situated above the cargo area and if no part of a VHF antenna for AIS stations is situated within 2 [m] from the cargo area.

5.5.9.3.8 The electrical equipment which does not meet the requirements set out in 5.5.9.3.7 above together with its switches are to be marked in red. The disconnection of such equipment is to be operated from a centralised location on board.

5.5.9.3.9 An electric generator which is permanently driven by an engine and which does not meet the requirements of 5.5.9.3.7 above, is to be fitted with a switch capable of shutting down the excitation of the generator. A notice board with the operating instructions is to be displayed near the switch.

5.5.9.3.10 Sockets for the connection of signal lights and gangway lighting are to be permanently fitted to the vessel close to the signal mast or the gangway. Connecting and disconnecting is not to be possible except when the sockets are not live.

5.5.9.3.11 The failure of the power supply for the safety and control equipment is to be immediately indicated by visual and audible signals at the locations where the alarms are usually actuated.

5.5.9.4 Earthing

5.5.9.4.1 The metal parts of electrical appliances in the cargo area which are not live as well as protective metal tubes or metal sheaths of cables in normal service are to be earthed, unless they are so arranged that they are automatically earthed by bonding to the metal structure of the vessel.

5.5.9.4.2 The provisions of 5.5.9.4.1 above apply also to equipment having service voltages of less than 50 V.

5.5.9.4.3 Independent cargo tanks are to be earthed.

5.5.9.4.4 Receptacles for residual products are to be capable of being earthed.

5.5.9.5 Electrical cables

5.5.9.5.1 All cables in the cargo area are to have a metallic sheath.

5.5.9.5.2 Cables and sockets in the cargo area are to be protected against mechanical damage.

5.5.9.5.3 Movable cables are prohibited in the cargo area, except for intrinsically safe electric circuits or for the supply of signal lights, gangway lighting.

5.5.9.5.4 Cables of intrinsically safe circuits are only to be used for such circuits and are to be separated from other cables not intended for being used in such circuits (e.g. they are not to be installed together in the same string of cables and they are not to be fixed by the same cable clamps).

5.5.9.5.5 For movable cables intended for signal lights, gangway lighting, , only sheathed cables of type H 07 RN-F in accordance with IEC publication-60 245-4 (1994) or cables of at least equivalent design having conductors with a cross-section of not less than 1.5 [mm^2] is to be used. These cables are to be as short as possible and installed so that damage is not likely to occur.

5.5.9.5.6 The cables required for the electrical equipment referred to in 5.5.9.3.2 and 5.5.9.3.3 are accepted in cofferdams, double-hull spaces, double bottoms, hold spaces and service spaces below deck. When the vessel is only authorized to carry substances for which no antiexplosion protection is required in column (17) of Table C in Chapter 3.2 of ADN, cable penetration is permitted in the hold spaces.

5.5.10 Inspection and Testing

5.5.10.1 Pressure tests

5.5.10.1.1 The cargo tanks, residual cargo tanks, cofferdams, piping for loading and unloading are to be subjected to initial tests before being put into service and thereafter at prescribed intervals. Where a heating system is provided inside the cargo tanks, the heating coils are to be subjected to initial tests before being put into service and thereafter at prescribed intervals.

5.5.10.1.2 The test pressure for the cargo tanks and residual cargo tanks is to be not less than 1.3 times the construction pressure. The test pressure for the cofferdams and open cargo tanks is to be not less than 10 [kPa] (0.10 bar) gauge pressure.

5.5.10.1.3 The test pressure for piping for loading and unloading is to be not less than 1000 [kPa] (10 bar) gauge pressure.

5.5.10.1.4 The maximum intervals for the periodic tests is to be 11 years.

5.5.10.1.5 The procedure for pressure testis to be approved by IRS.

Section 6

Vessels Carrying Dangerous Cargoes in Gaseous State (Type G Vessels)

6.1 Application

6.1.1 This section applies to propelled and non-propelled tankers of Types G, intended for the carriage of dangerous liquids of Class 2 in bulk.

6.2 Documents to be Submitted

6.2.1 Following plans and documents are to be submitted in addition to the documents required in the other parts of the rules for the parts of the vessel not affected by the cargo, as applicable.

6.2.1.1 For Approval

a) Gas-dangerous zones plan.

b) Location of void spaces and accesses to dangerous zones

c) Air locks between safe and dangerous zones.

d) Ventilation duct arrangement in gas-dangerous spaces and adjacent zones.

e) Details of hull structure in way of cargo tanks, including support arrangement for tanks, saddles, anti-floating and anti-lifting devices, deck sealing arrangements, etc.

f) Calculation of the hull temperature in all the design cargo conditions.

g) Intact and damage stability calculations.

h) Scantlings, material and arrangement of the cargo containment system.

i) Details of insulation.

j) Details of ladders, fittings and towers in tanks and relative stress analysis, if any.

k) Details of tank domes and deck sealings.

l) Plans and calculations of safety relief valves.

m) Details of cargo handling and vapour system, including arrangements and details of piping and fitting.

n) Details of cargo pumps and cargo compressors.

o) Details of process pressure vessels and relative valving arrangement.

p) Bilge and ballast system in cargo area.

q) Gas freeing system in cargo tanks including inert gas system.

r) Ventilation system in cargo area.

s) Refrigeration plant system diagram, if any.

t) Water spray system diagram.

u) Details of electrical equipment installed in cargo area, including the list of certified safe equipment and apparatus and electrical bonding of cargo tanks and piping.

v) Schematic electrical wiring diagram in cargo area.

w) Gas detection system.

x) Cargo tank instrumentation, including cargo and hull temperature monitoring system.

y) Emergency shutdown system.

z) Details of fire-extinguishing appliances and systems in cargo area.

aa) Arrangement drawing of the various fire bulkheads and decks with standard fire test reports for the various arrangements, surface coverings, paints and similar.

bb) Loading and unloading operation description, including cargo tank filling limits.

6.2.1.2 For Information

a) Design characteristics of products to be carried, including maximum density, maximum vapour pressure, maximum liquid temperature and other important design conditions.

b) General arrangement plan, showing location of cargo tanks and fuel oil, ballast and other tanks.

6.3 Materials of Construction

6.3.1 Materials and grades of steel are to comply with the requirements of Part 2 Inspection and Testing of Materials and as required by the individual vessel type. The independent cargo tanks may also be constructed of other materials, provided these have at least equivalent properties and resistance against the effects of temperature and fire.

6.3.2 Every part of the vessel including any installation and equipment which may come into contact with the cargo is to consist of materials which can neither be dangerously affected by the cargo nor cause decomposition of the cargo or react with it so as to form harmful or hazardous products. In case this aspect has not been examined during classification and inspection of the vessel a relevant reservation is to be entered in the list of cargoes .

6.3.3 The use of wood, aluminium alloys or plastic materials within the cargo area is not allowed, except where explicitly permitted as below or in the certificate of approval:

- The use of wood, aluminium alloys or plastic materials within the cargo area is only permitted for:
  - gangways and external ladders;
  - movable items of equipment;
  - chocking of cargo tanks which are independent of the vessel's hull and chocking of installations and equipment;
  - masts and similar round timber;
  - engine parts;
  - parts of the electrical installation;
  - lids of boxes which are placed on the deck.
- The use of wood or plastic materials within the cargo area is only permitted for:
  - supports and stops of any kind.
- The use of plastic materials or rubber within the cargo area is only permitted for:
  - all kinds of gaskets (e.g. for dome or hatch covers);
  - electric cables;
  - hose assemblies for loading and unloading;
  - insulation of cargo tanks and of piping for loading and unloading;
  - photo-optical copies of the certificate of approval.
- All permanently fitted material in the accommodation or wheelhouse, with the exception of furniture, is not to evolve fumes or toxic gases in dangerous quantities, if involved in a fire.

6.3.4 The paint used in the cargo area is not to be liable to produce sparks in case of impact.

6.3.5 The use of plastic materials for the vessel's boats is permitted only of the material does not readily ignite.

6.3.6 To avoid corrosive attack of the cargo tank structure by chemical cargoes, it is strongly recommended the structure be protected by suitable lining or coating.

6.3.7 The suitability of the lining or coating and its compatibility with the intended cargoes is the responsibility of the Builder and Owner. IRS will require the confirmation of the manufacturer that the lining or coating used to protect the cargo tank structure is compatible with the cargoes mentioned in list of cargoes.

6.4 Requirements for Type G Vessel

6.4.1 General

6.4.1.1 Application

6.4.1.1.1 Requirements of this subsection are applicable to Type G tankers.

6.4.2 Arrangement

6.4.2.1 Protection against Penetration of Gases

6.4.2.1.1 The vessel is to be designed so as to prevent gases from penetrating into the accommodation and the service spaces.

6.4.2.1.2 Outside the cargo area, the lower edges of door-openings in the sidewalls of superstructures and the coaming of access hatches to under-deck spaces are to have a height of not less than 0.50 [m] above the deck. This requirement need not be complied with if the wall of the superstructures facing the cargo area extends from one side of the vessel to the other and has doors the sills of which have a height of not less than 0.50 [m]. The height of this wall is not to be less than 2 [m]. In this case, the lower edges of door-openings in the sidewalls of superstructures and the coamings of access hatches behind this wall are to have a height of not less than 0.10 [m]. The sills of engine room doors and the coamings of its access hatches are to, however, always have a height of not less than 0.50 [m].

6.4.2.1.3 In the cargo area, the lower edges of door-openings in the sidewalls of superstructures are to have a height of not less than 0.50 [m] above the deck and the sills of hatches and ventilation openings of premises located under the deck are to have a height of not less than 0.50 [m] above the deck. This requirement does not apply to access openings to double-hull and double bottom spaces.

6.4.2.1.4 The bulwarks, foot-rails, etc are to be provided with sufficiently large openings which are located directly above the deck.

6.4.2.2 Ventilation

6.4.2.2.1 Each hold space is to have two openings. The dimensions and location of these openings are to be such as to permit effective ventilation of any part of the hold space. If there are no such openings, it is to be possible to fill the hold spaces with inert gas or dry air.

6.4.2.2.2 Double-hull spaces and double bottoms within the cargo area which are not arranged for being filled with ballast water, hold spaces and cofferdams, are to be provided with ventilation systems.

6.4.2.2.3 Any service spaces located in the cargo area below deck are to be provided with a system of forced ventilation with sufficient power for ensuring at least 20 changes of air per hour based on the volume of the space.

6.4.2.2.4 The ventilation exhaust ducts are to be located up to 50 [mm] above the bottom of the service space. The air is to be supplied through a duct at the top of the service space. The air inlets are to be located not less than 2 [m] above the deck, at a distance of not less than 2[m] from tank openings and not less than 6 [m] from the outlets of safety valves. The extension pipes which may be necessary may be of the hinged type.

6.4.2.2.5 Ventilation of accommodation and service spaces is to be possible

6.4.2.2.6 Ventilators used in the cargo area are to be designed so that no sparks may be emitted on contact of the impeller blades with the housing and no static electricity may be generated.

6.4.2.2.7 Notice boards are to be fitted at the ventilation inlets indicating the conditions when they are to be closed. All ventilation inlets of accommodation and service spaces leading outside are to be fitted with fire flaps. Such ventilation inlets are to be located not less than 2 [m] from the cargo area. Ventilation inlets of service spaces in the cargo area may be located within such area.

6.4.2.3 Engine rooms

6.4.2.3.1 Internal combustion engines for the vessel’s propulsion as well as internal combustion engines for auxiliary machinery are to be located outside the cargo area. Entrances and other openings of engine rooms are to be at a distance of not less than 2 [m] from the cargo area.

6.4.2.3.2 The engine rooms are to be accessible from the deck; the entrances are not to face the cargo area. The hinges are to face the cargo area when the doors are not located in a recess whose depth is at least equal to the door width.

6.4.2.4 Accommodation and Service Spaces

6.4.2.4.1 Accommodation spaces and the wheelhouse are to be located outside the cargo area forward of the fore vertical plane or abaft the aft vertical plane bounding the part of cargo area below deck. Windows of the wheelhouse which are located not less than 1 [m] above the bottom of the wheelhouse may tilt forward.

6.4.2.4.2 Entrances to spaces and openings of superstructures are not to face the cargo area. Doors opening outward and not located in a recess the depth of which is at least equal to the width of the doors are to have their hinges facing the cargo area.

6.4.2.4.3 Entrances from the deck and openings of spaces facing the weather are to be capable of being closed. The following instruction is to be displayed at the entrance of such spaces:

"DO NOT OPEN DURING LOADING, UNLOADING OR GAS-FREEING WITHOUT PERMISSION.

CLOSE IMMEDIATELY."

6.4.2.4.4 Entrances and windows of superstructures and accommodation spaces which can be opened as well as other openings of these spaces are to be located not less than 2 [m] from the cargo area. Wheelhouse doors and windows are not to be located within 2 [m] from the cargo area, except when there is no direct connection between the wheelhouse and the accommodation.

6.4.2.4.5 Penetrations

6.4.2.4.5.1 Driving shafts of the bilge or ballast pumps may penetrate through the bulkhead between the service space and the engine room, provided the arrangement of the service space is in compliance with 6.4.3.1.15, 6.4.3.1.16 and 6.4.3.1.17.

6.4.2.4.5.2 The penetration of the shaft through the bulkhead is to be gastight and is to be approved by IRS.

6.4.2.4.5.3 The necessary operating instructions are to be displayed.

6.4.2.4.5.4 Penetrations through the bulkhead between the engine room and the service space in the cargo area, and the bulkhead between the engine room and the hold spaces may be provided for electrical cables, hydraulic and piping for measuring, control and alarm systems, provided that the penetrations are approved by IRS. The penetrations are to be gastight. Penetrations through a bulkhead with an “A-60” fire protection insulation according to SOLAS 74 Ch II-2, Reg 3, are to have an equivalent fire protection.

6.4.2.4.5.5 Pipes may penetrate the bulkhead between the engine room and the service space in the cargo area provided that these are pipes between the mechanical equipment in the engine room and the service space which do not have any openings within the service space and which are provided with shut-off devices at the bulkhead in the engine room.

6.4.2.4.5.6 Notwithstanding 6.4.3.1.13, pipes from the engine room may penetrate the service space in the cargo area or a cofferdam or a hold space or a double hull space to the outside provided that within the service space or cofferdam or hold space or double-hull space they are of the thick-walled type and have no flanges or openings.

6.4.2.4.5.7 Where a driving shaft of auxiliary machinery penetrates through a wall located above the deck the penetration is to be gastight.

6.4.2.4.6 A service space located within the cargo area below deck is not to be used as a cargo pump room for the vessel’s own gas discharging system, e.g. compressors or the compressor/ heat exchanger/ pump combination, except where:

- the pump-room is separated from the engine room or from service spaces outside the cargo area by a cofferdam or a bulkhead with an “A-60” fire protection insulation according to SOLAS 74, Ch II-2 Reg 3, or by a service space or a hold space;
- the “A-60” bulkhead required above does not include penetrations referred to in 6.4.2.4.5.1;
- ventilation exhaust outlets are located not less than 6.0 [m] from entrances and openings of the accommodation and service spaces outside the cargo area;
- the access hatches and ventilation inlets can be closed from the outside;

- all piping for loading and unloading (at the suction side and delivery side) are led throught the deck above the pump room. The necessary operation of the control devices in the pump room, starting of pumps or compressors and necessary control of the liquid flow rate is to be effected from the deck;
- the system is fully integrated in the gas and liquid piping system;
- the cargo pump room is provided with a permanent gas detection system which automatically indicates the presence of explosive gases or lack of oxygen by means of direct-measuring sensors and which actuates a visual and audible alarm when the gas concentration has reached 20% of the lower explosive limit. The sensors of this system are to be placed at suitable positions at the bottom and directly below the deck. Measurement is to be continuous. The audible and visual alarms are installed in the wheelhouse and in the cargo pump room and, when the alarm is actuated, the loading and unloading system is shut down. Failure of the gas detection system is to be immediately signalled in the wheelhouse and on deck by means of audible and visual alarms;
- the ventilation system prescribed in 6.4.2.2.3 has a capacity of not less than 30 changes of air per hour based on the total volume of the service space.

6.4.2.4.7 The following instruction is to be displayed at the entrance of the cargo pump room:

"BEFORE ENTERING THE CARGO PUMP-ROOM CHECK WHETHER IT IS FREE FROM GASES AND CONTAINS SUFFICIENT OXYGEN.

DO NOT OPEN DOORS AND ENTRANCE OPENINGS WITHOUT PERMISSION.

LEAVE IMMEDIATELY IN EVENT OF ALARM."

6.4.2.5 Inerting Facility

6.4.2.5.1 In cases in which inerting or blanketing of the cargo is prescribed, the vessel is to be equipped with an inerting system.

6.4.2.5.2 This system is to be capable of maintaining a permanent minimum pressure of 7 [kPa] (0.07 bar) in the spaces to be inerted. In addition, the inerting system is not to increase the pressure in the cargo tank to a pressure greater than that at which the pressure valve is regulated. The set pressure of the vacuum-relief valve is to be 3.5 [kPa] (0.035 bar).

6.4.2.5.3 A sufficient quantity of inert gas for loading or unloading is to be carried or produced on board if it is not possible to obtain it on shore. In addition, a sufficient quantity of inert gas to offset normal losses occurring during carriage is to be on board.

6.4.2.5.4 The premises to be inerted are to be equipped with connections for introducing the inert gas and monitoring systems so as to ensure the correct atmosphere on a permanent basis.

6.4.2.5.5 When the pressure or the concentration of inert gas in the gaseous phase falls below a given value, this monitoring system is to activate an audible and visible alarm in the wheelhouse. When the wheelhouse is unoccupied, the alarm is also to be audible in a location occupied by a crew member.

6.4.2.6 Engines

6.4.2.6.1 Only internal combustion engines running on fuel with a flashpoint of more than 55 [°C] are allowed. This provision does not apply to internal combustion engines which are part of propulsion and auxiliary systems. These systems are to meet the requirements of IRS Classification Note "*Natural Gas Fuelled Vessels for Coastal and Inland Waters*".

6.4.2.6.2 Ventilation inlets of the engine room and, when the engines do not take in air directly from the engine room, the air intakes of the engines are to be located not less than 2 [m] from the cargo area.

6.4.2.6.3 Sparking is not to be possible within the cargo area.

6.4.2.6.4 The surface temperature of the outer parts of engines used during loading or unloading operations, as well as that of their air inlets and exhaust ducts are not to exceed the allowable temperature according to the temperature class of the substances carried. This provision does not apply to engines installed in service spaces provided the provisions of 6.4.8.3.7 are fully complied with.

6.4.2.6.5 The ventilation in the closed engine room is to be designed so that, at an ambient temperature of 20 [°C], the average temperature in the engine room does not exceed 40 [°C].

6.4.2.7 Oil Fuel Tanks

6.4.2.7.1 When the vessel is fitted with hold spaces and double bottoms, double bottoms within the cargo area may be arranged as oil fuel tanks, provided their depth is not less than 0.6 [m]. Oil fuel pipes and openings of such tanks are not permitted in the hold space.

6.4.2.7.2 Open ends of air pipes of all oil fuel tanks are to extend to not less than 0.5 [m] above the open deck. The open ends and the open ends of overflow pipes leading to the deck are to be fitted with a protective device consisting of a gauze diaphragm or a perforated plate.

6.4.2.8 Exhaust Pipes

6.4.2.8.1 Exhausts are to be evacuated from the vessel into the open air either upwards through an exhaust pipe or through the shell plating. The exhaust outlet is to be located not less than 2 [m] from the cargo area. The exhaust pipes of engines are to be arranged so that the exhausts are led away from the vessel. The exhaust pipes are not to be located within the cargo area.

6.4.2.8.2 Exhaust pipes of engines are to be provided with a device preventing the escape of sparks, e.g. spark arresters.

6.4.2.9 Bilge Pumping and Ballasting Arrangements

6.4.2.9.1 Bilge and ballast pumps for spaces within the cargo area are to be installed within such area. This provision does not apply to:

- double-hull spaces and double bottoms which do not have a common boundary wall with the cargo tanks;
- cofferdams and hold spaces where ballasting is carried out using the piping of the fire-fighting system in the cargo area and bilge–pumping is performed using eductors.

6.4.2.9.2 Where the double bottom is used as a liquid oil fuel tank, it is not to be connected to the bilge piping system.

6.4.2.9.3 Where the ballast pump is installed in the cargo area, the standpipe and its outboard connection for suction of ballast water is to be located within the cargo area.

6.4.2.9.4 It is to be possible for an under-deck pump-room to be stripped in an emergency using a system located in the cargo area and independent of any other system. This stripping system is to be located outside the pump-room.

6.4.3 Cargo Containment

6.4.3.1 Hold Spaces and Cargo Tanks

6.4.3.1.1 The maximum permissible capacity of a cargo tank is to be determined in accordance with Table 6.

where

Table 6: Tank Sizes	
L_{OA} x B_{OA} x H (m^3)	Maximum permissible capacity of a cargo tank (m^3)
< 600	L_{OA} x B_{OA} x H x 0.3
600 to 3750	180 + (L_{OA} x B_{OA} x H – 600) x 0.0635
> 3750	380

L_{OA} X B_{OA} X H : Product of the tank vessel main dimensions, in m, where :
L_{OA} : overall length of the hull, in m;
B_{OA}: Extreme breadth of the hull, in m;
H : Shortest vertical distance between the top of the keel and the lowest point of the deck at the side of the vessel (moulded depth) within the cargo area in m;
where
In the case of trunk deck vessels, H’ is to be substituted for H. H’ is to be determined by the following formula:

$$\boldsymbol{H' = H + \left(h_t \times \frac{b_t}{B} \times \frac{l_t}{L}\right)}$$

Where,
ht: Height, in m, of trunk (distance between trunk deck and main deck on trunk side measured at L/2)
bt : Trunk breadth, in [m]
lt : Trunk length, in [m]

6.4.3.1.2 Alternative constructions in accordance with Chapter 9, 9.3.4 of ADN are acceptable.

6.4.3.1.3 Length to diameter ratio of pressure tanks is not to exceed 7.

6.4.3.1.4 The pressure tanks are to be designed for a cargo temperature of + 40 [°C].

6.4.3.1.5 In the cargo area, the vessel is to be designed as follows Note 1) :

6.4.3.1.5.1 As a double bottom-hull and double bottom vessel:

6.4.3.1.5.1.1 The internal distance between the side platings of the vessel and the longitudinal bulkheads is not to be less than 0.80 [m],

6.4.3.1.5.1.2 The height of the double bottom is not to be less than 0.60 [m],

6.4.3.1.5.1.3 The cargo tanks are to be supported by saddles extending between the tanks to not less than 20° below the horizontal centreline of the cargo tanks.

6.4.3.1.5.1.4 Refrigerated cargo tanks and cargo tanks used for the transport of refrigerated liquefied gases are to be installed only in hold spaces bounded by double-hull spaces and double-bottom. Cargo tank fastenings are to meet the requirements of IRS (See 3.6.4).

6.4.3.1.5.2 As a single-hull vessel:

6.4.3.1.5.2.1 With the side platings of the vessel between gangboard and top of floor plates provided with side stringers at regular intervals of not more than 0.60 [m] which are supported by web frames spaced at intervals of not more than 2 [m];

6.4.3.1.5.2.2 The side stringers and the web frames are to have a height of not less than 10% of the depth, however, not less than 0.30 [m];

6.4.3.1.5.2.3 The side stringers and web frames are to be fitted with a face plate made of flat steel and having a cross-section of not less than that of 7.5 [cm^2] and 15 [cm^2], respectively;

6.4.3.1.5.2.4 The distance between the sideplating of the vessel and the cargo tanks are to be not less than 0.80 [m]and between the bottom and the cargo tanks not less than 0.60 [m]. The depth below the suction wells may be reduced to 0.50 [m];

6.4.3.1.5.2.5 The lateral distance between the suction well of the cargo tanks and the bottom structure is to be not less than 0.10 [m];

6.4.3.1.5.2.6 The cargo tank supports and fastenings are to extend not less than 10° below the horizontal centreline of the cargo tanks.

Note 1) : Alternatively, for a different design of the hull in the cargo area, proof is to be submitted by way of calculations that in the event of a lateral collision with another vessel having a straight bow, an energy of 22 [MJ] can be absorbed without any rupture of the cargo tanks and the piping leading to the cargo tanks. Alternative construction in accordance with Chapter 9, 9.3.4 of ADN are acceptable.

6.4.3.1.6 The cargo tanks are to be fixed so that they cannot float.

6.4.3.1.7 The capacity of suction well is to be limited to not more than 0.10 [m^3]. For pressure cargo tanks, however, the capacity of a suction well may be of 0.20 [m^3].

6.4.3.1.8 Side-struts linking or supporting the load-bearing components of the sides of the vessel with the load-bearing components of the longitudinal walls of cargo tanks and side-struts linking the load-bearing components of the vessel's bottom with the tank bottom are not to be provided.

6.4.3.1.9 Cargo tanks intended to contain products at a temperature below -10 [°C] are to be suitably insulated to ensure that the temperature of the vessel's structure does not fall below the minimum allowable design temperature. The insulation material is to be resistant to flame spread.

6.4.3.1.10 The hold spaces are to be separated from the accommodation, engine rooms and service spaces outside the cargo area below deck by bulkheads provided with a Class A-60 fire protection insulation according to SOLAS 74, Chapter II-2, Regulation 3. A space of not less than 0.20 [m] is to be provided between the cargo tanks and the tank bulkheads of the tank spaces. Where the cargo holds have plane end bulkheads, this space is not to be less than 0.50[m].

6.4.3.1.11 The hold spaces and cargo tanks are to be capable of being supported.

6.4.3.1.12 All spaces in the cargo region are to be capable of being ventilated. Means for checking their gas free condition are to be provided.

6.4.3.1.13 The bulkheads bounding the cargo tanks, cofferdams and hold spaces are to be watertight. The cargo tanks and the bulkheads bounding the cargo area are to have no openings or penetrations below deck. The bulkhead between the engine room and the service spaces within the cargo area or between the engine room and a hold space may be fitted with penetrations provided that they conform to the provisions of 6.4.2.4.5

6.4.3.1.14 Double-hull spaces and double bottoms in the cargo area are to be arranged for being filled with ballast water only. Double bottoms may, however, be used as fuel tanks, provided they comply with the requirements of 6.4.2.7.

6.4.3.1.15 A space in the cargo area below deck may be arranged as a service space, provided that the bulkhead bounding the service space extends vertically to the bottom and the bulkhead not facing the cargo area extends from one side of the vessel to the other in one frame plane. This service space is only to be accessible from the deck.

6.4.3.1.16 The service space is to be watertight with the exception of its access hatches and ventilation inlets.

6.4.3.1.17 No piping for loading or unloading is to be fitted within the service space referred to in 6.4.3.1.15 above. Piping for loading and unloading may be fitted in the cargo pump rooms below deck only when they comply with the requirements in 6.4.2.4.6

6.4.3.1.18 Where service spaces are located in the cargo area under deck, they are to be arranged so as to be easily accessible and to permit persons wearing protective clothing and breathing apparatus to safely operate the service equipment contained therein. They are to be designed so as to allow injured or unconscious personnel to be removed from such spaces without difficulty, if necessary by means of fixed equipment.

6.4.3.1.19 Hold spaces and other accessible spaces within the cargo area are to be arranged so that they may be completely inspected and cleaned in an appropriate manner. The dimensions of openings except for those of double hull spaces and double bottoms which do not have a wall adjoining the cargo tanks are to be sufficient to allow a person wearing breathing apparatus to enter or leave the space without difficulty. These openings are to have a minimum cross-sectional area of 0.36 [m^2] and a minimum side length of 0.50 [m]. They are to be designed so as to allow an injured or unconscious person to be removed from the bottom of such a space without difficulties, if necessary by means of fixed equipment. In these spaces the distance between the reinforcements is not to be less than 0.50 [m]. In double bottoms this distance may be reduced to 0.45 [m]. Cargo tanks may have circular openings with a diameter of not less than 0.68 [m].

6.4.3.1.20 In case the vessel has insulated cargo tanks, the hold spaces are to only contain dry air to protect the insulation of the cargo tanks against moisture.

6.4.3.2 Cargo Tank Openings

6.4.3.2.1 Cargo tank openings are to be located on deck in the cargo area. Cargo tank openings with a cross-section greater than 0.10 [m^2] are to be located not less than 0.50 [m] above the deck.

6.4.3.2.2 Cargo tank openings are to be fitted with gastight closures which comply with the provisions of 6.4.9.1.1.

6.4.3.2.3 The exhaust outlets of the pressure relief valves are to be located not less than 2 [m] above the deck at a distance of not less than 6 [m] from the accommodation and from the service spaces located outside the cargo area. This height may be reduced when within a radius of 1 [m] round the pressure relief valve outlet there is no equipment, no work is being carried out and signs indicate the area.

6.4.3.2.4 The closing devices normally used in loading and unloading operations is not to be capable of producing sparks when operated.

6.4.3.2.5 Each tank in which refrigerated substances are carried is to be equipped with a safety system to prevent unauthorized vacuum or overpressure.

6.4.4 Stability

6.4.4.1 General

6.4.4.1.1 Proof of sufficient stability is to be submitted including stability in damaged condition.

6.4.4.1.2 The basic value for the stability calculation, the vessel's lightweight and location of centre of gravity, is to be determined wither by means of an inclining experiment or by detailed mass and moment calculation. In latter case the light weight of the vessel is to be checked by means of a light weight test with a tolerance limit of ±5% between the mass determined by calculation and the displacement determined by the draught readings.

6.4.4.1.3 Proof of sufficient intact stability is to be submitted for all stages of loading and unloading and for the final loading condition for all the relative densities of the substances transported contained in the list of cargoes. For every loading operation, taking account of the actual fillings and floating position of cargo tanks, ballast tanks and compartment, drinking water and sewage tanks and tanks containing products for the operation of the vessel, the vessel is to comply with the intact and damage stability requirements. Intermediate stages during operations are also to be taken into consideration. The proof of sufficient stability is to be shown for every operating, loading and ballast condition in the stability booklet, to be approved. If it is unpractical to pre-calculate the operating, loading and ballast conditions, an approved loading instrument is to be installed and used which contains the contents of the stability booklet.

6.4.4.1.4 Floatability after damage is to be proved for the most unfavorable loading condition. For this purpose, calculated proof of sufficient stability is to be established for critical intermediate stages of flooding and for the final stage of flooding.

6.4.4.2 Intact Stability

6.4.4.2.1 The requirements for intact stability resulting from the damage stability calculation is to be fully complied with.

6.4.4.2.2 For vessels with cargo tanks of more than 0.7B in width, proof is to be submitted that the following stability requirements have been complied with:

a) In the positive area of the righting lever curve up to immersion of the first non-watertight opening, righting lever(GZ) is not to be less than 0.1 [m]

b) The surface of the positive area of the righting lever curve up to immersion of the first non-watertight opening and in any event up to an angle of heel ≤27˚ is not to be less than 0.024 [m rad]

c) The metacentric height (GM) is not to be less than 0.1 [m]

These conditions are to be met bearing in mind the influence of all free surface in tanks for all stages of loading and unloading.

6.4.4.2.3 The more stringent requirement of 6.4.4.2.1 and 6.4.4.2.2 is to be applied to the vessel.

6.4.4.3 Damage Stability

6.4.4.3.1 the following assumptions are to be taken into consideration for the damaged condition.

a) extent of side damage:

Longitudinal extent :	At least 0.10 L, but not less than 5 [m]
Transverse extent :	0.79 [m] inboard from the vessel's side at right angles to the centerline at the level corresponding to the maximum draught, or when applicable, the distance allowed by sec Chapter 9, 9.3.4 of ADN, reduced by 0.01[m]
Vertical extent :	From the base line upwards without limit

b) extent of bottom damage:

Longitudinal extent :	At least 0.10 L, but not less than 5 [m]
Transverse extent :	3 [m]
Vertical extent :	From the base 0.59[m] upwards, the well excepted

c) Any bulkhead within the damaged area is to be assumed damaged, which means that the location of bulkheads is to be chosen to ensure that the vessel remains afloat after the flooding of two or more adjacent compartments in the longitudinal direction.

The following provisions are applicable:

- For bottom damage, adjacent athwartship compartments are also to be assumed flooded;
- the lower edge of any non-watertight opening (e.g. windows, doors and access hatchways), at the final stage of flooding, is to be not less than 0.10 [m] above the damage waterline;
- In general, permeability is to be assumed to be 95%. Where an average permeability of less than 95% is calculated for any compartment, this calculated value obtained may be used. However, minimum values of permeability, μ, given in Table below are to be used. For the main engine room, only the one-compartment standard need be taken into account, i.e. the end bulkheads of the engine room are to be assumed as not damaged.

Engine Room	85%
Accommodation	95%
Double Bottom, Oil Fuel Tanks, Ballast Tanks, etc. depending on whether, according to their function, they have to be assumed as full or empty for vessel floating at the maximum permissible draft	0% or 95%

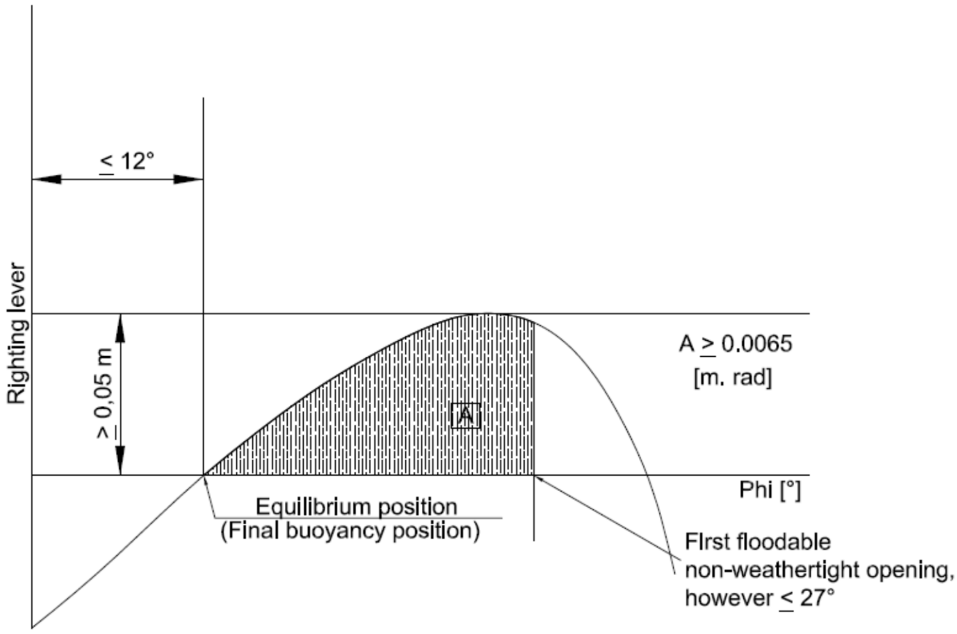
6.4.4.3.2 For the intermediate stage of flooding the following criteria have to be fulfilled:

GZ≥0.03[m]

Range of positive GZ: 5˚

6.4.4.3.3 At the stage of equilibrium (in the final stage of flooding), the angle of heel is not to exceed 12°. Non-watertight openings are not to be flooded before reaching the stage of equilibrium. If such openings are immersed before the stage of equilibrium, the corresponding spaces are to be considered flooded for the purpose of stability calculation.

6.4.4.3.4 The positive range of the righting lever curve beyond the stage of equilibrium is to have a righting lever of ≥ 0.05 [m] in association with an area under the curve of ≥ 0.0065 [m.rad]. The minimum values of stability are to be satisfied up to immersion of the first non-weathertight openings and in any event up to an angle of heel ≤ 27°. If non-watertight openings are immersed before that stage, the corresponding spaces are to be considered flooded for the purpose of stability calculation.



6.4.4.3.5 If openings through which undamaged compartments may additionally become flooded are capable of being closed watertight, the closing appliances are to be marked accordingly.

6.4.4.3.6 Where cross- or down-flooding openings are provided for reduction of unsymmetrical flooding, the time of equalization is not to exceed 15 min, provided during the intermediate stages of flooding sufficient stability has been proved.

6.4.5 Safety and Control Installations

6.4.5.1 Cargo tanks are to be provided with the following equipment:

a) a level gauge;

b) a level alarm device which is activated at the latest when a degree of filling of 86% is reached;

c) a high level sensor for actuating the facility against overflowing when a degree of filling of 97.5% is reached;

d) an instrument for measuring the pressure of the gas phase inside the cargo tank;

e) an instrument for measuring the temperature of the cargo;

f) a connection for a closed-type sampling device.

6.4.5.2 When the degree of filling in percent is determined, an error of not more than 0.5% is permitted. It is to be calculated on the basis of the total cargo tank capacity including the expansion trunk.

6.4.5.3 The level gauge is to allow readings from the control position of the shut-off devices of the particular cargo tank. The permissible maximum filling level of 91%, 95% and 97%, as given in list of substances is to be marked on each level gauge. Permanent reading of the overpressure and vacuum is to be possible from a location from which loading or unloading operations may be interrupted. The permissible maximum overpressure and vacuum is to be marked on each level gauge. Readings are to be possible in all weather conditions.

6.4.5.4 The level alarm device is to give a visual and audible warning on board when actuated. The level alarm device is to be independent of the level gauge.

6.4.5.5 High Level Sensor

6.4.5.5.1 The high level sensor referred in 6.4.5.1 c) above is to give a visual and audible alarm on board and at the same time actuate an electrical contact which in the form of a binary signal interrupts the electric current loop provided and fed by the shore facility against overflowing during loading operations. The signal is to be transmitted to the shore facility via a watertight two-pin lug of a connecter device in accordance with IEC 60309 for direct current of 40 to 50 volts, identification color white, position of the nose 10 h. The plug is to be permanently fitted to the vessel close to the shore connections of the loading and unloading piping.

6.4.5.5.2 The high level sensor is also to be capable of switching off the vessel's own discharging pump.

6.4.5.5.3 The high level sensor is to be independent of the level alarm device, but it may be connected to the level gauge.

6.4.5.5.4 During discharging by means of the on-board pump, it is to be possible for the shore facility to switch it off. For this purpose, an independent intrinsically safe power line, fed by the vessel, is to be switched off by the shore facility by means of an electrical contact. The signal is to be transmitted via arrangements as indicated in 6.4.5.5.1 above. The socket is to be permanently fitted to the vessel close to the shore connections of the loading and unloading piping.

6.4.5.6 The visual and audible signals given by the level alarm device are to be clearly distinguishable from those of the high level sensor. The visual alarm is to be visible at each control position on deck of the cargo tank stop valves. It is to be possible to easily check the functioning of the sensors and electric circuits or these are to be of the "fail safe" design.

6.4.5.7 When the pressure or the temperature exceeds a set value, the instruments for measuring the pressure and temperature of the cargo is to activate an audible and visible alarm in the wheelhouse. When the wheelhouse is unoccupied, the alarm is also to be audible in a location occupied by a crew member.

6.4.5.8 When the pressure exceeds a set value during loading or unloading, the instrument for measuring the pressure is to simultaneously initiate an electrical contact which, by means of the plug referred to in 6.4.5.5 above, enables measures to be taken to interrupt the loading and unloading operation. If the vessel's own discharge pump is used, it is to be switched off automatically. The sensors for the alarms referred to above may be connected to the alarm installation.

6.4.5.9 When the control elements of the shut-off devices of the cargo tanks are located in a control room, it is to be possible to stop the loading pumps and read the level gauges in the control room, and the visual and audible warning given by the level alarm device, the high level sensor referred to in 6.4.5.1 c) and the instruments for measuring the pressure and temperature of the cargo is to be noticeable in the control room and on deck. Satisfactory monitoring of the cargo is to be ensured from the control room.

6.4.5.10 The vessel is to be so equipped that loading or unloading operations can be interrupted by means of switches, i.e. the quick-action stop valve located on the flexible vessel-to-shore connecting line is to be capable of being closed. The switches are to be placed at two pints on the vessel (fore and aft). The interruption systems are to be designed according to the quiescent current principle.

6.4.5.11 When refrigerated substances are carried the opening pressure of the safety system is to be determined by the design of the cargo tanks. In the event of the transport of the substances that are to be carried in a refrigerated state the opening pressure of the safety system is not to be less than 25 [kPa] greater than the maximum pressure calculated according to 6.4.6.2

6.4.5.12 On vessels certified to carry refrigerated liquefied gases the following protective measures are to be provided in the cargo area:

6.4.5.12.1 Drip trays are to be installed under the shore connections of the piping for loading and unloading through which the loading and unloading operation is to be carried out. They are to be made of materials which are able to resist the temperature of the cargo and be insulated from the deck. The drip trays are to have a sufficient volume and an overboard drain.

6.4.5.12.2 A water spray system to cover:

- exposed cargo tank domes and exposed parts of cargo tanks;
- exposed on-deck storage vessels for flammable or toxic products;
- parts of the cargo deck area where a leakage may occur.

The capacity of the water spray system is to be such that when all spray nozzles are in operation, the outflow is of 300 [lit/m^2] of cargo deck area per hour. The system is to be capable of being put into operation from the wheelhouse and from the deck;

6.4.5.12.3 A water film around the shore connection of the piping for loading and unloading in use to protect the deck and the shipside in way of the shore connection of the piping for loading and unloading in use during connecting and disconnecting the loading arm or hose. The water film is to have sufficient capacity. The system is to be capable of being put into operation from the wheel house and from the deck.

6.4.5.13 Vessels carrying refrigerated liquefied gases are to have on board, for the purpose of preventing damage to the cargo tanks during loading and unloading, a written instruction for pre-cooling. This instruction is to be applied before the vessel is put into operation and after long term maintenance.

6.4.6 Cargo Pressure and Temperature Control

6.4.6.1 Requirements for maintenance of cargo pressure and temperature

6.4.6.1.1 Unless the entire cargo system is designed to resist the full effective vapour pressure of the cargo at the upper limits of the ambient design temperatures, the pressure of the tanks is to be kept below the permissible maximum set pressure of the safety valves, by one or more of the following means:

a) a system for the regulation of cargo tank pressure using mechanical refrigeration;

b) a system ensuring safety in the event of the heating or increase in pressure of the cargo. The insulation or the design pressure of the cargo tank, or the combination of these two elements, is to be such as to leave an adequate margin for the operating period and the temperatures expected; in each case the system is to be acceptable by IRS and is to ensure safety for a minimum time of three times the operation period;

c) when the LNG is used as fuel, a system for the regulation of cargo tank pressure whereby the boil-off vapours are utilized as fuel;

d) any other system, subject to special consideration

6.4.6.1.2 The systems prescribed in 6.4.6.1.1 are to be constructed, installed and tested to the satisfaction of IRS. The materials used in their construction are to be compatible with the cargoes to be carried. For normal service, the upper ambient design temperature limits are:

air: +45° C;

water: +32° C.

6.4.6.1.3 The cargo storage system is to be capable of resisting the full vapour pressure of the cargo at the upper limits of the ambient design temperatures, whatever the system adopted to deal with the boil-off gas. This requirement is indicated by the remark 37 in column (20) of Table C of Chapter 3.2 of ADN.

6.4.6.2 Refrigeration System

6.4.6.2.1 The refrigeration system referred to in 6.4.6.1.1 a) is to be composed of one or more units capable of keeping the pressure and temperature of the cargo at the upper limits of the ambient design temperatures at the prescribed level. Unless another means of regulating cargo pressure and temperature deemed satisfactory by a recognized classification society is provided, provision is to be made for one or more stand-by units with an output at least equal to that of the largest prescribed unit. A stand-by unit is to include a compressor, its engine, its control system and all necessary accessories to enable it to operate independently of the units normally used. Provision is to be made for a stand-by heat-exchanger unless the system's normal heat-exchanger has a surplus capacity equal to at least 25% of the largest prescribed capacity. It is not necessary to make provision for separate piping. Cargo tanks, piping and accessories are to be insulated so that, in the event of a failure of all cargo refrigeration systems, the entire cargo remains for at least 52 hours in a condition not causing the safety valves to open.

6.4.6.2.2 The security devices and the connecting lines from the refrigeration system are to be connected to the cargo tanks above the liquid phase of the cargo when the tanks are filled to their maximum permissible degree of filling. They are to remain within the gaseous phase, even if the vessel has a list up to 12 degrees.

6.4.6.2.3 When several refrigerated cargoes with a potentially dangerous chemical reaction are carried simultaneously, particular care is to be given to the refrigeration systems so as to prevent any mixing of the cargoes. For the carriage of such cargoes, separate refrigeration systems, each including the full stand-by unit referred to in 6.4.6.2.1, are to be provided for each cargo. When, however, refrigeration is ensured by an indirect or combined system and no leak in the heat exchangers can under any foreseeable circumstances lead to the mixing of cargoes, no provision need be made for separate refrigeration units for the different cargoes.

6.4.6.2.4 When several refrigerated cargoes are not soluble in each other under conditions of carriage such that their vapour pressures are added together in the event of mixing, particular care is to be given to the refrigeration systems to prevent any mixing of the cargoes.

6.4.6.2.5 When the refrigeration systems require water for cooling, a sufficient quantity is to be supplied by a pump or pumps used exclusively for the purpose. This pump or pumps are to have at least two suction pipes, leading from two water intakes, one to port, the other to starboard. Provision is to be made for a stand-by pump with a satisfactory flow; this may be a pump used for other purposes provided that its use for supplying water for cooling does not impair any other essential service.

6.4.6.2.6 The refrigeration system may take one of the following forms:

a) Direct system: the cargo vapours are compressed, condensed and returned to the cargo tanks. This system is not to be used for certain cargoes specified in Table C of Chapter 3.2 of ADN. This requirement is indicated by remark 35 in column (20) of Table C of Chapter 3.2 of ADN;

b) Indirect system: the cargo or the cargo vapours are cooled or condensed by means of a coolant without being compressed;

c) Combined system: the cargo vapours are compressed and condensed in a cargo/coolant heat-exchanger and returned to the cargo tanks. This system is not to be used for certain cargoes specified in Table C of Chapter 3.2 of ADN. This requirement is indicated by remark 36 in column (20) of Table C of Chapter 3.2 of ADN.

6.4.6.2.7 All primary and secondary coolant fluids are to be compatible with each other and with the cargo with which they may come into contact. Heat exchange may take place either at a distance from the cargo tank, or by using cooling coils attached to the inside or the outside of the cargo tank.

6.4.6.2.8 When the refrigeration system is installed in a separate service space, this service space is to meet the requirements of 6.4.2.4.6.

6.4.6.2.9 For all cargo systems, the heat transmission coefficient as used for the determination of the holding time are to be determined by calculation. Upon completion of the vessel, the correctness of the calculation is to be checked by means of a heat balance test. The calculation and test is to be performed under supervision of IRS. The heat transmission coefficient is to be documented and kept on board. The heat transmission coefficient is to be verified at every renewal of the certificate of approval.

6.4.6.3 Water Spray System

6.4.6.3.1 When water-spraying is required in column (9) of Table C of Chapter 3.2 of ADN a water-spray system is to be installed in the cargo area on deck for the purpose of reducing gases given off by the cargo by spraying water. The system is to be fitted with a connection device for supply from the shore. The spray nozzles are to be so installed that released gases are precipitated safely. The system is to be capable of being put into operation from the wheelhouse and from the deck. The capacity of the water-spray system is to be such that when all the spray nozzles are in operation, the outflow is of 50 [lit/m^2] of cargo deck area and per hour.

6.4.7 Pumps and Piping

6.4.7.1 Pumps, compressors and accessory loading and unloading piping are to be placed in the cargo area. Cargo pumps and compressors are to be capable of being shut down from the cargo area and, in addition, from a position outside the cargo area. Cargo pumps and compressors situated on deck are to be located not less than 6 [m] from entrances to, or openings of, the accommodation and service spaces outside the cargo area.

6.4.7.2 Piping

6.4.7.2.1 Piping for loading and unloading is to be independent of any other piping of the vessel. No cargo piping is to be located below deck, except those inside the cargo tanks and in the service spaces intended for the installation of the vessel's own gas discharging system.

6.4.7.2.2 Piping for loading and unloading is to be clearly distinguishable from other piping, e.g. by means of colour marking.

6.4.7.2.3 The piping for loading and unloading on deck, the venting piping with the exception of the shore connections but including the safety valves, and the valves are to be located within the longitudinal line formed by the outer boundaries of the domes and not less than one quarter of the vessel's breadth from the outer shell. This requirement does not apply to the relief pipes situated behind the safety valves. If there is, however, only one dome athwartships, these pipes and their valves are to be located at a distance not less than 2.7 [m] from the shell. Where cargo tanks are placed side by side, all the connections to the domes are to be located on the inner side of the domes. The external connections may be located on the fore and aft centre line of the dome. The shut-off devices is to be located directly at the dome or as close as possible to it. The shut-off devices of the loading and unloading piping are to be duplicated, one of the devices being constituted by a remote-controlled quick-action stop device. When the inside diameter of a shut-off device is less than 50 [mm] this device may be regarded as a safety device against bursts in the piping.

6.4.7.2.4 The shore connections are to be located not less than 6 [m] from the entrances to or openings of, the accommodation and service spaces outside the cargo area.

6.4.7.2.5 Each shore connection of the venting piping and shore connections of the piping for loading and unloading, through which the loading or unloading operation is carried out, is to be fitted with a shut-off device and a quick-action stop valve. However, each shore connection is to be fitted with a blind flange when it is not in operation.

6.4.7.2.6 Piping for loading and unloading, and venting piping, is not to have flexible connections fitted with sliding seals.

6.4.7.2.7 Piping for transport of refrigerated liquefied gases

6.4.7.2.7.1 The piping for loading and unloading and cargo tanks is to be protected from excessive stresses due to thermal movement and from movements of the tank and hull structure.

6.4.7.2.7.2 Where necessary, piping for loading and unloading is to be thermally insulated from the adjacent hull structure to prevent the temperature of the hull falling below the design temperature of the hull material.

6.4.7.2.7.3 All piping for loading and unloading, which may be closed off at each end when containing liquid (residue), is to be provided with safety valves. These safety valves are to discharge into the cargo tanks and are to be protected against inadvertent closing.

6.4.7.3 The distance referred to in 6.4.7.1 and 6.4.7.2.4 may be reduced to 3.00 [m] if a transverse bulkhead complying with 6.4.2.1.2 is situated at the end of the cargo area. The openings are to be provided with doors.

The following notice is to be displayed on the doors

DO NOT OPEN DURING LOADING AND UNLOADING WITHOUT PERMISSION.

CLOSE IMMEDIATELY.

6.4.7.4 Every component of the piping for loading and unloading is to be electrically connected to the hull.

6.4.7.5 The stop valves or other shut-off devices of the piping for loading and unloading are to indicate whether they are open or shut.

6.4.7.6 The piping for loading and unloading are to have, at the test pressure, the required elasticity, leak proofness and resistance to pressure.

6.4.7.7 The piping for unloading is to be fitted with pressure gauges at the inlet and outlet of the pump. Reading of the pressure gauges is to be possible from the control position of the vessel's own gas discharging system. The maximum permissible overpressure or vacuum is to be indicated by a measuring device. Readings are to be possible in all weather conditions.

6.4.7.8 Use of the cargo piping for ballasting purposes is not to be possible.

6.4.7.9 Compressed air generated outside the cargo area or wheelhouse can be used in the cargo area subject to the installation of a spring-loaded non-return valve to ensure that no gases can escape from the cargo area through the compressed air system into accommodation or service spaces outside the cargo area.

6.4.8 Requirements for Electrical Installations

6.4.8.1 Documents concerning electrical installations

6.4.8.1.1 In addition to the other required documentation, the following documents are to be on board:

a) a drawing indicating the boundaries of the cargo area and the location of the electrical equipment installed in this area;

b) a list of the electrical equipment referred to in (a) above including machine or appliance, location, type of protection, type of protection against explosion, testing body and approval number

c) a list of or general plan indicating the electrical equipment outside the cargo area which may be operated during loading, unloading or gas-freeing. All other electrical equipment is to be marked in red. See 6.4.8.3.7 and 6.4.8.3.8.

6.4.8.2 Electrical Installations

6.4.8.2.1 Only distribution systems without return connection to the hull are allowed.

This provision does not apply to:

- active cathodic corrosion protection;
- local installations outside the cargo area (e.g. connections of starters of diesel engines);
- the device for checking the insulation level referred to in 6.4.8.2.2 below:

6.4.8.2.2 Every insulated distribution network is to be fitted with an automatic device with a visual and audible alarm for checking the insulation level.

6.4.8.2.3 For the selection of electrical equipment to be used in zones presenting an explosion risk, the explosion groups and temperature classes assigned to the substances carried in the list of substances are to be taken into consideration (See columns (15) and (16) of Table C of Chapter 3.2 of ADN).

6.4.8.3 Type and Location of Electrical Equipment

6.4.8.3.1 Only the following equipment may be installed in cargo tanks and piping for loading and unloading (comparable to zone 0):

- measuring, regulation and alarm devices of the EEx (ia) type of protection.

6.4.8.3.2 Only the following equipment may be installed in the cofferdams, double-hull spaces, double bottoms and hold spaces (comparable to zone 1)

- measuring, regulation and alarm devices of the certified safe type;
- lighting appliances of the “flame-proof enclosure” or “apparatus protected by pressurization” type of protection;
- hermetically sealed echo sounding devices the cables of which are led through thick-walled steel tubes with gastight connections up to the main deck;
- cables for the active cathodic protection of the shell plating in protective steel tubes such as those provided for echo sounding devices;

  The following equipment may be installed only in double-hull spaces and double bottoms if used for ballasting:

- permanently fixed submerged pumps with temperature monitoring, of the certified type.

6.4.8.3.3 Only the following equipment may be installed in the service spaces in the cargo area below deck (comparable to zone 1):

- measuring, regulation and alarm devices of the certified safe type;
- lighting appliances of the “flame-proof enclosure” or “apparatus protected by pressurization” type of protection;
- motors driving essential equipment such as ballast pumps with temperature monitoring; they are to be of the certified safe type.

6.4.8.3.4 The control and protective equipment of the electrical equipment referred to in 6.4.8.3.1, 6.4.8.3.2 and 6.4.8.3.3 above are to be located outside the cargo area if they are not intrinsically safe.

6.4.8.3.5 The electrical equipment in the cargo area on deck (comparable to zone 1) is to be of the certified safe type.

6.4.8.3.6 Accumulators are to be located outside the cargo area.

6.4.8.3.7 Electrical equipment used during loading, unloading and gas-freeing during berthing and which are located outside the cargo area (comparable to zone 2) are to be at least of the “limited explosion risk” type.

6.4.8.3.7.1 The requirements of 6.4.8.3.7 are not applicable to:

a) lighting installations in the accommodation, except for switches near entrances to accommodation;

b) radiotelephone installations in the accommodation or the wheelhouse;

c) mobile and fixed telephone installations in the accommodation or the wheelhouse;

d) electrical installations in the accommodation, the wheelhouse or the service spaces outside cargo areas if:

A. These spaces are fitted with a ventilation system ensuring an overpressure of 0.1 [kPa] (0.001 bar) and none of the windows is capable of being opened; the air intakes of the ventilation system located as far away as possible, however, not less than 6 [m] from the cargo area and not less than 2 [m] above the deck;

B. The spaces are fitted with a gas detection system with sensors:

   i. at the suction inlets of the ventilation system;

   ii. directly at the top edge of the sill of the entrance doors of the accommodation and service spaces when the cargo in the gas phase is heavier than air; otherwise sensors are to be fitted close to the ceiling;

C. The gas concentration measurement is continuous;

D. When the gas concentration reaches 20% of the lower explosive limit, the ventilators are to be switched off. In such a case and when the overpressure is not maintained or in the event of failure of the gas detection system, the electrical installations which do not comply with 6.4.8.3.7 above, are to be switched off. These operations are to be performed immediately and automatically and activate the emergency lighting in the accommodation, the wheelhouse and the service spaces, which are to comply at least with the "limited explosion risk" type. The switching-off is to be indicated in the accommodation and wheelhouse by visual and audible signals;

E. The ventilation system, the gas detection system and the alarm of the switch-off device are to fully comply with the requirements of 6.4.8.3.7 above;

F. The automatic switch-off device is to be set so that no automatic switching-off may occur while the vessel is under way.

e) Inland AIS (automatic identification systems) stations in the accommodation and in the wheelhouse if no part of an aerial for electronic apparatus is situated above the cargo area and if no part of a VHF antenna for AIS stations is situated within 2 [m] from the cargo area.

6.4.8.3.8 The electrical equipment which does not meet the requirements set out in 6.4.8.3.7 above together with its switches are to be marked in red. The disconnection of such equipment is to be operated from a centralized location on board.

6.4.8.3.9 An electric generator which is permanently driven by an engine and which does not meet the requirements of 6.4.8.3.7 above, is to be fitted with a switch capable of shutting down the excitation of the generator. A notice board with the operating instructions is to be displayed near the switch.

6.4.8.3.10 Sockets for the connection of signal lights and gangway lighting are to be permanently fitted to the vessel close to the signal mast or the gangway. Connecting and disconnecting is also not to be possible except when the sockets are not live.

6.4.8.3.11 The failure of the power supply for the safety and control equipment is to be immediately indicated by visual and audible signals at the locations where the alarms are usually actuated.

6.4.8.4 Earthing

6.4.8.4.1 The metal parts of electrical appliances in the cargo area which are not live as well as protective metal tubes or metal sheaths of cables in normal service are to be earthed, unless they are so arranged that they are automatically earthed by bonding to the metal structure of the vessel.

6.4.8.4.2 The provisions of 6.4.8.4.1 above apply also to equipment having service voltages of less than 50 [V].

6.4.8.4.3 Independent cargo tanks are to be earthed.

6.4.8.4.4 Receptacles for residual products are to be capable of being earthed.

6.4.8.5 Electrical Cables

6.4.8.5.1 All cables in the cargo area are to have a metallic sheath.

6.4.8.5.2 Cables and sockets in the cargo area are to be protected against mechanical damage.

6.4.8.5.3 Movable cables are prohibited in the cargo area, except for intrinsically safe electric circuits or for the supply of signal lights and gangway lighting.

6.4.8.5.4 Cables of intrinsically safe circuits are only to be used for such circuits and are to be separated from other cables not intended for being used in such circuits (e.g. they are not to be installed together in the same string of cables and they are not to be fixed by the same cable clamps).

6.4.8.5.5 For movable cables intended for signal lights and gangway lighting, only sheathed cables of type H 07 RN-F in accordance with standard IEC 60 245–4:1994 or cables of at least equivalent design having conductors with a cross-section of not less than 1.5 [mm^2] are to be used. These cables are to be as short as possible and installed so that damage is not likely to occur.

6.4.8.5.6 The cables required for the electrical equipment referred to in 6.4.8.3.2 and 6.4.8.3.3 are accepted in cofferdams, double-hull spaces, double bottoms, hold spaces and service spaces below deck.

6.4.9 Inspection and Testing

6.4.9.1 Pressure Test

6.4.9.1.1 Cargo tanks and piping for loading and unloading are to comply with the provisions concerning pressure vessels.

6.4.9.1.2 All cofferdams are to be subjected to initial tests before being put into service and thereafter at the prescribed intervals. The test pressure is not to be less than 10 [kPa] (0.10 bar) gauge pressure.

6.4.9.1.3 The maximum intervals for the periodic tests referred to in 6.4.9.1.1 above is to be 11 years.

Section 7

Fire Safety Requirements for Tankers Carrying Dangerous Goods

7.1 Application

7.1.1 All tankers carrying dangerous goods are to meet the requirements of this section.

7.2 Fire-extinguishing arrangements

7.2.1 A fire-extinguishing system is to be installed on the vessel. This system is to comply with the following requirements:

7.2.1.1 It is to be supplied by two independent fire or ballast pumps, one of which is to be ready for use at any time. These pumps and their means of propulsion and electrical equipment are not to be installed in the same space;

7.2.1.2 It is to be provided with a water main fitted with at least three hydrants in the cargo area or wheelhouse above deck. Three suitable and sufficiently long hoses with jet/spray nozzles having a diameter of not less than 12 [mm] are to be provided. Alternatively one or more of the hose assemblies may be substituted by directable jet/spray nozzles having a diameter of not less than 12 [mm]. It is to be possible to reach any point of the deck in the cargo area simultaneously with at least two jets of water which do not emanate from the same hydrant. A spring-loaded non-return valve is to be fitted to ensure that no gases can escape through the fire-extinguishing system into the accommodation or service spaces outside the cargo area;

7.2.1.3 The capacity of the system is to be at least sufficient for a jet of water to have a minimum reach of not less than the vessel's breadth from any location on board with two spray nozzles being used at the same time;

7.2.1.4 The water supply system is to be capable of being put into operation from the wheelhouse and from the deck;

7.2.1.5 Measures are to be taken to prevent the freezing of fire-mains and hydrants.

7.2.2 In addition, the engine rooms, the pump-room and all spaces containing essential equipment (switchboards, compressors, etc.) for the refrigeration equipment, if any, are to be provided with a permanently fixed fire-extinguishing system meeting the following requirements:

7.2.2.1 Extinguishing agents

7.2.2.1.1 For the protection of spaces in engine rooms, boiler rooms and pump rooms, only permanently fixed fire-extinguishing systems using the following extinguishing agents are permitted:

a) CO_2 (carbon dioxide);

b) HFC 227 ea (heptafluoropropane);

c) IG-541 (52% nitrogen, 40% argon, 8% carbon dioxide).

d) FK-5-1-12 (dodecafluoro 2-methylpentane-3-one).

7.2.2.2 Ventilation, air extraction

7.2.2.2.1 The combustion air required by the combustion engines which ensure propulsion should not come from spaces protected by permanently fixed fire-extinguishing systems. This requirement is not mandatory if the vessel has two independent main engine rooms with a gastight separation or if, in addition to the main engine room, there is a separate engine room installed with a bow thruster that can independently ensure propulsion in the event of a fire in the main engine room.

7.2.2.2.2 All forced ventilation systems in the space to be protected are to be shut down automatically as soon as the fire-extinguishing system is activated.

7.2.2.2.3 All openings in the space to be protected which permit air to enter or gas to escape are to be fitted with devices enabling them to be closed rapidly. It is to be clear whether they are open or closed.

7.2.2.2.4 Air escaping from the pressure–relief valves of the pressurised air tanks installed in the engine rooms is to be evacuated to the open air.

7.2.2.2.5 Overpressure or negative pressure caused by the diffusion of the extinguishing agent is not to destroy the constituent elements of the space to be protected. It is to be possible to ensure the safe equalisation of pressure.

7.2.2.2.6 Protected spaces are to be provided with a means of extracting the extinguishing agent. If extraction devices are installed, it is not to be possible to start them up during extinguishing.

7.2.2.3 Fire alarm system

7.2.2.3.1 The space to be protected is to be monitored by an appropriate fire alarm system. The alarm signal is to be audible in the wheelhouse, the accommodation and the space to be protected.

7.2.2.4 Piping system

7.2.2.4.1 The extinguishing agent is to 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 their fittings are to be made of steel. This does not apply to the connecting nozzles of tanks and compensators provided that the materials used have equivalent fireretardant properties. Piping is to be protected against corrosion both internally and externally.

7.2.2.4.2 The discharge nozzles are to be so arranged as to ensure the regular diffusion of the extinguishing agent. In particular, the extinguishing agent must also be effective beneath the floor.

7.2.2.5 Triggering device

7.2.2.5.1 Automatically activated fire-extinguishing systems are not permitted.

7.2.2.5.2 It is to be possible to activate the fire-extinguishing system from a suitable point located outside the space to be protected.

7.2.2.5.3 Triggering devices are to be so installed that they can be activated in the event of a fire and so that the risk of their breakdown in the event of a fire or an explosion in the space to be protected is reduced as far as possible. Systems which are not mechanically activated are to be supplied from two energy sources independent of each other. These energy sources are to be located outside the space to be protected. The control lines located in the space to be protected are to be so designed as to remain capable of operating in the event of a fire for a minimum of 30 minutes. The electrical installations are deemed to meet this requirement if they conform to the IEC 60331–21:1999 standard. When the triggering devices are so placed as not to be visible, the component concealing them are to carry the "Fire-fighting system" symbol, each side being not less than 10 [cm] in length, with the following text in red letters on a white ground:

FIRE-EXTINGUISHING SYSTEM

7.2.2.5.4 If the fire-extinguishing system is intended to protect several spaces, it is to comprise a separate and clearly–marked triggering device for each space.

7.2.2.5.5 The instructions are to be posted alongside all triggering devices and are to be clearly visible and indelible. The instructions are to be in a language the master can read and understand. They are to include information concerning:

a) the activation of the fire-extinguishing system;

b) the need to ensure that all persons have left the space to be protected;

c) The correct behaviour of the crew in the event of activation and when accessing the space to be protected following activation or diffusion, in particular in respect of the possible presence of dangerous substances;

d) the correct behaviour of the crew in the event of the failure of the fire extinguishing system to function properly.

7.2.2.5.6 The instructions are to mention that prior to the activation of the fire-extinguishing system, combustion engines installed in the space and aspirating air from the space to be protected, are to be shut down.

7.2.2.6 Alarm device

7.2.2.6.1 Permanently fixed fire-extinguishing systems are to be fitted with an audible and visual alarm device.

7.2.2.6.2 The alarm device is to be set off automatically as soon as the fire-extinguishing system is first activated. The alarm device is to function for an appropriate period of time before the extinguishing agent is released; it is not to be possible to turn it off.

7.2.2.6.3 Alarm signals are to be clearly visible in the spaces to be protected and their access points and be clearly audible under operating conditions corresponding to the highest possible sound level. It is to be possible to distinguish them clearly from all other sound and visual signals in the space to be protected.

7.2.2.6.4 Sound alarms are to also be clearly audible in adjoining spaces, with the communicating doors shut, and under operating conditions corresponding to the highest possible sound level.

7.2.2.6.5 If the alarm device is not intrinsically protected against short circuits, broken wires and drops in voltage, it is to be possible to monitor its operation.

7.2.2.6.6 A sign with the following text in red letters on a white background is to be clearly posted at the entrance to any space the extinguishing agent may reach:

WARNING, FIRE-EXTINGUISHING SYSTEM!

LEAVE THIS SPACE IMMEDIATELY WHEN THE … (DESCRIPTION) ALARM IS ACTIVATED!

7.2.2.7 Pressurised tanks, fittings and piping

7.2.2.7.1 Pressurised tanks, fittings and piping are to conform to the requirements of the competent authority.

7.2.2.7.2 Pressurised tanks are to be installed in accordance with the manufacturer's instructions.

7.2.2.7.3 Pressurised tanks, fittings and piping are not to be installed in the accommodation.

7.2.2.7.4 The temperature of cabinets and storage spaces for pressurised tanks is not to exceed 50 [°C].

7.2.2.7.5 Cabinets or storage spaces on deck are to be securely stowed and are to have vents so placed that in the event of a pressurised tank not being gastight, the escaping gas cannot penetrate into the vessel. Direct connections with other spaces are not permitted.

7.2.2.8 Quantity of extinguishing agent

7.2.2.8.1 If the quantity of extinguishing agent is intended for more than one space, the quantity of extinguishing agent available does not need to be greater than the quantity required for the largest of the spaces thus protected.

7.2.2.9 Installation, maintenance, monitoring and documents

7.2.2.9.1 The mounting or modification of the system is to only be performed by a company specialised in fire-extinguishing systems. The instructions (product data sheet, safety data sheet) provided by the manufacturer of the extinguishing agent or the system are to be followed.

7.2.2.9.2 The system is to be inspected by an expert:

a) before being brought into service;

b) each time it is put back into service after activation;

c) after every modification or repair;

d) regularly, not less than every two years.

7.2.2.9.3 During the inspection, the expert is required to check that the system conforms to the requirements of 7.2.2.

7.2.2.9.4 The inspection is to include, as a minimum:

a) an external inspection of the entire system;

b) an inspection to ensure that the piping is leakproof;

c) an inspection to ensure that the control and activation systems are in good working order;

d) an inspection of the pressure and contents of tanks;

e) an inspection to ensure that the means of closing the space to be protected are leakproof;

f) an inspection of the fire alarm system;

g) an inspection of the alarm device.

7.2.2.10 Fire-extinguishing system operating with CO_2

7.2.2.10.1 In addition to the requirements contained in 7.2.2.1 to 7.2.2.9, fire-extinguishing systems using CO_2 as an extinguishing agent are to conform to the following provisions:

7.2.2.10.1.1 Tanks of CO_2 are to be placed in a gastight space or cabinet separated from other spaces. The doors of such storage spaces and cabinets are to open outwards; they are to be capable of being locked and are to carry on the outside the symbol “Warning: danger”, not less than 5 [cm] high and “CO_2” in the same colours and the same size;

7.2.2.10.1.2 Storage cabinets or spaces for CO_2 tanks located below deck are only to be accessible from the outside. These spaces are to have an artificial ventilation system with extractor hoods and are to be completely independent of the other ventilation systems on board;

7.2.2.10.1.3 The level of filling of CO_2 tanks is not to exceed 0.75 [kg/l]. The volume of depressurised CO_2 is to be taken to be 0.56 [m^3/kg];

7.2.2.10.1.4 The concentration of CO_2 in the space to be protected is to be not less than 40% of the gross volume of the space. This quantity is to be released within 120 seconds. It is to be possible to monitor whether diffusion is proceeding correctly;

7.2.2.10.1.5 The opening of the tank valves and the control of the diffusing valve are to correspond to two different operations;

7.2.2.10.1.6 The appropriate period of time mentioned in 7.2.2.6 b) is to be not less than 20 seconds. A reliable installation is to ensure the timing of the diffusion of CO_2.

7.2.2.11 Fire-extinguishing system operating with HFC-227 ea (heptafluoropropane)

7.2.2.11.1 In addition to the requirements of 7.2.2.1 to 7.2.2.9, fire-extinguishing systems using HFC-227 ea as an extinguishing agent is to conform to the following provisions:

7.2.2.11.1.1 Where there are several spaces with different gross volumes, each space is to be equipped with its own fire-extinguishing system;

7.2.2.11.1.2 Every tank containing HFC-227 ea placed in the space to be protected is to be fitted with a device to prevent overpressure. This device is to ensure that the contents of the tank are safely diffused in the space to be protected if the tank is subjected to fire, when the fire-extinguishing system has not been brought into service;

7.2.2.11.1.3 Every tank is to be fitted with a device permitting control of the gas pressure;

7.2.2.11.1.4 The level of filling of tanks is not to exceed 1.15 [kg/l]. The specific volume of depressurised HFC-227 ea is to be taken to be 0.1374 [m^3/kg];

7.2.2.11.1.5 The concentration of HFC-227 ea in the space to be protected is to be not less than 8% of the gross volume of the space. This quantity is to be released within 10 seconds;

7.2.2.11.1.6 Tanks of HFC-227 ea are to be fitted with a pressure monitoring device which triggers an audible and visual alarm in the wheelhouse in the event of an unscheduled loss of propellant gas. Where there is no wheelhouse, the alarm is to be triggered outside the space to be protected;

7.2.2.11.1.7 After discharge, the concentration in the space to be protected is not to exceed 10.5% (volume);

7.2.2.11.1.8 The fire-extinguishing system is not to comprise aluminium parts.

7.2.2.12 Fire-extinguishing system operating with IG-541

7.2.2.12.1 In addition to the requirements of 7.2.2.1 to 7.2.2.9, fire-extinguishing systems using IG-541 as an extinguishing agent is to conform to the following provisions:

7.2.2.12.1.1 Where there are several spaces with different gross volumes, every space is to be equipped with its own fire-extinguishing system;

7.2.2.12.1.2 Every tank containing IG-541 placed in the space to be protected is to be fitted with a device to prevent overpressure. This device is to ensure that the contents of the tank are safely diffused in the space to be protected if the tank is subjected to fire, when the fire-extinguishing system has not been brought into service;

7.2.2.12.1.3 Each tank is to be fitted with a device for checking the contents;

7.2.2.12.1.4 The filling pressure of the tanks is not to exceed 200 [bar] at a temperature of +15 [°C];

7.2.2.12.1.5 The concentration of IG-541 in the space to be protected is to be not less than 44% and not more than 50% of the gross volume of the space. This quantity is to be released within 120 seconds.

7.2.2.13 Fire-extinguishing system operating with FK-5-1-12

7.2.2.13.1 In addition to the requirements of 7.2.2.1 to 7.2.2.9, fire-extinguishing systems using FK-5-1-12 as an extinguishing agent is to comply with the following provisions:

7.2.2.13.1.1 Where there are several spaces with different gross volumes, every space is to be equipped with its own fire-extinguishing system;

7.2.2.13.1.2 Every tank containing FK-5-1-12 placed in the space to be protected is to be fitted with a device to prevent overpressure. This device is to ensure that the contents of the tank are safely diffused in the space to be protected if the tank is subjected to fire, when the fire-extinguishing system has not been brought into service;

7.2.2.13.1.3 Every tank is to be fitted with a device permitting control of the gas pressure;

7.2.2.13.1.4 The level of filling of tanks is not to exceed 1[kg/l]. The specific volume of depressurized FK-5-1-12 is to be taken to be 0.0719 [m^3/kg];

7.2.2.13.1.5 The volume of FK-5-1-12 in the space to be protected is to be not less than 5.5% of the gross volume of the space. This quantity is to be released within 10 seconds;

7.2.2.13.1.6 Tanks of FK-5-1-12 are to be fitted with a pressure monitoring device which triggers an audible and visual alarm in the wheelhouse in the event of an unscheduled loss of extinguishing agent. Where there is no wheelhouse, the alarm is to be triggered outside the space to be protected;

7.2.2.13.1.7 After discharge, the concentration in the space to be protected is not to exceed 10.0%.

7.2.3 Vessel is to be equipped with at least two additional hand fire-extinguishers, which are to be located in the cargo area. The fire extinguishing agent contained in these additional hand fire-extinguishers is to be suitable for fighting fires involving the dangerous good carried.

7.2.4 The fire-extinguishing agent and the quantity contained in the permanently fixed fire-extinguishing system is to be suitable and sufficient for fighting fires.

7.3 Fire and naked light

7.3.1 The outlets of funnels are to be located not less than 2 [m] from the cargo area. Arrangements are to be provided to prevent the escape of sparks and the entry of water.

7.3.2 Heating, cooking and refrigerating appliances are not to be fuelled with liquid fuels, liquid gas or solid fuels. The installation in the engine room or in another separate space of heating appliances fueled with liquid fuel having a flash–point above 55 [°C] is, however, permitted. Cooking and refrigerating appliances are permitted only in the accommodation.

7.3.3 Only electrical lighting appliances are permitted.

End of Chapter

Chapter 3

Passenger Vessels

Contents

Section 1

General

1.1 Application

1.1.1 This Chapter applies to self-propelled passenger vessels.

1.1.2 Attention is drawn to technical and operational requirements of National/Local authorities where the vessel is registered or operating.

1.2 Notation

1.2.1 Vessels complying with the requirements of this chapter are eligible for the assignment of the notation **PASSENGER VESSEL**.

1.2.2 An additional class notation **FERRY** will be assigned to a vessel on regular scheduled service.

1.2.3 An additional class notation **RO-RO PAX** will be assigned to passenger vessels intended for carriage of passengers and vehicles and built in accordance with Sec 6 of this chapter.

1.2.4 An additional class notation **PRM** will be assigned to a passenger vessel in which areas are provided for use by persons with reduced mobility, according to the provisions of Sec 7 of this chapter.

1.3 Definitions

1.3.1 **Passenger vessel**: a day trip or cabin vessel constructed and equipped to carry more than 12 passengers.

1.3.2 **Day-trip vessel**: a passenger vessel without overnight passenger cabins.

1.3.3 **Cabin vessel**: a passenger vessel with overnight passenger cabins.

1.3.4 **Main Engine Room**: Space where the propulsion engines are installed

1.3.5 **Engine Room**: Space where combustion engines are installed.

1.3.6 **Boiler Room**: a space housing a fuel-operated installation designed to produce steam or heat a thermal fluid.

1.3.7 **Wheelhouse**: the area which houses all the control and monitoring instruments necessary for manoeuvring the vessel.

1.3.8 **Crew Accommodation**: a space intended for the use of persons normally living on board, including galleys, store rooms, toilets and washing facilities, laundry facilities, passageways, but not the wheelhouse.

1.3.9 **Passenger Space**: space on board intended for passengers and enclosed areas such as offices, shops, hairdressing salons, drying rooms, laundries, saunas, toilets, washrooms, passageways, connecting passages and stairs not encapsulated by walls.

1.3.10 **Accommodation Space**: a living space of a crew accommodation or a passenger space. On board passenger vessels, galleys are not regarded as accommodation space.

1.3.11 **Stairwell**: the well of an internal staircase or of a lift.

1.3.12 **Galley**: a room equipped with an open flame cooking appliance or any electrically heated cooking plate or hot plate with a power of not more than 5 [kW].

1.3.13 **Muster Areas**: areas of the vessel which are specially protected and in which persons muster in the event of danger.

1.3.14 **Evacuation Areas**: part of muster areas of the vessel from which evacuation of persons can be carried out.

1.3.15 **Store Room of high risk**: a space for the storage of flammable liquids or a room with an area of over 4 [m^2] for storing supplies.

1.3.16 **Passageway**: an area intended for the normal movement of persons and goods.

1.3.17 **Persons with reduced mobility**: persons facing particular problems when using public transport, such as the elderly and the handicapped and persons with sensory disabilities, persons in wheelchairs, pregnant women and persons accompanying young children.

1.4 Material

1.4.1 Glass doors and walls in passageways and also window panes are to be manufactured from pre-stressed glass or laminated glass. They may also be made from a synthetic material.

Section 2

Vessel Arrangement

2.1 Stability and Freeboard

2.1.1 The intact stability, damage stability and freeboard of the vessel are to be in accordance with IRS Classification Note "*Stability Requirements for Inland Waterways Passenger Ships*".

2.1.2 The maximum draught is to be in compliance with the requirements of 2.1.1 and is to be marked on the vessel's sides at about mid-length.

2.2 Subdivision and Transverse Bulkheads

2.2.1 The number and position of bulkheads are to be selected such that, in the event of flooding, the vessel remains buoyant according to the requirements used for the compliance of 2.1.1. Every portion of the internal structure, which affects the efficiency of the subdivision of such vessels, is to be watertight, and is to be of a design which will maintain the integrity of the subdivision.

2.2.2 Bulkheads rising up to the deck are to be provided as follows :

a) A Collision Bulkhead: The distance between the collision bulkhead and the forward perpendicular is to be at least 0.04LWL and not more than 0.04LWL + 2 [m].

b) An Aft-Peak Bulkhead, where vessel length exceeds 25 [m]: The aft peak bulkhead is to be installed at a distance of between 1.4 [m] and 0.04 LWL + 2 [m] measured from the aft point of the intersection of the hull with the maximum draught line.

2.2.3 A transverse bulkhead may be fitted with a bulkhead recess, if all parts of this recess lie within the area which is externally bounded by a vertical surface running at a distance of $B_{WL}/5$ parallel to the course of the hull in the line of maximum draught.

2.2.4 The bulkheads, which are taken into account in the damage stability calculations, are to be watertight and are to extend up to the bulkhead deck.

2.2.5 The number of openings in the bulkheads referred above in 2.2.4 are to be kept to the minimum consistent with the type of construction and normal operation of the vessel. Openings and penetrations are not to have a detrimental effect on the watertight function of the bulkheads.

2.2.6 Collision bulkheads are to have no openings and no doors.

2.2.7 Doors are not permitted in bulkheads separating the engine rooms from passenger space or crew accommodation.

2.2.8 Where double bottoms are fitted, their height is to be at least 0.65 [m], and where wing voids are fitted, their width is to be at least 0.65 [m].

2.3 Watertight Doors and Doors

2.3.1 Manually operated doors without remote control, in bulkheads referred to in 2.2.4, are permitted only in areas not accessible to passengers. They are to:

a) remain closed at all times and be opened only temporarily to allow access;

b) be fitted with suitable devices to enable them to be closed quickly and safely;

c) display the following notice on both sides of the doors:

'Close door immediately after passing through'.

A manually controlled remote controlled bulkhead door in the passenger space may be provided on vessels of length not more than 45[m] and authorized to carry number of passengers restricted to that length of the vessel in meters, if:

a) the vessel has only one deck;

b) this door is accessible directly from the deck and is not more than 10 [m] away from the deck;

c) the lower edge of the door opening lies at least 0.3 [m]above the floor of the passenger space, and

d) each of the compartments divided by the door is fitted with a bilge level alarm.

2.3.2 Doors in bulkheads referred to in 2.2.4 that are open for long periods are to comply with the following requirements:

a) they are to be capable of being closed from both sides of the bulkhead and from an easily accessible point above the bulkhead deck;

b) after being closed by remote control, the door is to be such that it can be opened again locally and closed safely. Closure is not to be impeded by carpeting, foot rails or other obstructions;

c) the time taken for the remote-controlled closure process is to be at least 30 [seconds] but not more than 60 [seconds];

d) during the closure procedure an audible alarm is to sound by the door;

e) the door drive and alarm are also to be capable of operating independently of the on-board power supply. There is to be a device at the location of the remote control that displays whether the door is open or closed.

2.3.3 Doors in bulkheads referred to in 2.2.4, and their actuators are to be located in the area which is externally bounded by a vertical surface running at a distance of $B_{WL}/5$ parallel to the course of the hull in the line of maximum draught.

2.3.4 There is to be a warning system in the wheelhouse to indicate which of the doors in bulkheads referred to in 2.2.4 are open.

2.3.5 Remote controls of bulkhead doors according to 2.3.2 are to be clearly indicated as such.

2.3.6 Cold-storage room doors, even when locked, are also to be capable of being opened from the inside.

2.4 Windows

2.4.1 Windows may be situated below the margin line if they are watertight, cannot be opened, possess sufficient strength, protected by deadlights or portable covers and conform to 1.4.1.

2.4.2 Requirements of 2.4.1 are deemed to be fulfilled if the construction of watertight windows complies with the following provision:

a) Pre-stressed glass complying with International Standard ISO 614 : 2012 is used.

b) Round windows comply with International Standard

- ISO 1751 : 2012,
- Series B: medium heavy-duty windows
- Type: non-opening window.

c) Angular windows comply with International Standard

- ISO 3903 : 2012,
- Series E: heavy-duty windows
- Type: non-opening window

d) ISO Standard windows may be replaced by windows whose construction is at least equivalent to the requirements of b) to c).

2.4.3 Cabins without an opening window are to be connected to a ventilation system.

2.5 Passenger Spaces

2.5.1 Location of Passenger Spaces

2.5.1.1 On all decks, passenger spaces are to be located aft of the collision bulkhead and, if they are below the bulkhead deck, forward of the aft-peak bulkhead.

2.5.1.2 Passenger spaces are to be separated from the engine and boiler rooms by gas-tight boundaries.

2.5.1.3 Deck areas, which are enclosed by awnings or similar mobile installations not only above but also fully or partially to the side, are to comply with the same requirements as enclosed passenger spaces.

2.5.2 Number and Width of the Exits of Passenger Spaces

2.5.2.1 The number and width of the exits of passenger spaces are to comply with the following requirements:

a) Rooms or groups of rooms designed or arranged for 30 or more passengers or including berths for 12 or more passengers, are to have at least two exits. On day trip vessels, one of these two exits can be replaced by two emergency exits. Rooms, with the exception of cabins, and groups of rooms that have only one exit, are to have at least one emergency exit.

b) If rooms are located below the bulkhead deck, one of the exits can be a watertight bulkhead door, (complying with 2.3.2), leading into an adjacent compartment from which the upper deck can be reached directly. The other exit is to lead directly or, if permitted in accordance with (a), as an emergency exit into the open air, or to the bulkhead deck. This requirement does not apply to individual cabins.

c) Exits according to (a) and (b) are to be suitably arranged and are to have a clear width of at least 0.8 [m] and a clear height of at least 2 [m]. For doors of passenger cabins and other small rooms, the clear width can be reduced to 0.7 [m].

d) In the case of rooms or groups of rooms intended for more than 80 passengers the sum of the widths of all exits intended for passengers and which are to be used by them in an emergency is to be at least 0.01 [m] per passenger.

e) If the total width of the exits is determined by the number of passengers, the width of each exit is to be at least 0.005 [m] per passenger.

f) Emergency exits are to have a shortest side at least 0.6 [m] long or a minimum diameter of 0.7 [m]. They are to open in the direction of escape and be marked on both sides.

2.5.3 Doors of Passenger Spaces

2.5.3.1 Doors of passenger spaces are to comply with the following requirements:

a) With the exception of doors leading to connecting corridors, they are to be capable of opening outwards or be constructed as sliding doors.

b) Cabin doors are to be made in such a way that they can also be unlocked from the outside at any time.

c) Powered doors are to open easily in the event of failure of the power supply to this mechanism.

2.5.4 Corridors

2.5.4.1 Connecting corridors are to comply with the following requirements:

a) They are to have a clear width of at least 0.8 [m]. If they lead to rooms used by more than 80 passengers, they are to comply with the provisions mentioned in 2.5.2.1(d) and (e) regarding the width of the exits leading to connecting corridors.

b) Their clear height is not to be less than 2 [m].

c) Connecting corridors more than 1.5 [m] wide are to have handrails on either side.

d) Where a part of the vessel or a room intended for passengers is served by a single connecting corridor, the clear width thereof is to be at least 1 [m].

e) Connecting corridors are to be free of steps.

f) They are to lead only to open decks, rooms or staircases.

g) Dead ends in connecting corridors are not to be longer than two meters.

2.5.5 Stairs and their Landing

2.5.5.1 Stairs and their landings in the passenger spaces are to comply with the following requirements:

a) They are to be constructed in accordance with a recognized national/international standard.

b) They are to have a clear width of at least 0.8 [m]. If they lead to connecting corridors or areas used by more than 80 passengers, the stairs are to have a width of at least 0.01 [m] per passenger.

c) They are to have a clear width of at least 1 [m] if they provide the only means of access to a room intended for passengers.

d) Staircases in the same room are to be provided on each side of the vessel. In case, staircases in the same room are not provided on each side, then the staircases have to be in area, which is externally bounded by a vertical surface running at a distance of $B_{WL}/5$ parallel to the course of the hull in the line of maximum draught area.

2.5.6 Bulwarks and Guard Rail

2.5.6.1 Parts of the deck intended for passengers, and which are not enclosed, are to comply with the following requirements:

a) They are to be surrounded by a fixed bulwark or guard rail at least 1 [m] high or a railing according a recognized standard such as IS9448.

2.5.7 Embarking and Disembarking Arrangement

2.5.7.1 Parts of the deck intended for passengers, and which are not enclosed, are to comply with the following requirements:

a) Openings and equipment for embarking or disembarking and openings for loading or unloading are to be such that they can be secured and have a clear width of at least 1 [m].

b) If the openings and equipment for embarking or disembarking cannot be observed from the wheelhouse, appropriate auxiliary means are to be provided.

2.6 Escape from Passenger Spaces

2.6.1 In addition to the provisions of 2.5.4.1, escape routes are to also comply with the following requirements:

a) Stairways, exits and emergency exits are to be so arranged that, in the event of a fire in any given area, the other areas may be evacuated safely.

b) The escape routes are to lead by the shortest route to evacuation areas.

c) Escape routes are not to lead through engine rooms or galleys.

d) There are to be no rungs, ladders or the like installed at any point along the escape routes.

e) Doors to escape routes are to be constructed in such a way as not to reduce the minimum width of the escape route referred to in 2.5.4.1(a) or (d).

f) Escape routes and emergency exits are to be clearly indicated by signs. The signs are to be lit by the emergency lighting system.

2.6.2 Escape routes and emergency exits are to have a suitable safety guidance system (*Refer Section 4, 4.7*).

2.7 Warning against Unauthorized Entry

2.7.1 The parts of the vessels not intended for passengers, in particular access to the wheelhouse, to the winches and to the engine rooms, are to be such that they can be secured against unauthorised entry. At any such access, a warning symbol/sign is to be displayed in a prominent position.

2.8 Passageways in Passenger spaces

2.8.1 Transparent doors and transparent walls (if fitted) extending as far as the floor in passageways are to be prominently marked.

2.9 Superstructure

2.9.1 Superstructures (or their roofs) consisting entirely of panoramic panes, shelters created by awnings, or similar mobile installations, together with their substructures, may only be constructed in such a manner that the way in which they are built and the materials employed pose no risk of injury to persons on board in the event of damage.

2.9.2 Rooms in which crew members are accommodated are to comply with the provisions of this section, as far as practicable.

2.10 Tanks and Cofferdams

2.10.1 Tanks containing fuel oil/lubricating oil are to be separated from passenger, crew and baggage compartments by a gastight and watertight boundary or alternatively by a cofferdam.

2.10.2 A cofferdam between the passenger, crew and baggage compartments is mandatory when the common bulkhead is subject to a static liquid pressure under normal service conditions.

Section 3

Machinery and Systems

3.1 Bilge System

3.1.1 General

3.1.1.1 Requirements of this sub-section are to be complied with, in addition to the requirements of Pt.4, Ch.3, Sec.2.

3.1.1.2 A bilge pumping system with permanently installed pipe work is to be provided.

3.1.1.3 The bilge pumping plant is to be capable of draining any watertight compartment under all practicable conditions after a casualty, whether the vessel is upright or listed.

3.1.2 Number of Pumps

3.1.2.1 Two independent power driven bilge pumps are to be provided.

3.1.3 Arrangement of bilge pumps and bilge main

3.1.3.1 Bilge Pumps

3.1.3.1.1 The power bilge pumps are to be placed in separate watertight compartments, which will not readily be flooded by the same damage.

3.1.3.1.2 The arrangements are to be such that at least one power pump will be available for use in all ordinary circumstances in which the vessel may be flooded. This requirement will be satisfied if:

a) one of the pumps is an emergency pump of a submersible type having a source of power situated above the bulkhead deck;

or

b) the pumps and their sources of power are so disposed throughout the length of the vessel that, under any conditions of flooding which the vessel is required to withstand by Statutory Regulations at least one pump in an undamaged compartment will be available.

3.1.3.2 Bilge Main

3.1.3.2.1 The bilge main is to be so arranged that no part is situated nearer the side of the vessel than , B/5 measured at right angles to the centreline at the level of the deepest load line, where *B* is the breadth of the vessel.

3.1.3.2.2 Where any bilge pump or its pipe connection to the bilge main is situated outboard of the line B/5, then a non-return valve is to be provided in the pipe connection at the junction with the bilge main. The emergency bilge pump and its connections to the bilge main are to be so arranged that they are situated inboard of the line B/5

3.1.3.3 Bilge Valves

3.1.3.3.1 All manifolds and valves fitted in connection with the bilge pumping arrangements are to be located in positions which are readily accessible at all times under normal circumstances. If in any such vessel there is only one system of bilge pipes common to all such pumps, the necessary valves for controlling the bilge suctions are to be capable of being operated from above the vessel's bulkhead deck.

3.1.3.3.2 Where, in addition to the main bilge pumping system, an emergency bilge pumping system is provided, it is to be independent of the main system and so arranged that a pump is capable of operating on any compartment under flooding conditions; in this case, the valves and cocks necessary for the operation of the emergency system need to be capable of being operated from above the bulkhead deck.

3.1.3.3.3 Every valve which is required to be operated from above the bulkhead deck is to have its means of control, at its place of operation, clearly marked to show the purpose it serves and how it may be opened and closed. It is to be provided with a means to indicate whether it is open or closed.

3.1.4 Requirement for bilge pumps and bilge suction

3.1.4.1 Every bilge pump provided is to be self-priming.

3.1.4.2 Each independent bilge pump is to have a direct bilge suction from the space in which it is situated, but not more than two such suctions are required in any one space. Where two or more suctions are provided, there is to be at least one suction at each side of the space.

3.1.4.3 All bilge suctions are to be fitted with readily accessible strainers so that they may be regularly checked and cleaned.

3.1.4.4 Provision is to be made to prevent the compartment served by any bilge suction pipe being flooded, in the event of the pipe being severed, or otherwise damaged by collision or grounding in any other compartment. For this purpose, where the pipe is at any part situated nearer the side of the vessel than B/5 or less than 0.5 [m] above the bottom, a non-return valve is to be fitted to the pipe in the compartment containing the open end.

3.1.5 Bilge Alarms

3.1.5.1 A bilge alarm is to be fitted;

a) in any compartment containing propulsion machinery; and

b) in any other compartment likely to accumulate bilge water.

c) The alarm is to provide an audible warning, and a separate visual warning, for each protected space at the control position. Once activated the audible alarm is to continue to sound until acknowledged.

3.2 Air and Sounding Pipes

3.2.1 Short sounding pipes are permissible only for sounding cofferdams and double bottom tanks situated in a machinery space, and are in all cases to be fitted with self-closing cocks as described in Pt.4, Ch.3, 3.3.4. In addition:

a) Short sounding pipes to fuel oil, (flash point not less than 55°C), lubricating oil tanks and other flammable oil tanks (flash point not less than 55°C) are to be fitted with an additional small diameter self-closing test cock, in order to ensure that the sounding pipe is not under a pressure of oil before opening-up the sounding cock.

b) Provision is to be made to ensure that discharge of oil through this test cock does not present an ignition hazard.

c) An additional small diameter self-closing test cock is not required for lubricating oil tanks.

3.2.2 Elbow sounding pipes are not permitted.

3.2.3 Sounding pipes of fuel tanks are not to terminate in accommodation or passenger spaces.

3.3 Prevention of communication between compartments in the event of damage

3.3.1 Open ended pipes and ventilation ducts are to be arranged such that in any condition of flooding, water cannot enter other watertight compartments:

a) If several compartments are connected by means of open ended pipelines or ventilation ducts they are to be arranged such that the open ends are situated above the maximum assumed damage condition.

b) Pipelines/ ventilation ducts are not required to comply with (a) above if they are provided with shut off valves capable of being operated from above the bulkhead deck. Shut-off devices above the bulkhead deck are to be clearly indicated as such.

c) Pipelines having no open end are to be considered as not damaged if they are situated inboard of the line B/5 and the distance from the bottom is more than 0.5 [m]

Section 4

Electrical Installations

4.1 General

4.1.1 The electrical equipment and installations (including any electrical means of propulsion) are to be such that the vessel and all persons onboard are protected against electrical hazards.

4.1.2 The electrical equipment and installations are to be maintained to ensure that the vessel is in an operational and habitable condition.

4.1.3 The main source of electrical power may be driven by auxiliary or the main propulsion engine. It is to be capable of illuminating any part of the vessel normally accessible to and used by the passengers or crew, and provide power to main electrical systems, which are to operate without recourse to the emergency source of power.

4.2 Emergency source of electrical power

4.2.1 General

4.2.1.1 All passenger vessels are to be provided with an emergency source of electrical power.

4.2.1.2 A failure of the main or emergency power equipment is not to mutually affect the operational safety of the installations.

4.2.2 Equipment/Systems requiring Emergency Source of Power

4.2.2.1 Emergency source of power is to be provided to supply the following:

a) navigation lights;

b) search lights

c) audible warning devices;

d) emergency lighting;

e) radiotelephone installations;

f) general alarm, PA System and on-board message communications systems essential for safety and operation of vessel;

g) passenger and crew warning systems;

h) fire detection and alarm systems;

i) fire-extinguishing systems and fire-extinguishing media release alarms;

j) automatic sprinkler systems;

k) control and power systems to power-operated watertight doors and fire doors and their status indication;

l) personnel lifts and lifting equipment for persons with reduce mobility provided for evacuation purposes;

m) emergency bilge pump and equipment necessary for the operation of remote controlled bilge valves; and

n) davits and hoisting gear for gangways intended for emergency use and rescue boats, where installed.

4.2.3 Operating Period of Emergency power supply

4.2.3.1 The emergency source of power is to be capable of powering the items listed in 4.2.2.1 without refueling or recharging for a projected operating period depending on the purpose of the vessel and as agreed by the national/local authority. In any case, the operating period of the emergency of power is not to be less than 60 [minutes].

4.2.4 Arrangement

4.2.4.1 The emergency power plant is to be installed outside the main engine room, outside the rooms housing the main power sources and outside the room where the main switchboard is located; it is to be separated from these rooms by partitions according to Section 5. The emergency power plant is to be installed either above the margin line or as far away as possible from the main power sources, to ensure that, in the event of flooding, it is not flooded at the same time as these power sources.

4.2.4.2 Cables feeding the electrical installations in the event of an emergency are to be installed and routed in such a way as to maintain the continuity of supply of these installations in the event of fire or flooding affecting the main power supply. Unless emergency power cables are suitably protected against fire and flame to a duration as decided in 4.2.3.1, they are not to be routed through the main engine room, galleys or space where the main power source and connected equipment is installed, except where necessary to provide power to emergency equipment in such areas.

4.2.4.3 The emergency switchboard is to be installed as near as is practicable to the emergency source of power.

4.2.5 Types of Emergency Source of Electrical Power

4.2.5.1 The following are admissible for use as an emergency source of power:

a) auxiliary generator sets with their own independent fuel (flash point of not less than 43[°C]) supply, and independent cooling system which, in the event of a power failure, start and take over the supply of power within 30 [seconds] automatically or, if they are located in the immediate vicinity of the wheelhouse or any other location permanently manned by crew members, can be brought into operation manually; or

b) accumulator batteries, which, in the event of a power failure, connect automatically or, if they are located in the immediate vicinity of the wheelhouse or any other location permanently manned by crew members, can be connected manually.

Accumulator battery banks are to be capable of being isolated. They are to be capable of powering the power consumers as mentioned in 4.2.2.1 throughout the prescribed period without recharging and without an unacceptable voltage reduction.

To enable the crew to undertake a) or b) above, emergency battery lighting is to be provided in way of the emergency means of power supply described. This may be by the use of torches stowed in a readily accessible place nearby.

4.2.6 Control and Monitoring

4.2.6.1 Where emergency generating sets are fitted they are to be capable of being started readily when cold.

4.2.6.2 The emergency switchboard may be supplied from the main switchboard during normal operation.

4.2.6.3 Where the emergency source of power is an accumulator battery, arrangements are to be such that emergency lighting will automatically come into operation on failure of the main lighting supply.

4.2.6.4 An indicator is to be mounted in the machinery space, or in the wheelhouse, to indicate when any accumulator battery fitted in accordance with 4.2.5 is being discharged.

4.3 Lighting

4.3.1 General

4.3.1.1 Only electrical equipment are permitted for lighting.

4.3.1.2 When two or more lighting appliances are installed in an engine room or boiler room, they are to be distributed between at least two circuits. This requirement also apply to rooms where cooling machinery, hydraulic machinery or electric motors are installed.

4.3.1.3 In the important spaces mentioned below the lighting is to be supplied by at least two different circuits:

a) Passageways

b) stairways leading to the boat deck, and public spaces and day rooms for passengers and crew

c) large galleys.

The lamps are to be so arranged that adequate lighting is maintained even if one of the circuits fails.

4.3.1.4 If a vessel is divided into fire zones, at least two circuits are to be provided for the lighting of each fire zone, and each of these must have its own power supply line. One circuit is to be supplied from the emergency power source. The supply lines are to be so located that, in the event of a fire in one main fire zone, the lighting in the other zones is as far as practicable maintained.

4.3.2 Main Lighting

4.3.2.1 There is to be a main lighting system supplied by the main source of electrical power and illuminating all parts of the vessel normally accessible to the passengers and crew.

4.3.3 Emergency Lightning

4.3.3.1 An emergency lighting system is to be installed, the extent of which is to conform to 4.3.3.2.

4.3.3.2 For the following rooms and locations, adequate lighting and emergency lighting is to be provided:

a) locations where life-saving equipment is stored and where such equipment is normally prepared for use;

b) escape routes, access for passengers, including gangways, entrances and exits, connecting corridors, lifts and accommodation area companionways, cabin areas and accommodation areas;

c) markings on the escape routes and emergency exits;

d) in other areas intended for use by persons with reduced mobility;

e) operation rooms, engine rooms, steering equipment rooms and their exits;

f) wheelhouse;

g) emergency electrical power source room;

h) points at which extinguishers and fire extinguishing equipment controls are located;

i) areas in which passengers, shipboard personnel and crew muster in the event of danger

j) embarkation stations and over sides

4.3.3.3 The power supply and the duration of the supply is to conform to 4.2.

4.3.3.4 As far as practicable the emergency lighting system is to be installed in a manner, that it will not be rendered unserviceable by a fire or other incident in rooms in which the main source of electrical power, any associated transformers, the main switchboard and the main lighting distribution panel are installed.

4.3.3.5 The emergency lighting system is to be cut in automatically following a failure of the main power supply. Local switches are to be provided only where it may be necessary to switch off the emergency lighting (e.g. in the wheelhouse).

4.3.3.6 The light fittings for the emergency lighting is to be marked as such.

4.4 Batteries, Accumulators and their charging devices

4.4.1 Accumulators are not to be installed in the wheelhouse, accommodation area and holds, passenger spaces, cabins and galleys. The above requirement is not applicable for accumulators:

a) in mobile equipment; or

b) with charging power of less than 0.2 [kW].

4.5 Internal Communication Facilities

4.5.1 Communication from steering position

4.5.1.1 All passenger vessels are to have internal communication facilities according to 4.5.1.2.

4.5.1.2 It is to be possible to establish communication links from the steering position:

a) with the bow of the vessel;

b) with the stern of the vessel if no direct communication is possible from the steering position;

c) with the crew accommodation;

d) with the master's cabin.

e) with service spaces

f) with engine room (control platform)

g) muster areas for passengers

Reception at all positions of these internal communication links is to be via loudspeaker, and transmission is to be via a fixed microphone. The link with the bow and stern of the vessel may be of the radio-telephone type.

4.5.2 Public address systems

4.5.2.1 Required public address systems are to comply with the relevant requirements of the appropriate Statutory Authority and with the following requirements.

4.5.2.2 The public address system is to be capable of broadcasting messages from the wheelhouse to:

a) all passenger spaces;

b) control stations where there is no other direct communication means from the wheelhouse; and

c) in the access and evacuation areas for passengers.

Loudspeakers may be omitted in passenger spaces where it can be demonstrated that effective direct communication between the wheelhouse and the passenger spaces is possible.

4.5.2.3 The system is to be designed in such a way as to ensure that the information transmitted can be clearly distinguished from background noise.

4.6 Alarm System

4.6.1 Passenger and Crew Warning System

4.6.1.1 The vessel is to be equipped with an alarm system enabling passengers, crew members and shipboard personnel to alert the vessel's command and crew. This alarm is to be given only in areas assigned to the vessel's command and to the crew; it should only be possible for the vessel's command to stop the alarm. The alarm is to be capable of being triggered from at least the following places:

a) in each cabin;

b) in the corridors, lifts and stairwells, with the distance to the nearest trigger not exceeding 10 [m] and with at least one trigger per watertight compartment;

c) in accommodation area, dining rooms and similar recreation rooms;

d) in toilets, intended for use by persons with reduced mobility;

e) in engine rooms, galleys and similar rooms where there is a fire risk;

f) in the cold-storage rooms and other store rooms of high risk.

The alarm triggers are to be protected against unintentional use and installed at a height above the floor of 0.85 [m] to 1.10 [m];

4.6.2 General Emergency Alarm System

4.6.2.1 Required electrically operated bell or other equivalent warning systems for sounding the general emergency alarm signal are to comply with the relevant requirements of the appropriate Statutory Authority and with the requirements of this sub- Section.

4.6.2.2 The vessel is to be equipped with an alarm system enabling the vessel's command to alert passengers. This alarm is to be clearly and unmistakably audible in all rooms accessible to passengers. It is to be capable of being triggered from the wheelhouse and from a location that is permanently staffed.

4.6.2.3 The vessel is to be equipped with an independent alarm system enabling the vessel's command to alert the crew and shipboard personnel, in the accommodation, engine rooms and where appropriate, pump rooms. The alarm system is also to reach the recreation rooms for the shipboard personnel, the cold-storage rooms and other store rooms of high risk. Alarm triggers are to be protected against unintentional use.

4.6.2.4 Means are to be provided to allow the system to be capable of sounding the alarm required by 4.6.2.3 independently of the alarm to the passenger spaces required by 4.6.2.2.

4.7 Escape Guidance System

4.7.1 Passenger vessels are to have suitable guidance systems to clearly identify the escape routes and emergency exits when the normal emergency lighting is less effective due to smoke. Such guidance systems are to take the form of low-location lighting (LLL).

4.7.2 In addition to the emergency lighting as required by 4.3.3 the escape routes, including stairways, exits and emergency exits, are to be marked by low-location lighting (LLL) throughout the whole of the escape route, particularly at corners and intersections.

4.7.3 In general ,the LLL system is to be as per the requirements in IMO Resolution A.752(18) *"Guidelines for Evaluation, Testing and Application of Low-Location Lighting on Passenger Ships"*. Requirement for time duration of functioning of LLL System given in clause 2.3 of A.752(18) is dispensed and instead the LLL system is to function for at least 30 minutes after its activation.

4.8 Watertight Doors and Doors

4.8.1 Refer to Section 2 for the requirements for watertight doors and doors.

Section 5

Fire Protection, Detection and Extinction

5.1 General

5.1.1 Statutory Requirements

5.1.1.1 Attention is drawn to fire safety requirements of National/Local Authorities where the vessel is registered or operating.

5.1.2 Documentation

5.1.2.1 For fire safety of passenger vessels additional plans and information are to be submitted as detailed below for approval:

a) Structural fire protection, showing the method of construction, purpose and category of the various spaces of the vessels, the fire rating of bulkheads and decks, means of closings of openings divisions, draught stops.

b) Ventilation systems showing the penetrations on divisions, location of dampers, means of closing, etc.

c) Escape plan

5.2 Definitions

5.2.1 **Non-combustible**: a substance which neither burns nor produces flammable vapours in such quantities that they ignite spontaneously when heated to approximately 750 [°C];

5.2.2 **Flame-retardant**: material which does not readily catch fire, or whose surface at least restricts the spread of flames pursuant to the following test procedures :

a) Code for Fire Test Procedures, Annex 1 Part 5 (Test for surface flammability - Test for surface materials and primary deck coverings),

b) Code for Fire Test Procedures, Annex 1 Part 7 (Test for vertically supported textiles and films)

c) Code for Fire Test Procedures, Annex 1 Part 8 (Test for upholstered furniture)

d) Code for Fire Test Procedures, Annex 1 Part 9 (Test for bedding components) of the;

5.2.3 **Self-extinguishing**: the characteristic of a burning substance whereby it extinguishes itself of its own accord within a short period once the ignition source has been removed, i.e. does not continue to burn;

5.2.4 **Fire-resistance**: the property of structural components or devices as certified by the following test procedure :

a) Code for Fire Test Procedures Annex 1, Part 3, (Part 3 – Test for "A", "B" and "F" class divisions)

5.2.5 **Code for Fire Test Procedures**: the International Code for the Application of Fire Test Procedures (FTP code) adopted under Resolution MSC.307(88) by the Maritime Safety Committee of the International Maritime Organization (IMO);

5.3 Fire Prevention

5.3.1 Testing

5.3.1.1 The suitability for fire protection of materials and components is to be established by an accredited test institution based on appropriate test methods.

5.3.2 Structural Fire Protection

5.3.2.1 The minimum required fire integrity of all bulkheads and decks is shown in Table 5.3.2.1 (a) or 5.3.2.1(b), as applicable. Requirements given in Table 5.3.2.1 (a) and 5.3.2.1 (b) are not applicable to day trip vessels of length less than 24 [m].

5.3.2.2 In day trip vessels of length less than 24 [m], the machinery space boundaries are to be constructed of steel (rated A0) or equivalent material. The engine space is to be capable of being closed down in order that the fire extinguishing medium cannot escape. Where it is not practical to have a machinery space, the engine is to be enclosed in a box. The box is to perform the same function as the machinery space boundaries referred earlier. Partitions between galley, store rooms of high risk containing flammable liquids and other areas are also to be of Type A0 or equivalent material.

Table 5.3.2.1(a) : Partitions between rooms, in which no pressurised sprinkler systems according to Pt.4, Ch.9, 4.2 are installed

Rooms	Control centres	Stairwells	Muster areas	Accommodation Spaces	Engine Rooms	Galleys	Store Rooms of high risk
Control Centres	-	A0	A0/B15 1)	A30	A60	A60	A0/A60 5)
Stairwells		-	A0	A0	A60	A0	A0/A30 5)
Muster Areas			-	A0/B15 2)	A60	A30	A0/A60 5)
Accommodation Spaces				-/A0/B0 3)	A60	A30	A0/A30 5)
Engine Rooms					A60/A0 4)	A60	A60
Galleys						A0	A30/A0/B15 6)
Store Rooms of high risk							-

Table 5.3.2.1(b): Partitions between rooms, in which pressurised sprinkler systems according to Pt.4, Ch.9, 4.2 are installed

Rooms	Control centres	Stairwells	Muster areas	Accommodation spaces	Engine Rooms	Galleys	Store Rooms of high risk
Control Centres	-	A0	A0/B15[1)]	A0	A60	A30	A0/A30[5)]
Stairwells		-	A0	A0	A60	A0	A0
Muster Areas			-	A0/B15[2)]	A60	A0	A0/A30[5)]
Accommodation Spaces				-/B15/B0[3)]	A60	A0	A0
Engine Rooms					A60/A0[4)]	A60	A60
Galleys						-	A0/B15[6)]
Store Rooms of high risk							-

1) Partitions between control centres and internal muster areas are to correspond to Type A0, but external muster areas only to Type B15.

2) Partitions between accommodation spaces and internal muster areas are to correspond to Type A0, but external muster areas only to Type B15.

3) Partitions between cabins and corridors are to comply with Type B0. Partitions between cabins and saunas are to comply with Type A0, for rooms that are fitted with pressurised sprinkler systems, they are to comply with type B15.

4) Partitions between engine rooms according to 4.2.4.1 are to comply with Type A60; in other cases they are to comply with Type A0.

5) Partitions between store rooms for the storage of flammable liquids and control centres / muster areas are to comply with Type A60, for rooms fitted with pressurised sprinkler systems A30. Partitions between store rooms for the storage of flammable liquids and stairwells/ accommodation spaces are to be of Type A30.

6) Partitions between store rooms for the storage of flammable liquids and galleys are to be of Type A30 and A0 where pressurized sprinklers are fitted. Partitions between other store rooms of high risk and galleys are to be of Type A0. Type B15 is sufficient for partitions between galleys, on one side, and cold-storage rooms and food store rooms of high risk, on the other.

7) Windows below the muster areas/embarkation stations are to have same fire integrity as the structure on which it is fitted.

5.3.2.3 For the purpose of determining the appropriate fire integrity standard to be applied to boundaries between adjacent spaces, such spaces are classified according to their fire risk described in the following categories. The title of each category is intended to be typical rather than restrictive.

a) Control Centres : a wheelhouse, an area which contains an emergency electrical power plant or parts thereof or an area with a centre permanently occupied by crew , such as for fire alarm equipment, remote controls of doors or fire dampers;

b) Stairwell: the well of an internal staircase or of a lift;

c) Muster Areas: areas of the vessel which are specially protected and in which persons muster in the event of danger;

d) Accommodation Spaces: a room of an accommodation or a passenger space. On-board passenger vessels, galleys are not regarded as accommodation space.

e) Engine Room: space where combustion engines are installed;

f) Galley: a room equipped with an open flame cooking appliance or any electrically heated cooking plate or hot plate with a power of not more than 5 [kW];

g) Store Room of high risk: a room for the storage of flammable liquids or a room with an area of over 4 [m^2] for storing supplies.

5.3.2.4 Type A partitions are bulkheads, walls and decks which satisfy the following requirements:

a) They are made of steel or of another equivalent material;

b) They are appropriately stiffened;

c) They are insulated with an approved non-combustible material such that the average temperature on the side facing away from the fire rises to not more than 140 [°C] above the initial temperature and at no point, including the gaps at the joints, does a temperature increase of more than 180 [°C] above the initial temperature occur within the following specified periods:

Type A60	:60 minutes
Type A30	:30 minutes
Type A0	:0 minutes;

d) they are constructed in such a way as to prevent the transmission of smoke and flames until the end of the one-hour standard fire test;

5.3.2.5 Type B partitions are bulkheads, walls, decks, ceilings or facings that meet the following requirements:

a) they are made of an approved non-combustible material. Furthermore, all materials used in the manufacture and assembly of partitions are to be non-combustible, except for the facing, which is to be at least flame retardant;

b) they demonstrate an insulation value such that the average temperature on the side facing away from the fire rises to not more than 140 [°C] above the initial temperature and at no point, including the gaps at the joints, does a temperature increase of more than 225 [°C] above the initial temperature occur within the following specified periods:

Type B15	: 15 minutes
Type B0	: 0 minutes;

c) they are constructed in such a way as to prevent the transmission of flames until the end of the first half hour of the standard fire test.

5.3.2.6 Paints, lacquers and other surface treatment products as well as deck coverings used in rooms except engine rooms and store rooms of high risk are to be flame-retardant. Carpets, fabrics, curtains and other hanging textile materials as well as upholstered furniture and components of bedding are to be flame-retardant, if the rooms in which they are located are not equipped with a pressurised sprinkler system according to Pt.4, Ch.9, 4.2.

5.3.2.7 Ceilings and wall claddings of accommodation spaces, including their substructures, where these accommodation space do not have a pressurised sprinkler system in accordance with Pt.4, Ch.9, 4.2, are to be manufactured from non-combustible materials with the exception of their surfaces, which are to be at least flame-retardant. This requirement does not apply to saunas.

5.3.2.8 Furniture and fittings in accommodation space which serve as muster areas, where a pressurised sprinkler system according to Pt.4, Ch.9, 4.2 is not fitted, are to be manufactured from non-combustible materials.

5.3.2.9 Paints, lacquers and other materials used on exposed internal surfaces are not to produce excessive amounts of smoke or toxic substances. This is to be proven in accordance with the Code for Fire Test Procedures.

5.3.2.10 Insulation materials in accommodation spaces are to be non-combustible. This does not apply to insulations used on coolant-carrying pipes. The surfaces of the insulation materials used on these pipes are to be at least flame-retardant.

5.3.2.11 Awnings and similar mobile installations with which deck areas are fully or partially enclosed and their substructures are to be at least flame-retardant.

5.3.2.12 Doors in partitions according to 5.3.2.1 are to satisfy the following requirements:

a) They are to satisfy the same requirements set out in 5.3.2.1 as the partitions themselves.
b) They are to be self-closing in the case of doors in partition walls according to 5.3.2.13 or in the case of enclosures around engine rooms, galleys and stairwells.

c) Self-closing doors which remain open in normal operation are to be such that they can be closed from a location permanently occupied by crew; Once a door has been remotely closed, it is to be possible to reopen and close it safely on the spot.

d) Watertight doors according to Sec 2 need not be insulated.

5.3.2.13 Walls according to 5.3.2.1 are to be continuous from deck to deck or end at continuous ceilings, which satisfy the same requirements as referred to in 5.3.2.1.

5.3.2.14 The following passenger spaces are to be divided by vertical partitions of at least A-0 fire integrity and continuous from deck to deck (also refer to 5.3.2.1):

a) passenger spaces with a total surface area of more than 800 [m^2];

b) passenger spaces in which there are cabins, at intervals of not more than 40 [m].

5.3.2.15 Hollows above ceilings, beneath floors and behind wall claddings are to be separated at intervals of not more than 14 [m] by non-combustible draught stops which, even in the event of fire, provide an effective fireproof seal.

5.3.2.16 Stairs are to be made of steel or another equivalent non-combustible material.

5.3.2.17 Internal stairs and lifts are to be encapsulated at all levels by walls according to 5.3.2.1. The following exceptions are permissible:

a) a staircase connecting only two decks does not need to be encapsulated, if on one of the decks the staircase is enclosed according to 5.3.2.1;

b) in an accommodation space, stairs need not be encapsulated if they are located entirely within the interior of this room, and

i) if this room extends over only two decks, or

ii) if there is a pressurised sprinkler system according to Pt.4, Ch.9, 4.2 installed in this room on all decks, this room has a smoke extraction system according to 5.3.4 and the room has access on all decks to a stairwell.

5.3.3 Ventilation System

5.3.3.1 Ventilation systems and air supply systems are to satisfy the following requirements:

a) they are to be designed in such a way as to ensure that they themselves do not cause the spread of fire and smoke;

b) openings for air intake and extraction and air supply systems are to be such that they can be closed off;

c) ventilation ducts are to be made from steel or an equivalent non-combustible material and be securely connected to each other and to the superstructure of the vessel;

d) when ventilation ducts are passed through partitions according to 5.3.2.1 of Type A, or partitions according to 5.3.2.14, they are meet the following requirements:

i) with a cross sectional area equal to, or less than, 0.02 [m^2], are to be fitted with a steel sheet sleeve having a thickness of at least 3 [mm] and a length of at least 200 [mm], divided preferably into 100 [mm] on each side of a bulkhead or, in the case of a deck, wholly laid on the lower side of the decks penetrated;

ii) with a cross sectional area exceeding 0.02 [m^2], but not more than 0.075 [m^2], the openings are to be lined with steel sheet sleeves. The sleeves are to have a thickness of at least 3 [mm] and length of at least 900[mm] when passing through bulkheads, this length is to be divided preferably into 450 [mm] on each side of the bulkhead. These ducts, or sleeves lining such ducts, are to be provided with fire insulation. The insulation is to have at least the same fire integrity as the division through which the duct passes.

iii) with a cross-sectional area exceeding 0.075 [m^2] to be fitted with automatic fire dampers which can be operated from a location permanently manned by crew.

e) ventilation systems for galleys and engine rooms are to be separated from ventilation systems which supply other areas;

f) air extraction ducts are to be provided with lockable openings for inspection and cleaning. These openings are to be located close to the fire dampers;

g) built-in ventilators are to be such that they can be switched off from a central location outside the engine room.

5.3.3.2 Galleys are to be fitted with ventilation systems and stoves with extractors. The air extraction ducts of the extractors are to satisfy the requirements according to 5.3.3.1 and, additionally, be fitted with manually operated fire dampers at the inlet openings. Insulation on galley ducts are to be in accordance with the applicable requirements of 5.3.2.1 for galley.

5.3.4 Control of Smoke Spread

5.3.4.1 In vessels of 24 m length and over, control centres, stairwells and internal muster areas are to be fitted with natural or mechanical smoke extraction systems. Smoke extraction systems are to satisfy the following requirements:

a) they are to offer sufficient capacity and reliability;

b) they are to comply with the operating conditions for passenger vessels;

c) if smoke extraction systems also serve as general ventilators for the rooms, this shall not hinder their function as smoke extraction systems in the event of a fire;

d) smoke extraction systems are to have a manually operated triggering device;

e) mechanical smoke extraction systems are to additionally be such that they can be operated from a location permanently occupied by crew;

f) natural smoke extraction systems are to be fitted with an opening mechanism, operated either manually or by a power source inside the extraction system;

g) manually operated triggering devices and opening mechanisms are to be accessible from inside or outside the room being protected.

5.4 Fire Detection

5.4.1 General

5.4.1.1 Accommodation spaces, galleys, engine rooms and other rooms presenting a fire risk are to be connected to a fire alarm system (See Pt.4, Ch.9, Sec.3). The existence of a fire and its exact whereabouts is to be automatically displayed at a location permanently manned by crew members. Provision of fire alarm systems for accommodation spaces constantly supervised by crew may be specially considered.

5.4.1.2 On passenger vessels, which do not have a fire detection system with remote identification of individual fire detectors, a fire detection section is not to comprise more than the area constituted in accordance with 5.3.2.14. The activation of a fire detector in an individual cabin in this fire detection section is to set off a visual and acoustic signal in the passageway outside that cabin.

5.4.1.3 Power supply requirements for fire alarm system are to be as per Pt. 4, Ch. 9, 3.2.2.2. With respect to requirements of Pt. 4, Ch. 9, 3.2.2.2.2, on day-trip vessels up to 25 [m] length, a separate emergency power supply is sufficient.

5.5 Fire Extinction

5.5.1 Portable Fire Extinguishers

5.5.1.1 In addition to the portable extinguishers according to Pt.4, Ch.9, Sec.4, at least the following portable extinguishers are to be available on board:

a) one portable extinguisher for every 120 [m^2] of gross floor area in passenger spaces;

b) one portable extinguisher per group of 10 cabins, rounded upwards;

c) one portable extinguisher in each galley and in the vicinity of any room in which flammable liquids are stored or used. In galleys the extinguishing agent shall also be suitable for fighting fat fires.

These additional fire extinguishers are to meet the requirements of Pt.4, Ch.9, 4.4.6 & 4.4.7. In every galley and in hairdressing salons and perfumeries, there is to be a fire blanket to hand.

5.5.2 Water supply system

5.5.2.1 vessels are to be provided with a system consisting of:

a) two independent power-driven fire extinguishing pumps of sufficient capacity, at least one of which is permanently installed;

b) one fire extinguisher line with a sufficient number of hydrants with permanently connected fire extinguisher hoses at least 20 [m] in length and fitted with a nozzle capable of producing both a mist and a jet of water and incorporating a shut-off facility.

5.5.2.2 Systems are to be designed and dimensioned in such a way that:

a) any point of the vessel can be reached from at least two hydrants in different places, each with a single hose length of not more than 20 [m];

b) the pressure at the hydrants is at least 300 [kPa]; and

c) on all decks a water jet length of at least 6 [m] can be attained.

If a hydrant cupboard is provided, an 'extinguisher hose' symbol, of at least 10 cm side length, is to be affixed to the outside of the cupboard.

5.5.2.3 Hydrant valves with screw threads or cocks are to be such that they can be set so that each of the fire extinguisher hoses can be separated and removed during operation of the fire extinguishing pumps.

5.5.2.4 Fire extinguisher hoses in the internal area are to be rolled up on an axially connected reel.

5.5.2.5 Materials for fire-fighting equipment are to either be heat-resistant or be suitably protected against failure to work when subjected to high temperatures.

5.5.2.6 Pipes and hydrants are to be arranged in such a way that the risk of freezing is avoided.

5.5.2.7 The fire extinguishing pumps are to:

a) be installed or housed in separate compartments;

b) be such that they can be operated independently of each other;

c) each be capable, on all decks, of maintaining the necessary pressure at the hydrants and achieving the requisite length of water jet;

d) be installed forward of the aft-peak bulkhead.

Fire extinguishing pumps may also be used for general purposes.

5.5.3 Fixed fire extinguishing system

5.5.3.1 Engine rooms where total power output is 375 [kW] and above, are to be fitted with a fixed fire extinguishing system according to Pt.4, Ch.9, Sec.4, 4.3.2.

5.5.4 Breathing Apparatus

5.5.4.1 On cabin vessels there are to be:

a) two self-contained breathing apparatus sets corresponding to EN 137 : 2006 of Type 2 with full-face masks corresponding to EN 136 : 1998 or equivalent and provided with spare charges or a breathing air compressor;

b) two sets of equipment consisting of at least a protective suit, helmet, boots, gloves, axe, crowbar, torch and safety-line,

c) four smoke hoods.

5.5.4.2 For cabin vessels with a length of not more than 45 [m], 5.5.4.1 is not applicable, provided smoke-hoods in a number corresponding to the number of berths are readily accessible in each cabin.

Section 6

Additional Requirements for Ro-Ro PAX Notation

6.1 General

6.1.1 Application

6.1.1.1 Passenger vessels complying with the requirements of this Section are eligible for the assignment of the additional class notation **RO-RO PAX**.

6.1.2 Definition

6.1.2.1 Special category spaces are those enclosed vehicle spaces above and below the bulkhead deck, into and from which vehicles can be driven and to which passengers have access. Special category spaces may be accommodated on more than one deck.

6.1.3 Documentation to be submitted

6.1.3.1 In addition to the documentation required other parts of the rules following information is to be submitted:

a) Plans of ramps, elevators for vehicle/ cargo handling including structural and operational arrangements and test conditions.

b) Plan of arrangement of motor vehicles, railway cars and/or other types of vehicles which are intended to be carried and indicating securing and load bearing arrangements

c) Characteristics of motor vehicles, railways cars and/or other types of vehicles which are intended to be carried: (as applicable) axle load, axle spacing, number of wheels per axle, wheel spacing, size of tyre print.

d) Plan of dangerous areas, of vessels intended for the carriage of motor vehicles with fuel in their tanks.

6.2 Vessel arrangements

6.2.1 Ro-Ro Deck

6.2.1.1 Where vehicle ramps are installed to give access to spaces below the bulkhead deck, their openings are to be able to be closed weathertight to prevent ingress of water below. Such opening are to be alarmed with audible and visual indication to the navigation bridge

6.3 Hull structure

6.3.1 Framing

6.3.1.1 In general, car decks or platforms are to be longitudinally framed. Where a transverse framing system is adopted, it is to be considered by IRS on a case-by-case basis.

6.4 Drainage of Ro-Ro spaces, intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion

6.4.1 Scupper draining

6.4.1.1 Scuppers from cargo spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion are not to be led to machinery or other places where sources of ignition may be present.

6.5 Electrical installations

6.5.1 Protective measures on car decks

6.5.1.1 Installations in special category spaces situated above the bulkhead deck

6.5.1.1.1 On any deck or platform, if fitted, on which vehicles are carried and on which explosive vapours might be expected to accumulate, except for platforms with openings of sufficient size permitting penetration of fuel gases downwards, electrical equipment and cables are to be installed at least 450 [mm] above the deck or platform. Where the installation of electrical equipment and cables at less than 450 [mm] above the deck or platform is deemed necessary for the safe operation of the vessel, the electrical equipment is to be of a certified safe type as stated in 6.5.1.1.2 and to have the minimum explosion group IIA and temperature class T3. Electrical equipment is to be as stated in 6.5.1.1.3

6.5.1.1.2 Electrical equipment are not to be installed or operated in areas subject to explosion hazard, with the exception of explosion-protected equipment of a type suitable for shipboard use. Electrical equipment is deemed to be explosion protected, if they are manufactured to a recognized standard such as IEC 60079 publications or EN 50014-50020, and if they have been tested and approved by a testing authority recognized by IRS. Notes and restrictions at the certificate have to be observed. Cables are to be armoured or screened, or run inside a metal tube.

6.5.1.1.3 For equipment in these areas protective measures are to be taken which, depending on the type and purpose of the equipment, could comprise e.g.:

- use of explosion-protected facilities, or
- use of facilities with type Ex n protection, or
- use of facilities which in operation do not cause any sparks and whose surfaces, which are accessible to the open air, do not attain any unacceptable temperatures, or
- facilities which in a simplified way are overpressure encapsulated or are fumetight-encapsulated (minimum protection type IP 55) and whose surfaces do not attain any unacceptable temperatures.

6.5.1.2 Installations in special category spaces situated below the bulkhead deck

6.5.1.2.1 An electrical equipment installed is to be as stated in 6.5.1.1.2 and to have the minimum explosion group IIA and temperature class T3.

6.5.1.3 Ventilation

6.5.1.3.1 Electrical equipment and cables in exhaust ventilation ducts are to be as stated in 6.5.1.1.2 and to have the minimum explosion group IIA and temperature class T3.

6.6 Fire Safety

6.6.1 Fire Protection

6.6.1.1 The boundary bulkheads and decks surrounding ro-ro deck spaces are to be insulated to A60 standard. However, where an open deck space (that is not a passenger space, muster station or evacuation station), a sanitary or similar space, void or auxiliary machinery space having little or no fire risk, is on one side of the division, this standard may be reduced to A0.

6.6.1.2 Adequate ventilation is to be provided in special category spaces, sufficient to give at least 10 air changes per hour.

6.6.2 Fire Fighting

6.6.2.1 Enclosed ro-ro deck spaces are to be fitted with an approved fixed pressure water-spraying system for manual operation, which is to protect all parts of any deck and vehicle platform in such spaces.

6.6.2.2 In view of serious loss of stability, which could arise due to large quantities of water accumulating on the deck or decks consequent on the operation of fixed pressure water-spraying system, scuppers are to be fitted so as to ensure that such water is rapidly discharged directly overboard.

Section 7

Additional Requirements for PRM Notation

7.1 Introduction

7.1.1 Persons with reduced mobility have safety needs exceeding those of other passengers. These requirements are intended to ensure that persons with reduced mobility can stay and move safely on board vessels. In addition, in an emergency such persons should have the same level of safety as other passengers.

7.1.2 It is not necessary that all passenger spaces fulfil the specific safety requirements of persons with reduced mobility. Therefore, those requirements apply only to certain areas.

7.1.3 These rules do not address port facilities and similar installations, which are subject to national/local requirements.

7.2 General

7.2.1 Application

7.2.1.1 Passenger vessels complying with the requirements of this Section are eligible for the assignment of the additional class notation **PRM**.

7.3 Passenger Spaces

7.3.1 Number and Width of the Exits of Passenger Spaces

7.3.1.1 In addition to 2.5.2.1, number and width of the exits of passenger spaces are to comply with the following requirements:

a) Exits of rooms intended for use by persons with reduced mobility are to have a clear width of at least 0.9 [m].

7.3.2 Doors of Passenger Spaces

7.3.2.1 In addition to 2.5.3.1, doors of passenger spaces are to comply with the following requirements:

a) For doors intended for use by persons with reduced mobility, from the direction from which the door opens, there is to be a minimum clearance of 0.60 [m] between the inner edge of the doorframe on the lock side and an adjacent perpendicular wall.

7.3.3 Corridors

7.3.3.1 In addition to 2.5.4.1, connecting corridors are to comply with the following requirements:

a) Connecting corridors intended for use by persons with reduced mobility are to have a clear width of 1.3 [m].

7.3.4 Stairs and their Landing

7.3.4.1 In addition to 2.5.5.1, stairs intended for use by persons with reduced mobility are to comply with the following requirements:

a) the gradient of the stairs is not to exceed 38°;

b) the stairs are to have a clear width of at least 0.9 [m];

c) spiral staircases are not allowed;

d) the stairs are not to run in a direction transverse to the vessel;

e) the handrails of the stairs are to extend approximately 0.3 [m] beyond the top and bottom of the stairs without restricting traffic routes;

f) handrails, front sides of at least the first and the last step as well as the floor coverings at the ends of the stairs are to be colour highlighted.

7.3.4.2 Lifts intended for persons with reduced mobility, and lifting equipment, like stairlifts or lifting platforms, are to be constructed according to a relevant recognized standard or requirements of statutory authorities.

7.3.5 Bulwarks and Guard Rails

7.3.5.1 In addition to 2.5.6.1, parts of the deck intended for passengers, and which are not enclosed, are to comply with the following requirements:

b) Bulwarks and railings of decks intended for use by persons with reduced mobility are to be at least 1.1 [m] high.

7.3.6 Embarking and Disembarking Arrangement

7.3.6.1 In addition to 2.5.7.1, parts of the deck intended for passengers, and which are not enclosed, are to comply with the following requirements:

c) Openings, used normally for the embarking or disembarking of persons with reduced mobility, are to have a clear width of at least 1.5 [m].

7.3.7 Passageways in passenger spaces

7.3.7.1 Passageways intended for use by persons with reduced mobility are to have a clear width of 1.3 [m] and be free of doorsteps and sills more than 0.025 [m] high. Walls in passageways intended for use by persons with reduced mobility are to be equipped with handrails at a height of 0.9 [m] above the floor.

End of Chapter

Chapter 4

Tugs

Contents

Section 1

General

1.1 Application

1.1.1 The requirements of this chapter apply to tugs and are supplementary to those given for the assignment of main characters of class.

A tug is a vessel designed primarily for towage of other vessels, which does not exclude occasional pushing duties, if arranged for this purpose.

A pusher tug is a vessel designed primarily for pushing other vessels.

1.1.2 Vessels built in compliance with the above requirements will be eligible to be assigned the class notation " **TUG**" or **"PUSHER TUG"**.

1.1.3 The maximum value of bollard pull [tonnes] measured during bollard pull test will be entered in the Register of Ships as " **BPmax** .... ". In addition, if requested, the continuous bollard pull [tonnes] measured as per the procedure given in Sec.5.2 will be entered in the Register of Ships as "**BPcont** ..... ".

1.2 Documentation

1.2.1 The following additional plans and documents are to be submitted for approval, as applicable.

Towing arrangement

- Maximum and continuous bollard pull and the breaking strength of the tow rope.

Towing hook

- It's attachment and corresponding strengthening of hull structure, slip arrangements.

Bollard Pull test program

- Items specified in Sec.6.

1.2.2 Additional Certificates of Approval are to be submitted for :-

a) Towing hook with attachments
b) Towline.

1.3 Materials

1.3.1 Towing hook including its attachment is to be made of forged steel, special quality carbon and carbon-manganese steel castings or fabricated from rolled steel products manufactured and tested in accordance with Pt.2 of the 'Rules and Regulations for the Construction and Classification of Steel Ships.

Section 2

Hull Arrangement and Strength

2.1 General

2.1.1 The draught T, used for determination of scantlings is not to be taken less than 0.90 D.

2.1.2 The structure in the forebody and afterbody is to be adequately reinforced against forces arising from pushing operations.

2.1.3 Structure in way of openings provided for fitment of propulsion units is to be reinforced to ensure the continuity of longitudinal and transverse strength.

2.1.4 Single bottom floors clear of the machinery space may be flanged in lieu of a face plate.

2.2 Side structure

2.2.1 In fore peak space, side stringers supporting vertical peak frames are to be fitted at mid-height.

2.2.2 For tugs engaged in berthing operations, it is recommended to provide a stringer all around the vessel at a suitable height, to provide additional stiffness against contact.

2.3 Deck structure

2.3.1 Foundations of towing winch and towing hook are to be capable of withstanding the breaking strength of the towline without any permanent deformations. The design of structures under these foundations and under heavy duty bollards is to be based on additional loads imposed by the tow line at its breaking strength.

2.4 Machinery casings, emergency exits, scuttles, air pipes, ventilators & bulwark etc.

2.4.1 Exposed machinery casings are generally to be not less than 900 [mm] high above the upper surface of the deck. Proposals of reduced height to facilitate lowering of the towline, will receive individual consideration on the basis of safety against the ingress of water.

The scantlings of the exposed machinery casings are to be 20% more than those required for exposed deckhouses in the same location and at the casing stiffeners are to be connected to beams at both ends.

2.4.2 Emergency exit from the machinery space to the deck is to be capable of being used at extreme angles of heel and is to be located on or near the vessel’s centreline. The coaming height is to be not less than 450 [mm]. The hatch cover is to have hinges arranged athwartships and is to be capable of being opened and closed weathertight from either side.

2.4.3 Side scuttles are generally not permitted below the main deck except under special consideration when the distance from the lower edge of side scuttles to the waterline is at least 750 [mm] and the scuttles of non-opening type with hinged inside deadlights meeting the requirements of Type A (heavy) scuttles according to ISO Recommendation 1751, are provided.

Fixed lights of skylights on the deck are to have glass thickness appropriate to their location as required for side scuttles, and fitted with hinged deadlight on the weather side.

2.4.4 In the area aft of the tow hook, the air pipes and vent pipes are to be so arranged as to prevent damage from the towline and to provide maximum practicable angle of downflooding. Closing appliances on air pipes on upper deck the upper end of which may get immersed at an angle of 30° are to be of automatic type.

2.4.5 The bulwarks are to be sloped inboard to avoid damage due to contact.

2.5 Sternframe, rudder & steering gear

2.5.1 In the case of tugs designed for maximum helm angle more than 35°, the scantlings of the rudder, rudder stock, stern frame and the steering gear will be specially considered.

2.6 Fenders

2.6.1 In addition to the special fendering provided for pushing operations, an efficient fender is to be fitted all around on the vessels’s side at deck level.

Section 3

Towing Arrangement

3.1 General

3.1.1 The towline is to be in accordance with Pt.3, Ch.13, Sec.3.2.

3.1.2 The position of the towing hook or towing winch is to be carefully selected so as to minimise the heeling moment as well as the risk of girting due to the pull exerted by the tow rope.

3.2 Towing hook

3.2.1 Towing hook should be provided with an efficient slip arrangement to facilitate release of the towline regardless of the angle of heel and the direction of the towline. The releasing device is also to be operable from the bridge. The breaking strength of the hook, or its equivalent should at least be 50 percent more than that of the towline.

Section 4

Pushing Arrangements

4.1 General

4.1.1 Pusher tugs relying on direct contact for pushing are to be fitted with push stems or push knees and adequate coupling arrangements, such as winches and wires, are to be provided. Unless the stem is designed to fit into a slot in the pushed vessel, a twin push stem/knee is recommended. The push stem or pushing knees are to be adequately supported and integrated into the fore peak structure.

4.1.2 Where the transmission of forces from the pusher tug to be pushed vessel is arranged through rigid or semi-rigid coupling arrangements, the connecting devices as well as their supporting hull structure are to be in accordance with Pt.5, Ch.6, Sec.3.

Section 5

Stability

5.1 General

5.1.1 In addition to the general requirements, the stability of tugs is to be assessed considering the effect of transverse heeling force caused when the tow rope is not in line with the tug's longitudinal centerline. Compliance with the following criteria is recommended, as a minimum:

$GZ' > 1.5 (F_t \,.\, l_v) / (\text{Displacement})$ [m]

GZ' = Righting lever GZ, [m], at angle of deck immersion or at 30 degrees, whichever is lower.

F_t = The transverse heeling force, [tonnes], generally may be taken at 0.5 BPmax.

l_v = Vertical distance, [m], from the center of propeller(s) to the center of towline.

Section 6

Tests and Trials

6.1 Towing gear

6.1.1 In addition to the tests at the manufacturer's works, the towing gear including the towing hook, winch and their emergency release systems are to be tested after installation.

6.2 Bollard pull test procedure

6.2.1 The proposed test programme is to be submitted prior to the testing.

6.2.2 Test for continuous bollard pull is to be carried out with the main engines running at the maximum attainable engine RPM without exceeding the maximum RPM and torque recommended by the engine builder for continuous operation.

6.2.3 The test is to be carried out with the vessel's own propellers only. All auxiliary machinery which are normally driven from the main engine(s) or propeller shaft(s) while towing, are to be connected during the test.

6.2.4 The test is to be conducted in fair weather and at location where sufficient water depth and distance between the tug and the shore bollard is available. Corrections to the measured values of the bollard pull on any account will not be admissible.

6.2.5 An approved and calibrated load measuring device, preferably giving a continuous read-out is to be fitted between the eye of the towline and the bollard.

6.2.6 During the test, efficient communication is to be maintained between the vessel and the shore personnel recording the bollard pull.

6.2.7 The vessel is to maintain a fixed course for at least 10 minutes during which the bollard pull is to be recorded.

6.2.8 The pull maintained uniformly for minimum of 10 minutes without any tendency to decline shall be certified as the vessel's continuous bollard pull, subject to a limit of 50% of the breaking strength of the towline supplied.

End of Chapter

Chapter 5

Barges and Pontoons

Contents

Section 1

General

1.1 Application

1.1.1 The requirements of this chapter apply to manned or unmanned barges and pontoons and are supplementary to those given for the assignment of main characters of class.

Barges are non-self propelled vessels designed and constructed for carriage of dry cargoes in holds or liquid cargoes in tanks.

Pontoons are non-self propelled vessels designed and constructed for carriage of non-perishable cargoes or equipment on deck.

1.1.2 Vessels built in compliance with the above requirements will be eligible to be assigned class notations " **BARGE** " or " **PONTOON** ", as appropriate.

Barges and pontoons for special purpose or for carriage of specialised cargoes are also to comply with the requirements of relevant Chapters of Pt.5, and such vessels would be eligible for assignment of additional or appropriately modified class notations e.g.**, "ORE BARGE", "BARGE STRENGTHENED FOR HEAVY CARGOES", , " CRANE PONTOON** " etc.

1.2 Documentation

1.2.1 The following additional plans and documents are to be submitted for approval, as applicable.

- Towing arrangement and details of towing brackets, bollards and other fittings with under deck stiffening.

- Details of structure and fittings, if any, to which deck cargo securing lashings etc. are attached.

- In case of pusher tugs or integral tug/barge systems or combination units comprising many modules, details of the connecting elements, attachments and supporting structures.

Section 2

Hull Arrangement and Strength

2.1 General

2.1.1 Where a rudder is not fitted, the Rule length, L, is to be taken as 97% of the length of the load waterline at draught T.

In case of pusher tug/barge units with rigid connections, the Rule length, L, is to be based on the combined length of the tug and barge.

2.2 Bottom structure

2.2.1 For barges and pontoons having no rise of floor, the keel plate thickness may be same as adjacent bottom shell.

2.2.2 On hard chine vessels, where a solid round bar is provided at the knuckles, the diameter of round chine bar is not to be less than three times the bottom plate thickness.

2.3 Truss arrangements

2.3.1 A truss is a system of internal framing members comprising deck and bottom girders in association with regularly spaced stanchions and diagonal bracings inclined at about 45 degrees with the horizontal, in each space between the stanchions.

2.3.2 The scantlings of platings, stiffeners and girders are not to be less than the general requirements given in Pt.3, except as specified in 2.3.3. below.

2.3.3 The section modulus of bottom girders is not to be less than that required by Pt.3, Ch.6, Sec.5, taking the value of the coefficient 'm' as 6.

The section modulus of deck girders is not to be less than that required by Pt.3, Ch.8, Sec.5, taking the value of the coefficient 'm' as 8.

2.3.4 The scantlings of stanchions are to be based on the external pressure on bottom or the static cargo load on deck, whichever is higher; and the buckling requirements given in Pt.3, Ch.3, Sec.6. Stanchions in tank spaces are also to be checked for tension caused by internal pressure.

2.3.5 The cross sectional area of diagonals may be approximately 50% of that of the adjacent stanchion.

Section 3

Pushing, Towing - Devices and Connecting Elements

3.1 General

3.1.1 Devices for pushing and towing of linked barges as well as the elements connecting the modular units are to be adequately dimensioned for the acting external forces calculated considering all possible load combinations. Towing gear, brackets and bollards are to be adequately dimensioned for the estimated towing pull considering the displacement and towing speed.

3.1.2 The scantlings of these devices and elements as well as their supporting structures are to be based on following permissible stresses:

bending and normal stress σ = 100/k [N/mm^2]

shear stress τ = 60/k [N/mm^2]

equivalent stress,

$\sqrt{\sigma^2 + 3\tau^2}$ = 120/k [N/mm^2].

Section 4

Machinery and Electrical Installation

4.1 General

4.1.1 Machinery and electrical installations, when provided are to comply with the requirements of Pt.4.

End of Chapter